1961



*Report of the*

# DEPARTMENT OF MINES

## WESTERN AUSTRALIA

PRESENTED TO BOTH HOUSES OF PARLIAMENT BY HIS EXCELLENCY'S COMMA

# REPORT OF THE
# DEPARTMENT *of* MINES
## WESTERN AUSTRALIA
## FOR THE YEAR 1961

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*To the Hon. Minister for Mines.*

*Sir,*

*I have the honour to submit the Annual Report of the Department of Mines of the State of Western Australia for the year 1961, together with reports from the officers controlling Sub-Departments, and Comparative Tables furnishing statistics relative to the Mining Industry.*

*I have the honour to be, Sir,*

*Your obedient Servant,*

*A. H. TELFER,*

*Under Secretary for Mines.*

*Perth, 1962.*

# TABLE OF CONTENTS


## DIVISION I.

Page

Part 1.—General Remarks .... 7
Output of Gold during 1961 .... 7
Mining generally .... 8
Minerals .... 9
Coal .... 9
Oil .... 9
Water .... 9

Part 2.—Minerals Raised—
Quantity and Value of Minerals produced during 1960–61 .... 10
Value and Percentage of Mineral Exports compared with Total Exports .... 11
Amount of Gold from every Goldfield reported to Mines Department .... 12
Output of Gold from other States of Australia, Mandated Territory of New Guinea, and New Zealand .... 12
Dividends paid by Mining Companies during 1961 .... 13
Coal raised, Value, number of Men employed, and Output per man .... 13

Part 3.—Leases and other Holdings under the Various Acts relating to Mining—
Number and Acreage of Leases, Claims and Areas held for Mining .... 14
Total Number of Temporary Reserves held, 1960–61 .... 14
Total Number of Mineral Leases held, 1960–61 .... 14
Total Number of Permits to Export and Licenses to Prospect held, 1960–61 .... 14

Part 4.—Men employed—
Average Number of Men engaged in Mining during 1960–61 .... 15

Part 5.—Accidents—
Men killed and injured during 1960–61 .... 16

Part 6.—State Aid to Mining—
State Batteries .... 17
Prospecting Scheme .... 17
Geological Survey .... 17

Part 7.—School of Mines .... 17

Part 8.—Inspection of Machinery .... 18
Certificates granted to Engine-drivers under Machinery Act .... 18

Part 9.—Government Chemical Laboratories .... 18

Part 10.—Explosives .... 20

Part 11.—Miner's Phthisis and Mine Workers' Relief Act .... 20

Part 12.—Chief Draftsman Branch .... 20

## DIVISION II.

Report of the State Mining Engineer .... 21
Index to Report of State Mining Engineer .... 39

## DIVISION III.

Report of the Superintendent of State Batteries .... 41
Return of Parcels treated and Tons crushed at State Batteries for year 1961 .... 43
Tailing Treatment, 1961 .... 43
Statement of Revenue and Expenditure for year (Milling) .... 45
Statement of Revenue and Expenditure for year (Tailing Treatment) .... 46

## DIVISION IV.

Annual Progress Report of the Geological Survey .... 49

## DIVISION V.

Report of the Director, School of Mines .... 109

## DIVISION VI.

Report of the Chief Inspector of Machinery .... 121

## DIVISION VII.

Report of the Director, Government Chemical Laboratories .... 129

## DIVISION VIII.

Report of the Chief Inspector of Explosives .... 163

## DIVISION IX.

Report of the Chairman, Miners' Phthisis Board and Superintendent, Mines Workers' Relief Act .... 167

## DIVISION X.

Report of the Chief Draftsman .... 171

## STATISTICS.

Mining Statistics .... 173

**STATE OF WESTERN AUSTRALIA**

# *Report of the Department of Mines for the Year 1961*

# DIVISION I

*The Honourable Minister for Mines:*

I have the honour to submit for your information a report on the Mining Industry for the year 1961.

The estimated value of the mineral output of the State for the year was £A22,376,840, an increase of £A550,316 in value compared with that for the preceding year, and constituted yet another all time record for the fifth year in succession.

The estimated value of gold received at the Perth Branch of the Royal Mint and exported in gold-bearing material was £A13,706,890, being the second highest value recorded for that mineral, and equalled 61.254 per cent. of the value of all minerals for 1961.

(See footnote to Table (1) (a), Part 11).

Other minerals realised; coal 1,680,259; asbestos, £1,535,170; iron ore (for export), £1,284,768; iron ore (for pig), £1,088,192; manganese £884,262; ilmenite, £557,889; pyrites (for sulphur), £369,094; copper ore and concentrates, £320,371; tin concentrates, £235,580; cupreous ore and concentrates (fertiliser), £157,488; silver, £75,018; clays, £69,477; magnesite, £64,977; talc, £64,581; gypsum, £62,844; zircon, £61,314; beryl, £40,079; lead ore and concentrates, £25,766; monazite, £25,699; tanto-columbite ore and concentrates, £22,917; limestone, £18,839; rutile, £11,953; glass sand, £5,861; felspar, £5,210; leucoxene, £4,120; copper (metallic by-product), £2,128; ochre, £1,770; bentonite, £1,598; dolomite, £1,496; phosphatic guano, £807; petalite, £409; bismuth, £371; fuller's earth, £163; spodumene, £85; quartz grit, £58; and building stone, £53.

Subsequent industrial readjustments following the closure of one of the three mining companies in the Collie Coal Field, coupled with new contractual arrangements for Governmental supplies, resulted in a lower output of coal and a considerable reduction in value of nine shillings per ton when compared with similar figures for the previous year.

Comparative coal figures for 1961 and 1960, with the latter shown in parenthesis were as follows:—

Tons—765,740 (922,393).

Total value—£1,680,258 (£2,439,195).

Averaged value per ton—43.886 shillings (52.888 shillings).

Average effective workers engaged—582 (984).

Minerals other than gold and coal, however, continued their upward trend, and for the sixth successive year, created a new all-time record in value of £6,989,691, topping their last year's record value for such minerals by a further 8.60 per cent., bringing the aggregate for all minerals to £22,376,840 for the year, the highest annual figure ever achieved by the State.

Dividends paid by gold mining companies amounted to £2,185,783, an increase of £53,999 when compared with the previous year (see Table 6, Part 11).

To the end of 1961 the progressive total distributed by gold mining companies was £66,701,111.

To the same date the progressive value of the mineral production of the State amounted to £557,471,652, of which gold accounted for £457,379,014. (See Table VI at back.)

## GOLD

The quantity of gold reported as being received at the Perth Branch of the Royal Mint (868,902.39 fine ounces), together with that contained in gold-bearing material exported for treatment (2,942.58 fine ounces), totalled 871,884.97 fine ounces, which was 16,086.29 fine ounces more than the previous year, and the second highest figure since 1941 (*vide* Table 1 (a) of Part 11).

The total gold yield reported directly to the Department by the producers was 870,657.90 fine ounces, an increase of 691.50 fine ounces, and constituted the second highest reported gold yield since 1941.

The variation between the two annual totals is principally due to the fact that the gold advised as being received at the Mint and Exported for treatment, is not necessarily produced during the calendar year under review, a certain quantity being always in the transitory stage from the producer at the end of the year. The former total is accepted as the official gold production of the State on account of its realised monetary value, whilst the latter is utilised mainly in tracing the gold back to its source, i.e. individual mine production, to which its respective ore tonnage can be applied, and so furnish a record of the physical aspect of mining so necessary and valuable for geological and professional purposes.

The tonnage of ore reported to have been treated in 1961, viz. 2,984,458 tons, was 71,987 tons less than the previous year, and constituted 69.54 per cent. of the State record tonnage established in 1940.

The following tonnage increases were reported from the respective Goldfields—Pilbara 1,015, Gascoyne 100, East Murchison 193, Murchison 840, Yalgoo 94, North-East Coolgardie 97, Coolgardie, 9,380, and Outside Proclaimed Goldfields 209; those fields showing a reduction in tonnage being Peak Hill 1,029, Mount Margaret 1,953, North Coolgardie 7,619, Broad Arrow 618, East Coolgardie 52,955, Yilgarn 4,937, Dundas 14,642, and Phillips River 166.

Although the output of 2,016,209 tons from the East Coolgardie Goldfield was 52,955 tons less than the record tonnage established in the preceding twelve months, it was still the second highest from that region. Gold Mines of Kalgoorlie (Aust.) Ltd., dropped 55,954 in tonnage, but the increased gold recovery indicated that a higher grade of ore was handled. Similar circumstances prevailed in a little lower degree with the Lake View & Star Ltd., where a slightly reduced tonnage of 2,842 returned an increased gold yield over the previous year. Great Boulder Gold Mines Ltd. and North Kalgurli (1912) Ltd., topped their last year's output by 3,747 and 1,742 tons of ore respectively, and also treated ore of a slightly better grade.

In the Dundas Goldfield where Central Norseman Gold Corporation N.L. treated 15,555 tons less than the preceding year, the ore grade rose from 10.264 to 11.226 dwts. per ton.

Moonlight Wiluna Gold Mines Ltd. in the North Coolgardie Goldfield, and Sons of Gwalia Ltd. in the Mt. Margaret Goldfield, dropped 6,009 and 2,623 in tonnage respectively, but here again the ore grade showed a slight improvement.

A comparatively even tonnage of ore was treated by Great Western Consolidated N.L. from the six groups operated in the Yilgarn Goldfield, but the overall average grade declined from 3.25 dwts. to 2.98 dwts. per ton as compared with their 1960 operations.

The 9,380 higher tonnage reported in the Coolgardie Goldfield came principally from the Bayley's South Mines, operated by Gold Mines of Kalgoorlie (Aust.) Ltd., which showed a 4,350 tons increase, and an extra 3,500 ton output by the Northern Mineral Syndicate from the Paris Gold Mine, where the erection of a new fine grinding and flotation plant has just been completed.

Output from the Murchison Goldfield rose very slightly on account of the 1,580 increased tonnage produced by the Eclipse Gold Mine N.L., the average grade of which fell from 22.068 to 18.386 dwts. per ton, whilst the Hill 50 Gold Mine N.L. maintained an even tonnage and grade as compared with the previous year.

With no variation in the static price of gold to alleviate the problem of constantly rising costs, the gold mining industry is finding it is becoming increasingly difficult to meet the position by improved efficiency, because of the high standard that has already been attained. Further effort is being made by some of the larger producers to convert wholly to the use of heavy industrial oil as fuel for the diesel engines to effect saving in power costs. Every possible avenue affecting efficiency is being explored in the endeavour to maintain an industry which has featured so dominantly in the past history of the State, and notwithstanding the benefits anticipated from projected expansion in other minerals of the future, the commodity produced in this industry, is at all times a necessary requisite to national economy, apart from being a significant asset of the State. A successful preservation of the industry is most desirable.

West Australian gold included in sales on open dollar markets by the Gold Producers' Association Ltd. for the period from August, 1960 to July, 1961, totalled 840,873.19 fine ounces; the extra premium received therefrom in excess of Mint Value, amounted to £A84,313, an overall average of 24.064 pence per fine ounce. This amount, less expenses, was distributed to the producer members during the year and approximated 23.072 pence per fine ounce.

Subsidy payments made by the Commonwealth Government during the year under the Gold Mining Subsidy Act, 1954, totalled £475,251, a decrease of £222,991 on the previous year; of the amount distributed, £441,089 went to Large Producers, and £34,162 to Small Producers in this State.

COMPARATIVE MINERAL STATISTICS

| | 1960 | 1961 | Variation |
|---|---|---|---|
| GOLD— | | | |
| Reported to Department (Mine Production)— | | | |
| Ore (tons) | 3,056,445 | **2,984,458** | — 71,987 |
| Gold (fine oz.) | 869,966 | **870,658** | + 692 |
| Average Grade (dwts. per ton) | 5,693 | **5,835** | + 0·142 |
| Persons Engaged— | | | |
| (*a*) Effective Workers (excluding absentees) | 4,992 | **4,945** | — 47 |
| (*b*) Total Pay Roll | 5,430 | **5,337** | — 93 |
| Dividends (£A) | 2,131,784 | **2,185,783** | + 53,999 |
| Mint and Export (Realised Production)— | | | |
| Gold (fine oz.) | 855,759 | **871,845** | + 16,086 |
| Estimated Value (£A) (including Overseas Gold Sales Premium) | 13,371,661 | **13,706,890** | + 335,229 |
| COAL— | | | |
| Reported to Department (Mine Production)— | | | |
| Tons | 922,393 | **765,740** | — 156,653 |
| Value (£A) | 2,439,195 | **1,680,259** | — 748,936 |
| Persons Engaged— | | | |
| Effective Workers (excluding absentees) | 984 | 582 | — 402 |
| OTHER MINERALS— | | | |
| Reported to Department— | | | |
| Value (£A) | 6,015,668 | **6,989,691** | + 974,023 |
| Persons Engaged— | | | |
| Effective Workers (excluding absentees) | 1,296 | **1,530** | + 234 |
| TOTAL ALL MINERALS— | | | |
| Value (£A) | 21,826,524 | **22,376,840*** | + 550,316 |
| Persons Engaged— | | | |
| Effective Workers | 7,272 | **7,057†** | — 215 |

* Fifth successive all time record. † Excluding Oil Search Men which engaged an average of 87 men in the field in 1960 and 45 men in the field in 1961.

## PART II—MINERALS.

During the year royalty totalling £99,149 as against £81,307 for the preceding year, was collected under legislation passed in 1958, on certain prescribed minerals obtained from land held under the Mining Act.

Gold was exempted from royalty liability, and payment on Copper, Lead, and Mineral Beach Sands, temporarily suspended on account of the depressed state of the market.

Royalty has been collected on Coal production practically from inception and on Iron Ore (for export) from 1951.

Particulars for the year are shown hereunder:—

| Mineral | Amount per Ton | Royalty Collected |
|---|---|---|
| | s. d. | £ s. d. |
| Asbestos | 1 6 | 1,150 17 6 |
| Bauxite | 6 | 246 4 6 |
| Bentonite | 6 | 20 8 9 |
| Beryl | 2 0 | 16 4 0 |
| Building stone | 1 0 | 4 0 |
| Clays | 6 | 1,211 9 9 |
| Coal | 3 | 8,539 7 6 |
| Felspar | 6 | 29 17 0 |
| Glass Sand and Quartz Grit | 6 | 197 16 3 |
| Gypsum | 6 | 1,140 19 10 |
| Iron Ore (export only) | 1 6 | 79,432 3 6 |
| Limestone | 6 | 317 16 0 |
| Magnesite | 1 6 | 622 7 11 |
| Manganese | 1 6 | 3,259 18 3 |
| Phosphatic Guano | 1 6 | 5 15 0 |
| Petalite | * | 9 8 |
| Pyrites | 1 0 | 4 16 0 |
| Semi-precious stones | 1 0 | 2,841 10 0 |
| Spodumene | 1 0 | 11 0 |
| Tanto-Columbite | * | 74 10 2 |
| Tin Concentrates | 2 0 | 35 8 0 |
| Total | .... | £99,148 14 7 |

* One-half percentum of the realised F.O.B. Value.

As a result of the partial lifting of the ban on the export of iron ore by the Commonwealth Government late in December, 1960, there was immediate interest in the search for iron ore deposits in this State. The Government announced that applications would be received until the 15th May, 1961 for temporary reserves to prospect for iron ore deposits; and some 87 were granted in July. Many more applications were received after the closing date and it was anounced that further applications would be received up to 30th September, 1961.

A tremendous amount of exploratory work has been carried out over the areas allocated and it has been proved that the iron ore reserves of the State are very much greater than had been accepted previously.

Tenders were invited for the mining and exploration of iron ore from the deposits at Tallering Peak and Mt. Goldsworthy. Those of the Western Mining Corporation for Tallering Peak and Mt. Goldsworthy Associates for Mt. Goldsworthy were accepted and considerable progress has been made on the examination and evaluation of the deposits, also with surveys for the necessary railways and port facilities for the projects.

The Department has commenced drilling operations of the iron ore deposits at Wilgie Mia, with a view to calling for tenders for mining and exporting ore from the deposits.

With the passing of the Alumina Refinery Agreement Act the establishment of an alumina industry in the State has advanced another step. The exploration and testing of the deposits in the Darling Ranges by Western Aluminium N.L. is being carried on vigorously. Temporary Reserves have been granted to Reynolds Pacific Company also for the search for bauxite in areas south of those granted to Western Aluminium N.L.

The search for vanadium has been continued during the year by Mangore (Aust.) Pty. Ltd. on their reservation. Interest in minerals generally throughout the State has increased, and it is likely that with the improved transport facilities and conditions expected to result from the development of the iron ore deposits, the search for all minerals will benefit.

### COAL

During the year ended the 31st December, 1961 the coal production amounted to 765,740 tons. This is less than the tonnage produced in 1960 but the output and development of the mines is keeping pace with the demand.

It is pleasing to record that as a result of the new coal contracts signed in 1960, there has been a satisfactory saving in the cost of coal to the Government.

### OIL

The eight year search for oil which has cost one company alone £17,000,000 has been continued and in June a deep bore was commenced at Eneabba about 160 miles north of Perth and was sunk to 13,712 feet. As a result of the seismic examination of the area and the results of this bore further exploratory work is to be carried out in the Perth Basin next year. Altogether there has been renewed interest in the search for oil in this State.

### WATER

In the re-organisation and expansion of the Geological Survey provision was made for a Hydrological Section and during the year new geologists have joined the staff with the result that the Department has been able to extend its field of operations in the survey of the State's potential water supplies.

Our Failing rotary drill has been used in the search for water at Bunbury in connection with the La Porte Titanium Industry. Drilling for water has also been carried out at Byford, Westfield, Wiluna and Whitby Falls (Mental Hospital).

TABLE 1

*Quantity and Value of Minerals, other than Gold and Silver, produced during Years* 1960 *and* 1961
*Western Australia*

| Description of Minerals | 1960 | | 1961 | | Increase or Decrease for Year compared with 1960 | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| | Tons | £A | Tons | £A | Tons | £A |
| Asbestos (Chrysotile) | 61·26 | 1,602 | 156·13 | 2,629 | + 94·87 | + 1,027 |
| (Crocidolite) | 12,921·59 | 1,418,767 | 14,086·59 | 1,532,540 | + 1,165·00 | + 113,773 |
| Bauxite | 26,892·00 | † | 9,849·00 | † | — 7,043·00 | † |
| Bentonite | 382·00 | 1,533 | 586·70 | 1,598 | + 204·70 | + 65 |
| Beryl | 181·17 | 33,024 | 260·85 | 40,079 | + 79·68 | + 7,055 |
| | lb. | | lb. | | lb. | |
| Bismuth | .... | .... | 911·00 | 371 | + 911·00 | + 371 |
| | Tons | | Tons | | Tons | |
| Building Stone | 40·00 | 1,300 | 4·45 | 53 | — 35·55 | — 1,247 |
| Clays (Cement Clay) | 13,015·00 | 10,844 | 17,864·00 | 17,909 | + 4,849·00 | + 7,065 |
| (Fireclay) | 20,346·50 | 26,512 | 26,383·75 | 30,710 | + 6,037·25 | + 4,198 |
| (White Clay—Ball Clay) | .... | .... | 771·60 | 3,067 | + 771·60 | + 3,067 |
| (Brick, Pipe and Tile Clay) | *24,966·00 | 22,888 | *16,218·00 | 17,791 | — 8,748·00 | — 5,097 |
| Coal | 922,393·50 | 2,439,195 | 765,739·73 | 1,680,259 | — 156,653·77 | — 758,936 |
| Copper (Metallic By-product)§ | 4·72 | 731 | 16·46 | 2,128 | + 11·74 | + 1,397 |
| Copper Ore and Concentrates | 3,552·13 | 199,007 | 6,188·72 | 320,371 | + 2,636·59 | + 121,364 |
| Cupreous Ore and Concentrates | 7,726·81 | 140,252 | 7,383·82 | 157,488 | — 342·99 | + 17,236 |
| Dolomite | 403·92 | 1,616 | 374·00 | 1,496 | — 29·92 | — 120 |
| Felspar | 1,942·00 | 8,283 | 1,190·00 | 5,210 | — 752·00 | — 3,073 |
| Fuller's Earth | .... | .... | 40·76 | 163 | + 40·76 | + 163 |
| Glass Sand | 8,636·95 | 6,102 | 8,214·78 | 5,861 | — 422·17 | — 241 |
| Glauconite (Recovered) | 111·00 | 5,550 | .... | .... | — 111·00 | — 5,550 |
| Gypsum | 44,216·30 | 55,628 | 45,145·03 | 62,844 | + 928·73 | + 7,216 |
| Iron Ore (For Pig) | 79,085·00 | 1,098,825 | 80,437·00 | 1,088,192 | + 1,352·00 | — 10,633 |
| (For Export) | 837,147·00 | 830,124 | 1,284,768·00 | 1,274,053 | + 447,621·00 | + 443,929 |
| Lead and Silver/Lead Ore and Concentrates | 2,263·69 | 119,292 | 597·05 | 25,766 | — 1,666·64 | — 93,526 |
| Limestone | *11,327·75 | 14,935 | *14,199·15 | 18,839 | + 2,871·40 | + 3,904 |
| Magnesite | .... | .... | 9,624·92 | 64,977 | + 9,624·92 | + 64,977 |
| Manganese (Metallurgical, Low and Battery Grades) | 53,788·84 | 753,005 | 67,652·14 | 884,262 | + 13,863·30 | + 131,257 |
| Mineral Beach Sands (Ilmenite) | 114,661·72 | 485,562 | 123,538·46 | 557,889 | + 8,876·74 | + 72,327 |
| (Monazite) | 241·96 | 9,319 | 1,005·20 | 25,699 | + 763·24 | + 16,380 |
| (Rutile) | 621·41 | 15,686 | 552·84 | 11,953 | — 68·57 | — 3,733 |
| (Leucoxene) | 84·10 | 1,430 | 268·10 | 4,120 | + 184·00 | + 2,690 |
| (Zircon) | 4,624·45 | 49,270 | 6,098·90 | 61,314 | + 1,474·45 | + 12,044 |
| Ochre (Red) | 104·00 | 1,040 | 117·22 | 702 | + 13·22 | — 338 |
| (Yellow) | .... | .... | 177·05 | 1,068 | + 177·05 | + 1,068 |
| Petalite | .... | .... | 96·00 | 409 | + 96·00 | + 409 |
| Phosphatic Guano | 86·79 | 938 | 115·00 | 807 | + 28·21 | — 131 |
| Pyrites Ores and Concentrates (For Sulphur) | 53,298·79 | 366,739 | 52,397·00 | 369,094 | — 901·79 | + 2,355 |
| Quartz Grit | 288·00 | 243 | 58·20 | 58 | — 229·80 | — 185 |
| | lb. | | lb. | | lb. | |
| Semi-precious Stones (Prase) | 2,240·00 | 40 | .... | .... | — 2,240·00 | — 40 |
| (Tiger Eye Opal) | 120·00 | 97 | .... | .... | — 120·00 | — 97 |
| | Tons | | Tons | | Tons | |
| Spodumene | .... | .... | 5·00 | 85 | + 5·00 | + 85 |
| Talc | 5,470·39 | 69,114 | 5,149·28 | 64,581 | — 321·11 | — 4,533 |
| Tanto/Columbite Ores and Concentrates | 10·57 | 16,982 | 14·20 | 22,917 | + 3·63 | + 5,935 |
| Tin | 280·82 | 168,775 | 341·16 | 235,580 | + 60·34 | + 66,805 |
| Total | .... | 8,374,250 | .... | 8,594,932 | .... | + 220,682 |

TABLE 1 (A)

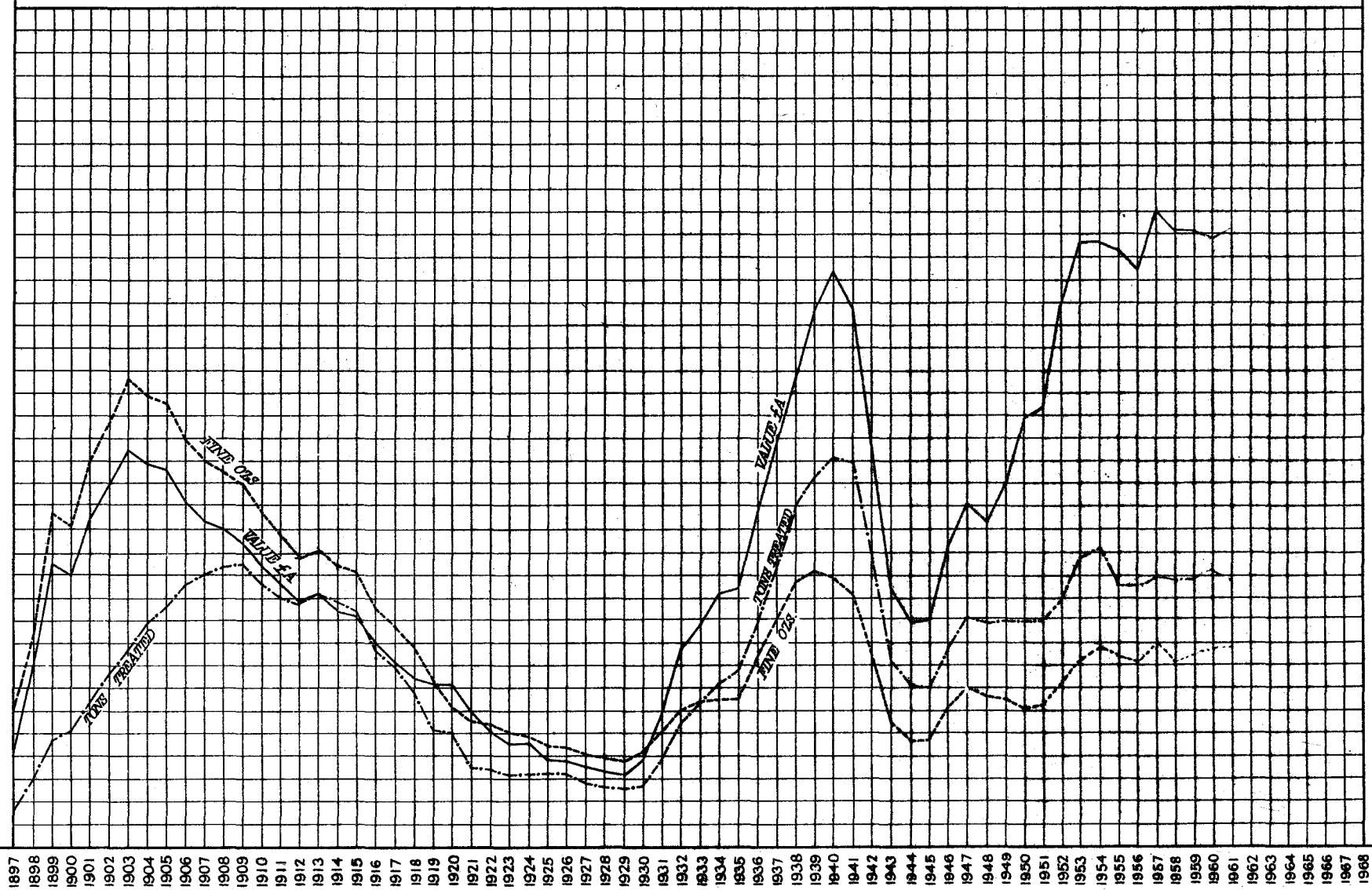
*Quantity and Value of Gold and Silver exported and minted during Years* 1960 *and* 1961

| Description of Minerals | 1960 | | 1961 | | Increase or Decrease for Year compared with 1960 | |
|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| | Fine oz. | £A | Fine oz. | £A | Fine oz. | £A |
| Gold (Exported and Minted) | 855,758·68 | ‡13,371,661 | 871,844·97 | ‡13,706,890 | + 16,086·29 | + 335,229 |
| Silver (Exported and Minted) | 193,821·63 | 80,613 | 179,992·12 | 75,018 | — 13,829·51 | — 5,595 |
| Total | .... | 13,452,274 | .... | 13,781,908 | .... | + 329,634 |
| GRAND TOTAL | .... | 21,826,524 | .... | 22,376,840 | .... | + 550,316 |

* Incomplete—figures relate only to production reported to the Department from holdings under the Mining Act.
† Value not available for publication.
‡ Including Overseas Gold Sales Premium.
§ By-product of Gold Mining.

# DIAGRAM OF GOLD OUTPUT

Showing Tonnage Treated (as reported to Mines Dept.); the Total Output of Gold Bullion, Concentrates etc., entered for export and received at the Perth Mint, and the Estimated Value thereof, in Australian Currency.




| TONS TREATED | FINE OUNCES | VALUE £A |
|---|---|---|
| 9,000,000 | 3,600,000 | 18,000,000 |
| | 3,400,000 | 17,000,000 |
| 8,000,000 | 3,200,000 | 16,000,000 |
| | 3,000,000 | 15,000,000 |
| 7,000,000 | 2,800,000 | 14,000,000 |
| | 2,600,000 | 13,000,000 |
| 6,000,000 | 2,400,000 | 12,000,000 |
| | 2,200,000 | 11,000,000 |
| 5,000,000 | 2,000,000 | 10,000,000 |
| | 1,800,000 | 9,000,000 |
| 4,000,000 | 1,600,000 | 8,000,000 |
| | 1,400,000 | 7,000,000 |
| 3,000,000 | 1,200,000 | 6,000,000 |
| | 1,000,000 | 5,000,000 |
| 2,000,000 | 800,000 | 4,000,000 |
| | 600,000 | 3,000,000 |
| 1,000,000 | 400,000 | 2,000,000 |
| | 200,000 | 1,000,000 |

YEAR

1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968

| VALUE £A | FINE OUNCES | TONS TREATED |
|---|---|---|
| 18,000,000 | 3,600,000 | 9,000,000 |
| 17,000,000 | 3,400,000 | |
| 16,000,000 | 3,200,000 | 8,000,000 |
| 15,000,000 | 3,000,000 | |
| 14,000,000 | 2,800,000 | 7,000,000 |
| 13,000,000 | 2,600,000 | |
| 12,000,000 | 2,400,000 | 6,000,000 |
| 11,000,000 | 2,200,000 | |
| 10,000,000 | 2,000,000 | 5,000,000 |
| 9,000,000 | 1,800,000 | |
| 8,000,000 | 1,600,000 | 4,000,000 |
| 7,000,000 | 1,400,000 | |
| 6,000,000 | 1,200,000 | 3,000,000 |
| 5,000,000 | 1,000,000 | |
| 4,000,000 | 800,000 | 2,000,000 |
| 3,000,000 | 600,000 | |
| 2,000,000 | 400,000 | 1,000,000 |
| 1,000,000 | 200,000 | |

YEAR

TABLE 2

*Value of Total Exports and Mineral Exports from Western Australia, as compared with Total Value of Mineral Production as from* 1900.

| Year | Total Exports † | Mineral Exports (exclusive of Coal) | Total Mineral Production |
|---|---|---|---|
| | £ | £ | £ |
| 1900 | 6,852,054 | 5,588,299 | 6,179,535 |
| 1901 | 8,515,623 | 6,789,133 | 7,439,470 |
| 1902 | 9.051,358 | 7,530,319 | 8,094,616 |
| 1903 | 10,234,732 | 8,727,060 | 8,971,937 |
| 1904 | 10,271,489 | 8,625,676 | 8,686,757 |
| 1905 | 9,871,019 | 7,731,954 | 8,555,841 |
| 1906 | 9,832,679 | 7,570,305 | 7,905,506 |
| 1907 | 9,904,860 | 7,544,992 | 7,669,468 |
| 1908 | 9,518,020 | 7,151,317 | 7,245,002 |
| 1909 | 8,860,494 | 5,906,673 | 7,056,079 |
| 1910 | 8,299,781 | 4,795,654 | 6,522,263 |
| 1911 | 10,606,863 | 7,171,638 | 6,105,853 |
| 1912 | 8,941,008 | 5,462,499 | 5,768,567 |
| 1913 | 9,128,607 | 4,608,188 | 6,036,115 |
| 1914 | 8,406,182 | 3,970,182 | 5,534,273 |
| 1915 | 6,291,934 | 2,969,502 | 5,478,149 |
| 1916 | 10,878,153 | 6,842,621 | 4,893,417 |
| 1917 | 9,323,229 | 5,022,694 | 4,629,028 |
| 1918 | 6,931,834 | 2,102,923 | 4,265,577 |
| 1919 | 14,279,240 | 6,236,585 | 4,061,600 |
| 1920 | 15,149,323 | 3,096,849 | 4,233,915 |
| 1921 | 10,331,405 | 1,373,810 | 3,470,597 |
| 1922 | 11,848,025 | 2,875,402 | 3,041,113 |
| 1923 | 11,999,500 | 3,259,476 | 2,747,108 |
| 1924 | 13,808,910 | 1,424,319 | 2,776,791 |
| 1925 | 13,642,852 | 173,126 | 2,393,890 |
| 1926 | 14,668,184 | 1,597,698 | 2,371,863 |
| 1927 | 15,805,120 | 472,041 | 2,202,438 |
| 1928 | 16,911,932 | 996,099 | 2,128,179 |
| 1929 | 16,660,742 | 1,802,709 | 2,087,893 |
| 1930 | 19,016,639 | 6,370,396 | 2,287,376 |
| 1931 | 14,266,650 | 4,333,421 | 3,353,923 |
| 1932 | 16,771,465 | 5,657,870 | 4,721,620 |
| 1933 | 18,098,214 | 5,328,869 | 5,239,498 |
| 1934 | 16,784,705 | 5,759,324 | 5,908,881 |
| 1935 | 17,611,547 | 5,698,721 | 6,132,811 |
| 1936 | 19,564,716 | 7,130,381 | 7,818,684 |
| 1937 | 21,594,942 | 9,026,313 | 9,210,079 |
| 1938 | 24,220,864 | 10,417,458 | 10,906,527 |
| 1939 | 23,244,509 | 11,969,562 | 12,331,659 |
| 1940 | 25,800,562 | 12,480,721 | 13,228,660 |
| 1941 | 24,536,777 | 12,411,316 | 12,398,141 |
| 1942 | 20,681,284 | 8,476,622 | 9,509,646 |
| 1943 | 18,014,340 | 6,539,295 | 6,401,594 |
| 1944 | 19,453,001 | (*a*) 1,282,867 | 5,737,096 |
| 1945 | 20,170,624 | 205,587 | 5,910,518 |
| 1946 | 26,342,125 | 211,890 | 7,693,951 |
| 1947 | 42,389,125 | 4,162,892 | 8,862,292 |
| 1948 | 57,779,996 | 342,646 | 8,584,843 |
| 1949 | 58,197,775 | 465,124 | 9,629,300 |
| 1950 | 78,804,864 | 531,245 | 11,489,897 |
| 1951 | 115,880,457 | 7,479,601 | 12,706,228 |
| 1952 | 101,620,138 | 7,952,834 | 17,126,506 |
| 1953 | 106,678,014 | 13,239,076 | 19,358,268 |
| 1954 | 79,955,207 | 5,342,462 | 19,953,665 |
| 1955 | 113,044,633 | 17,145,741 | 18,893,161 |
| 1956 | 142,852,512 | 9,531,471 | 19,447,510 |
| 1957 | 148,128,361 | 12,483,343 | 21,007,393 |
| 1958 | 123,624,508 | 5,464,465 | 20,570,701 |
| 1959 | 137,067,544 | 4,536,105 | 21,796,605 |
| 1960 | 190,494,475 | 43,302,398 | 21,826,524 |
| 1961 | 197,204,812 | 21,070,266 | 22,376,840 |

† Including Ships' Stores.

(*a*) Full value and use of gold, not always exported, as utilised by the Commonwealth Treasury in the financing of Australian Trade Economy from 1944, not available.

TABLE 3

*Showing for every Goldfield the amount of Gold reported to the Mines Department as required by the Regulations also the percentage for the several Goldfields of the total reported and the average value of the yield in pennyweights per ton of ore treated*

| Goldfield | Reported Yield | | Percentage for each Goldfield | | Average Yield per ton of ore treated | |
|---|---|---|---|---|---|---|
| | 1960 | 1961 | 1960 | 1961 | 1960* | 1961* |
| | Fine oz. | Fine oz. | Per cent. | Per cent. | Dwts. | Dwts. |
| 1. Kimberley | 18 | 16 | ·002 | ·002 | .... | .... |
| 2. West Kimberley | .... | .... | .... | .... | .... | .... |
| 3. Pilbara | 2,944 | 4,639 | ·338 | ·533 | 9·281 | 12·608 |
| 4. West Pilbara | 5 | 4 | ·001 | .... | 5·000 | 3·333 |
| 5. Ashburton | 1 | .... | .... | .... | .... | .... |
| 6. Gascoyne | 141 | 452 | ·016 | ·052 | 76·216 | 65·985 |
| 7. Peak Hill | 501 | 329 | ·058 | ·038 | 2·251 | 1·923 |
| 8. East Murchison | 381 | 373 | ·044 | ·043 | 8·759 | 7·018 |
| 9. Murchison | 91,970 | 91,877 | 10·572 | 10·553 | 10·876 | 10·812 |
| 10. Yalgoo | 1 | 86 | .... | ·010 | .... | 18·298 |
| 11. Mt. Margaret | 34,106 | 33,977 | 3·920 | 3·902 | 4·848 | 4·898 |
| 12. North Coolgardie | 20,250 | 15,849 | 2·328 | 1·820 | 10·751 | 10·547 |
| 13. Broad Arrow | 1,543 | 2,455 | ·177 | ·282 | 7·503 | 14·049 |
| 14. North-East Coolgardie | 141 | 161 | ·016 | ·019 | 5·165 | 5·008 |
| 15. East Coolgardie | 531,981 | 540,473 | 61·150 | 62·076 | 5·142 | 5·361 |
| 16. Coolgardie | 12,342 | 13,834 | 1·419 | 1·589 | 13·795 | 10·144 |
| 17. Yilgarn | 70,689 | 64,301 | 8·125 | 7·385 | 3·417 | 3·145 |
| 18. Dundas | 101,555 | 98,890 | 11·673 | 11·358 | 10·604 | 11·181 |
| 19. Phillips River | †1,331 | †2,720 | ·153 | ·313 | .... | .... |
| 20. Outside Proclaimed Goldfields | 66 | 222 | ·008 | ·025 | .... | 20·367 |
| | 869,966 | 870,658 | 100·000 | 100·000 | 5·693 | 5·835 |

The total yield of the State is shown in Table 1, being the amount of Gold received at the Royal Mint, the gold exported in bullion and concentrates and alluvial and other gold not reported to the Mines Department.

When comparisons are made as to the yield from any particular Field with the preceding year, the figures reported to the Department are used.

* Gold at £A15 12s. 6d. per fine ounce or 15s. 7½d. per pennyweight.

† By-Product of Copper Mining.

TABLE 4

*Output of Gold from the Commonwealth of Australia during* 1961

| State | Output of Gold | Value*† | Percentage of Total |
|---|---|---|---|
| | Fine oz. | £A | per cent |
| Western Australia | 871,845 | 13,622,578 | 82·095 |
| Victoria | 25,701 | 401,578 | 2·420 |
| New South Wales | ‡11,889 | 185,766 | 1·119 |
| Queensland | 58,706 | 917,281 | 5·528 |
| Tasmania | 24,528 | 383,250 | 2·310 |
| South Australia | 55 | 859 | 0·005 |
| Northern Territory | 69,274 | 1,082,406 | 6·523 |
| Total | 1,061,998 | 16,593,718 | 100·000 |

* £A15 12s. 6d. per fine ounce.

† Exclusive of Overseas Gold Sales Premium by Gold Producers' Association.

‡ Subject to slight adjustment.

TABLE 5

*Dividends, etc., paid by Western Australian Mining Companies during* 1961, *and the total to date*
(Mainly compiled from information supplied to the Government Statistician's Office by the Chamber of Mines of Western Australia)

| Goldfield | Name of Company | Dividends Paid | |
|---|---|---|---|
| | | 1961 | Grand Total to end of 1961 |
| | | £ | £ |
| Pilbara | Various Companies | .... | 26,513 |
| Peak Hill | do. do. | .... | 199,305 |
| East Murchison | do. do. | .... | 1,914,053 |
| Murchison | Eclipse Gold Mine N.L. | 16,800 | 54,600 |
| | Hill 50 Gold Mine N.L. | 675,000 | 6,315,626 |
| | Various Companies | .... | 2,764,945 |
| Mt. Margaret | Sons of Gwalia | .... | 2,075,050 |
| | Various Companies | .... | 958,286 |
| North Coolgardie | Moonlight Wiluna G.M.s Ltd. | .... | 15,000 |
| | Various Companies | .... | 712,551 |
| Broad Arrow | do. do. | .... | 92,500 |
| North-East Coolgardie | do. do. | .... | 129,493 |
| East Coolgardie | Gold Mines of Kalgoorlie (Aust.) Ltd. | 202,264 | 2,598,882 |
| | Great Boulder G.M.s Ltd. | 218,750 | 9,153,150 |
| | Lake View & Star Ltd. | 437,500 | (*b*) 9,805,750 |
| | North Kalgurli (1912) Ltd. | 180,469 | 2,949,373 |
| | Various Companies | .... | (*a*) 19,496,816 |
| Coolgardie | do. do. | .... | 410,000 |
| Yilgarn | do. do. | .... | (*c*) 1,205,556 |
| Dundas | Central Norseman Gold Corporation N.L. | 455,000 | 5,037,500 |
| | Various Companies | .... | 786,162 |
| | Totals | 2,185,783 | 66,701,111 |

(*a*) Excluding £45,091 in bonuses and profit-sharing notes in years 1935–1936 by Boulder Perseverance Ltd., and £55,000 Capital returned in year 1932 and £43,000 in bonuses and profit-sharing notes in year 1934 by Golden Horseshoe (New) Ltd.
(*b*) Excluding £75,000 in bonuses and profit-sharing notes and £93,750 Capital returned in 1932–1935.
(*c*) Excluding £67,725 Capital returned in 1948 by Edna May (W.A.) Amalgamated, N.L.

TABLE 6

*Total Coal output from Collie River Mineral Field* 1960 *and* 1961, *estimated Value thereof, Number of Men employed, and output per Man as reported Monthly*

| Year | Total Output | Estimated Value | Men Employed | | | Output per Man Employed | | |
|---|---|---|---|---|---|---|---|---|
| | | | Above Ground | Under Ground | Above and under Ground | Above Ground | Under Ground | Above and under Ground |
| | Tons | £A | No. | No. | No. | Tons | Tons | Tons |
| Deep Mining— | | | | | | | | |
| 1960 | 798,184 | 2,153,096 | 146 | 778 | 924 | 5,467 | 1,025 | 833 |
| 1961 | 506,306 | 1,314,006 | 105 | 384 | 489 | 4,821 | 1,318 | 1,035 |
| Open Cut Mining— | | | | | | | | |
| 1960 | 124,209 | 286,099 | 60 | .... | 60 | 2,070 | .... | 2,070 |
| 1961 | 259,433 | 366,252 | 93 | .... | 93 | 2,784 | .... | 2,784 |
| Totals— | | | | | | | | |
| 1960 | 922,393 | 2,439,195 | 206 | 778 | 984 | 4,477 | 1,185 | 937 |
| 1961 | 765,739 | 1,680,258 | 198 | 384 | 582 | 3,867 | 1,994 | 1,315 |

## PART III.–LEASES AND OTHER HOLDINGS UNDER THE VARIOUS ACTS RELATING TO MINING.

TABLE 7

*Total number and acreage of Leases, Mineral Claims, Dredging Claims and Prospecting Areas held for mining on the 31st December, 1960 and 1961*

| | 1960 | | 1961 | |
|---|---|---|---|---|
| | No. | Acreage | No. | Acreage |
| CROWN LANDS— | | | | |
| Gold Mining Leases | 1,027 | 18,788 | 1,016 | 18,556 |
| Mineral Leases | 225 | 40,368 | 171 | 20,916 |
| Dredging Claims— | | | | |
| Gold | 4 | 492 | 1 | 12 |
| Minerals | 124 | 7,065 | 135 | 6,997 |
| Mineral Claims | 554 | 43,395 | 586 | 48,196 |
| Prospecting Areas— | | | | |
| Gold | 460 | 7,711 | 430 | 7,388 |
| Minerals | 47 | 941 | 80 | 1,722 |
| Totals | 2,441 | 118,760 | 2,419 | 103,787 |
| PRIVATE PROPERTY— | | | | |
| Gold Mining Leases | 24 | 518 | 10 | 200 |
| Mineral Leases | 13 | 1,986 | 10 | 1,530 |
| Dredging Claims— | | | | |
| Gold | .... | .... | .... | .... |
| Minerals | 4 | 341 | 5 | 521 |
| Mineral Claims | 72 | 7,894 | 93 | 11,002 |
| Prospecting Areas— | | | | |
| Gold | 1 | 6 | 7 | 138 |
| Minerals | 1 | 24 | .... | .... |
| Totals | 115 | 10,769 | 125 | 13,391 |
| Grand Totals | 2,556 | 129,529 | 2,544 | 117,178 |

TABLE 7 (*a*)

*Total number and area of Temporary Reserves held as at the 31st December, 1960 and 1961*

| | 1960 | | 1960 | |
|---|---|---|---|---|
| | No. | Total Area | No. | Total Area |
| Temporary Reserves— | | | | |
| Gold | 56 | Acres 15,879 | 25 | Acres 6,845 |
| Minerals | 23 | square miles 254,202 | 92 | square miles 241,216 |

TABLE 7 (b)

*Total number and area of Mineral Leases granted under Special Acts held on 31st December, 1960 and 1961*

| | 1960 | | 1961 | |
|---|---|---|---|---|
| | No. | Area | No. | Area |
| .... | .... | .... | S.A. 1 | Acres 1,791,360 |
| .... | .... | .... | S.A. 2 | 25,751 |
| Totals | .... | .... | 2 | 1,817,111 |

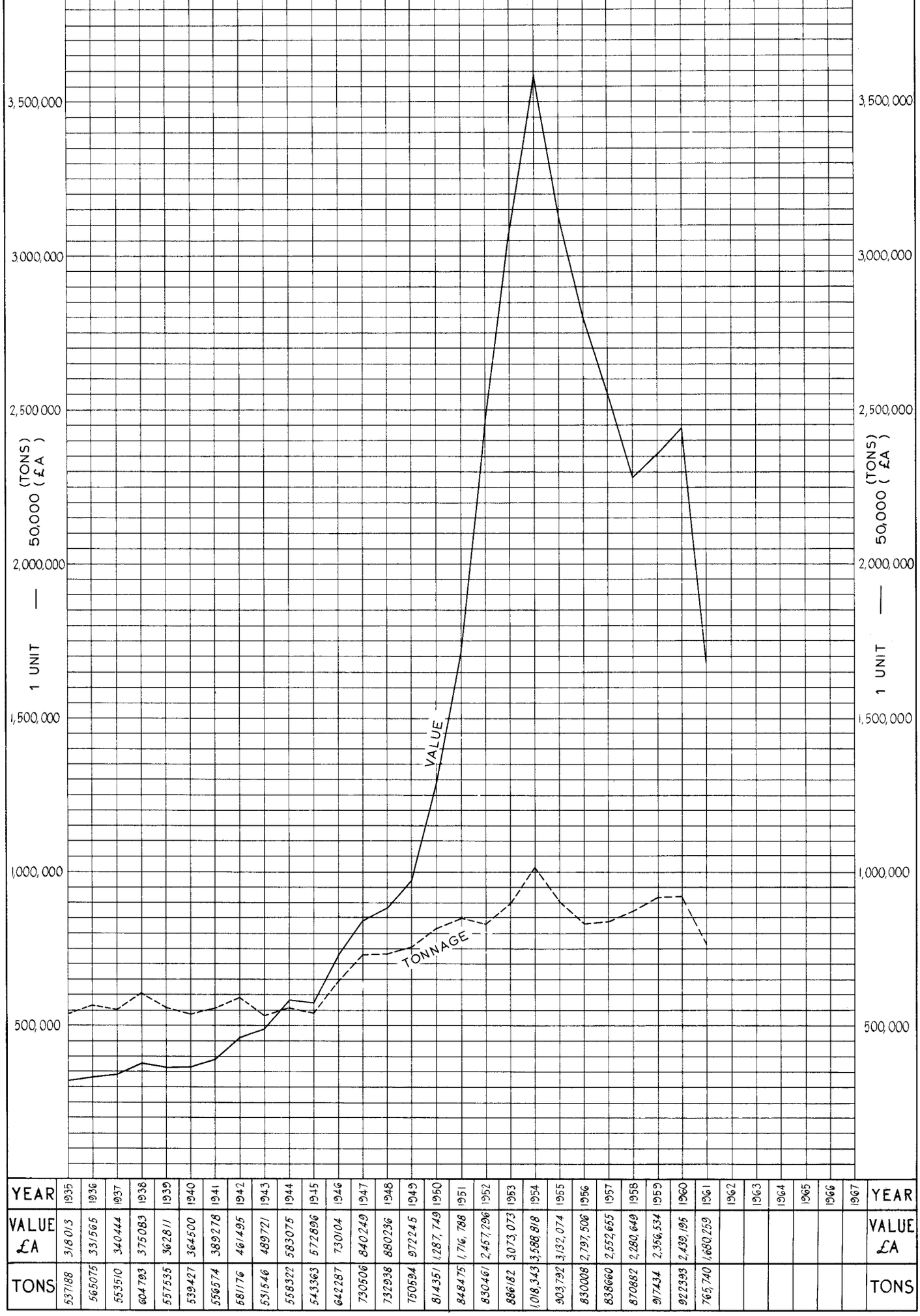
TABLE 7 (c)

*Total number and area of Permits to Explore and Licenses to Prospect held on 31st December, 1960 abd 1961*

| | 1960 | | 1961 | |
|---|---|---|---|---|
| | No. | Area in square miles | No. | Area in square miles |
| Permits to Explore | 31 | 628,850·000 | 30 | 615,165·000 |
| Licenses to Prospect | 36 | 6,469·381 | 43 | 7,647·909 |
| Totals | 67 | 635,319·381 | 73 | 622,812·909 |

# GRAPH OF COAL OUTPUT

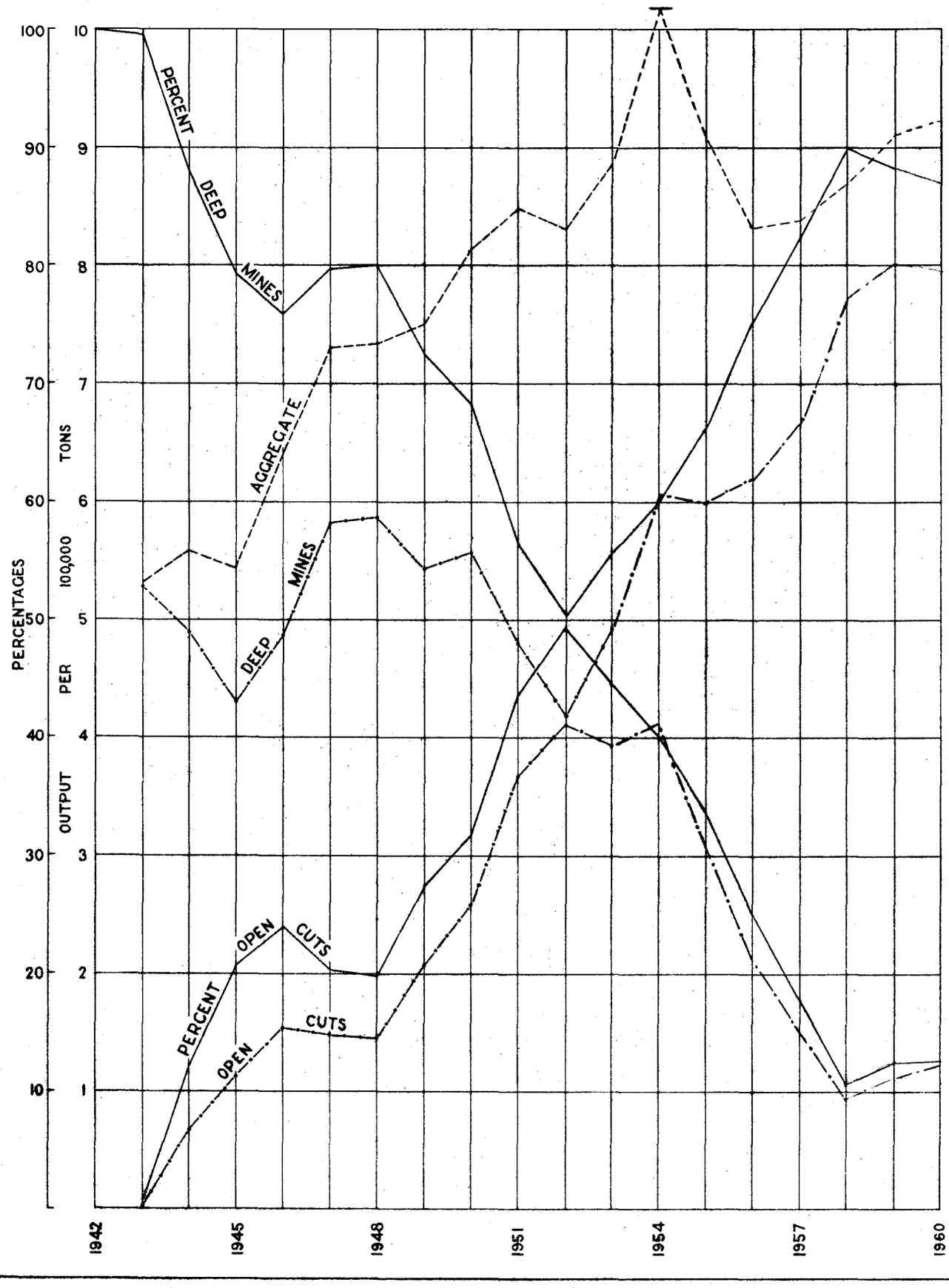
SHOWING QUANTITIES AND VALUES AS REPORTED TO MINES DEPT.




| YEAR | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUE £A | 318013 | 331565 | 340444 | 375083 | 362811 | 364500 | 389278 | 461495 | 489721 | 583075 | 672896 | 730104 | 840249 | 880236 | 972245 | 1287,749 | 1,716,788 | 2,457,296 | 3073,073 | 3,588,818 | 3132,074 | 2,797,506 | 2,552,655 | 2,280,649 | 2,356,534 | 2,439,195 | 1,680,259 | | | | | | | VALUE £A |
| TONS | 537188 | 565075 | 553510 | 604793 | 557535 | 539427 | 556574 | 681176 | 631546 | 558322 | 543363 | 642287 | 730506 | 732938 | 750594 | 814351 | 848475 | 830461 | 886182 | 1018,343 | 903792 | 830008 | 838660 | 870882 | 917434 | 922393 | 765,740 | | | | | | | TONS |

# GRAPH OF TREND IN COAL OUTPUT

Showing Comparison of Annual Tonnages and Percentages
between Deep and Open Cut Mining



# PART IV.—MEN EMPLOYED.

TABLE 8

** Average number of Men reported as engaged in Mining during* 1960 *and* 1961

| Goldfield | District | Total 1960 | Total 1961 |
|---|---|---|---|
| Kimberley | | 4 | 4 |
| West Kimberley | | .... | .... |
| Pilbara | Marble Bar | 28 | 24 |
| | Nullagine | 29 | 24 |
| West Pilbara | | 3 | 3 |
| Ashburton | | .... | .... |
| Gascoyne | | .... | .... |
| Peak Hill | | 10 | 12 |
| East Murchison | Lawlers | 8 | 11 |
| | Wiluna | 3 | 3 |
| | Black Range | 5 | 5 |
| Murchison | Cue | 32 | 27 |
| | Meekatharra | 18 | 26 |
| | Day Dawn | 9 | 10 |
| | Mt. Magnet | 236 | 237 |
| Yalgoo | | 4 | 5 |
| Mt. Margaret | Mt. Morgans | 4 | 2 |
| | Mt. Malcolm | 255 | 256 |
| | Mt. Margaret | 6 | 6 |
| North Coolgardie | Menzies | 96 | 100 |
| | Ularring | 30 | 35 |
| | Niagara | 4 | 4 |
| | Yerilla | 24 | 26 |
| Broad Arrow | | 67 | 78 |
| North-East Coolgardie | Kanowna | 15 | 18 |
| | Kurnalpi | 3 | 8 |
| East Coolgardie | East Coolgardie | 2,972 | 2,973 |
| | Bulong | 6 | 8 |
| Coolgardie | Coolgardie | 187 | 186 |
| | Kunanalling | 18 | 19 |
| Yilgarn | | 515 | 429 |
| Dundas | | 397 | 402 |
| Phillips River | | 2 | 2 |
| State Generally | | 2 | 2 |
| Total Gold Mining | | 4,992 | 4,945 |
| Minerals Other than Gold— | | | |
| Asbestos | | 345 | 405 |
| Bauxite | | 4 | .... |
| Bentonite | | .... | 1 |
| Beryl | | 51 | 43 |
| Clays | | 11 | 13 |
| Coal | | 984 | 582 |
| Copper | | 136 | 141 |
| Cupreous Ore (Fertiliser) | | 73 | 70 |
| Dolomite | | .... | 1 |
| Felspar | | 6 | 6 |
| Glass Sand | | 2 | 3 |
| Glauconite | | 2 | .... |
| Gypsum | | 18 | 19 |
| Iron Ore | | 257 | 401 |
| Lead | | 33 | 19 |
| Limestone | | 6 | 15 |
| Magnesite | | 2 | 6 |
| Manganese | | 77 | 83 |
| Mineral Beach Sands (Ilmenite, etc.) | | 119 | 146 |
| Ochre | | .... | 1 |
| Phosphatic Guano | | .... | 2 |
| Pyrites | | 105 | 101 |
| Talc | | 5 | 3 |
| Tanto/Columbite | | 1 | 2 |
| Tin | | 43 | 49 |
| Total Other Minerals | | 2,280 | 2,112 |

* **Effective** workers only and totally excluding non-workers for any reason whatsoever.

## PART VI—STATE AID TO MINING

(a) *State Batteries.*

At the end of the year there were 20 State Batteries including the Northampton Base Metal Plant.

From inception to the end of 1961, gold, tin, tungsten, lead, copper and tantalite ores to the value of £17,989,726 have been treated at the State Batteries. Included in the above amount is gold premium of £6,683,927, and premium paid by sales of gold by the Gold Producers Association Ltd., of £42,598. £17,574,821 came from 3,325,290 tons of gold ore, £94,577 from 81,818 tons of tin ore, £18,850 from 3,960 tons tungsten ore, £291,162 from 27,474¾ tons lead ore, £5,516 from 197 tons of copper ore and £4,800 from ¾ ton tantalite ore.

During the year 40,673 tons of gold ores were crushed for 16,324 ozs. bullion, estimated to contain 13,835 ozs. fine gold, equal to 6 dwts. 19 grs. per ton. The average value of sands after amalgamation was 2 dwts. 23grs. per ton, making the average head value 9 dwts. 18 grs. per ton. Cyanide plants produced 3,712 ozs. fine gold, giving a total estimated production for the year of 17,547 ozs. fine gold valued at £276,255.

The working expenditure for the year for all plants was £212,027 and the revenue was £52,540 giving a working loss of £159,487, which does not include depreciation or interest. Since the inception of State Batteries, the Capital expenditure has been £786,605, made up of £606,962 from General Loan Funds; £137,235 from Consolidated Revenue; £28,622 from Assistance to Gold Mining Industry: and £13,786 from Assistance to Metalliferous Mining.

Head Office expenditure including Workers' Compensation, Insurance and Pay Roll Tax was £21,288, compared with £20,178 for 1960.

The working expenditure from inception to the end of 1961 exceeds revenue by £1,521,833.

(b) *Prospecting Scheme.*

During the period 1st January, 1961, to 31st December, 1961 a total of 66 men were approved for assistance on the Prospecting Scheme, during the same period 37 cancellations were effected and after allowing for suspensions, 60 men were still receiving assistance at 31/12/61.

The cost of maintaining the Scheme for the 12 month period amounted to £10,630 0s. 4d., while refunds amounted to £2,152 6s. 2d.

Assisted prospectors reported as having crushed 2,059½ tons for a return of 611 ozs. 11 dwts.

Figures for the period since the Prospecting Scheme was incepted are as follows:—

| Expenditure | Refunds | Ore Crushed | Mineral and Gold Won |
|---|---|---|---|
| £ s. d. | £ s. d. | Tons | oz. dwts. |
| 415,796 4 8 | 84,175 6 6 | 114,004½ | 54,170 19 |

The above expenditure includes £80,346 1s. 9d. subsidised by the Commonwealth Government.

(c) *Geological Survey of Western Australia.*

The principal work of the Geological Survey Branch for the year 1961 is covered by the following reports published in Division IV of this report:—

- Report on a Pegmatite Locality 6 miles S.E. of Roebourne, N.W. Division.
- Recommendations on Future Exploratory Work at Wicherina.
- A Halloysite Deposit near Ryan's Find, 24 miles north of Boorabbin, Coolgardie Goldfield.
- Progress Report on the Regional Survey of the Widgiemooltha Sheet Area SH 54-14, International Series.
- Water Supplies, Warburton Range and Adjoining Areas, Eastern Division, Western Australia.
- Geological Reconnaissance of the Warburton Range Area, Western Australia.
- Report on Some Pegmatites North of Yalgoo.
- Report on New Iron Deposits in the North-West Division.
- The Search for Oil in Western Australia in 1961.
- Examination of Logue Brook Damsite, Harvey, South-West Division.
- Final Report on the Diamond Drill Exploration of the Ord River No. 2 Main Damsite, East Kimberley Division.
- Examination of Iron Ore, Pompeys Pillar, East Kimberley Division.
- The Geology of the Northampton Mineral Field and Environs, Western Australia.
- Summary Report on the Mendel Wongoondy Test Hole, Victoria District, South-West Division.
- Report on the Hydrological Investigation at the Wiluna Groundwater Research Station.

During the year the Annual Progress Report for 1959 was the only publication issued.

The Annual Progress Report for 1960 has been compiled and awaits publication.

The following manuscripts are being prepared:—

- A geological map of the Boorabbin 1:250,000 sheet (SH51-13 International grid) with explanatory notes.
- A geological map of the Balfour Downs 1:250,000 sheet (SF51-9 International grid) with explanatory notes.
- A geological map of the Port Hedland 1:250,000 sheet (SF50-4 International grid) with explanatory notes.
- A Mineral Resources Bulletin on the Copper Deposits of W.A.
- A Bulletin on portion of the Pilbara Goldfield covered by the Marble Bar and Nullagine 4-mile sheets.
- A Bulletin on the Manganese Deposits of W.A.

Officers of the Survey have rendered varied types of practical assistance to individuals, syndicates and companies, as well as other Government Departments who have been concerned with the exploration of mineral and water resources in all parts of the State.

## PART VII—SCHOOL OF MINES.

(a) *Kalgoorlie.*

The number of students enrolled was 310, a decrease of 22 by comparison with 1960. The decrease occurred almost entirely in the students not enrolled for any set course and not sitting for an external examination.

Mr. E. N. Johns was promoted to the position of Head of the Department of Engineering to replace Mr. Parker who retired at the end of 1960. In April, 1961 Mr. Lloyd was transferred from Bullfinch to the Department of Mathematics and Physics in Kalgoorlie.

Consideration was given to the Courses of Study during the year and some changes were made. The new courses and revised courses are printed in the 1962 Prospectus.

One student held a Mines Department Senior Scholarship during 1961. He completed a satisfactory year's work and his scholarship was renewed for 1962.

Fourteen students held Chamber of Mines Scholarships during 1961. Twelve completed a good year's work and the remaining two a fair year's work. All Scholarships were renewed for 1962. Four students holding scholarships completed Associateship Courses, which makes a total of 12 students who have completed Associateship Courses under the Chamber of Mines Scholarship Scheme.

The usual awards were made at the end of the year and a list is given in Appendix 2 of the Director's Report.

During the year 17 students completed Associateship Courses; 16, Certificate Courses; and 3, Technician Courses.

On Monday, May 29 a graduation ceremony was held in the Kalgoorlie Town Hall and Diplomas, Certificates, and Prizes awarded at the end of 1960 were presented to the successful students by the Hon. Minister for Mines, Mr. A. F. Griffith. The Guest Speaker was Professor K. L. Cooper, Professor of Civil Engineering in the University of W.A. who chose for his subject "The Engineer and Society."



(2)—57785

During the evening the Hon. Minister declared Technical Training Week on the Goldfields open, and because of the association of the School of Mines and the Technical School with Technical Training Week, presented awards made to Technical School students at the end of 1960.

The School continued to provide the usual services to the public in addition to its teaching activities. During the year 341 samples were received from prospectors for assay and/or mineral determination.

During the year there was quite a lot of activity so far as buildings were concerned. Most buildings were painted and additions or alterations were made at four places in the School.

The office was re-organised and a separate office provided for the Registrar. In the Department of Metallurgy and Chemistry additional library space was provided and a new lecture room added. A new geology library was provided and the building extended to provide a reading room and office for the Librarian, a work room, and store room for library use.

Extensions to the Kalgoorlie Metallurgical Laboratory were commenced, but will not be completed until next year.

Consideration is being given to the preparation of an overall plan for future extensions of the School buildings.

The Advisory Committee met on 10 occasions. Grants totalling £2,000 were received from the Chamber of Mines and the Mines Department, and were paid into the Trust Fund.

Three Reports of Investigations and 469 Certificates were issued during the year by the Kalgoorlie Metallurgical Laboratory. In addition numerous free assays were made for prospectors.

The Students' Association was again active and in addition to organising the usual functions it continued to take a lively interest in student affairs.

(b) *Norseman.*

The number of students enrolled during the year was 65, an increase of four over the previous year.

Twenty-two subjects were taught, and as in previous years use was made of mine workshops for practical instruction in Workshop Practice, in Practical Electricity and in Welding.

The Reg. Dowson Scholarships for 1961 were awarded to G. G. Prime and F. W. Rose. The two students who were awarded these Scholarships in 1960 both completed a satisfactory year's work.

The Advisory Committee met twice during the year. Two new member joined the Committee during the year, Messrs. A. J. C. Pritchard and W. G. Kerr, to replace Mr. E. L. Walker who died in 1960 and Mr. E. C. S. Kneebone who left Norseman.

(c) *Bullfinch.*

The number of students enrolled was 60, a decrease of three by comparison with 1960.

Eleven subjects were taught.

In April, Mr. Lloyd was transferred to Kalgoorlie and Mr. Browne was appointed Officer-in-Charge and Registrar. Six part-time lecturers were employed.

(d) *Wittenoom.*

Following a visit by the Director and a request from the manager of Australian Blue Asbestos it was decided to commence certain School of Mines classes at Wittenoom in February, 1961, and endeavour to continue classes for a test period of two years.

Classes in six subjects were commenced and although enrolments were not as high as early enquiries had suggested were satisfactory. Mr. J. P. Shanahan was appointed as part-time Officer-in-Charge and part-time instructors were recruited from mine staff and others.

Although the results for the first year were very disappointing it was decided to continue the classes in 1962 with the hope that interest would increase, and that the company and the people of Wittenoom would appreciate the opportunities for study which the School offered.

## PART VIII—INSPECTION OF MACHINERY.

The Chief Inspector of Machinery reports that the number of useful boilers registered at the end of the year totalled 7,634 against 7,341 for the preceding year, showing an increase of 293 boilers after all adjustments.

Of the 7,634 useful boilers 2,250 were out of use at the end of the year, 4,465 thorough and 919 working inspections were made and 4,460 certificates were issued.

Permanent condemnations total 58 and temporary condemnations 10; 93 boilers were transferred beyond the jurisdiction of the Act.

The total number of machinery groups registered was 45,170 against 43,370 for the previous year, showing an increase of 1,800.

Inspections made total 29,363 and 6,198 certificates were granted.

The total miles travelled for the year, were 113,001 against 93,718 miles for the previous year, showing an increase of 19,283. The average miles travelled per inspection were 3.25 as against 2.77 miles per inspection for the previous year.

419 applications were received and dealt with for Engine Drivers and Boiler Attendants' certificates, and 382 certificates all classes were granted as follows:—

| | |
|---|---|
| Winding Competency (including certificates issued under regulation 40 and Section 60) | 7 |
| First Class Competency (including certificates issued under Regulations 40 and 45, and Sections 60 and 63) | 19 |
| Second Class Competency (including certificates issued under Regulation 40 and Section 60 of the Act) | 10 |
| Third Class Competency (including certificates issued under Regulations 40 and 45 and Sections 60 and 63) | 11 |
| Locomotive and Traction Competency (including certificates issued under Regulation 40 and Section 60) | 4 |
| Diesel Locomotive "A" Class Certificates of Competency (including certificates issued under Regulation 40 and Sections 53 and 56) | — |
| Diesel Locomotive "B" Class Certificates of Competency (including certificates issued under Regulation 40 and Sections 53 and 56) | — |
| Internal Combustion Competency (including certificates issued under Regulation 40 and Section 60) | 31 |
| Crane and Hoist Competency (including certificates issued under Regulation 40 and Section 60) | 199 |
| Boiler Attendant Competency (including certificates issued under Regulation 40 and Section 60) | 74 |
| Copies | 17 |
| | 382 |

The total Revenue from all sources during the year was £15,901 5s. as against £15,568 18s. 4d. in the previous year, showing an increase of £332 6s. 8d.

The total Expenditure for the year was £38,970 11s. 10d. against £38,253 2s. 11d. for the previous year, showing an increase of £717 8s. 11d.

## PART IX—GOVERNMENT CHEMICAL LABORATORIES.

The total number of registrations during 1961 was 3,372 covering 11,921 samples, an increase of 7 per cent. in registrations but no appreciable difference in sample numbers compared with 1960, which were 3,151 registrations and 12,020 samples.

Samples were allocated as shown hereunder:—

| | |
|---|---|
| Agriculture, Forestry and Water Supply Division | 6,052 |
| Engineering Chemistry Division | 14 |
| Food, Drugs and Toxicology Division | 2,901 |
| Fuel Technology Division | 154 |
| Industrial Chemistry Division | 198 |
| Mineral Division | 2,662 |
| Total | 11,981 |

*Agriculture, Forestry and Water Supply Division.*

Approximately the same number of soils were received as in 1960 and the greatest number of these came from the Esperance Downs and Jerramungup-Gairdner River District.

Water analyses were made for the Public Works Department, Goldfields and Country Water Supply and Geological Surveys of waters from widely spread districts. For the Metropolitan Water Supply, Sewerage and Drainage Department routine analyses were made on the water from Canning Dam, Serpentine Dam, Victoria Reservoir, Wungong Brook, Churchman's Brook and the Metropolitan artesian bores. One of the disturbing features of the artesian bore analyses was the increase in total dissolved solids of the Mounts Bay Road Bore, an increase to 1,500 parts per million.

Samples of fertiliser analysed were generally satisfactory and only a few samples did not comply with the requirements of the Fertiliser Act.

A large number of samples was received for checking under the Feeding Stuffs Act. A wide variety of work was also carried out in connection with cereals, plant nutrition and other miscellaneous items.

*Engineering Chemistry Division.*

Three original research projects were undertaken by the Division during the year, viz.: the upgrading of local ilmenite, the beneficiation of local low-grade manganese ore, and the recovery of sulphur from Kalgoorlie Gold ore concentrates. Of these, the first has been successfully finalised in as much as a semi-commercial plant, based on the process developed is being erected by a local company for which the Division is acting as consultants.

Other work carried on was the crushing and calcination of spodumene, roasting of spongolite, treatment of Leucoxene and the beneficiation of calcareous beach sand and the production of lime from it.

The services that can be provided by the Division are available to Government Departments, but during the year 1961 only two enquiries were received from other Departments.

*Food, Drugs, Toxicology and Industrial Hygiene Division.*

As in recent years the major proportion of the work of this Division consisted of chemical examinations for the Departments of Public Health, Police and Agriculture, as well as for the Milk Board of Western Australia and the Swan River Conservation Board, but a wide variety of miscellaneous work was also performed for other Government departments and the general public.

Eight hundred and fifteen samples were received in 1961—more than double the number received in the previous year. Of the samples received 409 were samples of cows' milk submitted by the Milk Board of W.A.

Under the classification of human toxicology approximately 250 samples were received from cases of sudden death subject to police investigation. One hundred and ten cases were as a result of traffic accident, while 102 cases, comprising 321 exhibits, were examined for the presence of poison or other physiologically active drug.

One hundred and eighty samples of blood and/or urine were received in connection with investigations into fatal traffic accidents, and 132 samples of blood were submitted by the Police Department and three by Local Government Authorities in connection with charges of "driving while under the influence of alcohol."

There was no marked alteration in the number of samples received in connection with suspected poisoning of animals. Of 19 cases examined, 13 were found to be negative.

The considerable increase in the volume of industry hygiene work which first occurred in 1959 was maintained in 1961 when 335 such samples were received.

Samples were received and examined in connection with pollution surveys of the Swan River and Leschenault Inlet, Bunbury and 7 samples of oily fluids alleged to have been discharged from ships on to the waters of Fremantle Harbour.

*Fuel Technology Division*

Samples of coking coal were received during the year from the oil test bore at Eneabba. The coking properties shown were sufficiently well developed to suggest that a strong, formed coke could be made from the coal in accordance with the most recent developments in the production of blast furnace fuel. The coal was struck at 6,000 feet and if it could be proved at a workable depth both the quality and the quantity of the coal could be of importance to the State. Considerable work was done in connection with wood fired and oil fired boilers. Other work done by the Division included some on atmospheric pollution, gas chromatography, refractories, insulating materials and expanded aggregates.

*Industrial Chemistry Division.*

The work done in the Division has followed the lines of previous years, i.e. consultative service for Government Departments, industry and the public, short term investigations into the feasibility of new processes and the manufacture of new products, and the testing of a wide variety of materials, but mainly related to the construction industries.

An investigation was conducted into a new process, the treatment by solvent extraction of abattoir's offal and trash fish, and into the various aspects of solvent recovery, filtration and removal of residual solvent from the solid product.

Testing of materials such as floor tiles, paints and protective coatings continued. This aspect of the work of the Division is assuming increasing importance owing to the tendency to specify materials more rigidly, either by a performance or an ingredient specification.

The use of plastics in Western Australia continues to increase both in quantity and scope and this has necessitated constant literature reviews to keep abreast of the advances in plastic technology.

*Mineralogy, Mineral Technology and Geo-chemistry Division.*

The number of samples examined during the year was 2,653, much the same as last year, but the distribution was different. The completion of the preliminary surveys of the Koolyanobbing and Mt. Goldsworthy iron deposits led to a pronounced reduction in the number of iron samples submitted, and there was also a drop in the number of battery tailings submitted by the State Batteries for check gold assays.

Against these, there was an increase of almost 300 in the number of mineral identifications carried out, and also significant increases in tantalite, beryl and copper ores examined.

A dust sampling project initiated by the Public Health Department resulted in the microscopic examination of 370 dust samples.

During the year 584 specimens were added to the Mineral Division Collection and in March agreement was reached with the Trustees of the W.A. Museum for the formal transfer of the Simpson Collection to the Laboratories, and as a result much time has been spent in re-organising this collection.

Requests received from universities, schools, students and prospectors for collections of Western Australian minerals by the supply during the year of 12 sets, in addition to a number of individual minerals required for research purposes.

Four sets of Western Australian minerals were prepared for display by the Tourist Development Authority in their Perth, Adelaide, Melbourne and Sydney branches.

Preparations for registration with N.A.T.A. were completed during the year, and the Laboratories are now registered as Lab. No. 350 in the field of heat and temperature measurement.

## PART X—EXPLOSIVES.

The importation of explosives is now equally divided between shipping and direct transcontinental railway to the goldfields.

There have been no fundamental changes in the types of explosives.

Goldmining still uses the greatest proportion of explosive in the State and consumes 57.3 per cent. of the total. Other users are Coal Mining 8.1 per cent.; Geoseismic 8.9 per cent; Metals and Minerals (other than gold) 14.7 per cent; Public Works and others 10.8 per cent.

Some few defects in the quality of explosives were investigated but practically all explosives except those wetted in transit were found satisfactory and in conformity with definition.

The suitability for railage and road conveyance has been well established of fibreboard encased explosives and are now being shipped also regularly after some experimental packages had proved satisfactory.

On the Kalgoorlie Mines waxless ended explosives are preferred and arrangements have been made for the continued supply of these from the makers, although some difficulties have been encountered.

Assistance was given to the police in the matter of the criminal use of explosive in a Perth Suburb.

Magazine and store inspections were maintained and extended to most of the goldfields and lower portion of the State. Visual inspection of cases in the supply vessel's hold prior to detailed inspection and testing continued. The same vigilance could not be exercised over bulk at Kalgoorlie, but unopened cases railed each week to Woodman's Point were subjected to treatment identical with that for shipments.

Inspections of Ordnance movements at Fremantle were carried out and three big outside jobs were supervised.

The usual inspection of fireworks was maintained. There were few rejections, but some sharp pointed rockets were banned. Two local manufacturers of fireworks for display are still operating. Some imported semi-display lines were controlled in sale and use.

The new Explosives and Dangerous Goods Act was passed this session of Parliament but not assented to in 1961. Regulations have still to be gazetted.

## PART XI—MINERS' PHTHISIS ACT AND MINE WORKERS' RELIEF ACT.

Under arrangements made with this Department, the Public Health Department continued the periodical examination of mine workers, the work being carried on throughout the year at the Kalgoorlie Laboratory and a mobile x-ray unit visited the Dundas, Coolgardie, Murchison, Mt. Margaret, North Coolgardie, Phillips River, West Pilbara and Yilgarn Goldfields, the South West Mineral Field, and Esperance. The mobile unit staff examined miners at Yampi with equipment provided by Australian Iron and Steel Limited.

The examinations under the Mine Workers' Relief Act during the year totalled 5,753, six less than the previous year. Under the Mines Regulation Act, 2,133 mines were examined. These were in addition to the 5,753 examinations under the Mine Workers' Relief Act. There was an increase of 507 examinations under this Act in 1961. Of the 2,133 examined, 1,753 were new applicants and 380 re-examinees.

Under the Miners' Phthisis Act the amount of compensation paid during the year totalled £11,683 1s. 3d. compared with £12,734 1s. 10d. for the previous year. The number of beneficiaries was 106, being 8 ex-miners and 98 widows.

During the year extensive amendments were made to the Mine Workers' Relief Act.

## PART XII—CHIEF DRAFTSMAN.

Five contract surveyors were employed on the Department's surveys. In addition to the normal survey of tenements a series of connections were made to the State Triangulation system to fix more accurately some of the Department's isolated mining groups.

The main mapping programme has been continued and considerable progress has been achieved.

A State General Information map was published.

Two cadets succeeded in passing the final examinations at the end of their four year course of instruction at the Perth Technical College and are entitled to receive the Diploma of Cartography from that institution. They are also qualified for appointment as draftsmen in the Department.

The interest in iron ore in particular and in all minerals generally and oil has affected the Drafting Branch considerably, in the number of enquiries and the requests for plans showing where the principal activities are occurring.

## STAFF.

The past year has been an extremely active one for the Department. With the discovery of the vast iron ore deposits in our State, the interest in manganese, the developments in connection with the bauxite deposits of the Darling Ranges, and the increased activity generally in regard to mining and oil search, the work of the Department has been greatly expanded. The Staff has responded splendidly, and I would like to take this opportunity of thanking all members, both at Head Office and at Outstations for the loyal and efficient way they have carried out their duties.

The re-organisation of the Geological Survey Branch was put into effect during the year, and we have been fortunate in securing the services of Mr. J. H. Lord as Government Geologist and a number of highly qualified and experienced officers for the new positions which have been created. We are very pleased to have Mr. Lord with us as Government Geologist, as he began his career with our Geological Survey Branch and has worked with the Bureau of Mineral Resources and in private enterprise. With the much larger staff now available the Geological Branch can proceed with the surveys of the mineral and water resources of the State in much more detail than hitherto.

Additional staff to meet the increased work, has also been added to other Branches of the Department.

Once again I have to record the retirement of one of our valued and senior officers. Mr. J. F. Winzar retired from the position of Deputy Chief Inspector of Machinery in August last. Mr. Winzar was a capable and efficient officer, held in high regard both in the State Public Service and in industry. As a result of his retirement Mr. E. M. McManis was promoted to the position of Deputy Chief Inspector of Machinery.

In this summary of the various activities of the Department, I have commented only on the principal items. Divisions II to X of this publication contain the detailed reports of the responsible Branch officers.

A. H. TELFER,
Under Secretary for Mines.

Department of Mines,
Perth.

# DIVISION II

# *Report of the State Mining Engineer for the Year 1961*

*Under Secretary for Mines.*

The Annual Report on the activities of the Branch for 1961 has been prepared by the Assistant State Mining Engineer.

Staff changes included the appointment of Mr. I. W. Loxton as Assistant Inspector following the promotion of Mr. M. R. Simmons to District Inspector of Mines.

Accident rates in all mines were lower than those for the previous year. There were seven fatal accidents as compared with fourteen in 1960.

There was a small increase in gold output even with reduced returns from the Sons of Gwalia and Great Western Consolidated. The gold valued at £13,684,867 represented 61 per cent. of the total value of mineral output for the State.

Increased production was reported for asbestos, iron ore, ilmenite, manganese, copper and tin concentrates. The search for iron ore was intensified and some excellent results have been reported. Work has started on the erection at Kwinana of an alumina refinery to treat bauxite from the Darling Range deposits.

The drilling section has done useful work both in the search for iron and in the development of water resources.

E. E. BRISBANE,
State Mining Engineer.

*State Mining Engineer.*

Mining activities for the year 1961 are described in this report which is based on information supplied by the Statistician and Inspectors of Mines. The section on drilling written by Inspector Haddow and the report of the Board of Examiners for Mine Managers and Underground Supervisors Certificates appear as appendices to this report.

## STAFF.

Assistant Inspector M. R. Simmons was promoted to District Inspector of Mines (Ventilation) on the 24th March. Mr. I. W. Loxton was appointed to the position of Assistant Inspector on the 17th July. District Inspector J. M. Faichney was transferred from Kalgoorlie to Perth on the 16th October.

## ACCIDENTS.

Fatal and serious accidents in mines and quarries are shown below, the corresponding figures for 1960 are shown in brackets.

There were 7 (14) fatal and 460 (615) serious accidents.

In gold mines there were 4 (8) fatal and 318 (403) serious accidents. The number of men employed in such mines was 5,337 (5,430). The accident rate per 1,000 men was thus 0.75 (1.47) for fatal accidents and 59.58 (74.22) for serious accidents.

Two men were killed by falls of stone in quarries. One man collapsed at a coal mine and died shortly afterwards. A classification of serious accidents showing the nature of the injuries is given in Table "A."

Table "B" shows the fatal, serious and minor accidents reported and the number of men classified according to mineral mined.

Accidents classified according to causes for the various districts are shown in Table "C."

## WINDING MACHINERY ACCIDENTS.

Twenty-one accidents involving winding machinery were reported during the year and are briefly as follows.

*Overwinds.*—(4) An overwind occurred at Chaffers shaft on the 4th January. In preparation for the day's operations the air line from the receiver to the brake donkeys was cleared so that the oil bottle in the line could be filled. The driver then opened the valve from the receiver and as the brake lever was not in the neutral notch the air went straight through to the donkeys which raised the brakes. The balance weight at 3,700 feet caused the cage at the surface to be pulled up the sky shaft and the cage was suspended at the thimble by the detaching hook.

The accidental knocking of a control lever by the driver when gearing in to another level, caused an overwind at the Enterprise shaft on the 9th March.

The right hand cage of the Nevoria shaft was overwound on the 21st January when the driver applied the power in the wrong direction.

A bottom dump skip was overwound at the Ivanhoe shaft on the 28th December. The skip on reaching the upper portion of the dumping track still contained ore which prevented the bottom door from closing. The overwind limits operated before the detaching hook entered the catchplate but the rope was reshod, repairs effected to the skyshaft and the badly distorted skip replaced. The dumping track has been de-designed and the overwind limit switches repositioned lower in the skyshaft.

## TABLE A.

Serious Accidents for 1961.

| Class of Accident | West Kimberley | Pilbara | Pilbara West | Ashburton | Peak Hill | Murchison | Mt. Margaret | North Coolgardie | East Coolgardie | Coolgardie | Yilgarn | Dundas | Phillips River | South West | Collie | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major Injuries—Exclusive of Fatal— | | | | | | | | | | | | | | | | |
| Fractures : | | | | | | | | | | | | | | | | |
| Head | .... | .... | .... | .... | .... | .... | .... | 1 | 3 | .... | .... | 1 | .... | .... | .... | 5 |
| Shoulder | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 | .... | .... | .... | 2 |
| Arm | .... | .... | 1 | .... | .... | .... | .... | .... | 3 | 1 | .... | .... | 1 | .... | 1 | 7 |
| Hand | 1 | .... | .... | .... | .... | .... | .... | .... | 2 | .... | 2 | .... | .... | .... | 1 | 6 |
| Spine | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Rib | 1 | 1 | .... | .... | .... | .... | .... | .... | 4 | .... | .... | .... | .... | .... | 3 | 9 |
| Pelvis | 1 | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 1 | .... | 4 |
| Thigh | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 2 |
| Leg | 1 | .... | .... | .... | .... | .... | 2 | .... | 1 | .... | .... | .... | 1 | 1 | 1 | 7 |
| Ankle | .... | .... | .... | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | 1 | .... | .... | 3 |
| Foot | 1 | .... | .... | .... | .... | .... | 2 | .... | .... | .... | .... | .... | 1 | .... | .... | 4 |
| Amputations | .... | .... | | | | | | | | | | | | | | |
| Arm | 1 | 1 | .... | .... | .... | .... | .... | .... | 2 | .... | .... | .... | .... | .... | .... | 4 |
| Hand | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Finger | 1 | .... | .... | 1 | .... | 1 | .... | .... | 6 | .... | 2 | 1 | 2 | .... | 3 | 17 |
| Leg | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Foot | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Toe | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Loss of Eye | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Serious Internal | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Hernia | .... | .... | .... | .... | .... | .... | .... | .... | 4 | 1 | .... | .... | 1 | .... | 1 | 7 |
| .... Dislocations | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Other Major | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 | 4 |
| Total Major | 9 | 4 | 1 | 1 | .... | 1 | 5 | 1 | 27 | 2 | 4 | 5 | 8 | 2 | 11 | 81 |
| Minor Injuries— | | | | | | | | | | | | | | | | |
| Fractures : | | | | | | | | | | | | | | | | |
| Finger | .... | .... | .... | .... | .... | 1 | 1 | .... | 7 | .... | 1 | .... | 3 | .... | .... | 13 |
| Toe | .... | .... | .... | .... | 1 | .... | 2 | .... | 2 | .... | .... | .... | .... | 1 | 1 | 7 |
| Head | 1 | .... | .... | .... | .... | .... | .... | .... | 3 | .... | .... | 1 | .... | .... | 1 | 6 |
| Eyes | .... | .... | .... | .... | .... | 1 | .... | .... | 6 | .... | 2 | .... | .... | 1 | 1 | 11 |
| Shoulder | .... | .... | .... | .... | .... | .... | 1 | .... | 6 | .... | .... | 1 | 2 | .... | 3 | 13 |
| Arm | .... | .... | .... | .... | .... | 1 | 1 | 1 | 21 | .... | 3 | 1 | 2 | .... | 3 | 33 |
| Hand | .... | .... | 1 | .... | .... | .... | 4 | .... | 43 | 1 | 3 | 3 | 8 | 2 | 9 | 74 |
| Back | .... | .... | .... | .... | .... | 3 | .... | .... | 46 | .... | 2 | 7 | 2 | 1 | 13 | 74 |
| Rib | 1 | .... | .... | .... | .... | .... | .... | .... | 6 | .... | .... | .... | 1 | .... | 1 | 9 |
| Leg | 2 | .... | .... | .... | .... | 1 | 4 | .... | 46 | 2 | 1 | 5 | 7 | 1 | 14 | 83 |
| Foot | .... | .... | .... | .... | .... | 1 | 3 | .... | 14 | 1 | 2 | 4 | 1 | .... | 6 | 32 |
| Other Minor | .... | 2 | .... | 1 | .... | 4 | 1 | .... | 6 | .... | 1 | 2 | 1 | 1 | 5 | 24 |
| Total Minor | 4 | 2 | 1 | 1 | 1 | 12 | 17 | 1 | 206 | 4 | 15 | 24 | 27 | 7 | 57 | 379 |
| Grand Total | 13 | 6 | 2 | 2 | 1 | 13 | 22 | 2 | 233 | 6 | 19 | 29 | 35 | 9 | 68 | 460 |

There were no serious accidents reported in the year under review in the following Goldfields :— Kimberley, Gascoyne, East Murchison, Yalgoo, Northampton, Broad Arrow, North-East Coolgardie, Greenbushes.

## TABLE B

Minerals other than Coal and Oil

| Mineral | Men Employed | Accidents | | |
|---|---|---|---|---|
| | | Fatal | Serious | Minor |
| Asbestos | 405 | .... | 2 | 63 |
| Beryl | 43 | .... | .... | .... |
| Coal | 582 | 1 | 68 | 156 |
| Copper | 211 | .... | 36 | 151 |
| Gold | 5,337 | 4 | 318 | 1,343 |
| Ilmenite | 146 | .... | 2 | .... |
| Iron Ore | 401 | .... | 12 | 7 |
| Lead | 19 | .... | .... | 1 |
| Manganese | 83 | .... | 3 | 1 |
| Oil Exploration | 45 | .... | 6 | 6 |
| Pyrite | 101 | .... | 6 | 16 |
| Tin | 49 | .... | 2 | .... |
| Other Minerals | 72 | .... | .... | .... |
| Rock Quarries | 286 | 2 | 5 | 7 |
| Totals | 7,780 | 7 | 460 | 1,751 |

## TABLE C

Fatal and Serious Accidents showing Causes and Districts

| District | Explosives | | Falls | | Shafts | | Fumes | | Miscellaneous Underground | | Surface | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Serious | Fatal | Serious | Fatal | Serious | Fatal | Serious | Fatal | Serious | Fatal | Serious | Fatal | Serious |
| Kimberley | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| West Kimberley | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 13 | .... | 13 |
| Pilbara | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6 | .... | 6 |
| West Pilbara | .... | ... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 2 |
| Ashburton | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | .... | 2 |
| Peak Hill | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 1 |
| Gascoyne | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Murchison | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 5 | .... | 7 | .... | 13 |
| East Murchison | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Yalgoo | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Northampton | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Mt. Margaret | .... | .... | .... | 2 | .... | .... | .... | .... | .... | 13 | .... | 7 | .... | 22 |
| North Coolgardie | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 | .... | 2 |
| Broad Arrow | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| North-East Coolgardie | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| East Coolgardie | .... | .... | 3 | 33 | .... | .... | .... | .... | 1 | 165 | .... | 35 | 4 | 233 |
| Coolgardie | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 3 | .... | 1 | .... | 6 |
| Yilgarn | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 14 | .... | 4 | .... | 19 |
| Dundas | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 15 | .... | 12 | .... | 29 |
| Phillips River | .... | 1 | .... | 2 | .... | 1 | .... | .... | .... | 29 | .... | 2 | .... | 35 |
| Greenbushes | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| South-West | .... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | 9 | 2 | 9 |
| Collie | .... | .... | .... | 2 | .... | .... | .... | .... | .... | 51 | 1 | 15 | 1 | 68 |
| Total for 1961 | .... | 1 | 5 | 41 | .... | 6 | .... | .... | 1 | 297 | 1 | 115 | 7 | 460 |
| Total for 1960 | 2 | .... | 4 | 52 | 4 | 10 | .... | .... | 4 | 452 | .... | 101 | 14 | 615 |

## FATAL ACCIDENTS

A brief description of fatal accidents, reported during the year, is given below.

| Name and Occupation | Date | Mine | Details and Remarks |
|---|---|---|---|
| Sobota, Mieczyslaw (Machine Miner) | 7/3/61 | Enterprise Mine, Gold Mines of Kalgoorlie (Aust.) Ltd. Fimiston | Asphyxiated when a large slab of rock fell and crushed him whilst he was boring stripping holes in the 1700 ft., level, 1706 cut and fill stope. |
| Bilcich, Ivan (Quarryman) | 8/5/61 | Balcatta Lime & Stone Pty. Ltd. Limestone Quarry, Brittania Ave., South Coogee. | Suffered head and other injuries when he was struck by a stone which fell from the face of the quarry shortly after firing operations. |
| Danby, Colin Michael (Geologist) | 11/7/61 | Perseverance Shaft, Gold Mines of Kalgoorlie (Aust.) Ltd., Fimiston | Struck by a fall of rock whilst working in old workings situated just below the No. 2 level 213 South drive of the East Branch Lake View Lode. |
| Genovesi, Lorenzo (Locomotive Driver) | 28/8/61 | Chaffers Shaft, Lake View & Star Ltd., Fimiston | Genovesi was crushed between a timber stull and the loco battery box when he attempted to drive the loco. into a confined space on the 600 ft. level, East Lode. |
| Harding, Arthur (Labourer) | 9/9/61 | Centaur, Griffin Coal Mining Co. Ltd., Collie | Suffered a heart attack brought about by strain sustained in the course of his duties at the Centaur gantry at Muja. |
| Western, Ewin Jack (Timberman) | Injured 11/9/61 Died 12/9/61 | Chaffers Shaft, Lake View & Star Ltd., Fimiston | Died from internal haemorrhage and shock due to fractures of pelvis and femur suffered when he was struck by a falling rock during boring operations in the hanging wall of the 2500, ft. level No. 2 lode leading stope. |
| Faranda, Santo (Loader Operator) | 27/10/61 | Location 223, Limestone Quarry Beaconsfield, Snashall Bros. Pty. Ltd. | Received multiple injuries when he was buried under a fall of stone from a previously undercut face. |

*Cages Hung Up.*—(3) The south skip hung up in the Lake View shaft on the 19th April. The stop signal was given just as the north skip moved upwards from the 1,200 foot level and it was considered that the sudden stop caused the grippers of the south skip to operate. As the north skip proceeded upwards, so the south rope coiled out on the stationary south skip. After inspection, 65 feet of rope had to be cut off.

On the 23rd October a cage, containing 5 men was hung up in the Ivanhoe shaft when the cage was lowered onto the tumbler of the No. 30 level ore bin chute. The empty ore bin had just been refilled and either vibration or a stone had caused the tumbler to move. No injuries or damage resulted.

The bail and keepers were bent when the north skip in the Ivanhoe shaft became jammed in the dumping track on the 29th November. The rope was cut and recapped.

*Derailments.*—(10) During the year Central Norseman Gold Corporation reported six derailments in the Regent shaft and one in the Royal shaft. At the Sons of Gwalia there were three derailments. No serious personnel injury resulted from any of these accidents.

*Mechanical Failures.*—(2) A 1¼ ton electric cable on a reel was being lowered down the main shaft of the Hill 50 G.M. on the 11th February when the half inch diameter wire rope sling supporting the reel cable beneath the cage broke and the load crashed to the pentice some 870 feet below. The shaft was undamaged but two stulls and a leg of the pentice were split. It is believed that the sling failure was brought about by the rubbing action of a steel reinforcing plate on the outside of the reel which was in contact with the sling.

When running the empty skip through the Crown shaft at the commencement of day shift, the second reduction shaft of the winder broke close to the first reduction spur gear. No apparent cause of the failure was found as the skip was not overloaded and no obstruction was found in the shaft.

*Miscellaneous.*—(2) A shaft mishap involving personal injury occurred in the underlay Regent shaft on the 2nd August. The skipman suffered head injuries when he was struck by a stone which probably rolled down the shaft. At the time of the accident, the skipman seated on the skip bridle was making a shaft inspection.

Faulty loading of equipment on the Long Tom was the cause of an accident in the Royal shaft on the 7th September. A loading box placed on the Long Tom was dislodged near the No. 6 level and fell to the pentice at No. 13 level. One centre leg near the No. 8 level bin was knocked out.

## PROSECUTIONS.

It was found not necessary to prosecute anyone during 1961.

## SUNDAY LABOUR PERMITS.

Three applications for permission to employ labour on Sundays were received and granted.

Permission was given to Great Western Consolidated N.L. to employ Sunday labour in making safe their quarries after a storm, emptying dispersed surface ore bins and transporting the ore to the Copperhead plant.

The Sons of Gwalia Ltd. was permitted to hoist ore on two Sundays following break downs in the crushing section and underground pumps.

## AUTHORISED MINE SURVEYORS.

The Survey Board issued nine certificates during the year.

## CERTIFICATES OF EXEMPTION (SECTION 46).

Eighteen certificates were issued as compared with nine in 1960.

## PERMITS TO FIRE OUTSIDE PRESCRIBED TIME (REG. 51).

One permit was issued.

The Sons of Gwalia Ltd. was permitted to fire outside the recognised firing times in the 1,160 feet rise above No. 27 level. Rock movement closed the holes and it was found that the only way to advance the rise was to drill the cuts only 2 feet deep and to charge and fire the holes as soon as possible after drilling.

## PERMITS TO RISE (REGULATION 64).

Forty seven permits were issued and they related to 78 rises totalling 9,650 feet. Thirty-three of these rises were constructed using the rising gig method.

## ADMINISTRATIVE.

*Mines Regulation Act.*—An Act to amend the Mines Regulation Act was assented to on the 28th November. This Act will come into operation on a day to be fixed by proclamation. Amendments deal with the qualifications of Inspectors of Mines, the classes of certificates required by underground staff, Sunday labour on the Yampi Sound area and the capacity of hoists exempted from section 46 of the principal Act.

A notice in the *Government Gazette* No. 84 of the 13th October defined the districts covered by the Inspectors of Mines.

*Mining Act.*—Deletion of the interpretation of Minerals in section 136 was assented to on the 30th October.

The South West Mineral Field was proclaimed and its area defined in the *Government Gazette* of the 10th November.

Subregulation 1 of Regulation 55 was re-written to avoid naming particular minerals in mineral claims that miners may hold. Regulation 56 was amended to allow the Warden to grant a race or pipe track water right across any mining tenement. These amendments appear in *Government Gazette* No. 109 of the 29th December.

*Mine Workers' Relief Act.*—During the year a number of amendments were made to this Act. These amendments are covered in the report of the Superintendent, Mine Workers' Relief Act.

## VENTILATION.

All working places of major metalliferous mines were regularly inspected and dust counts and temperatures recorded. Assistance was given to various mines in the making of ventilation surveys and the designing and installation of ventilation appliances.

Routine afternoon shift inspections of underground workings were continued during the year. Most mines are now installing air-water blasts in all development headings to reduce the dust hazard after firing. Various tests have proved the effectiveness of the air-water blast as compared with clearing dust and fume from the working place with compressed air.

Results of dust counts taken during the year are tabulated below:

| Dust Samples from | Samples giving over 1,000 p.p.c.c. | Total No. of Samples | Average Count |
|---|---|---|---|
| Development .... | 19 | 386 | 243 |
| Stoping .... .... | 35 | 787 | 275 |
| Levels .... .... | 7 | 348 | 238 |
| Surface .... .... | 26 | 160 | 425 |
| Totals .... | 87 | 1,681 | 274 |

The average dust count was well above the average of 186 p.p.c.c. recorded in 1960. Eighty-seven samples had dust counts in excess of 1,000 p.p.c.c. as compared with twenty-eight for the previous year. A vigorous follow up campaign was instituted to help reduce the dust hazard in known trouble spots and this accounts in part for the large number of high counts. The year's average does illustrate that there are still many working places where there should be an improvement in ventilation and dust suppression. Higher standards of dust control are still needed in the crushing sections of rock quarries and in the metalliferous mines during afternoon shift.

It is with pleasure that I report that for the fifth year in succession there has not been a fatal accident due to fumes of explosives. Twenty-eight minor fuming accidents were reported and all were investigated. Most of these accidents were caused by mechanical bogger drivers commencing loading operations in development headings with the necessary secondary ventilation ducting too far back from the face and truckers pulling from chutes before allowing sufficient time for the smoke and fume to clear after firing.

Three occurrences of methane were investigated during the year. All of these were in workings off the Main Shaft of North Kalgoorlie (1912) Ltd. In each case the gas was escaping from diamond drill holes which were collared on the 15, 17 and 18 levels. Flow from the holes was of short duration.

Alterations have been made to the primary air flow on the Great Boulder. The flow of air has been divided into two major circuits. A programme of development will be completed in 1962 whereby a ventilation shaft will extend to the 800 ft. level. This shaft will be used as the main exhaust for the mine.

During the year a 60 inch axial flow fan, capacity 90,000 cumins was installed on the No. 5 level at the Colonial Mine, Wittenoom. This will allow the upper and lower seams to be separately ventilated.

Prophylactic treatment with the dispersal of aluminium powder in the change rooms, was continued throughout the year at most mines.

## GOLD MINING.

The ore treated during the year amounted to 2,984,458 tons as compared with 3,056,445 tons in the previous year. Gold recovered amounted to 870,658 fine ounces as compared with 869,966 fine ounces for 1960.

Grade of ore mined was slightly higher, recovery being 5.83 dwts. per ton as against 5.69 dwts. per ton for 1960.

The calculated value of the gold produced was £13,684,867 which included £80,836 distributed by the Gold Producer's Association from the sale of 840,873 fine ounces of gold at an average premium of 24.06d. per fine ounce.

The Mint value of gold throughout the year was £15 12s. 6d. per fine ounce.

There was a small decrease in the number of men employed in the industry, from 5,430 in 1960 to 5,337 in 1961. Average production of ore per man was 559 tons valued at 91.71 shillings per ton as compared with 563 tons valued at 88.95 shillings per ton for 1960. Gold recovery per man averaged 163.14 fine ounces as compared with 160.21 fine ounces in the previous year.

Statistics relating to the gold mining industry are tabulated as follows:—

Table "D"—Gold Production Statistics.

Table "E"—Classification of Gold Output for 1961 by Goldfields.

Table "F"—Classification of Gold Output, 1957-1961.

Table "G"—Mines that have produced 5,000 ounces and upwards in any one of the past five years.

Table "H"—Development Footages.

TABLE D

Gold Production Statistics

| Year | Tons Treated (2,240 lb.) | Total Gold Yield | Estimated Value of Yield | Value of Yield per ton | Number of Men Employed | Average Value of Gold per oz. | Average Yield per ton of Ore |
|---|---|---|---|---|---|---|---|
| | Tons | Fine oz. | £A | Shillings A | | Shillings A | Dwts. |
| 1932 .... | 1,327,021 | 599,421 | 4,358,989 | 65·70 | 8,695 | 145·44 | 9·03 |
| 1933 .... | 1,588,979 | 636,928 | 4,884,112 | 61·48 | 9,900 | 153·36 | 8·01 |
| 1934 .... | 1,772,931 | 639,871 | 5,461,004 | 61·60 | 12,523 | 170·69 | 7·22 |
| 1935 .... | 1,909,832 | 646,150 | 5,676,679 | 59·45 | 14,708 | 175·71 | 6·77 |
| 1936 .... | 2,492,034 | 852,422 | 7,427,687 | 59·61 | 15,698 | 174·27 | 6·84 |
| 1937 .... | 3,039,608 | 1,007,289 | 8,797,662 | 57·99 | 16,174 | 174·68 | 6·64 |
| 1938 .... | 3,759,720 | 1,172,950 | 10,409,928 | 53·38 | 15,374 | 177·50 | 6·24 |
| 1939 .... | 4,095,257 | 1,188,286 | 11,594,221 | 56·62 | 15,216 | 195·14 | 5·80 |
| 1940 .... | 4,291,709 | 1,154,843 | 12,306,816 | 57·35 | 14,594 | 213·15 | 5·38 |
| 1941 .... | 4,210,774 | 1,105,477 | 11,811,989 | 56·10 | 13,105 | 213·70 | 5·25 |
| 1942 .... | 3,225,704 | 845,772 | 8,840,642 | 54·81 | 8,123 | 209·04 | 5·24 |
| 1943 .... | 2,051,011 | 531,747 | 5,556,736 | 54·19 | 5,079 | 209·00 | 5·19 |
| 1944 .... | 1,777,128 | 472,588 | 5,966,451 | 55·89 | 4,614 | 210·18 | 5·32 |
| 1945 .... | 1,736,952 | 469,906 | 5,025,039 | 57·86 | 4,818 | 213·87 | 5·41 |
| 1946 .... | 2,194,477 | 618,607 | 6,657,762 | 60·70 | 6,961 | 215·25 | 5·64 |
| 1947 .... | 2,507,306 | 701,752 | 7,552,611 | 60·25 | 7,649 | 215·25 | 5·59 |
| 1948 .... | 2,447,545 | 662,714 | 7,132,748 | 58·28 | 7,178 | 215·25 | 5·42 |
| 1949 .... | 2,468,297 | 649,572 | 7,977,200 | 64·64 | 6,800 | 245·62 | 5·26 |
| 1950 .... | 2,463,423 | 608,633 | 9,428,745 | 76·55 | 7,080 | 309·83 | 4·94 |
| 1951 .... | 2,471,679 | 648,245 | 10,042,392 | 81·26 | 6,766 | 309·83 | 5·25 |
| 1952 .... | 2,626,612 | 727,468 | 11,809,047 | 89·92 | 6,394 | 324·66 | 5·54 |
| 1953 .... | 3,169,875 | 823,331 | 13,290,100 | 83·85 | 6,359 | 322·84 | 5·20 |
| 1954 .... | 3,240,378 | 861,992 | 13,492,209 | 83·27 | 6,128 | 313·04 | 5·32 |
| 1955 .... | 2,865,048 | 834,326 | 13,055,574 | 91·13 | 5,845 | 312·96 | 5·82 |
| 1956 .... | 2,870,273 | 813,617 | 12,724,923 | 88·67 | 5,612 | 312·80 | 5·67 |
| 1957 .... | 2,951,011 | 849,741 | 13,304,752 | 90·17 | 5,385 | 313·15 | 5·76 |
| 1958 .... | 3,021,072 | 874,819 | 13,674,193 | 90·53 | 5,352 | 312·62 | 5·79 |
| 1959 .... | 2,959,202 | 860,969 | 13,453,808 | 90·93 | 5,769 | 312·52 | 5·82 |
| 1960 .... | 3,056,445 | 869,966 | 13,593,462 | 88·95 | 5,430 | 312·51 | 5·69 |
| 1961 .... | 2,984,458 | 870,658 | 13,684,867 | 91·71 | 5,337 | 314·36 | 5·83 |

## TABLE E

*Classification of Gold Output for* 1960 *by Goldfields*

| Goldfield | Unclassified Sundry Claims Alluvial, etc. fine ozs. | Up to 100 ozs. | | 101–500 ozs. | | 501–1,000 ozs. | | 1,001–5,000 ozs. | | 5,001–10,000 ozs. | | 10,001–20,000 ozs. | | 20,001–50,000 ozs. | | 50,001–100,000 ozs. | | Over 100,000 ozs. | | Total fine ozs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | No. of Producers | Gold fine ozs. | |
| Kimberley | 16 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 16 |
| West Kimberley | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Pilbara | 451 | 10 | 157 | 1 | 121 | 1 | 676 | 1 | 3,234 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,639 |
| West Pilbara | .... | 1 | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 |
| Ashburton | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Peak Hill | 65 | 7 | 96 | 1 | 168 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 329 |
| Gascoyne | 246 | .... | .... | 1 | 206 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 452 |
| Murchison | 614 | 6 | 211 | 2 | 239 | .... | .... | .... | .... | 1 | 676 | .... | .... | .... | .... | 1 | 82,953 | .... | .... | 91,877 |
| East Murchison | 85 | 2 | 76 | 1 | 212 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 373 |
| Yalgoo | 86 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 86 |
| Mount Margaret | 839 | 2 | 74 | 1 | 117 | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 32,947 | .... | .... | .... | .... | 33,977 |
| North Coolgardie | 776 | 9 | 464 | 3 | 555 | .... | .... | 1 | 1,558 | .... | .... | 1 | 12,496 | .... | .... | .... | .... | .... | .... | 15,849 |
| Broad Arrow | 1,038 | 5 | 115 | 5 | 1,302 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2,455 |
| North-East Coolgardie | 92 | 1 | 69 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 161 |
| East Coolgardie | 884 | 16 | 403 | 4 | 880 | 2 | 1,336 | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 90,220 | 3 | 446,750 | 540,473 |
| Coolgardie | 1,088 | 11 | 433 | 2 | 794 | .... | .... | 1 | 1,548 | 1 | 9,971 | .... | .... | .... | .... | .... | .... | .... | .... | 13,834 |
| Yilgarn | 323 | 11 | 286 | 2 | 277 | 2 | 1,128 | 2 | 3,810 | .... | .... | .... | .... | .... | .... | 1 | 58,477 | .... | .... | 64,301 |
| Dundas | 116 | 2 | 50 | 2 | 419 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 98,305 | .... | .... | 98,890 |
| Phillips River | 2 | .... | .... | .... | .... | .... | .... | 1 | 2,718 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2,720 |
| State Generally | 108 | .... | .... | 1 | 114 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 222 |
| Totals | 6,829 | 83 | 2,438 | 26 | 5,404 | 5 | 3,140 | 6 | 12,868 | 2 | 17,831 | 1 | 12,496 | 1 | 32,947 | 4 | 329,955 | 3 | 446,750 | 870,685 |

TABLE F

*Classification of Gold Output*, 1957-1961

| Range of Output | 1961 | | | 1960 | | | 1959 | | | 1958 | | | 1957 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Producers | Production | Percentage of Total | No. of Producers | Production | Percentage of Total | No. of Producers | Production | Percentage of Total | No. of Producers | Production | Percentage of Total | No. of Producers | Production | Percentage of Total |
| fine ozs. | | fine ozs. | | | fine ozs. | | | fine ozs. | | | fine ozs. | | | fine ozs. | |
| Over 100,000 .... .... | 3 | 446,750 | 51·3 | 4 | 540,623 | 62·1 | 4 | 517,525 | 60·1 | 4 | 547,565 | 62·6 | 3 | 428,334·08 | 50·5 |
| 50,001–100,000 .... .... | 4 | 329,955 | 37·9 | 3 | 234,263 | 26·9 | 3 | 238,014 | 27·6 | 3 | 238,049 | 27·2 | 4 | 302,421·19 | 35·6 |
| 40,001– 50,000 .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 30,001– 40,000 .... .... | 1 | 32,947 | 3·8 | 1 | 32,983 | 3·8 | 1 | 33,469 | 3·9 | 1 | 30,269 | 3·5 | 1 | 31,043·09 | 3·6 |
| 20,001– 30,000 .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 10,001– 20,000 .... .... | 1 | 12,496 | 1·4 | 1 | 14,591 | 1·7 | 3 | 41,782 | 4·9 | 2 | 27,561 | 3·2 | 3 | 38,930·24 | 4·6 |
| 5,001– 10,000 .... .... | 2 | 17,831 | 2·0 | 2 | 16,771 | 1·9 | .... | .... | .... | .... | .... | .... | 2 | 13,499·79 | 1·6 |
| 4,001– 5,000 .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 3,001– 4,000 .... .... | 1 | 3,234 | 0·4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | 6,318·31 | 0·7 |
| 2,001– 3,000 .... .... | 2 | 5,114 | 0·6 | 1 | 2,257 | 0·3 | 1 | 2,217 | 0·3 | 1 | 2,942 | 0·3 | 2 | 5,160·59 | 0·6 |
| 1,001– 2,000 .... .... | 3 | 4,520 | 0·5 | 6 | 9,484 | 1·1 | 5 | 7,221 | 0·8 | 6 | 9,937 | 1·1 | 1 | 1,864·91 | 0·2 |
| 501– 1,000 .... .... | 5 | 3,140 | 0·4 | 3 | 1,922 | 0·2 | 5 | 4,219 | 0·5 | 5 | 3,617 | 0·4 | 6 | 4,205·13 | 0·5 |
| 101– 500 .... .... | 26 | 5,404 | 0·6 | 31 | 7,569 | 0·9 | 26 | 5,511 | 0·6 | 30 | 6,117 | 0·7 | 31 | 6,595·81 | 0·8 |
| Up to 100 .... .... .... | 83 | 2,438 | 0·3 | 104 | 2,996 | 0·4 | 121 | 3,079 | 0·4 | 104 | 2,690 | 0·3 | 117 | 3,284·65 | 0·4 |
| Sundry Claims, etc. .... | .... | 6,829 | 0·8 | .... | 6,507 | 0·7 | .... | 7,932 | 0·9 | .... | 6,072 | 0·7 | .... | 8,082·88 | 0·9 |
| Totals .... .... .... | 131 | 870,658 | 100·0 | 156 | 869,966 | 100·0 | 169 | 860,969 | 100·0 | 156 | 874,819 | 100·0 | 172 | 849,740·67 | 100·0 |

## TABLE G

*Mines that have Produced 5,000 ozs. and Upwards in any One of the Past Five Years*

| Mine | 1961 | | | 1960 | | | 1959 | | | 1958 | | | 1957 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons Treated | Fine ozs. | Dwts. per ton | Tons Treated | Fine ozs. | Dwts. per ton | Tons Treated | Fine ozs. | Dwts. per ton | Tons Treated | Fine ozs. | Dwts. per ton | Tons Treated | Fine ozs. | Dwts. per ton |
| Central Norseman Gold Corporation N.L. | 175,124 | 98,305 | 11·23 | 190,679 | 101,291 | 10·62 | 182,996 | 101,203 | 11·06 | 182,822 | 108,176 | 11·83 | 168,846 | 91,913 | 10·89 |
| Eclipse Gold Mines N.L. | 8,550 | 7,860 | 18·39 | 6,969 | 7,690 | 22·07 | 7,514 | 12,048 | 32·07 | 2,840 | 2,942 | 20·72 | .... | .... | .... |
| Gold Mines of Kalgoorlie (Aust.) Ltd. | 518,244 | 152,964 | 5·90 | 569,116 | 150,319 | 5·28 | 496,981 | 134,002 | 5·39 | 519,168 | 147,310 | 5·67 | 523,617 | 147,341 | 5·63 |
| Great Boulder Pty. Gold Mines Ltd. | 452,145 | 129,388 | 5·72 | 448,398 | 123,875 | 5·52 | 454,474 | 124,041 | 5·46 | 488,761 | 134,307 | 5·50 | 459,734 | 128,928 | 5·61 |
| Great Western Consolidated N.L. | 390,700 | 58,477 | 2·99 | 390,353 | 63,434 | 3·25 | 393,252 | 67,100 | 3·41 | 459,119 | 76,641 | 3·34 | 462,799 | 77,079 | 3·33 |
| Hill 50 Gold Mines N.L. | 157,196 | 82,953 | 10·55 | 156,844 | 82,988 | 10·58 | 155,471 | 81,907 | 10·54 | 133,081 | 77,209 | 11·60 | 107,128 | 83,193 | 15·53 |
| Lake View and Star Ltd. | 681,108 | 166,031 | 4·88 | 683,950 | 165,032 | 4·83 | 669,927 | 162,576 | 4·85 | 665,998 | 161,899 | 4·86 | 664,895 | 159,811 | 4·81 |
| North Kalgurli (1912) Ltd. | 373,795 | 90,220 | 4·83 | 372,053 | 87,841 | 4·72 | 361,344 | 89,007 | 4·93 | 345,983 | 84,199 | 4·87 | 337,888 | 75,327 | 4·46 |
| State Batteries | 40,673 | 13,835 | 6·80 | 39,219 | 14,704 | 7·50 | 39,048 | 14,700 | 7·53 | 41,806 | 13,498 | 6·46 | 42,837 | 15,813 | 7·38 |
| The Sons of Gwalia Ltd. | 135,995 | 32,947 | 4·85 | 138,618 | 32,983 | 4·76 | 135,932 | 33,469 | 4·92 | 137,377 | 30,269 | 4·41 | 137,934 | 31,043 | 4·50 |
| Timoni (Moonlight Wiluna G.M. Ltd.) | 23,871 | 12,496 | 10·47 | 29,880 | 14,591 | 9·77 | 32,229 | 15,879 | 9·85 | 31,838 | 15,746 | 9·89 | 31,445 | 15,781 | 10·04 |
| Total | 2,957,401 | 845,476 | 5·72 | 3,026,079 | 844,748 | 5·58 | 2,929,168 | 835,932 | 5·71 | 3,008,793 | 852,196 | 5·66 | 2,937,123 | 826,229 | 5·63 |
| Other Sources (excluding large Retreatment Plants) | 27,057 | 13,131 | 9·71 | 30,366 | 12,613 | 8·31 | 30,034 | 12,051 | 8·02 | 12,279 | 10,623 | 17·30 | 13,888 | 10,072 | 14·50 |
| Total (excluding large Retreatment Plants) | 2,984,458 | 858,607 | 5·75 | 3,056,445 | 857,361 | 5·61 | 2,959,202 | 847,983 | 5·73 | 3,021,072 | 862,819 | 5·71 | 2,951,011 | 836,301 | 5·67 |
| Lake View and Star Retreatment | .... | 8,339 | .... | .... | 9,187 | .... | .... | 9,844 | .... | .... | 8,989 | .... | .... | 9,934 | .... |
| State Batteries Tailing Treatment | .... | 3,712 | .... | .... | 3,418 | .... | .... | 3,142 | .... | .... | 3,011 | .... | .... | 3,506 | .... |
| Grand Total | 2,984,458 | 870,658 | 5·83 | 3,056,445 | 869,966 | 5·69 | 2,959,202 | 860,969 | 5·82 | 3,021,072 | 874,819 | 5·79 | 2,951,011 | 849,741 | 5·76 |

TABLE H

*Development Footages Reported by the Principal Mines*

| Gold or Mineral Field | Mine | Shaft Sinking | Driving | Cross-Cutting | Rising and Winzing | Diamond Drilling | Total |
|---|---|---|---|---|---|---|---|
| Gold— | | feet | feet | feet | feet | feet | feet |
| Murchison .... .... | Hill 50 Gold Mines N.L. .... | 181 | 1,673 | 1,201 | 1,385 | 15,732 | 20,172 |
| | Eclipse Gold Mines N.L. .... | 262 | 468 | 255 | 261 | 90 | 1,336 |
| Mount Margaret | Sons of Gwalia .... .... .... | .... | 1,444 | 251 | 1,796 | 9,653 | 13,144 |
| North Coolgardie | Timoni (Moonlight Wiluna G.M. Ltd). .... .... .... .... | 149 | 3,170 | 376 | 372 | .... | 4,067 |
| East Coolgardie.... | Lake View and Star Ltd. .... | .... | 18,988 | 3,124 | 5,164 | 24,808 | 52,084 |
| | Great Boulder Pty. Gold Mines Ltd. | 325 | 10,668 | 2,182 | 3,204 | 9,196 | 25,575 |
| | North Kalgurli (1912) Ltd. .... | .... | 10,213 | 1,498 | 2,490 | 25,227 | 39,428 |
| | Gold Mines of Kalgoorlie (Aust.) Ltd. .... .... .... .... | .... | 15,501 | 5,423 | 5,923 | 32,061 | 58,908 |
| Coolgardie .... | Gold Mines of Kalgoorlie (Aust.) Ltd. .... .... .... .... | 118 | 571 | 206 | 680 | 2,785 | 4,360 |
| | Paris Gold Mines Pty. Ltd .... | 121 | 445 | 147 | 104 | 4,000 | 4,817 |
| Yilgarn .... .... | Great Western Consolidated N.L. | .... | 1,623 | 9 | 1,071 | 396 | 3,099 |
| | Radio .... .... .... .... | .... | 110 | 69 | 160 | .... | 339 |
| Dundas .... .... | Central Norseman Gold Corporation N.L. .... .... .... | 1,250 | 9,408 | 1,779 | 3,053 | 35,804 | 51,294 |
| | Total in Gold Mines .... | 2,406 | 74,282 | 16,520 | 25,663 | 159,752 | 278,623 |
| Asbestos— | | | | | | | |
| West Pilbara .... | Australian Blue Asbestos .... | .... | 4,681 | 557 | 712 | 3,117 | 9,067 |
| Pyrite— | | | | | | | |
| Dundas .... .... | Norseman Gold Mines N.L. .... | .... | 883 | 148 | 461 | .... | 1,492 |
| Copper— | | | | | | | |
| Phillips River .... | Ravensthorpe Copper Mines N.L. | .... | 2,848 | 12 | 632 | 1,382 | 4,874 |
| Peak Hill .... | Thaduna Copper Mine .... .... | .... | 180 | 54 | 104 | .... | 338 |
| | Total in Copper Mines .... | .... | 3,028 | 66 | 736 | 1,382 | 5,212 |
| Lead— | | | | | | | |
| Northampton .... | Gurkha Lead Mine Pty. Ltd. .... | 40 | 151 | 21 | 60 | .... | 272 |
| | Total in All Mines .... | 2,446 | 83,025 | 17,312 | 27,632 | 164,251 | 294,666 |

## OPERATIONS OF THE PRINCIPAL MINES.

### EAST COOLGARDIE GOLDFIELD.

The total ore treated in this goldfield amounted to 2,016,209 tons with a recovery of 540,473 fine ounces of gold at an average of 5.36 dwts. per ton. This output was equal to 62.1 per cent. of the gold production for the State. In the previous year 2,069,164 tons of ore averaging 5.14 dwts. were treated for a recovery of 531,981 fine ounces of gold.

Production in the *Bulong District* amounted to 16 fine ounces from the treatment of 182 tons of ore.

In the *East Coolgardie District* 540,457 fine ounces were recovered from the treatment of 2,016,027 tons of ore. Following are notes on the activities of the principal producers in the district.

*Lake View and Star Ltd.*, with a production of 681,108 tons of ore for a return of 166,031 fine ounces of gold at an average recovery of 4.88 dwts. per ton, was the State's leading producer. Retreatment of tailings yielded an additional 8,339 fine ounces.

The previous year's production was 165,032 fine ounces from the treatment of 683,950 tons plus 9,187 fine ounces from tailings retreatment.

Estimated ore reserves as at the 1st July were 3,688,700 short tons of an average grade of 4.94 dwts.

This company maintained a vigorous development programme, 27,276 feet of development work being completed. Further work was done in extending the facilities for the delivery of hydraulic fill, prepared from mill tailings, to selected mining blocks on the Western Group.

The replacement of air driven secondary ventilation equipment with electric powered units continued throughout the year. A total of forty-five 2-5 H.P. units have been installed giving improved air flows at a reduced cost. The shifting of the Jeffrey aerovane fan from the 2,977 ft. level Horseshoe No. 2 shaft to the 3,140 ft. level Ivanhoe was completed during the year. This is now causing the Ivanhoe shaft to downcast from the 1,328 ft. level, the air coming in at this level from empty shrink stopes situated between the Ivanhoe and Horseshoe workings.

In the treatment plant, the 100 ft. diameter thickener purchased from Big Bell Mines Ltd. was installed and brought into operation in March. To reduce electric power costs, work has commenced in the power house to convert the machines to use heavy fuel oil. This conversion follows three years of test work on the use of this fuel.

*Gold Mines of Kalgoorlie (Aust.) Ltd.* produced 152,964 fine ounces from the treatment of 518,244 tons at an average recovery of 5.90 dwts. per ton. The Kalgoorlie group of mines produced 142,992 ounces from 500,293 tons with an average recovery of 5.72 dwts. per ton. The remainder of their production came from the Coolgardie District.

Total ore reserves of the company are stated as 1,119,000 tons at 5.9 dwts. per ton.

Development work on known ore bodies amounted to 26,847 feet. The Paringa No. 9 level is being developed by drivers into the Central and Federal leases on "B" and Federal lode. Results are encouraging. The sinking of the Oroya Internal shaft (below No. 15 level) was completed with a break through to the 1,900 level Perseverance shaft.

In the lower Blue Gap area, the installation of the cage, counterweight, winder and electricals is complete. The hydraulic fill surface installations have been completed at the Perseverance shaft. A further alternator set was installed at the Oroya power house.

This company is preparing to unwater the Mt. Charlotte mine for further underground diamond drilling.

*Great Boulder Pty. Gold Mines Ltd.* treated 452,145 tons of ore for a recovery of 129,388 fine ounces of gold, average recovery being 5.72 dwts. per ton. During the previous year 448,398 tons yielded 123,875 fine ounces at an average grade of 5.52 dwts. per ton.

Ore reserves as at the 6th June were 1,972,800 short tons at 5.54 dwts. per ton.

The Main Internal shaft was sunk a further 325 feet to 50 feet below the 4,000 ft. level. The plat at the 3,700 ft. level was completed and new plats excavated and completed at the 3,850 and 4,000 ft. horizons. The ore pass and skip loading system is complete to the 3,550 ft. level.

Active development was commenced from the 3,250; 3,400 and 3,550 ft. levels off the internal shaft and payable ore shoots on the 27 Lode East Branch have been established on each level.

To improve the downcast at main shaft and to give better distribution of air in the lower workings, a primary circuit ventilating fan was moved from the 1,400 and installed on the 2,650 feet level. Fans in workings off Hamilton shaft have been repositioned and total flow of air in the Great Boulder workings now totals 90,000 cumins.

Changes on the surface include the replacement of the Lodge Cottrell dust collecting unit by dry cyclones. Equipment was installed in the power house to convert the remaining diesel engines to burn heavy fuel oil. The five major engines in the power house are now using this fuel.

*North Kalgurli (1912) Ltd.* treated 373,795 tons of ore for a recovery of 90,220 fine ounces of gold at an average recovery of 4.8 dwts. per ton. In the previous year 87,841 ounces were recovered from 372,053 tons of ore.

The calculated ore reserves as at the 27th March, 1962, were 2,233,976 tons at 5.33 dwts. per ton. Completed during the year were 10,213 feet of driving, 1,498 feet of crosscutting, 722 feet of rising, 1,768 feet of winzing and 25,227 feet of diamond drilling.

On the lower levels there has been satisfactory developments on the McLeod, Brookman and Kalgurli Main lodes. Croesus No. 9 level exploration was extended a further 450 feet south in low values.

This company has commenced the erection of its own power house. Previously their supply was drawn from the Kalgoorlie Power and Lighting Corporation. In July the company placed an order for generating plant and switchgear which should be delivered early next year.

*Kalgoorlie Southern Gold Mines N.A.* A deflection of hole No. SE 12 was made at 3,990 feet from which point drilling was continued to a total depth of 7,848 feet where the hole was abandoned because of a stuck core barrel. A complete re-examination of all available drilling and geological data has been commenced.

The *Rosemary* mine at *Mount Monger* produced 740 fine ounces of gold from 985 tons of ore. Very little development was carried out and stoping operations were above the 150 foot level.

The *Daisy* mine at the same centre produced 596 ounces from 1,014 tons. All of this ore was carted to and treated at the Kalgoorlie State Battery.

The *Mount Monger Mining Syndicate* which was mining remnants of ore in the Hooma mine, ceased operations after producing 191 ounces from 458 tons for the year under review.

## DUNDAS GOLDFIELD.

The production of 98,890 fine ounces of gold from the treatment of 176,895 tons of ore represented 11.4 per cent. of the State's total production. In the previous year 191,538 tons of ore yielded 101,555 fine ounces.

*Central Norseman Gold Corporation N.L.* treated 175,124 tons for a recovery of 98,305 ounces. Gold recovery was at the rate of 11.23 dwts. per ton which compares favourably with the previous year's grade of 10.62 dwts. per ton when 190,679 tons yielded 101,291 ounces.

Estimated ore reserves are 472,000 tons at 10 dwts. per ton.

The Crown reef has been developed from the Nos. 16, 22, 25, 27, 29 and 32 levels of the Regent shaft. Originally the Crown shaft was sunk to the No. 15 level and the Crown reef developed on the No. 16 level Regent shaft which is the main haulage way of all ore above that level. Three winzes are in progress below the No. 22 level and preparations made for stoping block of ore above this level which is now the major level of the mine.

At the *Princess Royal* mine rich ore has been won by stripping the walls of old stopes and intermediate development has disclosed ore in what was considered blank areas.

The North Royal shaft has been sunk to 3,050 feet. It is anticipated that this shaft will be sunk to 4,000 feet in the coming year and that 3,000 feet of driving from the bottom of the shaft is planned.

The company has been engaged in an extensive diamond drilling programme which amounted to 35,804 feet for the year.

At *Beete*, Pope and Party obtained 419 fine ounces from 535 tons of ore crushed at the State Battery. The Party of four have straightened and skidded the shaft and are at present developing the 200 foot level.

## MURCHISON GOLDFIELD.

169,957 tons of ore were treated in this goldfield for a return of 91,877 fine ounces of gold. This production was equal to 10.6 per cent. of the State's total. In the previous year 91,970 ounces were obtained from the treatment of 169,117 tons.

Gold output from sundry claims in the *Cue* and *Day Dawn Districts* amounted to 129 ounces from the treatment of 685 tons.

In the *Meekatharra District* 513 ounces were recovered from the treatment of 3,083 tons of ore. The most successful producers were the *Haveluck* with 111 ounces, *Prohibition* with 66 ounces and the *Blue Bird* with 34 ounces. Most of the material obtained in the district came from dumps and stope fillings and barely covered the cost of carting and crushing.

The *Mount Magnet District* produced 91,235 fine ounces of gold from the treatment of 166,189 tons of ore. The principle producer was *Hill 50 Gold Mines N.L.* with 82,953 fine ounces from 157,196 tons. Average recovery was 10.55 dwts. per ton which was a little below the previous year's average of 10.58 dwts. when 82,988 ounces were produced.

The ore reserve as at 4th July was determined as 485,500 short tons at 10.0 dwts.

It was found necessary to rock bolt and retimber the main shaft between the 1,650 ft. and 1,902 ft. horizons. Sinking was recommended and shaft advanced 181 feet to a total depth of 2,108 feet. A winze sunk below the 1,800 foot horizon had been advanced to 2,300 feet at the end of the year. The company has commenced a programme of exploratory drilling from the surface in the Brown Hill area at Boogardie and on the St. George leases near Mt. Magnet.

*Eclipse Gold Mines N.L.* Production for 1961 was 7,860 fine ounces of gold from 8,550 tons of ore, recovery being at the rate of 18.39 dwts. per ton treated. The Main shaft was sunk to a depth of 914 feet with a new level cut at 866 feet. The primary crushing arrangement was modified by replacing the Wedag single stage impact crusher with a two stage closed circuit consisting of a Ruwolt 20 in. x 10 in. primary jaw crusher and a Kue Ken 18 in. secondary gyratory.

## YILGARN GOLDFIELD.

Production for the year was 64,301 fine ounces of gold from 408,869 tons averaging 3.1 dwts. per ton recovery. In the previous year 413,806 tons yielded 70,689 fine ounces at the rate of 3.4 dwts. per ton. This goldfield in 1961 was responsible for 7.4 per cent. of the State's production.

*Great Western Consolidated N.L.* milled 390,700 tons for a recovery of 58,477 fine ounces of gold averaging 2.99 dwts. per ton. Production for the previous year was 63,434 fine ounces from 390,353 tons. Ore reserves of the company are now 435,000 tons at an estimated grade of 3.45 dwts. There seems little chance of improving the reserves as development work has been cut to a minimum.

Production from the *Copperhead* mine at Bullfinch continued to fall and extraction of known ore is the only mining in progress. Operations at the *Corinthian* mine ceased in May. Work continues at the *Pilot* mine at a restricted rate. Increased tonnage has been drawn from the *Fraser's* mine where the open cut returns were better than expected. Underground work consisted mainly of mining known blocks of ore. There was increased production from the *Nevoria* mine but development was restricted to opening up known blocks of ore.

Output from the various mines operated by Great Western is listed below:—

| Mine | Ore Treated | Gold | Average |
|---|---|---|---|
| | tons | fine ozs. | dwts./ton |
| Copperhead .... .... .... | 162,073 | 19,912 | 2·46 |
| Corinthian .... .... .... | 13,486 | 1,660 | 2·46 |
| Fraser's .... .... .... | 95,528 | 16,917 | 3·54 |
| Golden Valley .... .... | 614 | 26 | 0·85 |
| Nevoria .... .... .... | 73,445 | 14,131 | 3·85 |
| Pilot .... .... .... .... | 45,554 | 5,626 | 2·47 |
| Sands Retreatment .... | .... | 205 | .... |
| Totals .... .... | 390,700 | 58,477 | 2·99 |

The *Radio* mine in the Golden Valley centre produced a total of 2,396 fine ounces of gold from the treatment of 4,600 tons of ore and retreatment of 7,824 of sands. Development work totalling 339 feet has kept the ore reserves at a satisfactory level of 4,100 tons.

3,078 tons of ore obtained from floor pillars and broken ore from old shrink stopes at *King Solomon Gold Mines*, Edwards Find yielded 1,414 fine ounces. All of this ore was treated by Great Western Consolidated at Bullfinch. Other producers in the Marvel Loch area include the *Frances Furness* with 570 ounces from 1,740 tons, *Newry* with 558 ounces from 5,201 tons, and the *Prince George* with 155 ounces from 1,323 tons.

At Eenuin the *Sweet William* mine produced 122 ounces from 452 tons.

## MOUNT MARGARET GOLDFIELD.

The total ore treated in this goldfield was 138,745 tons which yielded 33,977 fine ounces of gold at an average rate of 4.9 dwts. per ton. This output represented 3.9 per cent. of the State's total. In the previous year 140,698 tons averaging 4.8 dwts. recovery were treated for a yield of 34,106 fine ounces.

In the *Mt. Morgans District* 107 ounces were produced from 81 tons. Most of this production came from a prospecting area situated about ten miles north of Murrin.

The decline in mining activity in the *Mt. Margaret District* is inferred by the production of 10 ounces of alluvial gold.

The *Sons of Gwalia Ltd.* operating in the Mount Malcolm District produced 32,947 fine ounces from the treatment of 135,995 tons of ore. The average recovery was 4.85 dwts. per ton which compares favourably with the previous year's grade of 4.76 dwts. obtained when 138,618 tons yielded 32,983 ounces.

This mine employed an average of 272 men throughout the year, 116 on the surface and 156 underground.

Total development for the year was 3,491 feet which consisted of 1,444 feet driving, 251 feet crosscutting and 1,796 feet rising. Good values over 20 feet were cut in the No. 14 level crosscut but in most other cases values were average. Exploratory drilling from stations situated between the 12 and 27 levels amounted to 9,653 feet. Reserves are estimated at 224,000 tons of 4.95 dwt. ore.

The only small producer of note was the *Monte Christo* at Lake Darlot where mining of a low grade laterite deposit returned 117 ounces from 1,429 tons.

## NORTH COOLGARDIE GOLDFIELD.

Production from this goldfield amounted to 15,849 fine ounces of gold recovered from 30,053 tons of ore averaging 10.5 dwts. per ton. As a comparison the production for the previous year was 20,250 ounces from 37,672 tons averaging 10.8 dwts. Output for this goldfield was 1.8 per cent. of the total.

In the *Menzies District* the main producer was *Moonlight Wiluna Gold Mines Ltd.* operating the Timoni mine at Mt. Ida. From this mine 12,496 ounces were obtained from 23,871 tons. Development work concentrated in the southern section was successful in exposing payable ore. South drives were advanced on the 3, 4, 5, 6 and 7 levels and some winze connections were started. At 1,632 south, a shaft was sunk from the surface to 149 feet and a plat cut preparatory to level development. To improve the ventilation this shaft will be deepened to connect with the southern workings from the main shaft.

Production from the *Goodenough* mine at Menzies was 146 fine ounces from 274 tons. This ore came from 62 feet of driving and later leading stoping of the 139 foot level.

In the *Ularring District* the production was 492 fine ounces of gold from the treatment of 532 tons of ore. The *Oakley* mine at Davyhurst produced 196 ounces from 152 tons and the *Golden Wonder* at Mulline, 96 ounces from 83 tons.

The principal producer in the *Niagara District* was the *Altona* with 213 ounces from 665 tons. Ore breaking on the five level ceased and mining was concentrated on a block of ore left on the upper levels in the north end of the mine.

In the *Yerilla District* 1,974 tons were treated for a return of 1,654 fine ounces of gold. Practically all of this production came from the *Yilgangie Queen* which produced 1,558 ounces from 1,610 tons. Five men were employed on the mine and most of the ore was broken above the 375 level north of the Melody shaft. Towards the end of the year an electric pump was installed to unwater this shaft to the 425 foot level.

## COOLGARDIE GOLDFIELD.

During 1961, 27,274 tons of ore were treated for a return of 13,834 fine ounces of gold at an average recovery rate of 10.1 dwt. per ton. In the previous year 17,894 tons yielded 12,342 fine ounces.

*Gold Mines of Kalgoorlie (Aust.) Ltd.* operating the Bayley's mine at Coolgardie reported the production of 9,700 fine ounces from 17,219 tons of ore. In addition 272 fine ounces from 732 tons were obtained by tributers working certain blocks of ore in the Barbara and Surprise mines.

The internal shaft from the No. 11 level was sunk a further 118 feet during the year and development started on the Nos. 14 and 15 levels of Price's reef. Rich shoots of ore encountered on the 12 and 13 levels will be stoped out in 1962.

*Paris Gold Mines Pty. Ltd.* previously operating under the name of Northern Minerals Syndicate produced 1,548 ounces from the treatment of 5,540 tons. Included in this production was 483 ounces obtained from 102 tons of concentrates shipped to Sweden. These concentrates also contained 878 ozs. of silver and 16½ tons of copper valued at £2,472 f.o.b. Fremantle.

The treatment plant at the mine is capable of treating 10 tons of ore per hour. It consists of two ball mills, strakes and flotation cells for the gold-copper concentrates. Provision has been made in the plant for the treatment of the old Paris tailings dump estimated to contain 25,000 tons averaging 4.5 dwt. gold and 2 per cent copper.

Among the smaller producers, the best returns were from the *Little Nipper* at Ryans find with 455 ounces from five parcels (18 tons) of specimen stone treated in the State Battery Berdan pan, and the *Jackpot* at the Camel Farm Reserve with 340 ounces from 777 tons.

Revived interest in the *Kunanalling District* resulted in a number of small parcels yielding 385 ounces from 306 tons.

## PILBARA GOLDFIELD.

In the goldfield 4,639 fine ounces of gold were recovered from 7,359 tons of ore averaging 12.6 dwt. per ton.

*North West Mining N.L.* operating the *Blue Spec* mine at Nullagine treated 4,843 tons for a return of 3,234 ounces. Shortage of developed high grade ore and plant difficulties caused the closure of the mine in September. During the period that the mine was operating most ore was mined from the stope between Nos. 3 and 4 levels with some additional ore coming from the 608 sub level drives and from broken ore in the No. 3 stope.

A new shoot of ore was opened up at *Barton* mine and returned 121 fine ounces from 203 tons.

Mining at Bamboo Creek resulted in 1,640 tons being treated at the Marble Bar and Bamboo Creek State Batteries for a recovery of 765 fine ounces. The principal producer was the *Prince Charles* with 676 ounces from 923 tons. Sands retreatment at the two batteries yielded 374 fine ounces.

## PHILLIPS RIVER GOLDFIELD.

The only production in this field was from *Ravensthorpe Copper Mines N.L.* which recovered 2,720 fine ounces of gold as a by product of copper mining.

## BROAD ARROW GOLDFIELD

Total production for the year was 2,455 fine ounces of gold from the treatment of 3,495 tons of ore. This goldfield is popular with a number of weekend prospectors from Kalgoorlie. An expected boost to the Ora Banda centre was prevented by lack of water. The new plant at the *Gimlet South* was completed and after the usual teething troubles the plant was compelled to close down after only a few weeks run. This plant can treat 50 tons per day but for the year under review the output from this mine was 120 ounces from 921 tons. At the same centre the *Sleeping Beauty* produced 423 ounces from 1,045 tons.

At *Cave Hill* work was continued on the ore shoot discovered in the previous year. 335 fine ounces were recovered from the 32 tons treated. Among the other small producers in this goldfield the more successful were the *New Mexico* with 216 ounces from 233 tons and the *Prince of Wales* with 208 ounces from 133 tons.

## GASCOYNE GOLDFIELD

Gold output of 452 ounces from 137 tons was more than three times the reported production for the previous year. From a gold prospect on Mangaroon station the owners reported the recovery of 445 ounces from 137 tons of ore treated at the Meekatharra State Battery. Although the returns were good, no real effort has been made to thoroughly test the extent of the ore body.

## EAST MURCHISON GOLDFIELD

There was very little activity in this goldfield where 373 ounces were recovered from the treatment of 1,063 tons. The *Tahmoo* at the Goanna Patch on Wildara station produced 212 ounces from 533 tons. The *K.I.M.* syndicate at Agnew continued development work and about 120 tons of ore has been raised but not treated.

## PEAK HILL GOLDFIELD

Production totalled 329 fine ounces of gold from the treatment of 3,422 tons of ore. This total includes a parcel of 1,536 tons yielding 168 ounces from the *Horseshoe Lights*. Most of the remaining production came from the treatment of low grade laterite material from leases around Peak Hill.

## SOUTH WEST MINERAL FIELD

Recorded production from this field was 222 fine ounces from 218 tons. All of the ore crushed came from *Griffins Find* at Lake Grace and was treated at the Coolgardie State Battery for a return of 114 fine ounces of gold.

## NORTH EAST COOLGARDIE GOLDFIELD

Production from this goldfield amounted to 161 fine ounces from the treatment of 643 tons.

Other sources within the State produced 106 fine ounces of gold from 119 tons of ore treated.

## MINERALS OTHER THAN GOLD

The production of minerals, other than gold, for 1960 and 1961 is shown in the table below.

### MINERAL OUTPUT (EXCEPT GOLD)

| Mineral | 1960 | | 1961 | |
|---|---|---|---|---|
| | Tons | Value £A | Tons | Value £A |
| Asbestos— | | | | |
| Chrysotile .... | 61·26 | 1,602 | 156·13 | 2,629 |
| Crocidolite .... | 12,921·59 | 1,418,767 | 14,086·59 | 1,532,540 |
| Bauxite .... .... | 26,892·00 | * | 9,849·00 | * |
| Bentonite .... | 382·00 | 1,533 | 586·70 | 1,598 |
| Beryl .... .... | 181·17 | 33,024 | 260·85 | 40,079 |
| Bismuth .... .... | .... | .... | 0·41 | 371 |
| Building Stone .... | 40·00 | 1,300 | 4·45 | 53 |
| Clays— | | | | |
| Cement Clay .... | 13,015·00 | 10,844 | 17,864·00 | 17,909 |
| Fireclay .... | 20,346·50 | 26,512 | 26,383·75 | 30,710 |
| Brick Clays .... | 24,996·00 | 22,888 | 16,218·00 | 17,791 |
| White Clay .... | .... | .... | 771·60 | 3,067 |
| Coal .... .... | 922,393·50 | 2,439,195 | 765,739·73 | 1,680,259 |
| Copper— | | | | |
| Ore and Concentrates .... | 3,556·85 | 199,738 | 6,205·18 | 322,499 |
| Fertiliser Grade | 7,726·81 | 140,252 | 7,383·82 | 157,488 |
| Dolomite .... .... | 403·92 | 1,616 | 374·00 | 1,496 |
| Felspar .... .... | 1,942·00 | 8,283 | 1,190·00 | 5,210 |
| Fuller's Earth .... | .... | .... | 40·76 | 163 |
| Glass Sand .... | 8,636·95 | 6,102 | 8,214·78 | 5,861 |
| Glauconite .... | 111·00 | 5,550 | .... | .... |
| Ilmenite .... .... | 114,661·72 | 485,562 | 123,538·46 | 557,889 |
| Iron Ore— | | | | |
| Exported .... | 837,147·00 | 830,124 | 1,284,768·00 | 1,274,053 |
| For Pig .... | 79,085·00 | 1,098,825 | 80,437·00 | 1,088,192 |
| Lead Ore and Concentrates .... | 2,263·69 | 119,292 | 597·05 | 25,766 |
| Leucoxene .... | 84·10 | 1,430 | 268·10 | 4,120 |
| Limestone .... | 11,327·75 | 14,935 | 14,199·15 | 18,839 |
| Magnesite .... | .... | .... | 9,624·92 | 64,977 |
| Manganese .... | 53,788·84 | 753,005 | 67,652·14 | 884,262 |
| Monazite .... .... | 241·96 | 9,319 | 1,005·20 | 25,699 |
| Ochre .... .... | 104·00 | 1,040 | 294·27 | 1,770 |
| Petalite .... .... | .... | .... | 96·00 | 409 |
| Phosphatic Guano | 86·79 | 938 | 115·00 | 807 |
| Pyrites .... .... | 53,298·79 | 366,739 | 52,397·00 | 369,094 |
| Quartz Grit .... | 288·00 | 243 | 58·20 | 58 |
| Rutile .... .... | 621·41 | 15,686 | 552·84 | 11,953 |
| Semi-Precious Stones— | | | | |
| Prase .... | 1·00 | 40 | .... | .... |
| Tiger Eye Opal | 0·05 | 97 | .... | .... |
| Silver (fine ozs.) .... | 193,821·63 | 80,613 | 179,992·12 | 75,018 |
| Spodumene .... | .... | .... | 5·00 | 85 |
| Talc .... .... | 5,470·39 | 69,114 | 5,149·28 | 64,581 |
| Tantalo/Columbite | 10·57 | 16,982 | 14·20 | 22,917 |
| Tin Concentrates | 280·82 | 168,775 | 341·16 | 235,580 |
| Zircon .... .... | 4,624·45 | 49,270 | 6,098·90 | 61,314 |
| Totals .... | .... | 8,454,863 | .... | 8,669,950 |

* Value not available for publication. Brief notes on mineral production are given below.

## ASBESTOS

Old dumps at Lionel were the source of 49 tons of chrysotile and at Nunyerry 107 tons were produced from previously stockpiled low grade material. Testing of the Lionel deposits was started late in the year and it is expected that regular fibre output from this centre should be established by 1963.

*Australian Blue Asbestos Ltd.* at Wittenoom produced 14,087 tons of crocidolite valued at £1,532,540. This mine employed an average of 193 surface and 211 underground employees.

To improve underground ventilation an additional primary fan was installed and separate circuits were designed to ensure adequate ventilation throughout the workings. The company is making every effort to effectively control dust in both the mine and the mill.

Underground development has advanced to the No. 7 level and during the year the bulk of ore mined came from the lower seam sections of Nos. 2, 3 and 4 levels. Tests were made with a system of long wall mining in the stopes to eliminate the need to leave rock pillars. If this method proves practicable it will avoid the blind pockets which have been the main ventilation problem underground. Development work in the mine for the year was 4,681 feet of driving, 557 feet of crosscutting, 712 feet of rising and 3,117 feet of diamond drilling.

## BAUXITE

There were 9,849 tons of bauxite exported by *Western Aluminium N.L.* during the year. Most of the ore came from the Dwellingup-Jarrahdale area where testing of the deposits is still in progress. In June an agreement was signed by the State Government and the company for the establishment at Kwinana of a refinery for the production of alumina. The company, now Alcoa of Australia Pty. Ltd. has started work on the refinery site.

## BENTONITE

Bentonite production from Marchagee totalled 587 tons valued at £1,598.

## BERYL

Two hundred and sixty-one tons, containing 2,975 units of beryllium oxide, valued at £40,079, were obtained from claims in the Pilbara, West Pilbara, Gascoyne and Yalgoo goldfields. Main producing centres were Roebourne with 941 units, Yinnietharra with 926 units, Marble Bar with 604 units, Dalgaranga with 162 units and Mt. Francisco with 132 units.

## CLAYS

Reported clay production from the Metropolitan area, Clackline, Glen Forrest and Goomalling totalled 61,237 tons valued at £69,477.

## COAL

The total output from all mines in the Collie Coalfield was 765,740 tons valued at £1,680,259 at the pit head. Open cut production at 259,433 tons represented one third of the field's output.

The *Griffin Coal Mining Co. Ltd.* operating the Hebe mine and the Muja open cut produced 463,202 tons. In the Hebe mine, the extraction of bottom coal in the No. 1 right panel district was completed towards the end of the year and the same operation was commenced in No. 2 left panel district in an area where the first working had been completed. Where bottom coal is extracted, the pillars are rib-bolted to counteract any fretting which may occur. The main development headings progressed under good conditions and with gradients of approximately 1 in 20. Some trouble was experienced from the overburden dump on the east side of the open cut. The dump moved down on several occasions causing some loss of coal together with a loss in production.

Western No. 2 mine of *Western Collieries Ltd.* with a production of 239,873 tons was the largest deep mine producer in the field. The potential of this colliery was increased by the granting of two additional leases on the western side. No. 3 West lateral development headings which had been stopped at the boundary were restarted and at the end of the year had advanced 16 chains into the new leases. The coal is of good quality and varies from 14 to 16 feet in thickness.

Western No. 4 mine produced 62,665 tons for the year. Work is in progress with the driving of a drift into the 9 ft. thick No. 3 seam which is approximately 53 feet below the present workings.

## COPPER

Production of copper ore, for use as a trace element in fertilizers was 7,384 tons as compared wtih 7,727 tons for the previous year. An average grade of 10% Cu. was marketed during both periods. The State's leading producer was the *Copper Hills Copper Mine* in the Pilbara which produced 1,604 tons of a mixed ore and concentrate averaging 17% Cu. and valued at £72,885. A development and exploratory programme was started late in the year as most of the available ore had been mined.

The *Thaduna Copper Mining Coy.* in the Peak Hill Goldfield produced 3,895 tons of 7% copper valued at £38,190. Another ore body, adjacent to the main open cut, was discovered and this should provide the bulk of the 1962 demand for fertilizer grade ore.

From *Kumarina* 315 tons of 19% Cu. ore were mined and milled for a return of £17,218. This ore is finely ground and bagged at the mine prior to sale to the fertilizer companies.

*Ravensthorpe Copper Mines N.L.* produced 6,189 tons of concentrate containing 146,125 units valued at £320,371. This production was exported. In addition 2,501 fine ounces of gold, 7,867 fine ounces of silver and 44 tons of fertilizer grade ore were produced.

The company has equipped the Beryl mine at Kundip which is ready for ore production. The Cattlin shaft which was unwatered and reconditioned last year has proved a successful feeder to the Elverdton. The ore position was improved towards the end of the year by the development of several small shoots of ore on the No. 5 level Elverdton shaft.

## DOLOMITE.

From their leases at Mount Magnet, *Westralian Ores Pty. Ltd.* sold 374 tons valued at £1,496.

## FELSPAR.

*Australian Glass Manufacturers Co. Pty. Ltd.* reported a production of 1,190 tons from their quarry at Londonderry. This production was valued at £5,210 f.o.r. Coolgardie.

## FULLERS EARTH.

Forty-one tons were obtained from a deposit at Marchagee.

## GLASS SAND.

Production from the Lake Gnangarra deposit amounted to 8,215 tons valued at £5,861.

## GYPSUM.

Plaster manufacturers obtained their supplies of raw material from Yellowdine, Lake Brown, Baandee and Lake Cowcowing. This output of 28,045 tons was valued at £22,740. *Garrick Agnew Pty. Ltd.* exported through Esperance 14,479 tons of Lake Cowan gypsum valued at £37,889. Cement manufacturers obtained 2,427 tons from Nukarni. Total production for the year, including 194 tons for agricultural purposes, was 45,145 tons valued at £62,844.

## ILMENITE, LEUCOXENE, MONAZITE AND ZIRCON.

Overseas shipments of Ilmenite totalled 123,538 tons valued at £557,889 f.o.b. Bunbury.

*Cable (1956) Ltd.* operating at Bunbury sold 10,985 tons assaying 55.05% $TiO_2$. 22,852 tons containing 55.16% titanium dioxide was won from the Wonnerup deposit of *Ilmenite Pty. Ltd. Westralian Oil Ltd.* obtained 28,631 tons of 59.42% $TiO_2$ from their deposit at Yoganup. The State's leading producer, *Western Titanium N.L.* operating at Capel produced 61,070 tons having an average assay of 55.31% $TiO_2$. This company was also responsible for the total output of 268 tons of Leucoxene, 1,005 tons of Monazite, 553 tons of Rutile and 6,099 tons of Zircon.

## IRON ORE.

During 1961, 1,284,768 tons of iron ore were shipped from Cockatoo Island by *Australian Iron and Steel Ltd.* This ore destined for the Eastern States had an average assay of 62.75% Fe. This is the first year that output has exceeded one million tons.

At Koolan Island the preparation of a townsite, power house site, wharf loading structure, ore bin excavation and access roads has advanced quite rapidly.

In the Kimberley, Pilbara, West Pilbara, Ashburton, Gascoyne, Peak Hill and Yalgoo Goldfields the search for iron ore has been intensified and some excellent initial results have been reported by prospecting parties.

In the Murchison the Mines Department is diamond drilling the iron ore deposit at Wilgie Mia in the Weld Range.

The *Charcoal Iron and Steel Industry* at Wundowie obtained 80,437 tons of ore averaging 61.70% Fe from the Koolyanobbing deposit. Pig iron produced was 50,586 tons valued at £1,088,192.

## LEAD.

Production in the Northampton Mineral Field declined to 597 tons of concentrate, the lowest output since 1947. The concentrates contained 433 tons of lead valued at £25,766 f.o.b. Geraldton. No expansion in this industry is expected till there is a substantial rise in the price of lead.

The *Gurkha Lead Mine* ceased operations in November after having produced continuously since August 1954. During this period the mine treated 32,362 tons for a recovery of 6,460 tons of lead concentrates. An examination of the Wheal May mine, which had been idle for 50 years, showed that all available ore had been extracted and that values underfoot were not encouraging.

The *Nooka Lead Mine* which was re-opened during 1960 reported the sale of 198 tons of concentrate for 1961. This mine closed down late in the year when it was found that the zinc sulphides associated with the galena made mining uneconomical at ruling lead prices.

The only mine still operating at the end of the year was the *Mary Springs Lead Mine* which produced 84 tons of concentrate from approximately 370 tons of ore.

## LIMESTONE.

Limestone quarries in the Wanneroo district produced 14,199 tons valued at £18,839. This stone was used for home road foundations, and lime burning. The recorded output represented about one-quarter of the State's production. The two cement companies obtained their supplies from Spearwood and the Iron and Steel work's stone came from a quarry at Beaconsfield.

## MAGNESITE

Garrick Agnew Pty. Ltd. exported through Esperance 9,625 tons of magnesite obtained from the Bandalup Creek deposit near Ravensthorpe.

## MANGANESE

Exports from Port Hedland totalled 57,928 tons of 49% Mn ore valued at £760,614. The Principal producers were *Northern Minerals Syndicate* with 32,376 tons from Woody Woody, *Pindan Pty. Ltd.* with 11,995 tons from Nimingarra and *D.F.D. Rhodes Pty. Ltd.* with 8,851 tons from Mount Cooke.

Production of ore from the Horseshoe locality in the Peak Hill Goldfield was recommenced late in the year and a total of 1,689 tons was mined before the labour force moved to Skull Springs in the Pilbara. Exports of this and stockpiled ore at Geraldton amounted to 8,885 tons assaying 45% Mn. Other sales of Peak Hill manganese included 285 tons of battery grade and 554 tons of low grade material.

## OCHRE

*Universal Milling Co. Pty. Ltd.* obtained 177 tons of yellow and 117 tons of red ochre from the Wilgie Mia deposits in the Weld Range.

## PENTALITE

Ninety six tons were produced by hand picking in the felspar quarry at Londonderry.

## PHOSPHATIC GUANO.

Reported production from the Jurien Bay area was 115 tons valued at £807.

## PYRITES

*Norseman Gold Mines N.L.* railed 39,001 tons of concentrate, containing 18,412 tons of sulphur, to super phosphate works in the metropolitan area. This output was valued at £299,717 f.o.r. Norseman.

A small development programme was started to convert partly developed ore into blocks ready for stope preparation. Most of the 98,436 tons of ore mined came from stopes above the No. 6 level.

*Gold Mines of Kalgoorlie (Aust.) Ltd.* forwarded to works at Fremantle 13,396 tons of auriferous pyritic concentrate containing 5,550 tons of sulphur valued at £69,377.

## QUARTZ GRIT

Production for local use at Collie was 58 tons.

## SILVER

Silver as a by-product of gold, copper and lead mining amounted to 179,992 fine ounces valued at £75,018.

## SPODUMENE

Five tons were obtained from a deposit near Ravensthorpe in the Phillips River Goldfield.

## TALC

*Three Springs Talc Pty. Ltd.* produced 5,149 tons from their open cut at Three Springs. This output was valued at £64,581 at the works Welshpool

## TANTALO - COLUMBITE

Fourteen tons of concentrate containing 616.7 units of $Ta_2O_5$ and $Nb_2O_5$ valued at £22,917 were produced in the State. The main producing centres were Marble Bar with 4.25 tons, Greenbushes with 2.57 tons and Roebourne with 4.19 tons. Although no production was recorded, prospectors were active at the new find at Warda Warra in the Yalgoo Goldfield.

## TIN

Production for the year was 341 tons of concentrate containing 231 tons of the metal. Tin producers at the Moolyella, Cooglegong, and Shaw River deposits in the Pilbara were responsible for all but 20 tons of the State's output. Principal producers were Mineral Concentrates Pty. Ltd. with 106 tons, Northern Mineral Syndicate with 86 tons, H. V. Leonard with 48 tons and J. A. Johnston with 41 tons. The tin deposits at Greenbushes are being examined by Aberfoyle Tin N.L. which company has been granted a temporary reserve over the area.

J. K. N. LLOYD
Assistant State Mining Engineer.

Appendix No. 1.

## EXPLORATORY DRILLING.

*State Mining Engineer.*

*Report on Drilling Activities for Year Ended 31/12/61.*

The footage drilled for the year by the Mines Department drilling section showed an increase on that of last year of 840 feet, due to the Failing rig coming back into active commission. For the period no drilling for gold was undertaken by our Department throughout the State and our activities were restricted to prospecting for water and iron ore.

Mines Department Rig No. 2 (Failing) was occupied for a month at Mendel Wongoody, approximately 30 miles north of Mingenew, where it drilled a hole to 1,031 feet. Unfortunately the water had a salt content of 740 gr. per gallon and the hole was abandoned.

After construction of a steel ramp and platform about 4 feet high the rig was taken to Australind where drilling on behalf of La Porte Titanium for water was commenced. The first hole was completed at a depth of 739 feet and after development and cementing in of casing tests indicate that an output of 18,000 gallons per hour can be obtained.

Hole No. 2 was drilled to 900 feet and testing and developing of this bore showed an output of about 24,000 gallons per hour.

Total footage for the year drilled by this machine was 2,670.

Rig No. 3 was operated for the period by Mr. A. E. Horsham under a contract agreement at Weld Range on the Iron Ore Resources programme. A total of 3,749 feet was drilled by this plant.

Rig No. 4 was not used for the year and a nil footage return is submitted.

Rig No. 5, an A.2000 Mindrill, was hired by Mr. K McCallum from November, 1960, to November, 1961, and was used drilling on the Hill 50 leases at Mt. Magnet. Approximately 8,000 feet in 10 holes were completed here. Footage returns for this machine are not forwarded by the hirer and the figure given is an estimate made for the purpose of checking the life of the machine. The plant has since been returned to our store at Welshpool where it is undergoing a complete refit at the end of the year.

Rig No. 6—A.2000. The work proposed for this machine at Mt. Goldsworthy was cancelled and the plant was transported to Wilgie Mia in April, 1961, where 1,047 feet were drilled for the period under review.

Rig No. 7—Mindrill F.20. A nil footage return for this rig is submitted.

Rig. No. 8—Mindrill E.500. The head from this plant was returned from Wyndham where it was on hire to Mr. Burrows, and in March was hired by the Sons of Gwalia. No footage return for this machine has been recorded.

## HYDROLOGICAL SECTION.

Ruston Bucyrus Rig No. 1 was engaged on Hole No. 4 at Badgingarra, which was advanced from 852 to 962 feet. Developing, surging and testing of the hole was done, giving a result of about 6,000 gallons per hour.

Hole No. 5 was drilled to 790 feet but the water proved too saline for exploitation and the hole was abandoned.

On completion of this work this rig was hired by the Public Works Department and taken to Wicherina for drilling at this centre. A total of 840 feet was drilled by this machine for the drilling section during the period under review.

Rig. No. 2. After repairs and modifications to the towing arrangement on this rig following overturning on the road, this machine was taken to Westfield and drilled one hole to 442 feet for water to the year.

The total footages drilled by the hydrological section was thus 1,282 feet.

A policy of assistance to all drillers engaged in the development of the natural resources of the State has been followed during the year and technical assistance in the matter of advice and equipment has been tendered to the following firms for the period:—

- Public Works Department—Ord River job—Equipment loaned.
- State Batteries Department—Equipment stored, engine descaled.
- Rio Tinto—Equipment loaned.
- Geological Surveys—Equipment loaned.
- Sons of Gwalia—Equipment loaned.
- Wastphal Bros. & Co.—Equipment loaned, casing loaned.
- Baker Bros.—Equipment loaned, casing loaned.
- Davis Hankinson—Equipment loaned, casing loaned.
- Australian Blue Asbestos—Equipment loaned, casing loaned.
- Western Aluminium—Equipment loaned, casing loaned.
- Western Mining Corporation—Equipment loaned, casing loaned.
- Public Works Department—Wicherina—Ekuipment loaned, casing loaned.
- Union Carbide Company—Equipment loaned, casing loaned.
- Mangore Aust. Pty. Ltd; Equipment loaned, casing loaned.
- Midland Drilling Coy.—Equipment loaned, casing loaned.

The issuing, checking and receipt of equipment loaned and hired to these various contractors and firms involves a considerable amount of work to this section, but must ultimately be of benefit to the State in assisting to exploit our potential resources.

J. HADDOW,
Inspector of Mines (Drilling).

TABLE SHOWING FOOTAGE DRILLED FOR YEAR ENDED 31st DECEMBER, 1961

| Rig No. | Machine | Place | Purpose | Footage | Total | Basis | Remarks |
|---|---|---|---|---|---|---|---|
| 2 | Failing | Mendel Wongoondy | Water Supply | 1,031 | .... | Contract | |
| | | Australiand | Water Supply | 1,639 | .... | Contract | |
| | | | | | 2,670 | | |
| 3 | Mindrill A.3000 | Weld Range | Iron Ore Resources | 3,749 | 3,749 | Contract | |
| 4 | Mindrill A.2000 | .... | .... | *Nil* | .... | .... | |
| 5 | Mindrill A.2000 | Mt. Magnet | .... | *Not Recorded* | .... | .... | Hired by K. McCallum |
| 6 | Mindrill A.2000 | Weld Range | Iron Ore Resources | 1,047 | 1,047 | Contract | |
| 7 | Mindrill F.20 | .... | .... | *Nil* | .... | .... | |
| 8 | Mindrill E.500 | Gwalia | .... | *Not Recorded* | .... | .... | Hired by Sons of Gwalia G.M. |
| | | | PERCUSSION RIGS | | | | |
| 1 | Ruston Bucyrus | Badgingarra | Water Supply | 840 | .... | Wages | |
| 2 | Ruston Bucyrus | Westfield | Water Supply | 442 | .... | Wages | |
| | | | | | 1,282 | | |
| | | | | | 8,748 | | |

Appendix No. 2

June 19, 1962

The Chairman, Board of Examiners, for Mine Managers' and Underground, Supervisors' Certificates, Mines Department, Perth.

ANNUAL REPORT

Hereunder I submit the Annual Report on the activities of the Board of Examiners for Mine Managers' and Underground Supervisors' Certificates for the year 1961.

*Mining Law Examination*

An examination in Mining Law for the Mine Manager's Certificate of Competency was held on 10th April, 1961.

Details were as follows:—

| | |
|---|---|
| Entries | 4 |
| Admitted | 3 |
| Passed | 2 |
| Failed | 1 |

Names of successful candidates:—

Leyland, E. C.
Murphy, A. J.

Copies of the examination paper are attached.

A special examination was held at Wittenoom on 29th August, 1961 for a candidate named R. J. Salone who was successful in passing the examination.

*Underground Supervisor's Examination*

The examination for the Underground Supervisor's Certificate of Competency was held on 29th August, 1961 and attracted applicants from the following centres:—

| | |
|---|---|
| Gwalia | 1 |
| Kalgoorlie | 17 |
| Norseman | 2 |
| Ravensthorpe | 3 |
| Southern Cross | 1 |
| Perth | 2 |
| Wittenoom | 4 |
| | 30 |

All the applicants were admitted and sat for the examination with the following results:—

| | |
|---|---|
| Examined | 30 |
| Passed | 24 |
| Failed | 5 |
| Deferred | 1 |

Certificates of Competency were issued to the successful candidates whose names were as follows:—

| | |
|---|---|
| Bignell, M. W. D. | Simmons, R. O. |
| Cottingham, D. G. | Stone, A. D. |
| Fleay, M. W. | Urbanek, J. Z. |
| McGillivray, W. | Wylie, P. H. |
| Murphy, A. J. | Boyes, K. H. |
| Stillman, S. B. | Duggin, J. A. |
| Trethewey, A. S. | Lacey, S. J. |
| Watson, F. | Mulholland, A |
| Birch, D. F. | Srodzinski, S. C. |
| Deegan, J. B. | Swain, W. T. |
| Kirkham, C. L. | Van Mierlo, W. L. |
| Madalena, R. P. | Ziegler, A. M. |

Copies of the examination papers are attached.

*Mine Managers' Certificates*

Three applications for Mine Managers' Certificates were received during the year. Two of these were approved and one was deferred.

The names of the successful applicants were as follows:—

Antulov, V.
Leyland, E. C.

Legislation was passed during the year to amend the Mines Regulation Act to provide for First and Second Class Mine Managers' Certificates of Competency, to come into operation on a date to be fixed by proclamation; however such date had not been fixed by the end of the year.

*General*

Four meetings of the Board of Examiners were held during the year.

During the latter half of the year, Mr. R. A. Hobson a member of the Board of Examiners proceeded on long service leave. During this period Mr. J. Douglas Collister who was appointed Acting Director of the School of Mines, deputised for him as a member of the "Board".

The Board of Examiners visited the following centres during the year and examined candidates orally for the Underground Supervisor's Certificate of Competency.

Gwalia
Kalgoorlie
Norseman
Perth
Ravensthorpe
Southern Cross
Wittenoom

L. J. CARROLL,
Secretary, Board of Examiners for Mine Managers' and Underground Supervisors' Certificates of Competency.

MINES REGULATION ACT, 1946.
Examination for Mine Manager's Certificate of Competency.

MINING LAW.

April, 1961.

Attempt SIX (6) questions from Section A.
Attempt FOUR (4) questions from section B.

Time Allowed—THREE (3) Hours.

Candidates should note:

(a) The Mining Act and Regulations may be used at the examination but NOT the Mines Regulation Act.
(b) In answering questions in Section B reference to the appropriate Sections of the Act or the Regulations alone will not be sufficient. Candidates must summarise the requirements of the Act and/or Regulations and should also make reference to the relevant section(s) or regulation(s).
(c) Candidates are required to pass in both sections of the paper.

SECTION A.

MINES REGULATION ACT AND REGULATIONS

Attempt SIX (6) questions from this section.
Do NOT attempt more than SIX (6) questions from this section.

Marks allowed are TEN (10) per question.

What is required by the Mines Regulation Act and/or Regulations regarding the following:

1. (a) Raising or lowering of men or material in a cage.
   (b) Raising or lowering of men in a skip.
   (c) Raising or lowering of men in a winze in a kibble.
2. (a) Men working alone.
   (b) When can the underground compressed air supply be shut off.
   (c) Persons required to know signals.
3. (a) Firing in a shaft sink; the shaft cross section being 22 ft. x 8 ft. 6 in.
   (b) Misfires.
4. (a) Safety belts and safety ropes.
   (b) Safe working regarding underground locomotives.
5. (a) Temporary absence of the registered manager.
   (b) Temporary absence of the certificated underground manager.
   (c) What must be done when a mine is to be abandoned.
6. (a) Ladders in shafts.
   (b) Ladders in winzes.
7. (a) Plans to be submitted to the Mines Department.
   (b) Persons authorised to make surveys and draw plans.
8. (a) A development face approaching a a known accumulation of water.
   (b) Underground dams.
   (c) Safety requirements when repairing shafts.

## SECTION B.

## MINING ACT AND REGULATIONS.

Attempt FOUR (4) questtions from this section. Do NOT attempt more than FOUR (4) questions from this section.

Marks allowed are ten (10) per question.

9. (a) What is the difference, if any, between the following:—
   (i) Tailings Area?
   (ii) License to Treat Tailings?
   (b) If a Gold Mining Lease is surrendered what action must the lessee take if he wishes to protect any tailings on the lease?

10. If no exemption or partial exemption has been granted, when must labour conditions be first observed on the following:—
   (i) Gold Mining Lease?
   (ii) Mineral Lease?
   (iii) Mineral Claim?
   (iv) Prospecting Area?
   (v) Dredging Claim?

11. (a) If a mining lease extends into a townsite, surburban area, or other reserve, what protection does the Act provide for those who have surface rights?
   (b) Assuming that the rent (if any) is paid regularly and that the required labour conditions are observed, how long can the following be held:
   Prospecting Area?
   Gold Mining Lease?
   Mineral Claim?
   Mineral Lease?

12. (a) Under what conditions may a drain be constructed through a mining tenement?
   (b) Can a lessee prevent water from an adjacent lease being discharged through a natural channel on his own lease?
   (c) If a lease be declared void, cancelled, or forfeited, when is the land open for selection?

13. Two adjoining leases are connected underground, but are held by different lessees. The first lessee is keeping both properties drained by using his own pumping machinery.
   If the second lessee refuses to contribute to the cost, can he be compelled to contribute and, if so, how and to what extent?

14. (a) Under what circumstances may a dredging claim be granted?
   (b) A holder of a pastoral lease sinks a well on his property. Is the well protected under the Mining Act, and if so, in what way?
   (c) What area of land can be held as a Miner's Homestead Lease?

Western Australia

MINES REGULATION ACT, 1946

Examination for Certificate of Competency as Underground Supervisor

MINING

August, 1961

Time Allowed THREE (3) Hours
Answer ALL Questions

*Note:* Read the examination paper carefully. Answers must be written in ink.

Candidates should illustrate with sketches where possible.

1. Explain in detail what, in your opinion, are the safety precautions and general safe practices, to be always taken and followed by platmen and skipmen, to ensure safety to themselves, the mine personnel, the shaft, and haulage appliances.
2. It is desired to sink a winze below No. 5 level, which is a working level. A winze is to be sunk 150 feet, and 200 feet of exploratory driving is to be carried out in both directions from the winze when sunk. Explain how you would carry out the work, and give details of the equipment you would require for the completion of the project. Sketch the layout and show ventilation in detail.
3. You are the underground supervisor in charge of night shift, and whilst you are on No. 14 level the platman reports to you that a skid 60 feet above the No. 12 level is broken. You have to take charge of the operation of replacing the skid. Explain your actions following the report, and how you would replace the skid.
4. Development on a lower level has exposed a rich ore shoot 40 feet long and 4 feet wide. Diamond drilling shows that the ore body extends only 110 feet above the level. The level next above is 200 feet up. The ore body dips at 60 degrees. Explain how you would stope this ore maintaining good ventilation at all times. Sketches are necessary.
5. Explain how you would charge and fire a winze face for two different methods of firing. Full details must be given.
6. You are an underground supervisor. In the course of your duties you should make certain of the safety of your shift, as well as leave everything in safe order for the oncoming shift.
   What do you do when you—
   (a) Meet up with an ore train
   (b) Examine a winze being sunk
   (c) Enter a leading stope being cleaned out with a mechanical loader
   (d) Are completing your shift?

Western Australia

MINES REGULATION ACT, 1946

Examination for Certificate of Competency as Underground Supervisor

MINING LAW

August, 1961

Time Allowed TWO (2) Hours
Attempt FIFTEEN (15) Questions

*Note:* Read the examination paper carefully. Answers must be written in ink.

What is required by the Mines Regulation Act *or* the Regulations made under that Act regarding ANY FIFTEEN (15) of the following:—

1. Raising or lowering materials in the man cage.
2. A First Aid outfit.
3. Examination of a face to be drilled.
4. "A charge of explosive which has missed fire shall be reprimed and fired" — When?
5. Signal to winding driver, when firing adjacent to shaft.
6. Ventilation stoppings and doors.
7. Ventilation machines.
8. Place where a serious accident has occurred.
9. Hours of employment underground.
10. Control of main magazine.
11. Working party's magazines.
12. Handling of explosives.
13. Who may fire electrically?
14. Men working alone.
15. Penthouses.
16. Winzes.
17. Safety helmets.
18. Safety belts in winzes.
19. Division of shafts.
20. Raising or lowering men in an ore skip in a vertical shaft.
21. Winding machinery brakes and indicators.
22. Power supply indicators for underground winches.
23. Signalling — (Code of Signals not required).
24. Wrong signals.
25. Used ropes.
26. Return airways.
27. Recirculation of air.
28. Development ends.
29. Use of locomotives underground.
30. Underground dams.

# Index to State Mining Engineer's Annual Report for 1961


| | Page |
|---|---|
| Accidents | 21 |
| Accidents—Fatal | 23 |
| Accidents—Serious | 22 |
| Accidents—Winding Machinery | 21 |
| Administrative | 24 |
| Annual Report | 36 |
| Alcoa of Australia Pty. Ltd. | 33 |
| Altona Mine | 31 |
| Asbestos | 33 |
| Australian Blue Asbestos Ltd. | 33 |
| Australian Glass Manufacturers | 33 |
| Australian Iron and Steel Ltd. | 34 |
| Authorised Mine Surveyors | 24 |
| Bamboo Creek | 32 |
| Barton Mine | 32 |
| Bauxite | 33 |
| Bentonite | 33 |
| Beryl | 33 |
| Blue Bird | 30 |
| Blue Spec | 32 |
| Broad Arrow Goldfield | 32 |
| Bulong District | 29 |
| Cable (1956) Limited | 34 |
| Cave Hill | 32 |
| Central Norseman Gold Corporation | 30 |
| Certificates of Competency | 36 |
| Certificates of Exemption | 24 |
| Charcoal Iron and Steel | 34 |
| Classification of Gold Output | 26 and 27 |
| Clays | 33 |
| Coal | 33 |
| Cockatoo Island | 34 |
| Coolgardie Goldfield | 31 |
| Copper | 33 |
| Copperhead Mine | 31 |
| Copper Hills Mine | 33 |
| Corinthian Mine | 31 |
| Cue District | 30 |
| Daisy Mine | 30 |
| Day Dawn District | 30 |
| Development Footages | 29 |
| Dolomite | 33 |
| Drilling—Exploratory | 35 |
| Dundas Goldfield | 30 |
| East Coolgardie District | 29 |
| East Coolgardie Goldfield | 29 |
| East Murchison Goldfield | 32 |
| Eclipse Gold Mines N.L. | 31 |
| Exploratory Drilling | 35 |
| Felspar | 33 |
| Frances Furness | 31 |
| Fraser's Mine | 31 |
| Fuller's Earth | 33 |
| Garrick Agnew Pty. Ltd. | 33 |
| Gascoyne Goldfield | 32 |
| General | 36 |
| Gimlet South | 32 |
| Glass Sand | 33 |
| Goanna Patch | 32 |
| Golden Valley | 31 |
| Golden Wonder | 31 |
| Gold Mines of Kalgoorlie (Aust.) Ltd. | 29, 30, 31, 34 |
| Gold Mining | 25 |
| Gold Production Statistics | 25 |
| Goodenough Mine | 31 |
| Great Boulder Gold Mines Ltd. | 30 |
| Great Western Consolidated | 31 |
| Griffin Coal Mining Co. Ltd. | 33 |
| Griffins Find | 32 |
| Gurkha Lead Mine | 34 |
| Gypsum | 33 |
| Haveluck | 30 |
| Hill 50 Gold Mines N.L. | 30 |
| Horseshoe | 34 |
| Horseshoe Lights | 32 |
| Hydrological Section | 35 |
| Ilmenite | 34 |
| Ilmenite Pty. Ltd. | 34 |
| Iron Ore | 34 |
| Jackpot Mine | 32 |
| Kalgoorlie South Mines | 30 |
| King Solomon Gold Mine | 31 |
| Koolan Island | 34 |
| Koolyanobbing | 34 |
| Kumarina | 33 |
| Kununalling District | 32 |
| Lake Gnangarra | 33 |
| Lake View & Star Ltd. | 29 |
| Lead | 34 |
| Leucoxene | 34 |
| Limestone | 34 |
| Little Nipper | 32 |
| Magnesite | 34 |
| Manganese | 34 |
| Marble Bar | 32 |
| Marchagee | 33 |
| Mary Springs Lead Mine | 34 |
| Meekatharra District | 30 |
| Menzies District | 31 |
| Mine Managers' Certificates | 36 |
| Mine Workers' Relief Act | 24 |
| Mineral Output (except Gold) | 32 |
| Minerals Other than Gold | 32 |
| Mines Producing 5,000 oz. and upwards | 28 |
| Mines Regulation Act | 24, 36 |
| Mining | 36 |
| Mining Act | 24 |
| Mining Law | 36, 37 |
| Monazite | 34 |
| Monte Christo | 31 |
| Moonlight Wiluna Gold Mines Ltd. | 31 |
| Mount Magnet District | 30 |
| Mount Malcolm District | 31 |
| Mount Margaret Goldfield | 31 |
| Mount Monger Mining Syndicate | 30 |
| Mount Morgans District | 31 |
| Murchison Goldfield | 30 |
| Nevoria Mines | 31 |
| New Mexico | 32 |
| Newry | 31 |
| Niagara District | 31 |
| Nimingarra | 34 |
| Nooka Lead Mine | 34 |
| Norseman Gold Mine | 34 |
| Northampton Mineral Field | 34 |
| North-East Coolgardie Goldfield | 32 |
| Northern Minerals Syndicate | 32, 34 |
| North Kalgurli (1912) Ltd. | 30 |
| North-West Mining N.L. | 32 |
| Oakley Mine | 31 |
| Ochre | 34 |
| Operations of the Principal Mines | 29 |
| Ora Banda | 32 |
| Paris Gold Mines N.L. | 32 |
| Peak Hill Goldfield | 32 |
| Pentalite | 34 |
| Permits to Fire | 24 |
| Permits to Rise | 24 |
| Phillips River Goldfield | 32 |
| Phosphatic | 34 |
| Pilbara Goldfield | 32 |

| | Page |
|---|---|
| Pindan Pty. Ltd. | 34 |
| Pilot Mine | 31 |
| Prince Charlie | 32 |
| Prince George | 31 |
| Prince of Wales | 32 |
| Princess Royal | 30 |
| Prohibition | 30 |
| Prosecutions | 24 |
| Pyrites | 34 |
| Quartz Grit | 34 |
| Radio Gold Mine | 31 |
| Ravensthorpe Copper Mine N.L. | 32, 33 |
| Rhodes Pty. Ltd. | 34 |
| Rosemary Mine | 30 |
| Sands Retreatment | 31 |
| Silver | 34 |
| Sleeping Beauty | 32 |
| Sons of Gwalia Ltd. | 31 |
| South-West Mineral Field | 32 |
| Spodumene | 34 |
| Staff | 21 |
| Sunday Labour Permits | 24 |
| Sweet William | 31 |
| Tables showing Footage Drilled 1961 | 35 |
| Tahmoo | 32 |
| Talc | 34 |
| Tantalo-Columbite | 34 |
| Thaduna Copper Mining Co. | 33 |
| Three Springs Talc Co. Pty. Ltd. | 34 |
| Tin | 34 |
| Ularring District | 31 |
| Underground Supervisors' Examination | 36 |
| Universal Milling Co. | 34 |
| Ventilation | 24, 25 |
| Wanneroo District | 34 |
| Western Aluminium | 33 |
| Western Collieries Ltd. | 33 |
| Western Titanium N.L. | 34 |
| Westralian Ore Ltd. | 34 |
| Westralian Ores Pty. Ltd. | 33 |
| Winding Machinery Accidents | 21 |
| Yerilla District | 31 |
| Yilgangie Queen | 31 |
| Yilgarn Goldfield | 31 |
| Zircon | 34 |

# DIVISION III

# *Report of the Superintendent of State Batteries—1961*

*Under Secretary for Mines:*

For the information of the Hon. Minister for Mines, I have the honour to submit my report on the operations of the State Batteries for the year ending 31st December, 1961.

*Crushing Gold Ores.*

One 15-head, five 10-head, and twelve 5-head mills crushed 40,673 tons of ore made up of 584 separate parcels, an average of 69.64 tons per parcel. The bullion produced amounted to 16,324 ozs. which is estimated to contain 13,835 ozs. of fine gold, equal to 6 dwts. 19 grs. of gold per ton of ore.

The cost of crushing, including administration, was 71s. 5d. per ton, a decrease of 4d. per ton compared with the previous year when 39,219 tons were crushed at a cost of 71s. 9d. per ton.

The average value of the ore after amalgamation, but before cyanidation, was 2 dwts. 23 gr. Thus the average head value of the ore was 9 dwts. 18 grs. which is 14 grs. less than the previous year's average.

Values in this ore before cyanidation can be segregated as follows:—

| | Tons. | Per Cent. |
|---|---|---|
| Over 2 dwts. 8 grs. per ton | 16,692¼ | 41.0 |
| 1 dwt. 18 grs. to 2 dwts. 8 grs. per ton .... .... | 6,550 | 16.1 |
| Under 1 dwt. 18 grs. per ton | 17,264 | 42.5 |
| Refractory .... .... .... | 166¾ | .4 |
| | 40,673 | 100.0 |

*Cyaniding.*

Nine plants treated 25,177 tons of tailings from amalgamation for a production of 3,712 fine ozs. of gold worth £58,070. The average content was 3 dwts. 21 grs. before cyanidation, while the residue after treatment averaged 1 dwt. 2 grs. The theoretical extraction was therefore 73 per cent. The actual extraction was 73 per cent.

The cost of cyaniding was 45s. 7d. per ton, an increase of 1s. 10d. per ton on the previous year, when 20,827 tons were treated at a cost of 43s. 9d. per ton.

*Estimated Overall Recovery.*

Figures for estimated recovery are:—

| | Content. Fine Ozs. | Per Ton Crushed. Dwts. | Grs. | Per Cent. |
|---|---|---|---|---|
| Head Value .... | 19,828 | 9 | 18 | 100.0 |
| Amalgamation Recovery .... | 13,835 | 6 | 19 | 69.6 |
| Cyanidation Recovery .... | 3,712 | 1 | 20 | 18.8 |
| Total Recovery .... | 17,547 | 8 | 15 | 88.4 |

*Treatment of Ores other than Gold.*

*Lead Ores.*

During the year the Northampton State Battery crushed 2,471½ tons of lead ore with an estimated average content of 17.3 per cent. lead. There were 14 separate parcels, giving an average of 176.5 tons of ore per parcel.

A total of 533.8 tons of concentrates were produced. The concentrates averaged 72.8 per cent. lead giving an estimated content of 388.7 tons of lead in concentrates.

1,941.7 tons of tailings were discarded. These had an average content of 2.0 per cent. lead, giving a total of 39.7 tons of lead discarded in tailings.

The recovery of lead in the concentrates was 90.7 per cent. of the lead in the ore delivered to the plant.

The cost of operating the Northampton State Battery, including administration, was £9,438 7s. 7d. being 76s. 4d. per ton of ore crushed. Revenue received was £2,957 8s. 6d., 23s. 11d. per ton. The corresponding figures for 1960, when 2,894¾ tons of ore were crushed, were operating cost £8,860 16s. 11d., 61s. 3d. per ton, and revenue £3,101 12s. 6d., 21s. 5d. per ton.

Sales of lead concentrates from the Northampton State Battery for the year were valued at £23,038.

*Tantalite Ore.*

During the year the Northampton Battery crushed ¾ ton of ore for 14 cwt. of concentrates valued at £4,800.

*Agriculture Copper Ore.*

The Meekatharra Battery crushed 67 tons of ore valued at £2,868.

*Value of Production.*

The estimated value of production from the State Batteries since their inception, excluding the value of gold tax paid to the Commonwealth is:—

GOLD.

| Par Production— | 1961. £ | Grand Total. £ |
|---|---|---|
| Crushing | 58,770 | 8,697,644 |
| Cyanidation | 15,768 | 2,150,652 |
| Gold Premium— | | |
| Crushing | 157,439 | 5,198,607 |
| Cyanidation | 42,234 | 1,485,320 |
| Open Market Premium— | | |
| Crushing | 1,687 | 31,981 |
| Cyanidation | 357 | 10,617 |
| Total Gold Production | £276,255 | £17,574,821 |

OTHER ORES REALISED.

| Tin— | | |
|---|---|---|
| Ores | Nil | 94,005 |
| Residues | Nil | 572 |
| Tungsten Concentrates | Nil | 18,850 |
| Agricultural Copper Ore | 2,868 | 5,516 |
| Lead Concentrates | 23,038 | 291,162 |
| Tantalite Concentrates | 4,800 | 4,800 |
| Total Other Ores | £30,706 | £414,905 |
| Grand Total | £306,961 | £17,989,726 |

| | Tons | Expenditure | Receipts | Loss |
|---|---|---|---|---|
| | £ | £ | £ | £ |
| Crushing (Gold Mills) | 40,673 | 145,190 | 20,013 | 125,177 |
| Crushing (Northampton) | 2,472¼ | 9,438 | 2,957 | 6,481 |
| Cyaniding | 25,177 | 57,399 | 29,570 | 27,829 |
| | .... | 212,027 | 52,540 | 159,487 |

The loss of £159,487 is an increase of £5,003 on the previous year. It does not include depreciation and interest on capital.

Capital expenditure, all from General Loan Fund, was incurred as below:—

| | £ | s. | d. |
|---|---|---|---|
| Coolgardie—Alteration to Crushing Plant | 24 | 0 | 0 |
| Kalgoorlie— | | | |
| Arc Welding and Wood Working Machines | 343 | 11 | 8 |
| Rebuild Nos. 1 and 2 Mills | 5,029 | 14 | 11 |
| Lake Darlot—Portable Wheel Weigher | 245 | 5 | 9 |
| Leonora—Erection of Building over Battery | 394 | 15 | 2 |
| Marvel Loch— | | | |
| Rebuild Ramp and Battery Frame | 1,126 | 13 | 2 |
| Renewal of Electrical Wiring | 1,683 | 14 | 5 |
| Meekatharra—Alternator | 212 | 10 | 0 |
| Menzies—Rotary Hoe | 418 | 0 | 0 |
| Nullagine—New Living Quarters | 4,112 | 16 | 7 |
| Ora Banda—Renewal of Electrical Wiring | 1,174 | 9 | 2 |
| Yarri— | | | |
| Improvements to Living Quarters | 2,435 | 13 | 5 |
| Renewal of Electrical Wiring | 78 | 15 | 0 |
| | £17,280 | 0 | 1 |

*Cartage Subsidies.*

| | Tons. | Cost. |
|---|---|---|
| Ore carted to State Plants | 13,402 | £6,347 |

Comparative figures for the last three years are:—

| | | State Plants | | | | Private Plants | | |
|---|---|---|---|---|---|---|---|---|
| Year | Tons Crushed | Tons Subsidised | Per-cent Subsidised | Cost | Tons Subsidised | Cost | Total Cost |
| | | | | £ | | £ | £ |
| 1959 | 39,048 | 12,559 | 32·16 | 6,758 | 853 | 525 | 7,283 |
| 1960 | 39,219 | 12,986 | 33·1 | 6,661 | 296 | 152 | 6,813 |
| 1961 | 40,673 | 13,402 | 32·9 | 6,347 | 298 | 184 | 6,531 |

*Administrative.*

Expenditure amounted to £21,287 16s. 3d., equivalent to 6s. 6d. per ton of ore crushed and cyanided, compared with an expenditure of £20,178 1s. 5d., 6s. 5d. per ton, for 1960.

| | 1960 £ | s. | d. | 1961 £ | s. | d. |
|---|---|---|---|---|---|---|
| Salaries | 11,320 | 10 | 1 | 12,232 | 10 | 8 |
| Pay Roll Tax | 2,964 | 13 | 9 | 3,314 | 7 | 5 |
| Workers' Compensation | 3,728 | 18 | 0 | 4,068 | 15 | 8 |
| Travelling and Inspection | 1,659 | 15 | 6 | 1,259 | 14 | 10 |
| Sundries | 504 | 4 | 1 | 412 | 7 | 8 |
| | £20,178 | 1 | 5 | £21,287 | 16 | 3 |

*Staff.*

I have to report the death of Manager C. C. Ross and the retirement, due to illness, of Manager C. A. Morrow. Both these managers had ably carried out their duties, and their loss will be felt by the Department and other officers.

R. Stevens was appointed Assistant Manager of the Leonora and Lake Darlot Batteries.

Manager Marr was transferred from Ora Banda to Menzies.

I wish to thank all officers for their capable and willing service during the year.

*General.*

The gold mills crushed 1,454 tons more than in 1960, but the average grade of ore crushed was lower. Recovery by amalgamation was 869 oz. fine gold less. The tonnage cyanided was 4,350 tons higher than 1960, and although the grade of material before cyanidation was lower, the recovery by cyaniding was up 294 fine oz. With continued low lead prices, the ore crushed at the Northampton Battery was again lower, being 423 tons less than in 1960.

A small parcel of high grade hand picked tantalite ore was treated at the Northampton Battery. Much of the gangue was discarded, resulting in a higher grade more valuable concentrate. This tantalite ore is mined in the Yalgoo district, and further parcels are expected at the Northampton Battery, or the much closer Boogardie or Cue State Batteries.

The cost per ton of crushing gold ore was fourpence per ton lower than in 1960, while the cost of cyaniding was 1s. 10d. per ton higher. The treatment cost at Northampton was 76s. 4d. per ton, being 15s. 1d. higher than 1960. This plant worked at less than 30 per cent. capacity, making high operating costs inevitable.

K. M. PATERSON,
Superintendent of State Batteries.

## SCHEDULE No. 1

*Return showing tons crushed, Gold Yield by Amalgamation, Average per ton in shillings, and Total value without Premium for the Year Ended 31st December, 1961*

| Battery | Tons Crushed | Gold Yield Bullion ozs. | Value per Ton in shillings | Total Value without Premium £ s. d. |
|---|---|---|---|---|
| Bamboo Creek | 1,333·00 | 941·50 | 50·85 | 3,389 8 0 |
| Boogardie | 443·25 | 453·30 | 73·63 | 1,631 17 8 |
| Coolgardie | 4,247·00 | 2,316·50 | 39·27 | 8,339 8 0 |
| Cue | 693·25 | 141·50 | 14·69 | 509 8 0 |
| Kalgoorlie | 9,353·50 | 3,259·45 | 25·09 | 11,734 0 5 |
| Lake Darlot | 2,078·00 | 450·70 | 15·61 | 1,622 10 5 |
| Leonora | 1,375·75 | 388·95 | 20·35 | 1,400 4 5 |
| Marble Bar | 864·25 | 150·00 | 12·49 | 540 0 0 |
| Marvel Loch | 2,622·50 | 983·00 | 26·98 | 3,538 16 0 |
| Meekatharra | 3,294·50 | 1,101·50 | 24·07 | 3,965 8 0 |
| Menzies | 3,921·25 | 1,118·40 | 20·53 | 4,026 4 10 |
| Norseman | 1,976·25 | 770·85 | 28·08 | 2,775 1 2 |
| Nullagine | 318·50 | 206·50 | 46·68 | 743 8 0 |
| Ora Banda | 2,688·50 | 1,603·80 | 42·95 | 5,773 13 7 |
| Paynes Find | 80·00 | 5·50 | 4·95 | 19 16 0 |
| Peak Hill | 3,317·00 | 366·05 | 7.94 | 1,317 15 7 |
| Sandstone | 92·50 | 63·40 | 49·35 | 228 4 9 |
| Yarri | 1,974·00 | 2,003·15 | 73·06 | 7,211 6 9 |
| Total | 40,673·00 | 16,324·05 | 28·89 | 58,766 11 7 |

## SCHEDULE No. 2

*Number of Parcels Treated, Tons Crushed and Head Value for the Year ended 31st December, 1961*

| No. of Parcels Treated | Battery | Tons Crushed | Yield by Amalgamation: Bullion oz. | Bullion dwts. | Fine Gold oz. | Fine Gold dwts. | Tailings Gross at 100 per cent. oz. | Tailings dwts. | Fine Gold: Total Contents of Ore oz. | Total dwts. | Average per Ton dwts. | grs. | Gross Value per Ton at £4 4 11½d. per Oz. £ s. d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Bamboo Creek | 1,333 | 941 | 10 | 797 | 18 | 561 | 7 | 1,359 | 5 | 20 | 9 | 4 6 6 |
| 15 | Boogardie | 443¼ | 453 | 6 | 384 | 4 | 111 | 14 | 495 | 18 | 22 | 9 | 4 15 0 |
| 85 | Coolgardie | 4,247 | 2,316 | 10 | 1,963 | 5 | 686 | 5 | 2,649 | 10 | 12 | 11 | 2 12 11 |
| 16 | Cue | 693¼ | 141 | 10 | 119 | 18 | 80 | 6 | 200 | 4 | 5 | 19 | 1 4 7 |
| 121 | Kalgoorlie | 9,353½ | 3,259 | 9 | 2,762 | 8 | 1,293 | 18 | 4,056 | 6 | 8 | 16 | 1 16 10 |
| 16 | Lake Darlot | 2,078 | 450 | 14 | 382 | .... | 355 | 6 | 737 | 6 | 7 | 2 | 1 10 1 |
| 29 | Leonora | 1,375¾ | 388 | 19 | 329 | 13 | 156 | 1 | 485 | 14 | 7 | 2 | 1 10 1 |
| 11 | Marble Bar | 864¼ | 150 | .... | 127 | 3 | 297 | 18 | 425 | 1 | 9 | 20 | 2 1 9 |
| 32 | Marvel Loch | 2,622½ | 983 | .... | 833 | 2 | 339 | 7 | 1,172 | 9 | 8 | 23 | 1 18 0 |
| 37 | Meekatharra | 3,294½ | 1,101 | 10 | 933 | 10 | 535 | 18 | 1,469 | 8 | 8 | 22 | 1 17 10 |
| 69 | Menzies | 3,921¼ | 1,118 | 8 | 947 | 17 | 383 | 17 | 1,331 | 14 | 6 | 19 | 1 8 10 |
| 42 | Norseman | 1,976¼ | 770 | 17 | 653 | 6 | 258 | 10 | 911 | 16 | 9 | 5 | 1 19 1 |
| 5 | Nullagine | 318½ | 206 | 10 | 175 | .... | 79 | 4 | 254 | 4 | 15 | 23 | 3 7 9 |
| 38 | Ora Banda | 2,688¾ | 1,603 | 16 | 1,359 | 4 | 575 | 8 | 1,934 | 12 | 14 | 9 | 3 1 1 |
| 1 | Paynes Find | 80 | 5 | 10 | 4 | 13 | 4 | .... | 8 | 13 | 2 | 4 | 9 2 |
| 27 | Peak Hill | 3,317 | 366 | 1 | 310 | 4 | 95 | 6 | 405 | 10 | 2 | 11 | 10 5 |
| 1 | Sandstone | 92½ | 63 | 8 | 53 | 15 | 44 | 3 | 97 | 18 | 21 | 4 | 4 9 11 |
| 28 | Yarri | 1,974 | 2,003 | 3 | 1,697 | 13 | 134 | 19 | 1,832 | 12 | 18 | 14 | 3 18 11 |
| 584 | Total | 40,673 | 16,324 | 1 | 13,834 | 13 | 5,993 | 7 | 19,828 | .... | 9 | 18 | 2 1 5 |

Average Tons per Parcel .... .... .... .... .... .... .... 69·64
Average Yield by Amalgamation per ton (Fine Gold) .... .... .... 6 dwts. 19 grs.
Average Head Value of Tailings .... .... .... .... .... .... 2 dwts. 23 grs.

## SCHEDULE No. 3

*Segregation of Tailings Produced according to Value, Year ended 31st December, 1961*

| Battery | Payable: Tons | oz. | dwts. | 2 dwts. 8 grains to 1 dwt. 18 grains: Tons | oz. | dwts. | 1 dwt. 18 grains and under: Tons | oz. | dwts. | Refractory: Tons | oz. | dwts. | Total: Tons | oz. | dwts. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bamboo Creek | 1,203 | 554 | 12 | .... | .... | .... | 130 | 6 | 15 | .... | .... | .... | 1,333 | 561 | 7 |
| Boogardie | 308 | 99 | 4 | 112 | 11 | 1 | 23¼ | 1 | 9 | .... | .... | .... | 443¼ | 111 | 14 |
| Coolgardie | 1,823¼ | 472 | 19 | 678¾ | 74 | 5 | 1,683¼ | 116 | 1 | 61¾ | 23 | .... | 4,247 | 686 | 5 |
| Cue | 164½ | 46 | 8 | 186¾ | 20 | 3 | 342 | 13 | 15 | .... | .... | .... | 693¼ | 80 | 6 |
| Kalgoorlie | 3,970¾ | 915 | 15 | 1,644 | 147 | 13 | 3,738¾ | 230 | 10 | .... | .... | .... | 9,353½ | 1,293 | 18 |
| Lake Darlot | 1,606 | 315 | 7 | 185½ | 18 | 11 | 286½ | 21 | 8 | .... | .... | .... | 2,078 | 355 | 6 |
| Leonora | 410½ | 98 | 2 | 210¾ | 21 | 3 | 755 | 36 | 16 | .... | .... | .... | 1,375¾ | 156 | 1 |
| Marble Bar | 714¾ | 288 | 18 | 31 | 3 | 2 | 118½ | 5 | 18 | .... | .... | .... | 864¼ | 297 | 18 |
| Marvel Loch | 1,553¾ | 233 | 10 | 717½ | 72 | 6 | 313½ | 18 | 6 | 38 | 15 | 5 | 2,622½ | 339 | 7 |
| Meekatharra | 1,881¾ | 450 | 14 | 376 | 33 | 1 | 969¾ | 52 | 3 | 67 | .... | .... | 3,294½ | 535 | 18 |
| Menzies | 852½ | 189 | 17 | 808¾ | 86 | 10 | 2,260¼ | 107 | 10 | .... | .... | .... | 3,921¼ | 383 | 17 |
| Norseman | 447¼ | 151 | .... | 300¾ | 30 | 5 | 1,228¼ | 77 | 5 | .... | .... | .... | 1,976¼ | 258 | 10 |
| Nullagine | 258½ | 75 | .... | .... | .... | .... | 60 | 4 | 4 | .... | .... | .... | 318½ | 79 | 4 |
| Ora Banda | 1,381¾ | 476 | 15 | 842½ | 84 | 16 | 464¼ | 13 | 17 | .... | .... | .... | 2,688½ | 575 | 8 |
| Paynes Find | .... | .... | .... | .... | .... | .... | 80 | 4 | .... | .... | .... | .... | 80 | 4 | .... |
| Peak Hill | 24 | 3 | 19 | 10 | 1 | 2 | 3,283 | 90 | 5 | .... | .... | .... | 3,317 | 95 | 6 |
| Sandstone | 92½ | 44 | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 92½ | 44 | 3 |
| Yarri | .... | .... | .... | 446 | 44 | 13 | 1,528 | 90 | 6 | .... | .... | .... | 1,974 | 134 | 19 |
| Total | 16,692¼ | 4,416 | 3 | 6,550 | 648 | 11 | 17,264 | 890 | 8 | 166¾ | 38 | 5 | 40,673 | 5,993 | 7 |

## SCHEDULE No. 4

*Details of Extraction Tailings Treatment*, 1961

| Battery | Tons Treated | Head Value | | Contents | Tail Value | | Contents | Recovery Per Cent. | Call | Recovery | Shortage | Surplus |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dwts. | Grs. | Dwts. | Dwts. | Grs. | Dwts. | | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| Bamboo Creek .... | 980 | 7 | 6 | 7,112 | 3 | 19 | 3,720 | 48 | 720 7 8 | 749 18 11 | .... | 29 11 3 |
| Coolgardie .... .... | 2,938 | 3 | 13 | 10,379 | .... | 22 | 2,659 | 74 | 1,639 13 7 | 1,699 10 4 | .... | 59 16 9 |
| Kalgoorlie .... .... | 4,400 | 4 | 2 | 18,033 | .... | 23 | 4,218 | 77 | 2,955 9 0 | 3,016 5 11 | .... | 60 16 11 |
| Lake Darlot .... | 4,030 | 3 | 18 | 15,167 | .... | 18 | 3,109 | 79 | 2,561 0 11 | 2,660 14 9 | .... | 99 13 10 |
| Marble Bar .... | 1,240 | 3 | 23 | 4,885 | 1 | 12 | 1,862 | 62 | 642 0 2 | 660 1 3 | .... | 18 1 1 |
| Marvel Loch .... | 2,619 | 2 | 21 | 7,564 | .... | 17 | 1,872 | 75 | 1,208 17 6 | 1,107 3 10 | 101 13 8 | .... |
| Meekatharra .... | 1,377 | 3 | 20 | 5,302 | 1 | 4 | 1,591 | 70 | 788 6 2 | 590 16 10 | 197 9 4 | .... |
| Menzies .... .... | 3,468 | 3 | 3 | 10,878 | 1 | .... | 3,514 | 68 | 1,742 6 1 | 1,783 9 3 | .... | 41 3 2 |
| Ora Banda .... | 4,125 | 5 | 10 | 22,439 | 1 | 2 | 4,852 | 78 | 3,735 6 11 | 3,740 11 7 | .... | 5 4 8 |
| Total .... .... | 25,177 | 3 | 21 | 101,759 | 1 | 2 | 27,397 | 73 | 15,993 8 0 | 16,008 12 8 | 299 3 0 | 314 7 8 |

| | |
|---|---|
| Net Surplus .... .... .... .... .... .... .... .... | £15 4s. 8d. |
| Head Value .... .... .... .... .... .... .... .... | 3 dwts. 21 grains |
| Tail Value .... .... .... .... .... .... .... .... | 1 dwt. 2 grains |
| Theoretical Recovery .... .... .... .... .... .... .... | 73% |
| Actual Recovery .... .... .... .... .... .... .... | 73% |

## SCHEDULE No. 5

*Direct Purchase of Tailings, Year Ended* 31*st December*, 1961

| Battery | Tons of Tailings Purchased | Amount Paid at £4 4s. 11½d. per oz. | Amount Paid Account of Premium |
|---|---|---|---|
| | | £ s. d. | £ s. d. |
| Bamboo Creek .... .... .... .... .... .... .... .... | 1,174·75 | 917 10 1 | 2,305 12 4 |
| Boogardie .... .... .... .... .... .... .... .... .... | 277·00 | 182 11 2 | 419 2 0 |
| Coolgardie .... .... .... .... .... .... .... .... .... | 1,767·50 | 935 12 11 | 2,470 1 7 |
| Cue .... .... .... .... .... .... .... .... .... .... | 148·25 | 77 19 7 | 179 0 3 |
| Kalgoorlie .... .... .... .... .... .... .... .... .... | 3,943·00 | 1,515 0 11 | 4,240 19 5 |
| Lake Darlot .... .... .... .... .... .... .... .... .... | 1,232·50 | 279 12 1 | 946 19 10 |
| Leonora .... .... .... .... .... .... .... .... .... .... | 248·00 | 96 5 2 | 220 19 7 |
| Marble Bar .... .... .... .... .... .... .... .... .... | 578·75 | 597 7 8 | 1,546 15 0 |
| Marvel Loch .... .... .... .... .... .... .... .... .... | 1,642·25 | 402 13 7 | 1,045 17 10 |
| Meekatharra .... .... .... .... .... .... .... .... .... | 2,275·75 | 762 1 5 | 1,858 9 11 |
| Menzies .... .... .... .... .... .... .... .... .... .... | 638·75 | 252 19 4 | 863 1 9 |
| Norseman .... .... .... .... .... .... .... .... .... | 322·50 | 289 19 5 | 665 13 8 |
| Nullagine .... .... .... .... .... .... .... .... .... | 140·75 | 122 18 10 | 282 4 9 |
| Ora Banda .... .... .... .... .... .... .... .... .... | 1,054·75 | 885 12 11 | 2,712 13 5 |
| Peak Hill .... .... .... .... .... .... .... .... .... | 55·00 | 38 19 8 | 89 9 10 |
| Sandstone .... .... .... .... .... .... .... .... .... | 83·25 | 95 11 11 | 219 9 2 |
| Total .... .... .... .... .... .... .... .... .... | 15,582·75 | 7,452 16 8 | 20,066 10 4 |

## SCHEDULE No. 6

*Cyanide Yield*, 1961

| Battery | Tons | Fine oz. | Value | Premium | Total |
|---|---|---|---|---|---|
| | | | £ | £ | £ |
| Bamboo Creek .... .... .... .... .... .... | 980 | 174·35 | 749·946 | 1,983·620 | 2,733·566 |
| Coolgardie .... .... .... .... .... .... | 2,938 | 395·49 | 1,680·011 | 4,499·724 | 6,179·735 |
| Kalgoorlie .... .... .... .... .... .... | 4,400 | 707·36 | 3,016·296 | 8,046·598 | 11,062·894 |
| Lake Darlot .... .... .... .... .... .... | 4,030 | 628·03 | 2,667·738 | 7,145·379 | 9,813·117 |
| Marble Bar .... .... .... .... .... .... | 1,240 | 158·05 | 676·688 | 1,798·221 | 2,474·909 |
| Marvel Loch .... .... .... .... .... .... | 2,619 | 260·56 | 1,107·191 | 2,964·492 | 4,071·683 |
| Meekatharra .... .... .... .... .... .... | 1,377 | 139·08 | 590·841 | 1,582·526 | 2,173·367 |
| Menzies .... .... .... .... .... .... .... | 3,468 | 370·71 | 1,602·413 | 4,217·870 | 5,820·283 |
| Ora Banda .... .... .... .... .... .... | 4,125 | 878·64 | 3,744·086 | 9,996·375 | 13,740·461 |
| Total .... .... .... .... .... .... | 25,177 | 3,712·27 | 15,835·210 | 42,234·805 | 58,070·015 |

## SCHEDULE No. 7

*Statement of Receipts and Expenditure for the Year ended 31st December, 1961*

**Milling**

| Battery | Tons Crushed | Management and Supervision | Wages | Stores | Total Working Expenditure | Cost per Ton | Repairs and Renewals | Sundries | Gross Expenditure | Cost per Ton | Receipts | Receipts per Ton | Profit | Loss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bamboo Creek .... .... | 1,333 | 705 13 2 | 2,798 10 0 | 1,338 9 7 | 4,842 12 9 | 72 8 | 553 12 5 | 702 10 4 | 6,098 15 6 | 91 6 | 790 16 10 | 11 10 | .... | 5,307 18 8 |
| Boogardie .... .... | 443½ | 309 13 1 | 901 3 6 | 509 0 4 | 1,719 16 11 | 77 8 | 719 9 5 | 588 9 11 | 3,027 16 3 | 136 7 | 226 11 7 | 10 3 | .... | 2,801 4 8 |
| Coolgardie .... .... | 4,247 | 2,414 6 9 | 3,835 13 1 | 2,264 14 6 | 8,514 14 4 | 40 1 | 2,167 0 8 | 1,494 9 8 | 12,176 4 9 | 57 4 | 2,001 6 9 | 9 5 | .... | 10,174 18 0 |
| Cue .... .... .... | 693½ | 2,358 17 7 | 443 3 9 | 516 10 4 | 3,318 11 8 | 95 9 | 447 8 7 | 461 4 1 | 4,227 3 11 | 122 0 | 315 4 5 | 9 1 | .... | 3,911 19 6 |
| Kalgoorlie .... .... | 9,353½ | 4,025 17 9 | 7,113 5 7 | 6,049 11 6 | 17,188 14 10 | 36 9 | 3,941 5 2 | 3,283 2 0 | 24,413 2 6 | 52 3 | 4,205 7 10 | 9 0 | .... | 20,207 14 8 |
| Lake Darlot .... | 2,078 | 1,457 1 11 | 3,055 4 7 | 1,673 1 8 | 6,185 8 2 | 59 7 | 1,064 11 7 | 910 14 9 | 8,160 14 6 | 78 6 | 1,178 12 8 | 11 4 | .... | 6,982 1 10 |
| Laverton .... .... | .... | .... | 138 0 0 | .... | 138 0 0 | .... | 619 7 11 | 27 4 9 | 784 12 8 | .... | .... | .... | .... | 784 12 8 |
| Leonora .... .... | 1,375½ | 1,613 5 2 | 2,061 16 4 | 1,122 18 8 | 4,798 0 2 | 69 9 | 1,099 14 7 | 667 4 3 | 6,564 19 0 | 95 5 | 663 13 7 | 9 8 | .... | 5,901 5 5 |
| Marble Bar .... .... | 864½ | 1,994 5 1 | 1,148 7 4 | 1,133 1 8 | 4,275 14 1 | 98 11 | 1,052 19 3 | 777 0 1 | 6,105 13 5 | 140 2 | 544 8 10 | 12 7 | .... | 5,561 4 7 |
| Marvel Loch .... | 2,622½ | 1,513 2 10 | 4,850 1 2 | 1,646 19 4 | 8,010 3 4 | 61 1 | 2,094 8 3 | 1,107 5 2 | 11,211 16 9 | 85 6 | 1,471 4 10 | 11 3 | .... | 9,740 11 11 |
| Meekatharra .... | 3,294½ | 1,858 4 4 | 5,855 17 11 | 1,757 1 0 | 9,471 3 3 | 57 6 | 1,023 8 10 | 1,269 0 1 | 11,763 12 2 | 71 5 | 1,411 12 11 | 8 7 | .... | 10,351 19 3 |
| Menzies .... .... | 3,921½ | 3,602 5 11 | 3,106 10 11 | 1,585 11 9 | 8,294 8 7 | 42 4 | 699 17 3 | 1,726 14 6 | 10,721 0 4 | 54 8 | 1,741 19 8 | 8 11 | .... | 8,979 0 8 |
| Norseman .... .... | 1,976½ | 1,477 19 10 | 3,281 9 6 | 1,250 8 8 | 6,009 18 0 | 60 10 | 1,977 19 8 | 1,260 17 2 | 9,248 14 10 | 93 7 | 1,005 1 2 | 10 2 | .... | 8,243 13 8 |
| Nullagine .... .... | 318½ | 588 4 8 | 1,270 9 9 | 725 1 9 | 2,583 16 2 | 162 3 | 976 18 10 | 1,039 16 0 | 4,600 11 0 | 288 10 | 189 9 2 | 11 11 | .... | 4,411 1 10 |
| Ora Banda .... .... | 2,688½ | 834 11 2 | 1,803 19 5 | 1,352 8 2 | 3,990 18 9 | 29 9 | 1,319 18 5 | 1,062 14 2 | 6,373 11 4 | 47 5 | 1,382 3 2 | 10 3 | .... | 4,991 8 2 |
| Paynes Find .... | 80 | 204 13 1 | 414 15 9 | 101 16 9 | 721 5 7 | 180 4 | 136 10 0 | 62 12 11 | 920 8 6 | 230 1 | 42 0 0 | 10 6 | .... | 878 8 6 |
| Peak Hill .... .... | 3,317 | 1,218 2 7 | 4,878 14 0 | 1,331 8 8 | 7,428 5 3 | 44 9 | 377 4 5 | 1,652 11 5 | 9,458 1 1 | 57 0 | 1,492 15 1 | 9 0 | .... | 7,965 6 0 |
| Sandstone .... .... | 92½ | 78 3 0 | 95 15 10 | 104 3 2 | 278 2 0 | 60 2 | 66 9 2 | 231 7 5 | 575 18 7 | 124 6 | 47 12 0 | 10 4 | .... | 528 6 7 |
| Yarri .... .... | 1,974 | 1,495 14 3 | 3,025 7 4 | 1,887 17 0 | 6,408 18 7 | 64 11 | 1,495 5 11 | 853 8 4 | 8,757 12 10 | 88 9 | 1,281 8 0 | 13 0 | .... | 7,476 4 10 |
| Head Office .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 21 15 10 | .... | 21 15 10 | .... |
| | 40,673 | 27,750 2 2 | 50,078 5 9 | 26,350 4 6 | 104,178 12 5 | 51 3 | 21,833 10 6 | 19,178 7 0 | 145,190 9 11 | 71 5 | 20,013 4 4 | 9 10 | 21 15 10 | 125,199 1 5 |
| Northampton (Lead) | 2,472½ | 3,056 4 11 | 2,220 15 2 | 1,211 1 8 | 6,488 1 9 | 52 6 | 1,565 11 10 | 1,384 14 0 | 9,438 7 7 | 76 4 | 2,957 8 6 | 23 11 | .... | 6,480 19 1 |
| Total .... .... | 43,145½ | 30,806 7 1 | 52,299 0 11 | 27,561 6 2 | 110,666 14 2 | 51 4 | 23,399 2 4 | 20,563 1 0 | 154,628 17 6 | 71 8 | 22,970 12 10 | 10 8 | 21 15 10 | 131,680 0 6 |
| Net Loss .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 131,658 4 8 |

## SCHEDULE No. 8

*Receipts and Expenditure,* 1961

### Cyaniding

| Battery | Tons | Management and Supervision | Wages | Stores | Total Working Expenditure | Cost per Ton | Repairs and Renewals | Sundries | Gross Expenditure | Cost per Ton | Receipts | Receipts per Ton | Profit | Loss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bamboo Creek .... .... | 980 | 195 18 4 | 1,100 12 11 | 522 13 11 | 1,819 5 2 | 37 2 | 618 10 7 | 574 0 10 | 3,011 16 7 | 61 6 | 804 14 4 | 16 5 | .... | 2,207 2 3 |
| Coolgardie .... .... | 2,938 | 816 17 11 | 3,513 14 7 | 1,094 6 9 | 5,424 19 3 | 36 11 | 367 14 11 | 1,202 8 4 | 6,995 2 6 | 47 8 | 2,832 17 8 | 19 3 | .... | 4,162 4 10 |
| Cue .... .... .... | .... | .... | .... | 22 14 10 | 22 14 10 | .... | .... | .... | 22 14 10 | .... | .... | .... | .... | 22 14 10 |
| Kalgoorlie .... .... | 4,400 | 1,246 4 6 | 4,169 19 11 | 3,314 10 7 | 8,730 15 0 | 39 8 | 597 14 0 | 1,821 7 8 | 11,149 16 8 | 50 8 | 5,140 10 2 | 23 4 | .... | 6,009 6 6 |
| Lake Darlot .... | 4,030 | 810 0 8 | 2,521 3 10 | 1,548 13 10 | 4,879 18 4 | 24 3 | 559 16 7 | 1,423 12 7 | 6,863 7 6 | 34 1 | 6,882 8 4 | 34 2 | 19 0 10 | .... |
| Marble Bar .... .... | 1,240 | 581 7 10 | 1,515 3 4 | 569 19 7 | 2,306 10 9 | 37 3 | 76 2 9 | 474 14 11 | 2,857 8 5 | 43 8 | 1,182 17 8 | 19 1 | .... | 1,674 10 9 |
| Marvel Loch .... | 2,619 | 878 18 11 | 2,038 0 7 | 1,060 7 11 | 3,977 7 5 | 30 5 | 219 5 7 | 1,544 8 6 | 5,741 1 6 | 43 10 | 2,476 12 4 | 18 11 | .... | 3,264 9 2 |
| Meekatharra .... | 1,377 | 306 7 1 | 1,404 17 2 | 482 6 3 | 2,193 10 6 | 31 10 | 350 7 5 | 511 14 10 | 3,055 12 9 | 44 5 | 1,075 17 7 | 15 8 | .... | 1,979 15 2 |
| Menzies .... .... | 3,468 | 948 5 9 | 3,954 2 1 | 1,286 14 3 | 6,189 2 1 | 35 9 | 697 12 8 | 1,696 1 0 | 8,582 15 9 | 49 6 | 4,023 14 11 | 23 3 | .... | 4,559 0 10 |
| Ora Banda .... .... | 4,125 | 716 10 2 | 4,682 6 4 | 1,589 4 2 | 6,988 0 8 | 33 10 | 507 10 8 | 1,623 6 0 | 9,118 17 4 | 44 3 | 7,310 11 6 | 35 5 | .... | 1,808 5 10 |
| Total .... .... | 25,177 | 6,500 11 2 | 24,540 0 9 | 11,491 12 1 | 42,532 4 0 | 33 10 | 3,994 15 2 | 10,871 14 8 | 57,398 13 10 | 45 7 | 31,730 4 6 | 25 3 | 19 0 10 | 25,687 10 2 |
| Interest Paid to Treasury .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2,160 0 0 | .... | .... | 2,160 0 0 |
| Gross Loss .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 29,570 4 6 .... | .... | .... | 27,847 10 2 |

## STATE BATTERIES

*Trading and Profit and Loss Account for the Year Ended 31st December, 1961*

| 1960 | | 1961 | |
|---|---|---|---|
| £ | | £ | £ |
| | Trading Costs— | | |
| 106,222 | Wages | 114,146 | |
| 32,437 | Stores | 39,053 | |
| 25,772 | Repairs, Renewals and Battery Spares | 27,394 | |
| 30,626 | General Expenses and Administration | 31,435 | |
| 195,057 | | | 212,028 |
| | Earnings— | | |
| 40,573 | Milling and Cyaniding Charges | | 52,541 |
| 154,484 | Operating Loss for the Year | | 159,487 |
| | Other Charges— | | |
| 24,376 | Interest on Capital | 25,153 | |
| 12,708 | Depreciation | 12,643 | |
| 2,413 | Superannuation—Employers Share | 2,603 | |
| 39,497 | | | 40,399 |
| £193,981 | Total Loss for the Year | | £199,886 |

## STATE BATTERIES

*Balance Sheet as at 31st December, 1961*

| 31st December, 1960 | Funds Employed | 31st December, 1961 | |
|---|---|---|---|
| £ | | £ | £ |
| | Capital— | | |
| 589,682 | Provided from General Loan Fund | 606,962 | |
| 137,235 | Provided from Consolidated Revenue Fund | 137,235 | |
| 726,917 | | | 744,197 |
| | Reserves— | | |
| 28,622 | Commonwealth Grant—Assistance to Goldmining Industry | 28,622 | |
| 13,786 | Commonwealth Grant—Assistance to Metalliferous Mining | 13,786 | |
| 42,408 | | | 42,408 |
| | Liability to Treasurer— | | |
| 973,798 | Interest on Capital | | 998,951 |
| | Other Funds— | | |
| 1,357,003 | Provided from Consolidated Revenue Fund (Excess of payments over collections) | | 1,521,833 |
| 3,100,126 | | | 3,307,389 |
| | Deduct— | | |
| | Profit and Loss : | | |
| 2,719,713 | Loss at Commencement of year | 2,913,695 | |
| 193,981 | Loss for Year | 199,886 | |
| 2,913,694 | Total Loss from Inception | | 3,113,581 |
| £186,432 | | | £193,808 |
| | **Employment of Funds** | | |
| | Fixed Assets— | | |
| 721,326 | Plant, Buildings and Equipment | 738,606 | |
| 616,579 | Less Depreciation | 629,222 | |
| 104,747 | | | 109,384 |
| | Current Assets— | | |
| 4,331 | Debtors | 4,677 | |
| 64,820 | Stores | 71,041 | |
| 1,914 | Battery Spares | 2,069 | |
| | Purchase of Tailings— | | |
| 9,899 | Treasury Trust Account | 10,815 | |
| 42,097 | Tailings not treated | 39,508 | |
| 5,957 | Estimated Gold Premium | 5,649 | |
| 129,081 | | | 133,759 |
| 233,765 | Total Assets | | 243,143 |
| | Deduct— | | |
| | Current Liabilities : | | |
| 10,443 | Creditors | 11,823 | |
| 26,937 | Liability to Treasurer (Superannuation—Employers Share) | 29,540 | |
| | Purchase of Tailings : | | |
| 3,996 | Creditors | 2,323 | |
| 5,957 | Estimated Premium Due | 5,649 | |
| 47,333 | | | 49,335 |
| £186,432 | | | £193,808 |

# DIVISION IV

●

## *Annual Progress Report of the Geological Survey Branch of the Mines Department for the Year 1961*

●

## CONTENTS


| | Page |
|---|---|
| Letter of Transmittal | 51 |
| Administration : | |
| Staff | 51 |
| Activities of Professional Officers | 52 |
| Reorganisation | 52 |
| Accommodation | 53 |
| Field Work | 53 |
| Transport | 54 |
| Service to the General Public | 54 |
| Activities of the Commonwealth Bureau of Mineral Resources | 54 |
| Publications | 54 |


## REPORTS


| | |
|---|---|
| Report on a Pegmatite Locality 6 miles S.E. of Roebourne, N.W. Division | 54 |
| Recommendations on Future Exploratory Work at Wicherina | 55 |
| A Halloysite Deposit near Ryan's Find, 24 miles north of Boorabbin, Coolgardie Goldfield | 56 |
| Progress Report on the Regional Survey of the Widgiemooltha Sheet Area SH54–14, International Series | 57 |
| Water Supplies. Warburton Range and Adjoining Areas. Eastern Division, Western Australia | 61 |
| Geological Reconnaissance of the Warburton Range Area, Western Australia | 65 |
| Report on Some Pegmatites North of Yalgoo | 69 |
| Report on New Iron Deposits in the North-West Division | 70 |
| The Search for Oil in Western Australia in 1961 | 71 |
| Examination of Logue Brook Damsite, Harvey, South-West Division | 75 |
| Final Report on the Diamond Drill Exploration of the Ord River No. 2 Main Damsite, East Kimberley Division | 75 |
| Examination of Iron Ore, Pompeys Pillar, East Kimberley Division | 88 |
| The Geology of the Northampton Mineral Field and Environs, Western Australia | 89 |
| Summary Report on the Mendel Wongoondy Test Hole, Victoria District, South-West Division | 98 |
| Report on the Hydrological Investigation at the Wiluna Groundwater Research Station | 100 |

# LIST OF PLATES


| Plate No. | Title | Faces Page |
|---|---|---|
| I. | Geological Sketch Map Halloysite Deposit 24 miles North of Boorabbin. Scale : 600 feet to an inch | 56 |
| II. | Geological Sketch Map of Portion of Widgiemooltha Sheet SH51–14. Scale : 4 miles to an inch | 60 |
| III. | Geological Map of Portion of Sheet 468 (Talbot SG52–9 International Series), Warburton Range Area, W.A. Scale : 1 mile to an inch (approx.) | 70 |
| IV. | Map of Portion of the North-West Division, W.A., showing Pisolitic Limonite Deposits. Scale : 10 miles to an inch | 70 |
| V. | Western Australia showing Oil Holdings as at 31st December, 1961. Scale : 150 miles to an inch | 72 |
| VI. | Geological Plan of Logue Brook Damsite. Scale : 50 feet to an inch | 72 |
| VII. | Diagrammatic Sketch Plan showing Geology, Regional Faulting and Structure in vicinity of Ord River Main Damsite. Scale : 60 chains to an inch (approx.) | 88 |
| VIII. | Geological Plan of Western Abutment, Ord River Main Damsite. Scale : 150 feet to an inch | 88 |
| IX. | Geological Plan of Eastern Abutment, Ord River Main Damsite. Scale : 150 feet to an inch | 88 |
| X. | Geological Plan of Northern Spillway, Ord River Main Damsite. Scale : 150 feet to an inch | 88 |
| XI. | Geological Plan No. 2, Ord River Main Damsite, showing completed Diamond Drill Holes. Scale : 200 feet to an inch | 88 |
| XII. | Structure Contour Map, Ord River Main Damsite, showing probable position of Phyllite/Quartzite Contact. Scale : 40 feet to an inch | 88 |
| XIII. | Cross Sections through Diamond Drill Holes, Nos. 7M, 8M, 19M, 26M, Ord River Main Damsite. Scale : 20 feet to an inch | 88 |
| XIV. | Cross Sections through Diamond Drill Holes, Nos. 12M, 15M, Ord River Main Damsite. Scale : 20 feet to an inch | 88 |
| XV. | Cross Sections through Diamond Drill Holes, Nos. 13M, 14M, 16M, 17M, 25M, 27M, Ord River Main Damsite. Scale : 10 feet to an inch | 88 |
| XVI. | Cross Sections through Diamond Drill Holes, Nos. 18M, 23M, Ord River Main Damsite. Scale : 20 feet to an inch | 88 |
| XVII. | Cross Sections through Diamond Drill Holes, Nos. 20M, 22M, 24M, Ord River Main Damsite. Scale : 20 feet to an inch | 88 |
| XVIII. | Cross Sections through Diamond Drill Hole, No. 21M, Ord River Main Damsite. Scale : 20 feet to an inch | |
| XIX. | Column Logs of Diamond Drill Hole, No. 12M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XX. | Column Logs of Diamond Drill Hole, No. 13M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXI. | Column Logs of Diamond Drill Hole, No. 14M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXII. | Column Logs of Diamond Drill Hole, No. 15M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXIII. | Column Logs of Diamond Drill Hole, No. 16M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXIV. | Column Logs of Diamond Drill Hole, No. 17M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXV. | Column Logs of Diamond Drill Hole, No. 18M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXVI. | Column Logs of Diamond Drill Hole, No. 19M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXVII. | Column Logs of Diamond Drill Hole, No. 20M, Ord River Nain Damsite. Scale : 4 feet to an inch | 88 |
| XXVIII. | Column Logs of Diamond Drill Hole, No. 21M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXIX. | Column Logs of Diamond Drill Hole, No. 22M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXX. | Column Logs of Diamond Drill Hole, No. 23M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXXI. | Column Logs of Diamond Drill Hole, No. 24M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXXII. | Column Logs of Diamond Drill Hole, No. 25M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXXIII. | Column Logs of Diamond Drill Hole, No. 27M, Ord River Main Damsite. Scale : 4 feet to an inch | 88 |
| XXXIV. | Plan and Diagrammatic Sketch, Pompeys Pillar Iron Ore Deposit. Scales : Plan—40 miles to an inch ; Section—Vertical 160 feet to an inch, horizontal 480 feet to an inch | 88 |
| XXXV A. | Geological Map of the Northampton Mineral Field and Invirons. Scale : 4 miles to an inch | 98 |
| XXXV B. | Structural Sketch Map of the Northampton Block. Scale : 4 miles to an inch | 98 |
| XXXVI. | Locality Plan, Mendel Wongoondy Bore | 102 |
| XXXVII. | Composite Log, Mendel Wongoondy Bore | 102 |
| XXXVIII. | Groundwater Bore Sites, Agricultural Research Station, Wiluna. Scale : 800 feet to an inch | 102 |


# LIST OF FIGURES


| Fig. No. | Title | Page |
|---|---|---|
| 1 | Kapi Kanpa waterhole formed along a small watercourse in the lateritised mottled zone of a low Breakaway developed over Palaeozoic beds | 63 |
| 2 | Wort native well, margin of Lake Throssell, showing calcrete limestone surface | 63 |
| 3 | Wort native well showing solution pipe which extends below water level (16 feet) | 63 |
| 4 | Northern Spillway looking east. Faulted contact between quartzite phyllite—showing blocky characteristics of phyllite | 73 |
| 5 | Western Abutment looking south showing folded and contorted phyllite | 73 |
| 6 | Western Abutment looking south showing quartzite capping overlying phyllite | 73 |
| 7 | Western Abutment looking south showing open jointing in quartzite | 77 |
| 8 | Western Abutment looking south showing minor faulting | 77 |
| 9 | Western Abutment looking south showing minor faulting and quartzite/phyllite contact | 79 |
| 10 | Fault zone west side of River showing vertical sheeting | 81 |
| 11 | Eastern Abutment showing approximate contact between thinly bedded and more massive varieties of quartzite | 81 |
| 12 | East Abutment looking north-east showing quartzite steepening in dip | 81 |
| 13 | East Abutment looking north-east showing steeply dipping quartzite | 83 |
| 14 | East Abutment looking north showing strong jointing—tunnel outlet and site of DDH 12M | 83 |
| 15 | Northern Spillway looking south-east showing faulted contact between quartzite and phyllite | 83 |
| 16 | Northern Spillway looking east showing suggested fault line between quartzite and phyllite. Probable movement shown by arrows | 85 |
| 17 | Western Abutment showing freestanding quartzite in adit | 86 |
| 18 | Western Abutment showing blocky jointing characteristics ; looking west | 87 |
| 19 | Diagrammatic Sketch showing shear movement along a curved plane | 92 |
| 20 | Gurkha Lead Mine, M.L. 256, Northampton. Longitudinal Section. Scale : 100 feet to an inch | 98 |
| 21 | Protheroe Lead Mine, Nabawa. Longitudinal Section. Scale : 100 feet to an inch | 98 |

# DIVISION IV

# *Annual Progress Report of the Geological Survey Branch of the Mines Department for the Year 1961*

*The Under Secretary for Mines:*

I submit herewith for the information of the Honourable the Minister for Mines my report on the activities of the Geological Survey for the year 1961, together with reports on investigations not made specifically for departmental purposes.

## STAFF.

Staff members as at 31st December, 1961, were as follows:—

*Professional :*

| | |
|---|---|
| Lord, J. H., B.Sc. (W.A.) .... .... | Government Geologist |
| Berliat, K., D.Sc. (Switzerland) .... | Senior Geologist |
| Sofoulis, J., B.Sc. (W.A.) .... .... | Geologist |
| de la Hunty, L. E., B.Sc. (W.A.) .... | Geologist |
| Low, G. H., B.Sc. (W.A.) .... .... | Geologist, Grade 1 |
| Wyatt, J. D., B.A. (W.A.) .... .... | Geologist, Grade 2 |
| Connolly, R. R. .... .... .... | Geologist, Grade 2 |
| Bock, W. M., B.Sc. (Q.) .... .... | Geologist, Grade 2 |
| Morgan, K. H., B.Sc. (W.A.) .... | Geologist, Grade 2 |
| Jones, W. R. K., B.Sc. (Hons.) (W.A.) | Geologist, Grade 2 |
| Kriewaldt, M. J. B., B.Sc. (W.A.) .... | Geologist, Grade 2 |

*Clerical :*

| | |
|---|---|
| Hargrave, F. .... .... .... .... | Clerk |
| Cook, Miss M. L. .... .... .... | Typist (Temporary) |
| Macliver, R. D. .... .... .... | Junior Clerk |
| D'Arcy-Evans, Miss E., B.A. (W.A.) .... | Librarian Assistant (Temporary) |

*Laboratory :*

| | |
|---|---|
| Fimmell, L. H. .... .... .... | Laboratory Technician |

*Resignations, Appointments, Promotions.*

On 15th May Mr. H. A. Ellis retired from the position of Government Geologist.

Mr. Ellis joined the State Service as an Assistant Geologist in January 1935, was promoted to Government Geologist in August 1945, and served in that capacity until his retirement. Under his supervision the Geological Survey Branch grew from a staff of three professional officers to one of thirteen, in keeping with the growing demand for Government geological services in the State. An energetic, practical and forthright man, Mr. Ellis set a fine personal example of fortitude and professional integrity to his staff. He amassed a vast firsthand knowledge of the economic geology of the State, knowledge which was always available to a genuine enquirer and respected throughout the profession.

Mr. G. D. Bartram resigned on 6th January, 1961 to further his studies at the W.A. University after having served the department well for four years.

Mr. A. J. Noldart resigned on 8th December, 1961 to take up an appointment with the Geological Survey of Tasmania, thus terminating over nine years of valuable service with the Survey Branch.

Temporary Clerk Mr. G. Robinson was replaced by Mr. F. Hargrave on 17th February, 1961, Mr. Hargrave having been transferred from the Government Chemical Laboratories.

Mr. M. J. B. Kriewaldt commenced duties as Geologist Grade 2 on 15th May, 1961.

Miss E. D'Arcy-Evans commenced duty as temporary library assistant on 6th June, 1961 to continue the reorganisation of the library. This work was commenced at the beginning of the year with the assistance for two months of Miss E. Fowler, working during University vacation.

Mr. J. H. Lord was promoted to Government Geologist on 30th June.

Mr. L. E. de la Hunty and Mr. J. Sofoulis were promoted to Geologists (P-II-10/11) in the Mineral Resources and Regional Mapping Divisions respectively on 18th August 1961.

## PROFESSIONAL STAFF.

The authorised establishment for professional officers as at 31st December 1961 was as follows:—

Government Geologist 1
Deputy Government Geologist 1 (Vacant)
Senior Geologists 4 (3 vacant)
Geologists 3 (1 vacant)
Geologists Grade 1, 4 (3 vacant)
Geologists Grade 2, 13 (7 vacant)

Specialists:

Petrologist 1 (vacant)
Palaeontologist 1 (vacant)
Geophysicist 1 (vacant)
Total 29 (18 vacant)

Although from the large number of vacancies the staff would appear to be well below the authorised strength, appointments have actually been made to most vacancies, and appointees will commence duties in 1962.

The following tabulated statement shows the relationship between the area of the State and the availability of geologists during the year.

| Period | No. of Geologists available including Government Geologist | Area of State | Square Miles per Geologist | Population of State |
|---|---|---|---|---|
| | | sq. miles | | |
| Jan.-Dec. .... | 13 | 975,920 | 75,071 | 736,624 |

## FIELD ACTIVITIES OF PROFESSIONAL OFFICERS.

(Time not mentioned spent on the compilation of reports and administrative duties.)

*H. A. Ellis, Government Geologist, retired May 15th 1961.*

In addition to head office administrative duties the following field work was undertaken:—

February.—Wilgie Mia, exploratory diamond drilling.

April.—Roebourne, inspection pegmatite locality.

Wilgie Mia, diamond drilling.

Carnarvon, inspection of clay barrier in Gascoyne River.

Whim Creek, Copper mine area.

*J. H. Lord, Deputy Government Geologist, Government Geologist from 30th June, 1961.*

January-February.—Accompanied the Honourable the Minister for Mines and Under Secretary to Canberra and Japan on iron ore market investigations.

April.—Inspected Tallering Peak, Mt. Gould and Weld Range iron deposits.

May.—Attended Underground Water Conference in Canberra.

June.—Visited Sons of Gwalia Mine with State Mining Engineer. Inspected Eneabba No. 1 oil well. Accompanied Honourable Minister for Mines on inspection of Mt. Goldsworthy and Tallering Peak iron deposits.

July.—Visited Collie and Greenbushes Mineral Fields.

October.—Inspected Weld Range and Tallering Peak iron deposits; also Pinnacles (near Cue) drilling for gold.

December.—Inspected Weld Range and Morawa iron deposits; also Pinnacles drilling.

*K. Berliat, Senior Geologist.*

January.—Geological supervision of water drilling operations in the Hill River area.

February.—Underground water investigations on Rottnest Island.

March.—Underground water investigations at Wicherina.

April-May.—Geological supervision of water drilling operations, Westfield and Hill River areas.

June.—Underground water investigations at Yunderup, Furnissdale, Mandurah, Beverley, Northam and Byford.

July.—Geological supervision of water drilling operations at Byford and Westfield.

August.—Field and drilling supervision at Wiluna.

September-December.—Geological supervision of water drilling operations at Byford, Westfield, Whitby Falls and Jurien Bay.

*L. E. de la Hunty, Geologist.*

January.—Bridge-site investigations at Augusta and water supply investigations in the Metropolitan Area.

May.—Investigation of iron deposits at Scott River and Nannup with Mr. D. O'Driscoll, Bureau of Mineral Resources.

July.—Inspection and core logging, Weld Range drilling.

October.—Investigation of pegmatite deposits near Yalgoo.

November.—Investigation of iron deposits in the North-West Division and magnetic anomalies near Yalgoo with Messrs. D. O'Driscoll and G. F. Clarke of the Bureau of Mineral Resources.

*J. Sofoulis, Geologist.*

April-September.—Widgiemooltha regional survey.

October.—Regional reconnaissance Warburton Range Area.

*G. H. Low, Geologist Grade 1.*

April.—Inspection of iron ore deposits at Tallering Peak and Mt. Gould.

June-July.—Field mapping Pt. Hedland 4-mile Sheet and work associated with Mt. Goldsworthy iron ore deposits.

August-September.—Field work on Copper Resources of W.A.

*A. J. Noldart, Geologist Grade 1.*

May-September.—Northampton Regional Survey.

*J. D. Wyatt, Geologist Grade 2.*

February-April.—Investigation and mapping Serpentine and Logue Brook dam sites. Selection of drill sites for water supplies.

May-October.—Drill supervision and mapping Ord River dam site.

*R. R. Connolly, Geologist Grade 2.*

This officer has been appointed to the position of Technical Information Officer, and his duties have involved the following:—

Library reorganisation, public enquiry, accommodation, furnishing, instruments, equipment and vehicles for anticipated new staff; preparation of brochure for Japanese Steel Mission; reorganisation of plan storage, camp equipment storage and vehicle storage. Miscellaneous assignments as directed by the Government Geologist.

*W. M. Bock, Geologist Grade 2.*

April-October.—Regional mapping of the Widgiemooltha area.

*K. H. Morgan, Geologist Grade 2.*

January-February.—Miscellaneous water supply investigations and field supervision of Mendel-Wongoondy water drilling programme.

March-June.—Field supervision of water drilling at Australind for Laporte Industries, and Hydrological Survey of Mundijong area.

July-October.—Field supervision of underground water drilling for agricultural research station, Wiluna.

*W. R. K. Jones, Geologist Grade 2.*

May-September.—Northampton survey and inspection of radioactive anomalies in the Carnarvon basin in association with the Bureau of Mineral Resources.

*M. J. B. Kriewaldt, Geologist Grade 2.*

Commenced duties May 15th, 1961.

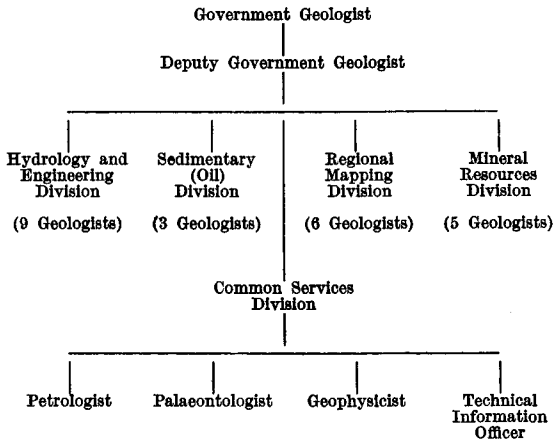
June.—Hydrological survey of Waroona area.

July-December.—Hydrological survey of Bunbury area and field supervision of water drilling at Australind for Laporte Industries.

## REORGANISATION.

In 1960 as a result of a greatly increased demand for services from this Branch, the Honourable Minister for Mines (Mr. Arthur Griffith, M.L.C.) announced the Government's intention to double the professional staff strength of the Geological Survey. Accordingly, after personal investigation of similar organisations in other States and close examination of the current and future needs of this State, proposals covering new staff and reorganisation of existing staff were submitted for approval in February, 1961. These proposals were approved without alteration and, following advertisement of newly created positions, selection of appointees was made from a large number of applicants. As previously stated the majority of positions had been filled by December, 1961 but with the exception of two promotions made within the Branch, appointees had not commenced duties at the year's end.

The following structure diagram shows the new organisation of the Branch:




Sectionalisation of the Branch is instituted for the first time, having been made possible by the larger number of officers. The five Divisions created have been designed to allow senior staff to specialise to the required degree without the danger of over-specialisation as can result from the creation of too many divisions. It is proposed where possible to give junior officers experience in a number of divisions at convenient intervals before final allocation to any one division.

## ACCOMMODATION.

This Branch now occupies three separate office suites, two on a short term leasehold basis, and the third on a temporary basis at the discretion of the State Library Board. The bulk of the registered specimen collection is housed in the Nicolay Gallery of the W.A. Museum, while bore core and bulk gear are stored in two separate buildings. The scattered nature of the accommodation is far from satisfactory and it is hoped that governmental building programmes will provide for integral accommodation for the Branch in the near future.

To provide office accommodation for the additional staff a one-time church located at 13 Aberdeen Street, Perth, which fortuitously became available for lease in March, 1961, was secured on a leasehold basis by the Public Works Department in May. Renovations and internal partitioning carried out by Public Works Department have provided ten office rooms and one large drafting room of acceptable standard. The building was occupied in December, 1961.

To meet the requirements of additional storage space for camp gear, publications, bore core, and vehicles, a site at 13 Harold Street, Dianella, was made available by the Public Service Commissioner in July. The building contract, previously let for a site at Welshpool, was renewed and at the year's end the building shell has been completed, but internal fixtures have yet to be installed. In addition to the abovementioned site, the Public Service Commissioner also made available for temporary use an existing storage building on the adjoining land. A security fence was erected to surround this building and the whole used for camp gear storage and vehicle parking. Utilisation of this building expedited the vacation of the old laboratory and store at the rear of the Art Gallery premises (formerly Geological Survey main office). The laboratory was handed over to the Director of the Art Gallery in October, 1961.

## FIELD WORK.

*Field Work completed during the year or in progress as at 31st December, 1961.*

(1) Completion of a detailed geological survey of the Northampton Mineral Field.

(2) Completion of field work in connection with the preparation of a Mineral Resources Bulletin on the Copper Resources of W.A.

(3) Completion of field work in connection with the preparation of a Bulletin on the Manganese and Chromite Resources of W.A.

(4) Completion of a regional Geological Survey of the Port Hedland four-mile map sheet.

(5) Completion of the regional Geological Survey of the Boorabbin four-mile map sheet as the first stage of the Coolgardie-Norseman regional survey.

(6) Diamond drilling of iron deposits in the Weld Range.

(7) Diamond drilling at Pinnacles, near Cue, for gold.

(8) Underground water investigations at Hill River, Wiluna, Byford, Westfield, Whitby Falls, and near Australind.

*Field Work Planned for 1962.*

*Hydrology and Engineering Division.*

*A.—Hydrology.*

(i) Continuation of the hydrological survey of the Perth Basin;

(ii) Geological control of drilling programmes:
- (a) Westfield;
- (b) Byford;
- (c) Australind;
- (d) Jurien Bay;
- (e) Busselton;
- (f) Lake Allanooka.

(iii) Hall's Creek area—hydrological assistance to pastoralists.
- (a) Regional mapping (3-4 year programme in conjunction with B.M.R.);
- (b) Bore site selection as required by pastoralists.

(iv) Miscellaneous minor investigations.

*B.—Engineering.*

(i) Ord River Dam.
- (a) Rock strength tests;
- (b) Final examination of dam site;
- (c) Map the shaft to be sunk in northern spillway;
- (d) Location of coarse size aggregate;
- (e) Location of pozzolanic materials for cement admixture.

(ii) Bandicoot Bar Diverson Dam: General examination.

(iii) Dimond Gorge (Fitzroy River): Regional mapping.

(iv) Margaret River Damsite: General examination.

*Sedimentary (Oil) Division.*

(i) Active interest in the exploratory programmes of the companies engaged in oil prospecting in this State;

(ii) Miscellaneous investigations pertinent to oil prospecting in the Perth Basin;

(iii) Geological Survey of the Lennard Shelf area, Fitzroy Basin;

(iv) Miscellaneous minor investigations as required.

*Mineral Resources Division.*

(i) Completion of copper resources investigation;

(ii) Completion of manganese resources investigation;

(iii) Continuation of the drilling and investigation of the Weld Range for iron;

(iv) Investigation of the new iron deposits in the Pilbara area;

(v) Minor investigations on Greenbushes Mineral Field to delineate by drilling, land suitable for alienation;

(vi) Investigation by drilling of manganese deposit near Ravensthorpe in conjunction with the Bureau of Mineral Resources;

(vii) Completion of drilling programme at Pinnacles near Cue;

(viii) Miscellaneous minor investigations as required.

*Regional Mapping Division.*

(1) Continuation of regional mapping in the Kalgoorlie-Norseman area (Widgiemooltha and Norseman four-mile sheets);

(2) Continuation of regional mapping in the Pilbara Goldfield. (Roebourne, Pyramid, and Dampier four-mile sheets).

(3) Commencement of a regional mapping programme in the East Kimberley (Gordon Downs four-mile sheet). Joint operation with the Bureau of Mineral Resources.

## TRANSPORT.

Tabulated details of transport at present in use by the Geological Survey are as follows:—

| Vehicle W.A.G. | Make and Type | Load (cwt.) | Mileage as at 31-12-61 | Mileage for 1961 | Date purchased (new) | Remarks |
|---|---|---|---|---|---|---|
| 909 | Willys Jeep .... | 5 | 56,239 | 1,631 | 1953 | Sold by tender 27/11/61 |
| 3135 | Fargo Utility .... | 15 | 80,941 | 7,181 | 1954 | |
| 3535 | Landrover L.W.B. | 10 | 78,496 | 12,348 | 1955 | |
| 3678 | Dodge Utility .... | 15 | 57,248 | 6,248 | 1955 | |
| 3876 | Landrover L.W.B. | 10 | 60,991 | 10,702 | 1956 | |
| 4559 | do. do. | 10 | 63,824 | 12,001 | 1957 | |
| 4475 | do. do. | 10 | 66,585 | 11,235 | 1957 | |
| 4691 | International F.W.D. .... | 20 | 43,102 | 5,986 | 1957 | |
| 5009 | do. do. | 20 | 43,020 | 12,460 | 1958 | |
| 4793 | do. do. | 20 | 38,444 | 5,854 | 1958 | |
| 5352 | do. do. | 20 | 24,698 | 8,703 | 1959 | |
| 5712 | Landrover L.W.B. | 10 | 25,378 | 11,246 | 1960 | |
| 5958 | do. do. | 10 | 13,480 | 10,370 | 1960 | |
| 6060 | do. do. | 10 | 4,581 | 4,581 | 1960 | |
| 6239 | Holden Panel Van | 10 | 3,907 | 3,907 | 1961 | Purchased 5/5/61 |

Total Miles : 124,453.

In addition to the vehicles listed above a two-wheeled Trailer (W.A.G. 462) and two Caravans (W.A.G. 1122 and W.A.G. 1140) were used by officers of the Survey.

## SERVICES TO THE GENERAL PUBLIC, MINING INTERESTS, AND GOVERNMENT DEPARTMENTS.

This year public and company interests in minerals exploration continued at a very high level, the principal interest being in iron ores. At various times throughout the year representatives of individual Japanese, American, British and Australian firms received personal attention, while a considerable amount of time was spent in preparing material for the information of a Japanese Steel Mission, members of which visited this State in June 1961.

In the second six months of the year at least 483 public enquiries were dealt with by various staff members at the counter.

A number of field investigations were made at the request of other Government Departments, and in some instances private concerns were assisted in the field.

## ACTIVITIES OF THE COMMONWEALTH BUREAU OF MINERAL RESOURCES.

The activities of the Bureau of Mineral Resources were confined to geophysical work. The following projects were undertaken:—

(1) Reconnaissance seismic survey from Giles to Carnegie;

(2) Aeromagnetic and radiometric survey in portions of the Carnarvon Basin;

(3) Magnetic Survey on the Scott River iron deposits;

(4) Radioactive Survey of a portion of the Billiluna 4-mile sheet;

(5) Ground inspection of radiometric anomalies in the Carnarvon Basin region in association with a geologist from the Geological Survey of W.A.;

(6) Regional magnetic survey in the Gibson desert area.

## PUBLICATIONS.

*Issued during 1961.*

Annual Progress Report for 1959.

*In the Press.*

Annual Progress Report for 1960.

*In Course of Preparation.*

A geological map of the Boorabbin 1:250,000 sheet (SH51-13 International grid) with explanatory notes.

A geological map of the Balfour Downs 1:250,000 sheet (SF51-9 International grid) with explanatory notes.

A geological map of the Port Hedland 1:250,000 sheet (SF50-4 International grid) with explanatory notes.

A Mineral Resources Bulletin on the Copper Deposits of W.A.

A Bulletin on portion of the Pilbara Goldfield covered by the Marble Bar and Nullagine 4-mile sheets.

A Bulletin on the Manganese Deposits of W.A.

J. H. LORD,
Government Geologist.

21st March, 1962.

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## REPORT ON A PEGMATITE LOCALITY 6 MILES S.E. OF ROEBOURNE.

N-W Division.

Approx. Lat. 20°-50′ S.

Approx. Long. 117°-10′ E.

*By H. A. Ellis, B.Sc., A.O.S.M., Government Geologist.*

*Introduction.*

Some 18 months ago eight Prospecting Areas each of 24 acres were applied for by D. McLeod in a strip of hilly country extending approximately six miles S-W from the eastern end of Crown Reserve 1662 which is close to Trig. Station, Mt. Hall, situated about four miles E.S.E. of Roebourne township.

Returns made to the Mines Department Statistics Branch early this year showed that to the end of April 72.46 tons had been sold for an F.O.B. value at Fremantle of £A11,444.5.

As this was the first recorded production of beryl from this part of the North-west a reconnaissance examination of the area was made by the writer during the period April 26-27, 1961.

Mr. D. McLeod, a European, is the leader of a group of aboriginals who have been working off and on in the Pilbara and West Pilbara Goldfields with varying success mining alluvial and eluvial columbite, tantalite, cassiterite, wolfram and scheelite lode deposits, and eluvial beryl and beryl bearing pegmatites for upwards of five years now.

The mining effort is a co-operative one, with males and females participating in the mining operations. There were some 150 aboriginals, including women and children in the camp at the time of inspection (April, 1961). Mining equipment consisting of motor trucks, two portable compressors and drilling machines and accessories is all owned by the Co-operative, and the natives appoint their own working foremen and plan their own work under the overall supervision of Mr. McLeod. Mining operations have been confined so far to the normal surface ore-winning processes associated with eluvial and alluvial deposits and hard-rock mining has not extended beyond comparatively shallow open cuts some 10 to 12 feet deep.

A considerable proportion of the beryl in the pegmatites at present being worked occurs in a *disseminated* form, a mode of occurrence very seldom seen in pegmatites in Western Australia. The natives hand-cob the pegmatite as mined, and both males and females engage in this work. It is doubtful whether Europeans could make this type of deposit pay without concentrating machinery.

*General Geology.*

The principal pegmatites are of small dimensions and occur in highly sheared portions of massive, very basic greenstones which include much serpentinous rock. The relation of the various greenstone types to each other could not be determined in a reconnaissance survey.

The group of low rugged hills extends in a north-east south-west direction for approximately eight miles and is perhaps three miles wide, the maximum height above the general level of the surrounding plain country being about 200 feet. The hill complex is completely surrounded by flat plain country in which granite probably predominates. Granite also occurs in the narrow valley floors in the hills and one gets the impression that the range of hills is completely underlain by granite at a shallow depth.

The pegmatites do not assume the dimensions of those at Wodgina, Strelley, Tabba Tabba and Pilgangoora or those on Pippingarra Station just south of Port Hedland, but are much shorter and narrower. Some 11 occurrences are known, but all have not been equally productive.

In the present state of development it is not possible to quote maximum dimensions, but some workings indicate known length as 60 feet and maximum widths of 12 feet.

Some of the dykes have vertical dips and others steep dips in varying directions. A feature of the more productive occurrences is the injection of flatly dipping thin (6"±) pegmatite veins into wall rock joints adjacent to either wall, and as is common in highly sheared basic rocks, some of the pegmatites reveal two hanging-walls when opened up in 10-12 ft. deep excavations.

No obvious quartz-core structure was seen, and the state of all shallow workings was such that no zoning could be detected either. The principal mineralogical feature of all of the exposures seen was the inevitable presence of albite felspar, broadly lamellar, finely lamellar ("curly albite"), finely crystalline and medium grained massive crystalline, with the minerals of economic importance, viz. beryl, columbite, cassiterite, spodumene and lepidolite mica.

Of the above minerals only beryl occurs in payable quantities, but future exploration could yield payable concentrations of the other minerals. The beryl occurs in two ways: as massive crystals up to several tons in weight, and in a disseminated form, and in both cases is intimately associated with albite felspar and quartz. The size of the individual beryl occurrences varies from particles just visible to the naked eye and recognisable by its pale green colour, to pieces several inches across and of irregular shape. Occasionally some of the prisms are developed, and in the thin pegmatitic intrusions in the joints of the wall rock—sheared basic rocks with a strong development of phlogopite mica—some narrow prisms of intensely flawed green beryl were seen. There is a prospect of the occurrence of gem quality material in this mode of occurrence.

Grey, white and pale green beryl is broken from the quartz-albite matrix by the natives using a variety of tools such as old axe heads, pick heads, short lengths of drill steel etc. and it is obvious that much finely disseminated beryl goes uncollected.

Prehnite—hydrous calcium aluminium silicate—occurs as an accessory mineral and its pale blue colour is apt to cause it to be mistaken for beryl.

A yellow powdery mineral determined by the Mineral Section, Government Chemical Laboratories as Powellite (calcium molybdate) occurs as a joint staining and a filling in small drusy cavities in one locality at the eastern end of the area.

*Production.*

Realised production to the end of April, 1961, is as follows:—

| Nett Dry Weight | Units BeO | Assay per cent. BeO | Value F.O.B. Fremantle |
|---|---|---|---|
| Tons | | | £A |
| 44·36 | 521·60 | 11·76 | 7,054·35 |
| 20·74 | 225·44 | 10·87 | 3,310·00 |
| 5·64 | 57·48 | 10·20 | 814·85 |
| 1·72 | 18·71 | 10·90 | 265·30 |
| 72·46 | 823·23 | 11·36 Av. | 11,444·50 |

The first parcel of ore from this locality was shipped from Pt. Samson on 12/6/60.

*Conclusions.*

(1) The comparatively short and narrow pegmatites of the area had not been sufficiently explored at the time of examination (April 1961), to enable a reliable appreciation of their strikes, dips, and structures to be made, but such work as had been done encourages the belief that the locality could produce appreciable quantities of beryl under more intensive exploration.

(2) The area is worthy of detailed mapping in order to gain a knowledge of the structural pattern influencing the emplacement of the pegmatites and the chrysotile asbestos mineralisation in the serpentinous rocks in the vicinity of Crown Reserve 1662 known as the Police Paddock. Future prospects of the pegmatites in depth could then be assessed.

(3) The whole of the area of 4m. to 1 inch map areas Roebourne and Dampier could yield valuable information on the relationships of a varied rock succession if they were geologically surveyed in adequate detail. The mineral prospects of this area are encouraging and drilling targets would be likely to be discovered as a result of detailed work.

## RECOMMENDATIONS ON FUTURE EXPLORATORY WORK AT WICHERINA.

*By K. Berliat, D.Sc., Senior Geologist.*

*General.*

The present position (March 1961), at Wicherina is that 10 producing bores are pumped for a combined weekly output of 7 million gallons. Seven of these bores draw from the Jurassic aquifer of the southern sub-basin and 3 from uppermost Permian aquifers of the recently developed northern sub-basin. Subsurface evidence indicates that there is no hydraulic connection between the two areas.

The town water supply position at Geraldton (which derives its entire supplies from Wicherina) has reached a critical stage. At its present level of population the Municipality is in immediate need of an additional million gallons of water per week. The problem is whether, for future requirements, exploration should be directed towards an extension of the Wicherina field, or whether entirely new areas should be considered.

A critical analysis of the various sub-basins reveals the following facts:—

*South Basin.*—This basin, the only producing one up to the end of 1959 is rapidly approaching the end of its usefulness because of ever increasing salinities and falling rest levels, caused by heavy pumping combined with no or inadequate recharge.

*Woodcote Basin.*—This basin, centred some 2 miles south-east from Wicherina has been extensively tested with negative results. The determining factors are rapidly increasing salinities outward from the central portion, and also marked vertical salinity increases.

*North Basin.*—Exploration of the northern areas has shown a gradual salinity increase towards the Irwin River Coal Measures outcropping along the Greenough River and, as a rule, the salinities east

of a line passing through bores X20 and X49 are too high. However to the west of that line suitable supplies have been located. The 3 producing bores (N1, N2, N3) referred to above, are situated in this area, and 3 additional bores (N4, N5, N6) are at present in various stages of development.

Although these bores have been pumped for a total period of less than 18 months, the problem of recharge has already become apparent. The writer is informed that the rest level in observation bore X20 has fallen from 258 ft. in April 1959, to 266 ft. in February 1961. It is obvious therefore that the present supplies are drawn from storage, and that a stage identical to that now existing in the South Basin will be reached at some future time.

*Future Extension of the Wicherina Field.*

There can be no doubt that any extension of the Wicherina field must proceed to the northward. In this direction lies the continuation of the favourable gelogical conditions found in the western portion of the North Basin, with porous Jurassic sediments flanking the eastern margin of the Ajana granite inlier. The geological picture remains unaltered for a distance of approximately 8 miles north of X48. At this point there appear isolated outcrops of Holmwood Shales, indicating a reduced thickness of the Jurassic aquifers.

*Recommendations.*

It is considered that the present requirements of Geraldton can be met by continuing the drilling programme immediately northward from X47 (N3), X48 (N6) and X54, in that order of priority.

For long term planning it is recommended, in the first instance, to test the further northward extension of the Wicherina North Basin. This covers a strip of country 7 to 8 miles long (from X48), between the Ajana granite inlier in the west and the Greenough River in the east. In the exploration of this area it will be essential to take advantage of the experience gained at Wicherina in respect to increasing salinities towards the Greenough River.

This area has in its favour the relative proximity to Wicherina, existing power lines, pipe lines, etc.

The only other area within reasonable distance of Geraldton offering sound geological arguments for exploration is the country centered about Lake Allanooka and its northerly and north-westerly extension towards the Greenough River. This is an entirely new area, consisting of undulating, high level sandplain, underlain to a great depth by sandstones and siltstones of the Jurassic Yarragadee formation. Hydrologically this area is almost entirely unexplored, and little is known in this particular belt about the nature and capacity of the deeper aquifers. The deepest bores (to the writer's knowledge) 280 ft. and 430 ft. are situated some 4 miles north-west and 5 miles north respectively of Lake Allanooka. Both bores are stated to have "unlimited" supplies, although they have probably never been properly tested. Salinities are 40 grs./gall. NaCl.

The Yarragadee formation is known to contain excellent aquifers at depths varying between 400 ft. and 700 ft., and it is suggested that early positive steps be made to sink a number of exploratory bores, particularly as this area offers the only alternative to Wicherina and its northern extension.

## A HALLOYSITE DEPOSIT NEAR RYAN'S FIND, 24 MILES NORTH OF BOORABBIN, COOLGARDIE GOLDFIELD.

*By J. Sofoulis, B.Sc., and W. M. Bock, B.Sc.*

*Introduction.*

The deposit is located on the west side of a lake floor situated some twenty-four miles north of Boorabbin. The lake is bounded to the west by a limestone breakaway some twelve feet high. While sampling the limestone (results of analyses in appendix) an attempt was made to establish the type of material below the adjacent lake's surface. The material forming a strip some five hundred feet north to south, one hundred and eighty feet east to west and less than seven feet in depth, was found to be a soft, white, malleable clay which was subsequently determined to be halloysite.

This is the first substantial deposit located in this State, the mineral being only recorded as thin veinlets and cavity fillings in the metamorphic rocks (Simpson, E.S., 1951, "Minerals of Western Australia", Vol. 2, pp. 564-71).

*Geology of the Deposit Area.*

The clay forms a layer up to seven feet in thickness below a thin (6 inches to a foot) surface covering of red saline alluvium. The lake is part of an east-west drainage line believed to be portion of an old Tertiary drainage which forms the headwaters of the Swan-Avon system. The associated limestones are recognised as a secondary calcrete form similar to those noted in the Murchison-Pilbara drainage areas. The limestone is distinctly younger than the laterite profile and, as seen in the lake floor, it is underlain by the halloysite and thence by lateritized and weathered metamorphic rocks forming the most southerly extension of the Ryan's Find Belt. This belt outcrops on the lake floor a short distance north of the sampled area, and was also noted in the deeper auger holes.

The limestone forms a low breakaway on the western edge of the lake, forming a strip some five hundred feet wide. It is flanked to the west again by north-east striking and north-west dipping granitic rocks.

*Chemical Composition of the Halloysite.*

The original sample submitted to the Government Chemical Laboratories was described by the analyst as "probably the hydrated form of Halloysite, an aluminium silicate with the formula $(OH)_8Si_4Al_4O_{10}.\ 4H_2O$ which, on partial air drying, would become a mixture of this form and the dehydrated form, metahalloysite, $(OH)_8Si_4Al_4O10$. No colloidal silica was found to be present".

A bulk sample weighing some three hundredweight was subsequently collected and submitted to the Government Chemical Laboratories for further testing. The report by the Deputy Government Mineralogist is given below—

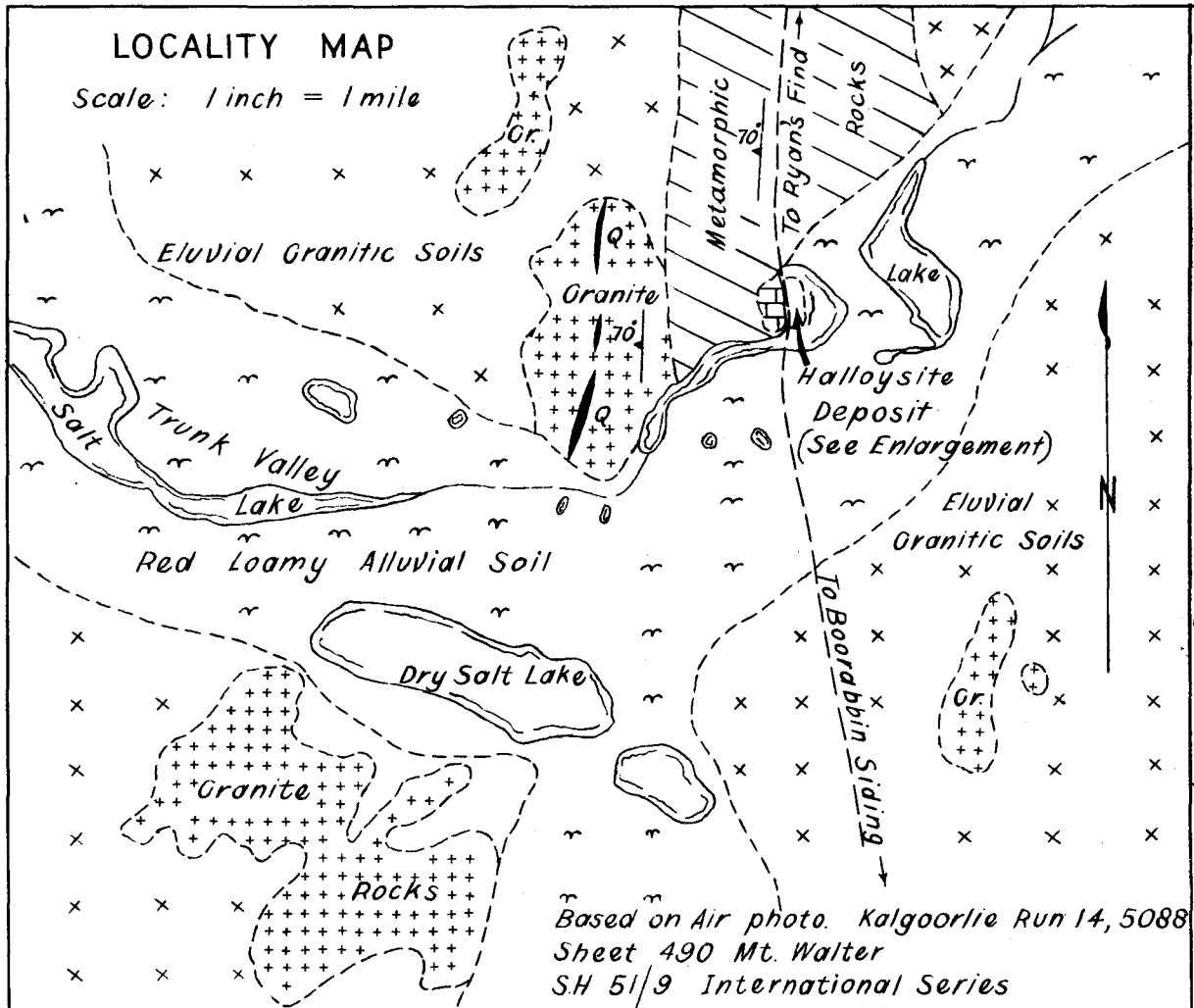
"The damp clay was sampled as received and the sample divided into halves. One half was washed through a 200 mesh screen, the minus 200 mesh material filtered and dried at 80°C. The sample is referred to as the washed clay sample.

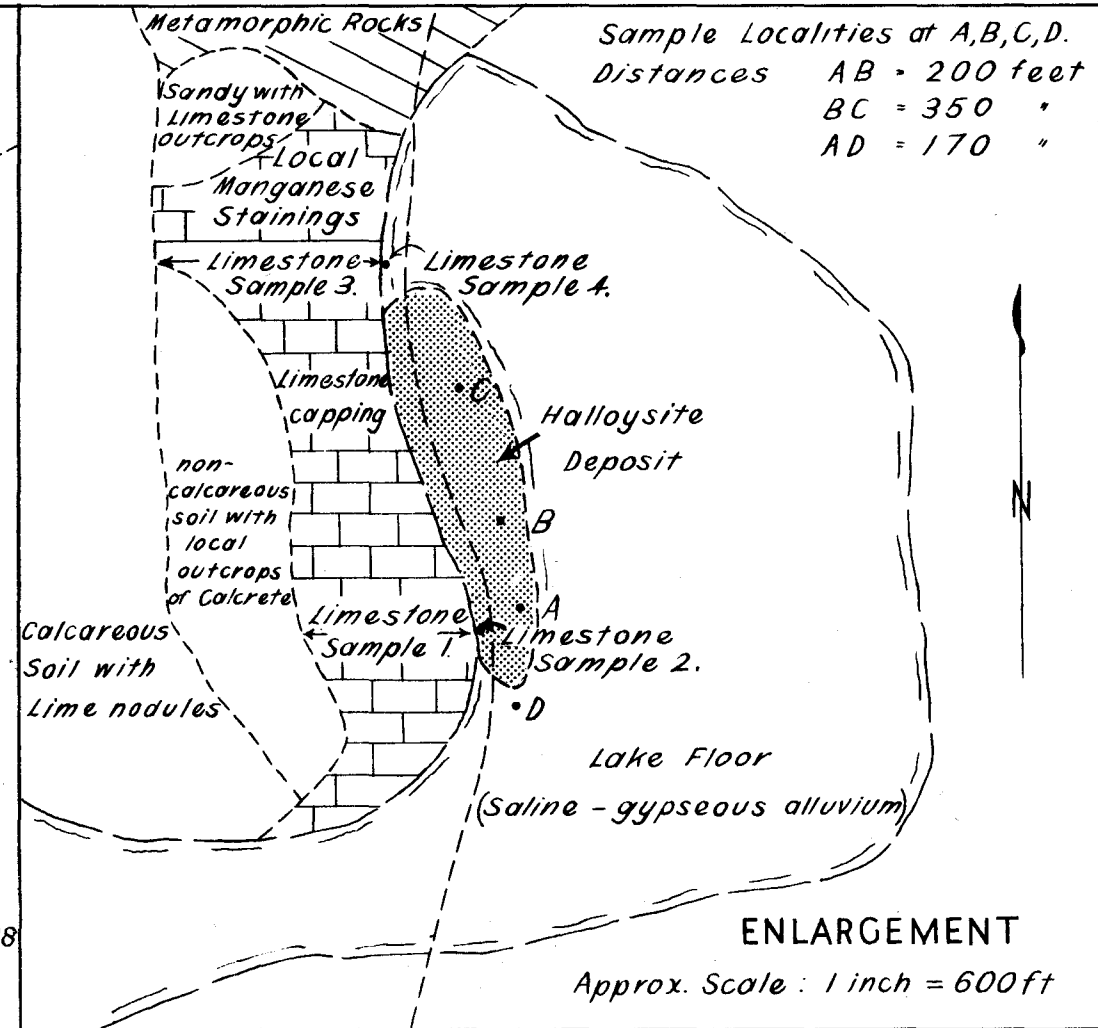
The second half was dried at 80°, and analysed without further treatment, and represents the sample as received".

Complete chemical analysis gave the results as shown in the following table—

| | Washed Clay Fraction Per cent. | molecular ratio | Sample as received Per cent. |
|---|---|---|---|
| Silica $SiO_2$ .... .... | 35·58 | 5·92 | 33·00 |
| Alumina $Al_2O_3$ .... | 38·99 | 3·83 | 39·41 |
| Ferric Oxide $Fe_2O_3$ .... | 0·19 | .... | 0·28 |
| Ferrous Oxide FeO .... | *Nil* | .... | *Nil* |
| Magnesia MgO .... | 0·33 | .... | 0·39 |
| Lime CaO .... .... | 0·15 | .... | 0·20 |
| Soda $Na_2O$ .... .... | 1·29 | .... | 1·86 |
| Potash, $K_2O$ .... .... | 0·20 | .... | 0·22 |
| Combined Water $H_2O+$ | 19·81 | 11·0 | 20·87 |
| Moisture $H_2O$— .... | 2·02 | .... | 2·04 |
| Titania $TiO_2$ .... .... | 0·03 | .... | 0·04 |
| Phosphorus Pentoxide $P_2O_5$ .... .... | 0·01 | .... | 0·01 |
| Sulphur trioxide $SO_3$ | 0·01 | .... | 0·02 |
| Chloride Cl .... .... | 1·61 | .... | 2·49 |
| Chromic Oxide $Cr_2O_3$ | *Nil* | .... | *Nil* |
| Manganese Oxide MnO | trace | .... | trace |
| | 100·27 | | 100·83 |
| Less O = Cl .... | 0·37 | | 0·56 |
| Total .... .... | 99·90 | | 100·27 |

Analyst : J. R. Gamble.




## REFERENCE

Track

Salt Lake

Strike & Dip of foliation 70°

Sampling and Geology by J. Sofoulis and W. Bock 1961.

G. S. W. A.

GEOLOGICAL SKETCH MAP

# HALLOYSITE DEPOSIT

24 Miles North of Boorabbin

Coolgardie Goldfield

The Deputy Government Mineralogist, in summing up, suggests that—"this material, after removal of water soluble salts and coarse contaminants, is made up of a mixture of halloysite, metahalloysite and gibbsite with metahalloysite probably originating from partial dehydration of halloysite on drying. X-ray patterns have been obtained, confirming the presence of gibbsite."

The bulk sample was collected from locality "A", as shown in the accompanying sketch. This is representative of the material available from a depth of 0-5 feet below the lake floor (water table lies at 5 feet). A further sample taken from below the water table 5-7 feet was described as predominantly halloysite and gibbsite with some halite and a trace of quartz.

Further samples of the same deposit were taken at localities "B", "C" and "D" with the following results:—

Locality B, depth 0-6 ft.; the sample contains halloysite, halite, calcite, gibbsite and quartz, with a trace of clay mica.

Locality C, depth 0-4 ft.; similar to B, but with a larger proportion of clay mica.

Locality D, depth 0-5 ft.; the sample contains kaolinite, halite and quartz, with a trace of clay mica. The presence of kaolinite in this sample is indicated in the X-ray patterns by better orientation and less hydration effects. However, some halloysite may also be present.

*Estimated Tonnage.*

Using a factor of 20 cubic feet of halloysitic material to the ton and assuming the dimensions of the deposit to be five hundred feet long, one hundred and eighty feet wide, and with an average depth of four feet, an estimation of the material available could be in the vicinity of 18,000 tons.

*Origin of the Deposit.*

The most logical explanation of the origin of the halloysite is from the decomposition of the greenstones underlying the lake, probably during and after Tertiary times, contemporaneously with the formation of the secondary limestones. The presence of a stream bed leading into the lake and rising on the slopes of Mount Walter would account for the moist condition of the clay. Further thin seams of halloysite have been noted in other lake floors of the metamorphic rocks in the Kalgoorlie-Widgiemooltha areas.

*Potentialities.*

The halloysite has subsequently been taken out as a Mineral Claim by Universal Milling Company which intends mining and selling the clay on the Australian market. Previously the material has been imported from Europe. Some industrial uses found for halloysite have been—pozzolanas, ceramics, refractories, fuller's earth, paint and soap filters, water-proofer and foundry-work.

*Conclusion.*

This is the only commercial accumulation of halloysite known in Western Australia, and it is estimated that a possible 18,000 tons of material could be available from this deposit. Considerable programmes of deposit testing and material experimentation will be necessary to prove the full extent and usefulness of halloysite in the above or other avenues.

There is every possibility of more halloysitic accumulations awaiting discovery in the floors of salt lakes in these and other goldfield areas, particularly lake floors associated with the metamorphic rocks.

*Appendix.*

*Analyses of Limestone adjacent to Halloysite Deposit*

| Sample No. | Feet Sampled | Acid Insoluble | Lime CaO | Magnesia MgO |
|---|---|---|---|---|
| | | % | % | % |
| 1 | 300 | 7·50 | 39·3 | 9·08 |
| 2 | 5 | 7·30 | 44·4 | 4·89 |
| 3 | 580 | 6·69 | 43·8 | 6·15 |
| 4 | 12 | 4·49 | 34·6 | 15·8 |
| Averages .... | .... | 6·49 | 40·5 | 8·98 |

Samples 1 and 3—Surface chip samples.

Samples 2 and 4—Chip samples—breakaway section.

## PROGRESS REPORT ON THE REGIONAL SURVEY OF THE WIDGIEMOOLTHA SHEET AREA, SH51-14, INTERNATIONAL SERIES.

*By J. Sofoulis and W. Bock.*

### INTRODUCTION.

The Widgiemooltha sheet, defined by latitudes 30 degrees and 32 degrees south, and by longitudes 121 degrees 30 minutes and 123 degrees east, covers an area of approximately 6,000 square miles. It lies south-east of Kalgoorlie within the southern portion of what is commonly known as the West Australian Precambrian shield.

The sheet forms the second of a series primarily initiated to establish geological continuity between West Australia's principal gold mining centres of Kalgoorlie and Norseman.

The Boorabbin sheet, adjoining the Widgiemooltha sheet to the west, was completed during the 1960 field season, and is at present under compilation.

### FIELD WORK.

The field investigations took place from April to October, 1961. Geologists engaged on the survey were J. Sofoulis (Party leader) and W. Bock, each accompanied by a field assistant, and working independently.

Approximately two-thirds of the area consisting of the southern, western, and eastern portions, were completed during the field season. The present progress report (compiled by J. Sofoulis) is accompanied by a tentative geological sketch map at a scale of 1: 250,000.

Where possible, the geological boundaries shown were plotted by direct observation in the field but, in areas of restricted outcrop, additional data was obtained from patterns and tonal differences observed on aerial photographs, allied with morphological analyses, and both carried out in conjunction with field observations. Thus in these areas, boundaries are approximate.

### GENERAL GEOLOGY.

The major geological elements recorded within the Widgiemooltha sheet area include units of Archean, Proterozoic, Palaeozoic, and Cainozoic age. The latter includes developments of surface encrustations, of eluvium, alluvium, aeolian sands, and salt lake deposits. These cover approximately 85 per cent. of the area investigated and restrict the "solid geology" to rare topographically prominent belts, to scattered outcrops in soil covered areas, and to weathered breakaway exposures marginal to salt lakes.

A tentative stratigraphic table for the area is presented below:—

Stratigraphic Table—Widgiemooltha Sheet.

| Period | Age | Rock Unit | Lithology | Remarks |
|---|---|---|---|---|
| Cainozoic .... | Quaternary—Recent and undifferentiated Tertiary | | Aeolian, alluvial, eluvial and lake deposits. Ferruginous and siliceous duricrusts | Gypseous and sandy lunettes, of lake margins, salt, silts, clays, muds, of lake floors. Extensive aeolian sands and superficial loamy soils over granitic and metamorphic terrains. |
| Cainozoic .... | Eocene .... .... | Plantagenet Beds .... | Spongolites, thin limestones, shell beds | Horizontally bedded thin veneers transgressive over Precambrian and Palaeozoic rocks. |
| Palaeozoic .... | Lower Permian .... | Wilkinson Range Beds | Felspathic grits, tillitic siltstones with sandy clayey variations | Horizontally bedded as thin veneers or shallow basin fills over Pre-Cambrian basement. |
| Proterozoic .... | Upper (?) .... .... | Woodline Beds .... | Quartzites, mudstones, shales, conglomerate | Trend north-east, flatly dipping south-east. Local crenulations along north-east lines. |
| Proterozoic .... | Lower (?) .... .... | Dundas Dyke Suite | Quartz-dolerite dykes. Gabbroic noritic variations | Locally hypersthene-bearing. Occupy widely spaced fissures of east-north-east trend in Archaean basement. |
| Archean .... | .... .... .... | .... .... .... | Granites .... .... .... | *Internal Granites*—locally intrusive, but generally forming regionally concordant masses. Mainly developed within metasedimentary belts. *External Granites*—flank the metamorphic terrains. Are locally gneissic in character. |
| | | | Porphyries .... .... .... | Generally albitic, probably generated from mobilisation of meta-psammitic and psephitic sediments (Kurrawangs). |
| Archean .... | .... .... .... | .... .... .... | Charnockite rocks—acid, basic, ultrabasic, hypersthene-bearing granulitic rocks, gneisses | Developed in south-east sector (Frazer Range) of north-east trend. |
| | | | Granulites, gneisses—mainly of pelitic, psammatic origins | Outcrop rare, mainly developed in central and southern sectors. |
| Archean .... | .... .... .... | Coolgardie-Kalgoorlie Metamorphics (Whitestones including Kurrawangs) | Metasediments—predominantly meta-pelitic-psammitic and psephitic | Locally as thin intercolations in the basic and ultrabasic belts. Broader developments occupy primitive depositional basins. Particularly prone to mobilisation where structurally disturbed or compressed. |
| | | Coolgardie-Kalgoorlie Metamorphics (Greenstones) .... | Meta-gabbroic rocks (younger greenstones) Meta-volcanic basic igneous and ultrabasic (? meta-dolomitic) rocks, schists | Generally as regional strike trending belts. Locally mineralised where complexly folded or associated with granite-porphyry emplacements. Ultrabasics are preferred hosts for gold mineralisation. |

## ARCHEAN.

Archean rocks form the basement to and probable source for all the younger sediments. Major subdivisions are:—

*Coolgardie-Kalgoorlie Metamorphics.*

The metamorphic rocks of the area are regarded as extensions, repetitions, or modifications, of the Coolgardie-Kalgoorlie Metamorphics already mapped on the adjoining Boorabbin sheet (Sofoulis 1960).

In past literature, fundamental subdivisions of these rocks are commonly referred to as "greenstones" and "whitestones". McMath (1953) groups the "greenstones" and "whitestones" of the Coolgardie area as respectively forming meta-igneous and meta-sedimentary phases of the "Yilgarn-Kalgoorlie System".

*Greenstones.*—The greenstones distinguished within the Widgiemooltha sheet area follow the regional north-north-west trend and are lithologically similar to the "greenstones" recognised in most West Australian goldfield areas. They consist essentially of altered basic igneous and sedimentary rocks. Ultrabasic rocks believed to be mainly altered dolomites, (or metasedimentary rocks of appropriate composition), and metagabbroic rocks forming the "younger greenstones" of Prider (1948) are also included within this unit.

Sedimentary rocks lithologically similar to those forming the bulk of the next unit (Whitestones) appear as subordinate and often discontinuous bands.

*Whitestones.*—This unit comprises mainly schists and siliceous rocks that range in texture from jaspilites to psephites. They appear to form broad

regional basins which suggest that they are younger than the "greenstones". This is in agreement with the observations of McMath (1953) in the Coolgardie area, and of Ellis (1939) in the Yilgarn Goldfield.

Belts of this unit locally contain developments which are tentatively correlated with the "Kurrawangs" of Honman (1914) known west of Kalgoorlie. On the Widgiemooltha sheet they have been recorded as far south as Lake Cowan.

*Granulites.*

Rocks with a granulitic texture are extensively developed in the central and south-eastern sectors of this sheet. They are presumed to be the result of a deep seated metamorphism of what were dominantly pelitic and psammitic rocks.

In the south-east sector of the sheet, the granulites have a strong gneissosity and grade into hypersthene-bearing varieties (charnockites).

Economic gold mineralisation is unknown in the granulitic terrains of this area.

*Charnockites.*

Hypersthene-bearing granulites (commonly described as charnockites) are developed in the south-east sector of the sheet. Here they give rise to topographic expressions that form part of the Frazer Ranges.

Wilson (1959) describes the charnockitic rocks as "dark, greasy, bluish-grey or greenish-grey, medium-grained rocks, with xenomorphic texture, ranging in composition from granite through norite to pyroxenite, and characterised throughout by the presence of orthopyroxene".

The regional north-east trend of this belt, and of the hypersthene development both suggest affinities with the north-east trending "Woodline Beds" and hypersthene-bearing "Dundas Dyke Suite" described below. Thus the metamorphism responsible for the charnockitic suite may be related to a Proterozoic orogeny.

*Porphyries.*

Albitic porphyries appear as minor developments within the metamorphic belts. They are generally intrusive but in some instances form larger, regionally concordant masses (e.g. Porphyry of Emu Rocks).

Other forms of "Porphyritisation" have yielded minor porphyrites and selective albitisation of country rocks. Porphyries and "porphyritisations" are particularly prominent about past gold mining centres.

The transition from country rock to "porphyritised" country rock, porphyry, and thence granite also suggests a genetic relationship between these various members, with the porphyry development representing a "front" or "pregranitisation" stage.

Accepting the genetic relationship of gold mineralisation to granite, this concept of a porphyry "front" is supported in the "Celebration-Kambalda" belt, where many porphyries are associated with, or contain, minor forms of gold mineralisation.

*Granites.*

Granites are grouped as internal granites and external granites, dependent on their mode of occurrence.

The internal granites are completely enclosed within the belts of metamorphic rocks and are usually confined to metasediments. Detailed examination shows intrusive relationships but at a broad scale, the granites are concordant and follow the same regional trend as the metamorphic belts. The internal granites are assumed to be contemporaneous.

External granites cover wider areas and flank the belts of metamorphic rocks. Those developed within the limits of this sheet include the Erayinia-Coffin Rock granite of the north-east quadrant, and the extensive granitic terrains west of the Widgiemooltha-Norseman road.

In general, the complex lithia-pegmatites, and areas of known gold distribution, are restricted to metamorphic terrains marginal to the internal granites.

PROTEROZOIC.

Rocks tentatively assigned to the Proterozoic era are developed within the area. Two major subdivisions are recognised. They are:—

*Lower (?) Proterozoic—"Dundas Dyke Suite".*

Vertically-disposed, east-north-east trending, gabbroic dykes which cut across the Archean members, are distinguished as a major tectonic lineament in the southern portion of this Archaean block.

They are tentatively grouped here as the "Dundas Dyke Suite" after the major development (generally known as the "Norseman Norite") forming the Dundas Hills near Norseman.

Dykes of the suite vary in composition and have been described as norites, gabbros, quartz dolerites, quartz diorites, peridotites, quartz gabbros and hypersthene gabbros. Analyses of the "Norseman Norite" have been given by Campbell (1906). Dominant constituents include twinned plagioclase and diallage. Hypersthene, where developed, is intimately associated with diallage and shows a preference for the thicker dyke developments. Marked schiller structures are general.

The dykes appear as equigranular, coarse-grained rocks, but locally they present an exaggerated coarseness where ferro-magnesian constituents are clotted.

A major dyke of this suite has been traced by the authors over a distance of some 120 miles. This dyke extends east-north-east from the northern extension of the "Bremer Range Metamorphics" on the Boorabbin sheet, to as far east as Murdunna Lake on the Widgiemooltha sheet. Thickest development is at Cowan Hill where an approximate width of two miles is known. In the Murdunna Hill area, the extension of this same dyke is referred by Hooper (1959) as the "Murdunna Gabbro."

Minor dykes belonging to the same suite have also been recognised by the authors in the Widgiemooltha area. Further north, the hypersthene gabbro, recorded by Honman (1916) in the "Celebration Mine" locality, has now been traced in discontinuous outcrop to within four miles north-north-west of Randell Siding on the Transcontinental Railway.

Lithologically similar rocks following the same east-north-east trend, and cutting across the Archean elements, have been recorded as quartz dolerites and quartz gabbros in the Phillips River Goldfield (Sofoulis 1958). The westerly extension of this same dyke suite has also been noted by the authors in the Needilup, Jerramongup, Ongerup, Borden, and Gnowangerup localities of the South West Division.

In all these areas, the dykes maintain the same regional trend and are not known to intrude the Proterozoic rocks forming the Stirling-Barren Ranges.

Until precise dating information becomes available, the dykes of this suite are tentatively placed as Lower Proterozoic. The suite is known to be younger than the north-north-west trending epidiorites in the Phillips River Goldfield (Sofoulis op. cit.) but apparently older than the quartz dolerites recorded by Clarke, Phillips, and Prider (1954) in the "Stirling Range Beds."

*Upper (?) Proterozoic—"Woodline Beds."*

"Woodline Beds" is the name proposed for a younger system of shallow-water sediments unconformably overlying the Archean basement in the south-east portion of the Widgiemooltha sheet. These sediments are not intruded by the "Dundas Dyke Suite," and are therefore tentatively assigned to the Upper Proterozoic.

The Woodline Beds were first recognised by the authors near the disused woodlines some eighteen miles south-east of the north-east limit of Lake Cowan, where they form a prominent topographic expression. In this locality, these sediments form a belt up to six miles in width which can be traced in a north-east direction for some thirty six miles (see plate).

The sequence is estimated to be five hundred to seven hundred feet thick and consists of forty to sixty feet of flat to gently dipping, current-bedded, ripple-marked, blocky, white to grey quartzites, overlying a thinly-bedded succession of chocolate and grey mudstone-shale formations.

A thin basal conglomerate locally recorded along the northern margin, shows strong brecciation and fusion to the underlying basement rocks. The "Woodline Beds" are thus separated from the Archean basement by a marked unconformity, further modified by mild tectonic movement along the contact.

A flat-lying, current-bedded, ripple-marked quartzite unconformably overlies steeply-dipping kaolinised schists in a lake breakaway section north of the main distribution. Further north, a small development of ripple-marked quartzite occurs at Woolibar Dam. Both occurrences are believed to be "Woodline Beds" outliers.

At a regional scale, the "Woodline Beds" trend north-east and show gentle dips to the south-east. Local steepenings and dip reversals in the form of minor crenulations (oriented along north-east lines) were noted in the mudstone-shale formations.

The "Woodline Beds" can be regarded as a further strike extension of the "Stirling-Barren" sediments of Proterozoic age (Sofoulis 1958). This correlation is based on geographic disposition of both units and on their similarities in lithology degree of folding, trend, and relationship to basement.

PALAEOZOIC.

Flat-lying, unfossiliferous tillitic beds form thin veneers over, or occupy shallow basins in, the Archean and Proterozoic terrains of the eastern sector of the sheet.

These beds are difficult to recognise in the field as most surfaces in this sector are covered by soil or siliceous duricrusts (billy). The best exposures generally occur below the duricrust, in breakaway escarpments marginal to salt lakes. In some lakes, the underlying Precambrian rocks are exposed at the base of breakaway sections, or locally form outcrops at lake floor level.

The thickest development noted was at a salt lake located some six miles west-south-west of Fitzgerald's Lagoon. Here some eighty feet of tillitic siltstones are overlain by twenty-five feet of felspathic grits.

The tillites proper generally have a grey to white siltstone matrix (with sandy-clayey variations). The size of erratics varies from small pebbles to blocks of four feet or more across. Faceting is common and some of the smaller boulders are noticeably grooved.

Heavier boulder concentrations generally appear towards the base but isolated boulders occur in any horizon. Quartzite boulders predominate but granitic, porphyritic, and other metamorphic rocks similar to those of the underlying basement also occur.

A characteristic of the tillite beds is the local development of cherty mudcakes (showing concentric ring patterns) up to eighteen inches in diameter.

As can be observed on the accompanying plate, the shape of the Palaeozoic basins (and also the present salt lake distributions) of this area have been influenced by the younger north-east trending Precambrian grain.

By analogy with similar fluvio-glacial and aqueo-glacial beds known as the "Wilkinson Range Beds" in the areas adjacent to the north-east (Talbot and Clarke 1916), the tillite beds are tentatively placed in the Lower Permian.

CAINOZOIC.

The following groups form major subdivisions within the Cainozoic:—

*Eocene.*

Flat-lying spongolitic rocks and thin limestone and shell beds have previously been recorded about the margins of Lake Cowan (McWhae *et al.* (1958)). Minor developments in the Binneringi locality of the Widgiemooltha sheet have also been described by Clarke (1925) and Hooper (1959).

Further developments have been noted in the eastern sector of the sheet. These are transgressive and rest on Archean, Proterozoic and Palaeozoic rocks.

In these areas, porous, patchily iron-stained, spongolites form the dominant lithology, and are probably correlative with the "Princess Royal Spongolites" described by Glauert (1926) five miles north-north-east of Norseman and the spongolites of the "Plantagenet Beds" recorded by Jutson and Simpson (1917) along the south coastal areas of the Plantagenet District.

On fossil evidence (Singleton 1954), this shallow marine transgression took place during the Eocene period. The occurrences of the Widgiemooltha sheet are considered to be the northernmost areas transgressed.

*Quaternary—Recent.*

These are mainly of a superficial nature and consist of various deposits of eluvial, alluvial, and aeolian origin as well as lake deposits and duricrusts, similar to those of the Boorabbin sheet (Sofoulis 1960).

On the Widgiemooltha sheet, additional features include an extensive development of siliceous duricrust associated with areas of Palaeozoic, a blanketing of Archean rocks through general stripping and reworking of superficial soils, and the extensive accumulations of aeolian sands marginal to larger salt lake systems.

## STRUCTURAL FEATURES.

The present area forms but a small portion of West Australia's principal gold producing belt extending through the North Coolgardie, Coolgardie and Dundas Goldfield areas, and embracing the major gold producing centres of Kalgoorlie and Norseman.

Although much scattered information is available over these areas, the data is mostly uncoordinated, and would not be of great benefit until the complete regional picture has been elucidated.

Within the present sheet area, some of the fundamentals evolving are:—

(1) Metamorphic belts follow the same regional north-north-west trend recognisable over most portions of the central, southern and eastern goldfield areas.

(2) Local structural disturbances at regular intervals along these belts result in belt termination, deflection or the production of a complexly folded sector.

(3) Subordinate cross-flexuring along north-east lines has locally affected the regional trending belts. The fold elements of this trend predominate in the complexly folded areas.

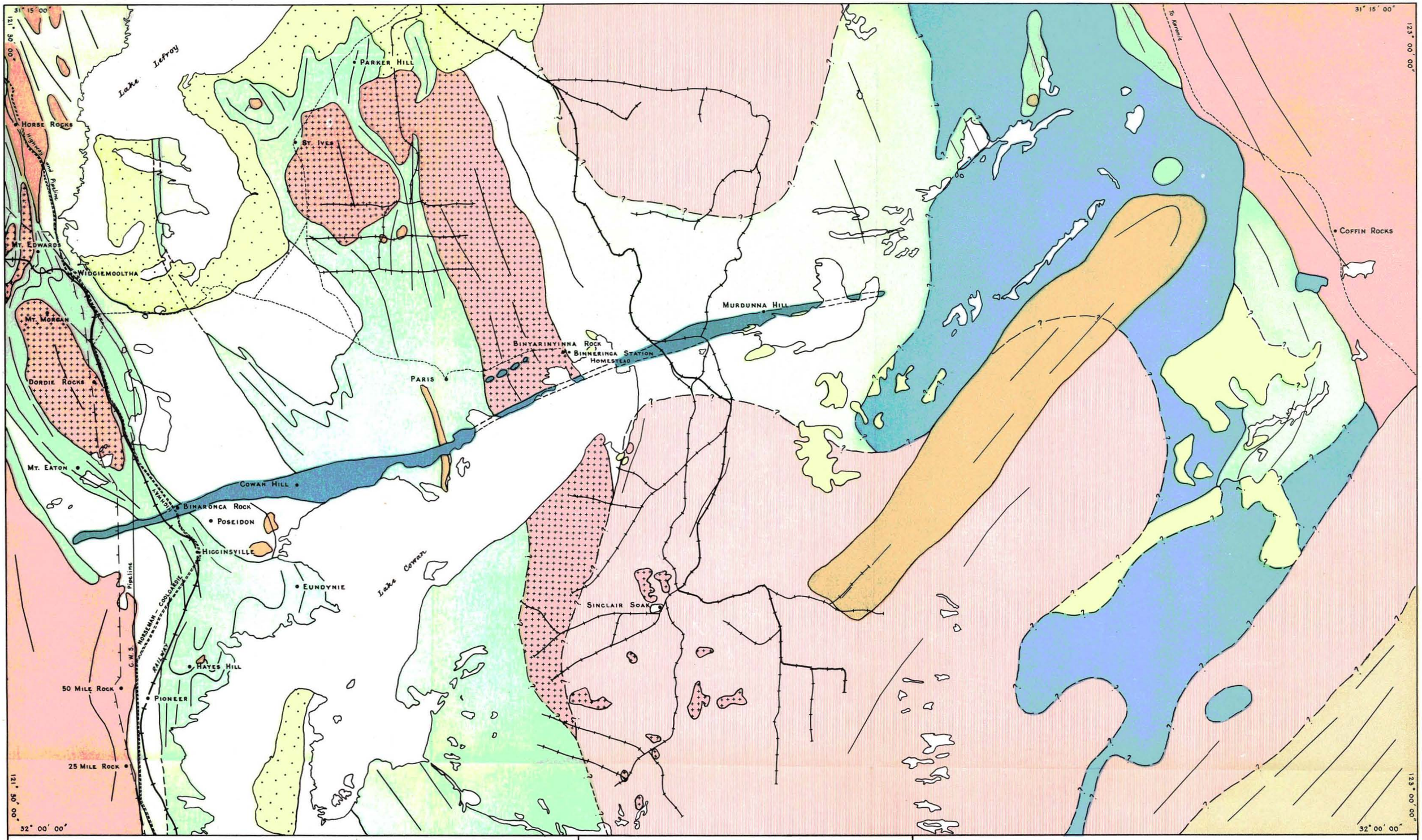
(4) North-east trends also predominate in the non-auriferous granulitic and charnockitic terrains of the south-east sector.

(5) A linkage between the north-north-west trend of the northern areas, and the north-east trend of the southern areas is apparent in the eastern metamorphic belts.

(6) Pelitic, psammitic and psephitic beds reflect primitive basins of deposition. They are particularly prone to mobilisation where tightly folded or structurally compressed.

(7) Granite and porphyry emplacements favour meta-sedimentary belts and are frequently developed in the complexly folded areas.

PLATE II




## LEGEND

**PROTEROZOIC**

- ? UPPER WOODLINE BEDS — Quartzites, mudstones, shales, conglomerate.
- ? LOWER DUNDAS DYKE SUITE — Hypersthene-bearing dolerites, -gabbroic - noritic variations.

**PALAEOZOIC**

- ? PERMIAN (WILKINSON RA. BEDS) — Glacial beds — felspathic grits, tillitic siltstones with sandy, clayey variations.

**CAINOZOIC**

- EOCENE (PLANTAGENET BEDS) — Spongolites, thin limestones, shell beds, etc.
- QUATERNARY - RECENT — Aeolian, alluvial, eluvial soils, ferruginous and siliceous cements, lake deposits, etc.

**ARCHAEOZOIC**

- COOLGARDIE - KALGOORLIE METAMORPHICS
  - Predominantly meta-pelitic, psammitic rocks, schists [Whitestones - including Kurrawang]
  - Meta-gabbroic rocks [Younger greenstones]. Meta-volcanic, basic, ultrabasic (? meta-dolomitic) rocks, schists [Greenstones]
- Internal granites
- External granitic rocks
- Porphyries - albitic
- Charnockitic rocks - acid, basic ultrabasic hypersthene - bearing granulitic rocks, gneisses
- Granulitic rocks, gneisses - meta-pelitic psammitic origins.

Established nomenclature shown in parentheses.

## REFERENCE

- Observed Geological Boundaries
- Approximate Geological Boundaries
- Inferred Geological Boundaries.
- Trend Lines
- Railway Line
- Current Woodline
- Disused Woodline
- Telegraph Line
- Highway
- Tracks.
- Salt Lakes.

G. S. W. A.

# GEOLOGICAL SKETCH MAP

OF

# PORTION OF WIDGIEMOOLTHA SHEET SH 51-14

COOLGARDIE GOLDFIELD AREA

WESTERN AUSTRALIA

Scale: 4 Miles to an Inch

4 3 2 1 0 4 8 12

Geology based on fieldwork by J. Sofoulis and W. Bock. April - Oct. 1961

(8) In general, the distribution of gold mineralisation is associated with granite and porphyry emplacements.

(9) Widely spaced, east-north-east trending tension fissures of the Archean basement are now occupied by the "Dundas Dyke Suite." They are post gold mineralisation but are suspected of following a more primitive weakness. They are often in the vicinity of major gold producing centres.

(10) Younger sedimentary basins of Proterozoic, Palaeozoic, and Cainozoic age, and the present salt lake distribution of the area follow north-east trends.

## CONCLUSIONS.

The present field work has been responsible for the discovery and delineation of Proterozoic and Palaeozoic rocks, previously unrecorded in this locality.

The east-north-east trending gabbroic dykes (Dundas Dyke Suite) are now recognised as a separate post-mineralisation dyke suite forming a major tectonic lineament within this southern portion of the West Australian Archean block.

Delineation of the various metamorphic and igneous elements in the crystalline basement should provide a better understanding of the geology, structure, and mineralisation relationship of the area as well as materially assisting in future mineral exploration programmes.

The remainder of the Widgiemooltha sheet is expected to be completed during the 1962 field season.

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# WATER SUPPLIES, WARBURTON RANGE AND ADJOINING AREAS.

Eastern Division, Western Australia.


*By John Sofoulis, B.Sc., Geological Survey of W.A.*


## GENERAL.

Natural watering points over the general region have previously been reported upon by Talbot and Clarke (1917). These are mainly in the form of gnamma holes, rock holes, or small catchments in rock depressions, and are generally referred to as native wells or soaks.

Developed ground water supplies from a calcrete limestone aquifer exist only at the Mission Station locality. Similar calcrete limestones occurring along the principal drainages in and about the area can be regarded as the potential sources of further shallow ground water supplies.

## NATURAL SURFACE SOURCES.

The gnamma, rock hole and other short lived surface soaks and catchments are generally restricted to small watercourses or scoured depressions in the mottled or lateritised surfaces of low breakaways. Such occurrences are restricted to the minor lateritic developments locally appearing within the sand plain areas (mainly over Palaeozoic beds.)

Natural sources are rare in the more dissected upland belts, but following precipitation, the concentration of run off waters in bare rock depressions or drainage lines can result in short lived pools or periodic stream flow.

None of the natural surface sources can be classified as permanent although some are capable of retaining water for long periods (e.g., Lilian rock hole). When charged, the known surface catchments serve as "game concentrators" and enable the nomadic natives to move safely about the area, and to follow their normal pursuits.

Most of the catchments could be improved by establishing short run off diversions or blocking natural spillways. Additional catchments could also be constructed by erecting earth barriers across small water courses in the better (kaolinised) holding ground.

In their present state, the gnamma or rock hole sources would be of little use to pastoral development as they are generally small, unreliable, inaccessible to stock, and usually too remote from suitable feeding grounds.

## CALCRETE LIMESTONE SOURCES.

*General.*

The principal shallow ground water sources are calcrete limestone areas developed along drainage lines. These are similar to the calcrete limestones extensively developed throughout the North-West and Eastern Divisions of West Australia and have been described previously as travertine, creek limestone, secondary limestone, surface limestone, or kunkar. In the Pilbara area, similar dissected deposits known in the Oakover valley have been described by Maitland (1904) as "Oakover Beds."

In these areas, the calcrete limestones are now recognised as the principal sources of shallow water supplies. Typically they consist of some tens of feet of surface limestone often interbedded with, or overlying vesicular opaline silica bands and fine unconsolidated gravels.

These can occupy extensive drainage tracts up to several miles in width, or fill minor basins eroded in weathered rock. In their surface exposures, the calcrete limestone areas can appear as hard or soft, low platforms, mounds, cappings, or rubbly and puffy undulating limestone surfaces, which locally show sub karst features.

The limestone itself is regarded as chemically formed by precipitation out of solution in ponded sectors of the main drainages, at the close of a past (Tertiary) period of greater rainfall.

In their present state, the drainages now appear as "choked" systems and the contained calcrete limestones are physically suited to water storage and possess extensive catchments. Such underground storages are capable of yielding excellent supplies of domestic and stock waters and in some localities have been utilised for irrigation purposes (Lorna Glen, Wiluna.)

*Calcrete Sources—Warburton Area.*

The only developed underground water sources are the Mission wells situated in calcrete limestone forming an alluviated area adjoining Elder Creek. Here, five shallow wells 25 to 30 feet deep are providing sufficient water for station needs, as well as supplying some 200 or more natives camped in the immediate precincts. These wells also provide the needs for some 150 head of stock (sheep and cattle) feeding in adjacent areas.

A further shallow well (30 feet deep) in the same calcrete development, is located at the Elder and Hughes Creek junction and has provided similar supplies but at the present time is not equipped.

Within the mapped area, the most extensive calcrete development forms the upper reaches of Lilian Creek and if required ideal well sites could be selected where crossed by the Blackstone Road. Other minor developments of calcrete are present along the main headwaters of Elder Creek. These exist as isolated pockets but can be regarded as potential sources since most are independently recharged from adjacent outwash or hilly areas.

*Calcrete Sources—Adjoining Areas.*

Similar calcrete limestones are known further east and probably exist along principal drainage lines of this and adjoining State areas.

Westerly the area is mainly sand covered but calcrete drainages can occur. Developed sources have been noted by the present writer in the Lake Carnegie-Wells region and also along the Warburton road between Cosmo-Newberry and the Mount Shenton metamorphics.

The "Wort" native well located along the southern margin of Lake Throssell has probably been in use for centuries, and is formed by a vertical limestone solution hole (3 to 4 feet across) which extends below the water table (at 16 feet) to provide a reliable if not permanent source of fresh water.

Other calcrete drainages and developments marginal to salt lakes would similarly serve as useful water sources particularly where independently recharged from adjacent sand plain or outwash areas.

## OTHER GROUND WATER SOURCES.

Additional wells in the Warburton locality are established along alluviated (but non-calcreted) drainages and penetrate metamorphic rocks at shallow depth.

There are Wururu well (30 feet + deep) situated on Elder Creek eight miles north-north-east of the Mission and "Mulya Ngiril" well (30 + feet deep) on Scamp Creek approximately five miles north of "Wururu" well.

In the past, these wells have been utilised for pastoral and domestic (native) uses.

They are not regarded as satisfactory sources because of greater depths, higher salinities, poorer yields and failure during drought periods.

An attempt was made to establish a well on Hughes Creek some five miles south-east of the Mission but proved unsuccessful. This well, known as "Yulta Tjara," is 60 feet deep and is dry. A further dry well (40 feet +) is also located on a watercourse five miles south of the Elder-Hughes Creek junction.

On present indications, and in view of the calcrete sources available, the further search for ground water in the metamorphic, granitic and sedimentary rocks would not be recommended.

## RECHARGE.

Recharge to natural surface catchments and calcrete storages are entirely dependent on the heavier rains precipitated during the summer months.

Average annual rainfall would be in the vicinity of 8 to 10 inches although both amount and distribution would be unreliable. Heavier falls, as experienced during cyclonic disturbances, frequently results in stream flow and serves as the principal method of calcrete aquifer recharge.

The storages are further augmented by run off waters derived from adjacent outwash plain areas during lighter falls. Under normal pastoral use, the storage capacities of the calcrete acquifers would probably be sufficient to withstand severe drought periods.

## CONCLUSIONS.

Calcrete acquifers similar to those developed in the North-West Division of Western Australia also exist in the Warburton area.

Several shallow wells (to 30 feet deep) established at the Warburton Aboriginal Mission are tapping the same calcrete storage and provide full water requirements. If properly harnessed, the same source is also capable of irrigating small vegetable or pasture plots.

Other calcrete developments known within this and adjoining areas, are regarded as the potential sources of similar ground water supplies which could be utilised if required. Sites already recommended on the Lilian Creek drainage would make new pastoral country amenable to immediate exploitation.

Natural gnamma and rock hole sources are unreliable and consequently native movements are generally restricted to post pluvial periods. The extra burdens thrown on the Mission during drought periods could be considerably reduced by the construction of further permanent wells in other calcrete aquifers of this and adjoining areas.

It is also considered that the establishment of additional wells along access routes between the Warburton Mission and other permanent settlements of the "Centre" would assist in the free and safe movement of nomadic natives as well as serve as permanent watering points for itinerant whites.

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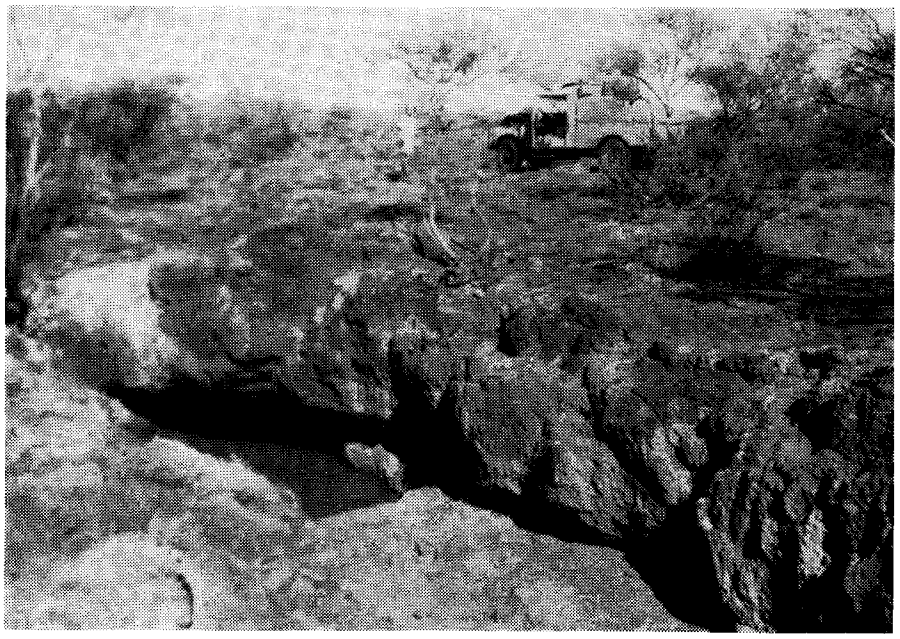

Fig. 1. Kapi Kanpa formed along a small watercourse in the laterised mottled zone of a low breakaway developed over Palaeozoic beds.

(Photo reference: Breaden Sheet R13/5064.)

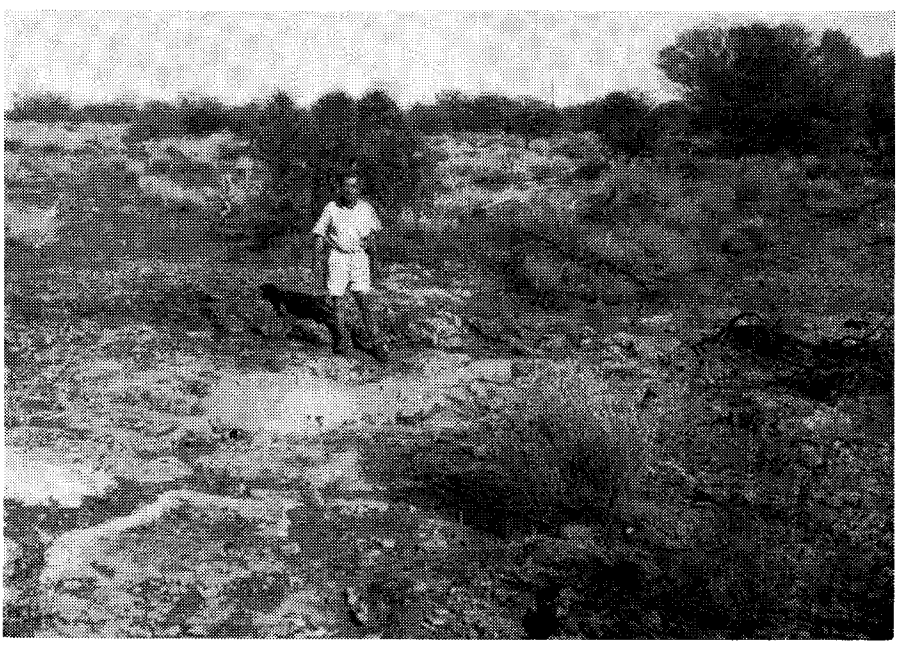

Fig. 2. Wort native well, margin of Lake Throssell, showing calcrete limestone surface.

(Photo reference: Throssell Sheet R4/5024.)

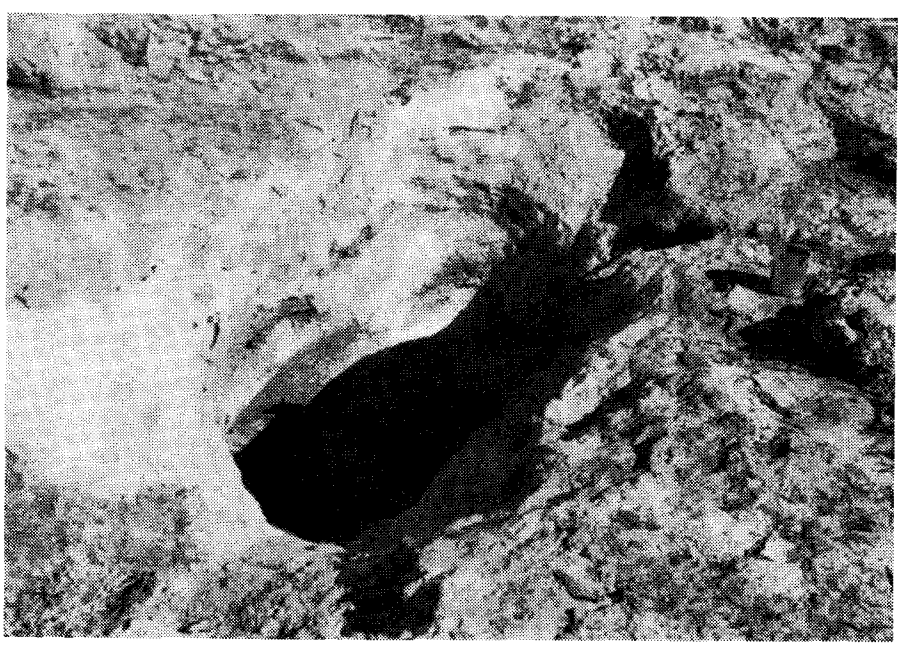

Fig. 3. Wort native well showing solution pipe which extends below water level (16 feet.)

# GEOLOGICAL RECONNAISSANCE OF THE WARBURTON RANGE AREA, WESTERN AUSTRALIA.

*By John Sofoulis, B.Sc.*

## INTRODUCTION.

A geological reconnaissance of the Warburton Range area was prompted by the recent marketing of copper ores extracted from the immediate vicinity of the Warburton Range Aboriginal Mission. Earlier geological reconnaissances of the same area were conducted by Talbot and Clarke (1917) and Forman (1932, 1933).

The present report discusses the physiography, stratigraphy, structure and economic potential of the area, and also suggests correlations with adjacent areas. The report is accompanied by a geological compilation based on photo index map Talbot, sheet 3/468, scale 1 mile = 1 inch.

The geological reconnaissance was carried out during the period October 2nd to 12th, 1961.

## LOCATION AND ACCESS.

The Warburton Range Area is contained within the "Talbot" international series sheet S.G. 52-9 delineated by latitudes 26° and 27° south and longitudes 126° and 127° 30′ east. The locality falls within a native reservation, and permission to enter the area must be obtained from the Department of Native Welfare.

A native mission Station, operated by the United Aborigines Mission, is located near the junction of Hughes and Elder Creeks on the north-west foothills of the Warburton Ranges, and caters for the welfare of the nomadic natives of the region. The Station includes a store, hospital, and school, and is connected to the Flying Doctor radio network based at Kalgoorlie. A landing strip for light aircraft, and water facilities, are available at the Mission.

From the West Australian side, the Warburton area may be reached by travelling eastwards along a graded dirt road from Laverton to Cosmo Newberry Mission (50 miles), and thence north-eastwards for a further 300 miles via the southern margin of Lake Throssell.

A graded dirt road running north-eastwards for some 170 miles connects the Warburton Mission with the Giles Weather Station. Forty miles along this road, a newly-constructed track branches westwards to link with Carnegie Pastoral Station and thence to Wiluna.

Supplies and mail are carted by the Mission truck which makes a trip monthly to Laverton. The Giles Weather Station forms the nearest permanent settlement and has a weekly mail service from Alice Springs. Giles is operated jointly by the Bureau of Meteorology and Weapons Research, and is connected by a graded dirt road running some 400 miles eastwards via Mulga Park and Mount Davies pastoral Stations to meet the Adelaide to Alice Springs Highway 10 miles south of Kulgera. From this South Australian side, a branch track also connects to the Warburton area via the Blackstone Ranges.

## PHYSIOGRAPHY.

From a regional aspect, the area has an average elevation between 1,500 and 2,000 feet above sea level but shows a gradual fall from north-east to south-west. Consequently major drainages are controlled by this fall and drain westerly or southerly to terminate in outwash aprons or become lost in adjacent sand plains areas.

Dissection of the hilly belts is influenced mainly by structural and lithological features and, with the exception of the higher Warburton Range ridges, local differences in elevation seldom exceed 200 feet. Physiographic units distinguished within the area are:—

*Dissected Hills and Ranges.*

Resistant ridges and dissected hills of metamorphic rocks comprising the Warburton Ranges form the major positive elements of relief. These are south-east trending in the north-west sector, but alter to an east trend in the south-east sector.

Higher ridges range up to 600 feet above the Elder Creek level at the mission site, and are flanked by, or interbedded with, lower, less-resistant belts of similar trend. Dissection of the hilly belts has been general with drainages mainly controlled by rock fracture systems, strike and dip features, and lithological diversity.

In the south-west sector, lower lying breakaway and butte features are formed by dissection of the flat-lying Palaeozoic sediments.

*Outwash Plains.*

Flat alluviated plains skirt or occupy the lower lying areas of the hilly belts. These are associated with the sheet drainage of the area, and appear as red loamy outwash plains (or aprons) showing little, if any outcrop, but frequently mantled by veneers of stoney or fragmentary material derived from the upland areas.

These plains support strong stands of mulga vegetation and (dependent on gradient) usually present regular dense grove patterns, arcuately arranged (convex downslope), and up to a half mile in length. Intergrove areas may be bare or show scantier vegetation. In some sectors, the increased frequency of mulga banding presents a dense thicket appearance.

Other alluviated and calcreted drainages also included with this unit are separately discussed in the water supply report for this area.

*Sand Plains.*

Extensive developments of red aeolian sand plains, commonly formed into parallel seif dunes, appear in the north-east and south-west sectors. Dunes average 30 feet in height, and can vary up to 1 mile in length. General dune orientation is along south-west lines, but directions appear confused, anastomising, or chain-like, where adjacent to upland belts.

Some recent sand movements has occurred (directed towards the south-west), but in general, the sand plain and dune areas are now fixed by spinifex and low scrub cover.

In the south-west sector, sand plain areas locally contain small developments of mulga-covered lateritic rises and occasional low breakaways, forming the Tertiary surface as developed over Palaeozoic sediments.

## STRATIGRAPHY.

Within the area, metamorphic rocks of sedimentary and volcanic origins, rise abruptly out of the sand plains to form upland areas and prominent ridge belts. On lithological and structural grounds, these rocks bear a strong resemblance to the Nullagine System overlying the undoubted Archean rocks in the Pilbara and Murchison areas of West Australia.

In the Warburton region, it is apparent that the metamorphic rocks have been mobilised to form porphyry and granite bodies, and are thus tentatively relegated to the Lower Proterozoic era.

These rocks form the basement and probably the source areas for the Palaeozoic beds developed marginal to and transgressing the Warburton rocks in the west and south-west.

Younger superficial formations of Cainozoic age mask a large proportion of the metamorphic and Palaeozoic terrains.

All of the rocks appear unfossiliferous and formation names which are proposed below are purely tentative, subject to more intensive field and petrological study, and approval by the West Australian Stratigraphical Nomenclature Committee.

*Lower Proterozoic Metamorphics.*

Distribution and attitudes of the metamorphic rocks indicate a major anticlinal flexure with the eroded core now represented by the various metamorphic belts of the Warburton Range. Higher grades of metamorphism are confined to the axial

zone of the anticline, whilst on the east flank, upper horizons of the sequence have been further mobilised to yield granite and porphyry bodies.

From bottom to top, the formations which can be distinguished are:

*Miller Volcanics* (after Miller Hill).—This name is tentatively proposed for a sequence of some 5,000 to 6,000 feet of fine to medium grained doleritic and basaltic lavas and extrusives appearing along the axial portion of the flexure. The sequence also contains minor intraformational volcanic breccias, tuffs, and agglomerates, and thin metasedimentary bands (mainly calcareous).

Metamorphism has produced massive and schistose rocks of amphibolitic grade, but relic volcanic and sedimentary textures are frequently recognised in the relatively unaltered zones.

The Miller Volcanics are conformably overlain on both flanks by the Elder Dolomites, and in the axial sector are also intruded by two concordant porphyry sills (Warburton Porphyry). Basal beds of the Miller Volcanics are not exposed.

*Elder Dolomites* (after Elder Creek).—Thinly bedded dolomitic limestones, associated with ribboned, argillaceous and cherty beds, are exposed on either side of the structure to form the immediate lower slopes and foothills of the Warburton Ranges.

This dolomitic sequence is approximately 1,500 feet thick and is conformably overlain on both flanks by the Hughes Volcanics.

*Hughes Volcanics* (after Hughes Creek).—A sequence of predominantly fine grained doleritic and basaltic lavas and flows which overlie the Elder Dolomites are tentatively grouped as the Hughes Volcanics. This sequence is approximately 3,000 feet thick and locally contains thin pyroclastic and calcareous members.

A discontinuous thin chert breccia horizon appears towards the upper part of the sequence along the western foothills, and forms two topographic ridges.

The Hughes Volcanics are conformably overlain by the Ainslie Volcanics.

*Ainslie Volcanics* (after Ainslie Hill).—This name is tentatively proposed for the sequence of fine to medium grained doleritic and basaltic lavas and flows which overlie the Hughes Volcanics.

The sequence is approximately 4,000 to 5,000 feet thick and locally contains thin pyroclastic and sedimentary members. Amygdaloidal lava varieties predominate throughout the sequence and appear as fine grained greenish rocks containing calcite and quartz amygdales, locally rimmed or replaced by secondary epidote, and more rarely by copper carbonates or sulphides.

Copper mineralisation occurs within the Ainslie Volcanics on the western limb of the structure and forms the potentially cupriferous belt of the area. Epidote mineralisation in the form of stainings. coatings, joint and shear fillings, is also common in the Ainslie rocks, particularly about the areas of known copper mineralisation.

The Ainslie Volcanics are overlain on both flanks by the Townsend Quartzites and in the south-west sector are also transgressed by the Palaeozoic beds. On the west flank, outliers of overthrusted Townsend Quartzites are frequently repeated over the Ainslie Volcanics, whilst on the east flank the upper Ainslie Volcanics and Townsend Quartzites are mobilised to yield porphyry.

*Townsend Quartzites* (after Townsend Range).—A sequence consisting of some 500 feet or more of quartzites, form a prominent escarpment facing north-east near the junction of Hughes and Elder Creeks. These extend in an almost unbroken line for some 30 miles south-east to Lilian Creek, where they form the topographic prominence known as the Townsend Range.

The dominant lithology is a uniform white to buff coloured, thinly laminated, current-bedded, medium grained, blocky quartzite which also contains thin pebble horizons towards the base.

Talbot and Clarke (1917) refer to these beds as comprising part of their "Townsend Range Series" of Ordovician age.

From the present investigation, the Townsend Quartzites appear more or less conformable with the underlying Ainslie Volcanics, but are separated from them by a low angle thrust. Isolated quartzite outliers frequently appear as conformable strike remnants fused to the underlying Ainslie Volcanics east of the main escarpment.

On the eastern limb, the Townsend Quartzites are metamorphosed and grade into phyllitic schists, quartz schists, sericite schists, etc., whilst further east, they have been completely mobilised to yield porphyry and granite masses. In view of this mobilisation, the Townsend Quartzites are preferably grouped with the Lower Proterozoic sequence.

*Lower Proterozoic Mobilisations and Igneous Intrusives.*

Mobilisations and igneous intrusives distinguished within the area are:—

*Warburton Porphyry.*—This name is tentatively proposed for the massive or foliated fine-grained, dark grey, brown, or black, quartz-albite porphyries which intrude the Miller Volcanics in the axial zone of the flexure and is also extensively developed along the eastern limb.

Twin concordant porphyry intrusions appearing on either side of the axis, form prominent ridges, and are suggestive of two bedded horizons injected along axial crests in sill form.

The porphyry dykes contain prominent phenocrysts of quartz, albite, and microline (rare), and are locally pyritic. Felspars are pink or white, whilst quartz of similar dimension is pale blue (often opalescent) or clear.

Along the eastern flank, the porphyry developments are identical with the sill forms but often show relic bedding and contain remnant horizons of "porphyritised" but undigested country rocks. Further east, the porphyry passes transitionally into granitic rocks and is presumably a form of rock mobilisation (analagous to grantitisation) which may represent a "front" or pre-granitisation stage.

*Granitic Rocks.*—Pink and grey, medium to coarse grained granitic rocks developed in the north-east sector are considered to represent a further mobilisation from the "porphyritised" stage. Such rocks appear as composite, fine to coarse grained, foliated, or gneissic varieties, often porphyritic in albite, microline, and blue quartz. The granite terrains also contain remnant metamorphics and younger dyke intrusives.

Absence of ferromagnesian minerals in some of the granitic terrains suggests a widespread mobilisation of psammitic rocks. Prominent jointing sets are developed in the granitic rocks but the general rock grain which can be observed, conforms to the trend of the adjacent metamorphic belts.

*Minor Intrusives.*—These include younger quartz bars and doleritic dykes. The quartz bars are extensively developed in the metamorphic rocks, being generally concordant but on the west flank locally appear as transverse joint or fracture fillings.

A more or less conformable doleritic dyke intrudes the Hughes Volcanics along the central northern margin. Other minor forms are also present in the granitic terrains.

Prefolding sill intrusives appear as dark green, mottled and black, coarse grained, basic, gabbroic, amphibolitic rocks. These are difficult to distinguish from the hypabyssal phases associated with most of the volcanic belts. Some of the basic and ultrabasic gabbroic rocks could be related to the broader developments of similar rocks known in the Blackstone Range area and forming part of the Giles Complex of South Australia.

*Palaeozoic Glacial Beds.*

The Proterozoic rocks are overlapped to the west and south-west by a flat-lying glacial sequence considered to be of Palaeozoic age. The sequence is unfossiliferous but similar extensive developments known in adjacent regions are generally regarded as Permian.

For the most part, the sequence is overlain by extensive sand plains or secondary cappings of ferruginous (lateritic) or siliceous (billy) cements. Geology in these areas is therefore restricted to cliff edges, breakaways, or flat-topped mesas.

In the south-west sector ("Sisters" locality), approximately 60 feet of section is exposed. Here the beds consist of tillitic siltstones showing graduations into sandy varieties and are often micaceous, ripple-marked or current-bedded. Erratics generally occur within the siltstone flour matrix but can appear in any horizon. The erratics are commonly faceted, and unsorted, and show a great variation from pebble to boulder size.

A basal bed which transgresses the volcanic rocks on the western flank is made up of a fine grained, brown, sandstone which is extensively ripple-marked. This sandstone also contains a heavy concentration of rounded pebbles and boulders to present a conglomeratic appearance.

Upper beds of the sequence contain scattered erratics only, and these consist mainly of quartzite similar to the Townsend Quartzites which form the uppermost member of the Proterozoic sequence.

*Cainozoic Formations.*

Ferruginous and siliceous cements are common in the interdune areas of the sand plain country and represent portion of the lateritic profile as developed during the Tertiary period. Thicker cappings (up to 10 feet) were recorded in dissected Palaeozoic areas.

Calcrete limestone formations, also of Tertiary age, are recorded along the trunk drainages of the area. These form the principal sources of shallow water, and are further discussed in a separate report.

Quaternary aeolean sand plains and other outwash plain formations which mask a large proportion of the area have already been discussed under Physiography.

## STRUCTURE.

From the repetition of strata and recorded dips it is apparent that the Lower Proterozoic rocks of the Warburton Area form part of a major anticlinal flexure. The anticline is itself refolded along south-west lines to present a distribution which arcuates from a north-west trend in the north-west sector to an east trend in the south-east. Local dip reversals noted across the structure indicate the existence of minor crenulations.

No closure is evident in the mapped area but from the structural widening in the south-east, a closure to the north is suspected. As evidenced by the relationship between the Townsend Quartzites and Ainslie Volcanics, the folding gives way to low angle thrusting on the west flank.

On the eastern limb, upper members of the Lower Proterozoic sequence have been mobilised to yield porphyry bodies which are locally intrusive into the metamorphic rocks and also pass transitionally into granitic rocks further east.

As mentioned earlier, the "porphyritisation" is regarded as a form of rock mobilisation (analagous to granitisation) and probably represents a "front" or pregranitisation stage. (Similar transitions from identical porphyries to granite have also been recorded by Noldart and Wyatt (unpublished) on what could represent a strike extension of the same group of rocks, east of the Gregory Range in the East Pilbara).

The mobilisation is probably contemporaneous with the period of major folding and has been responsible for the introduction of minor forms of mineralisation into the associated metamorphic rocks.

Both granite and porphyry are strongly factured with master jointing developed along north-east and north-west lines. Quartz bars, copper bearing shears, younger doleritic dykes, and minor faults follow similar directions but also appear as conformable strike features.

Foliations and lineations noted in the granite and porphyry terrains generally parallel the bedding trends of the adjacent metamorphic belts. Other lineations including those related to thrusting movements, are mainly parallel to the axis of refolding and trend at 215°.

Small displacements noted in the metamorphic terrains and the presence of numerous quartz bars indicated the widespread existence of minor transcordant and strike faults. Except for the thrusting recorded on the western flank, the existence of major faulting within the area was not established.

Flat-lying Palaeozoic glacial beds occur marginal to, or transgress the Proterozoic rocks in the west and south-west. From the extensive developments known west of the area it is apparent that arched structures are extremely unlikely and if present would only exist in the broadest form. Absence of major escarpments is sufficient evidence that the glacial beds have remained comparatively undisturbed since deposition.

Tertiary and Quaternary formations of this area are merely superficial and contain no structural elements.

## CORRELATION WITH ADJACENT AREAS.

Suggested correlations already referred to in the text and those given below, are purely tentative proposals which could assist in providing a better understanding of the Precambrian Stratigraphy both in this State and those adjoining.

*Lower Proterozoic Rocks.*

The Lower Proterozoic rocks are unfossiliferous but are classified as Proterozoic purely on structural and lithlogical similarities to rocks of the "Nullagine System" which overlie the undoubted Archean in other sectors of this State (Pilbara, Murchison). A similar correlation has been suggested by Forman (1932, 1933).

In the Warburton area (and also in the East Pilbara), these Proterozoic rocks are considered to have undergone geosynclinal deformation and mobilisation to yield granite and porphyry masses. For this reason they are tentatively grouped as Lower Proterozoic.

Comparing descriptions given by Commonwealth geologists (Wells, Forman and Ranford) in Bureau of Mineral Resources Records 1959-61 entitled "Geological Reconnaissance of the Rawlinson-Macdonald Area, Western Australia," the metamorphic rocks of the Warburton area are tentatively suggested as being equivalent to the "Dean Metamorphics" (also classified by Commonwealth geologists as Lower Proterozoic).

Further, the "Rawlinson Prophyry" which intrudes the "Dean Metamorphics" in the northern areas is similar in composition, characater, and rock relationshps to the Warburton Porphyry. Similar porphyries are also known in the East Pilbarian and South Australian extensions.

*Upper Proterozoic Rocks.*

Upper Proterozoic tillites and associated beds recorded by the Commonwealth geologists in the Rawlinson-Macdonald area suggest affinities with the tillites of the Upper Proterozoic "Adelaide System" of South Australia. They are not represented in the Warburton area.

*Palaeozoic Rocks.*

Ordovician rocks as recorded in the Rawlinson-Macdonald area have no equivalents in the Warburton region.

The glacial beds form part of Talbot and Clarke's "Wilkinson Range Beds", and in the Warburton locality, form the northern margins of the "Officer Basin".

They are tentatively regarded as Permian and are probably correlative with the "Buck Formation" as recorded in the adjacent Rawlinson-Macdonald area.

*Discussion on Precambrian Correlations.*

On regional trends, lithology, and folding, the metamorphic belts of the Warburton area are suggested as forming an extension of the "Nullagine System" of the Pilbara area, and developed within a major north-west to south-east trending geosynclinal belt, marginal to the more primitive Archean (Pilbarian-Yilgarnian) nucleus. The same belt is also suggested as extending through the Blackstone-Musgrave areas and thence to Spencer's Gulf in South Australia.

Mobilisations recognised within these terrains have apparently been confined to the main geosynclinal trough, and are not evident where filling shallow basins on the more stable Archean block. Within the geosyncline, a comparable pattern of folding, and generation of similar suites of microcline, blue quartz (often opalescent), and albite bearing granite and porphyry (often transitional) has resulted.

Epidotisation, minor copper mineralisation and the generation of charnockitic and younger adamellitic granites are also characteristic and have been recognised throughout the belt.

Age determinations on the more primitive "Pilbarian Yilgarnian" block show the oldest metamorphism to be 2400 to 2800 m.y. (Wilson *et al.* 1960). This is considerably older than the oldest metamorphisms recorded on other Pre-Cambrian areas of this and adjoining States (1100, 1500-1800 m.y.).

From the above it is further suggested that the rocks forming the undoubted Archean in the "Pilbarian-Yilgarnian" block are not represented in these eastern areas. Also, the Archean of South Australia would be equivalent to the Lower Proterozoic as recognised by the present author in the Warburton area and to the Lower Proterozoic mapped by Commonwealth geologists in the adjacent West Australian and Central Australian regions.

## ECONOMIC GEOLOGY.

Underground water and copper form the principal minerals of economic interest known within the area. The former is discussed in a separate report entitled "Water Supplies, Warburton Range and Adjoining Areas" (Sofoulis, this publication). Copper, other minerals, and the oil potentialities of the sedimentary rocks are discussed below.

*Copper Mining.*

The presence of copper mineralisation from this remote region was first reported by explorer F. Hann in 1903, but it was not until recently that any development had been undertaken. There are no registered tenements as the area forms part of a large native reserve and the mining itself is carried out exclusively by native working parties.

To date, a total production of 68.68 tons of approximate 11 per cent. ore and valued at £1,526 has been reported to the Mines Statistical Branch as having been sold for use in the trace mineral fertilising industry.

*Workings.*—Examination of the known copper occurrences were made in conjunction with Mr. E. Timoney of the Mines Inspectors' Branch, and the relative plans, sampling, and assay data for each deposit are given in Mr. Timoney's report entitled "Copper Deposits, Warburton Range Area", (W.A. Mines Department, unpublished).

Development of the eight known occurrences are still in the prospecting stages and the workings are mainly in the form of scattered costeans and shallow trenches, confined to the "Ainslie Volcanics" at the localities shown on the accompanying plate. These deposits are numbered one to eight in keeping with Mr. Timoney's classifications.

Deepest workings (13 ft. V.D.) are at the "Windlass Shaft" on No. 3 deposit, located approximately one mile north-west of the Mission Station.

*Copper Lodes.*—Some of the lodes are discontinuously traceable over the surface for long distances but show considerable variation in copper content and can grade into barren quartz-calcite or quartz bars. Where copper bearing, the lodes consist of a ferruginised silica-calcite matrix containing varying amounts of copper carbonates, silicates, oxides (local) and sulphides (rare).

The copper lodes are usually vertically disposed and can appear as thin copper bearing veinlets, or tabular, lenticular bodies from several inches up to 3 to 4 feet thick. Local developments up to 8 feet thick are also known. The principal lodes generally have well defined walls and are recognised as occupying minor shears or fractures in the volcanic rocks. These are transcordant to the enclosing country rocks (similar to the mapped quartz bars) and would correspond to the fracture pattern recognised in the adjacent porphyry, granite and metamorphic belts.

Epidote veins are commonly associated with the copper lodes and epidotisation of country rocks adjacent to copper lodes is also a prominent feature.

*Future of the Industry.*—There are no deposits of major economic importance known within the area.

Deposits 1, 3, and 5 are considered to be suitable for small scale mining by native working parties.

Mr. Timoney estimates that deposit No. 1 could supply some 400 to 500 tons of 10 per cent. to 12 per cent. copper ore which at current prices and cartage costs is estimated to give a net return of £10 to £12 per ton. Deposits Nos. 3 and 5 show possibilities of smaller tonnages of higher grade ores if selectively mined. Other deposits of the area are considered insignificant.

Under normal circumstances, the exploitation of these deposits would be out of the question as the full value of most of the ores capable of being produced would be taken up in transportation to the nearest rail head (Leonora, 440 miles).

The present development by native working parties is probably the only method of exploitation and the success of this venture is wholly dependent on the cheap cartage rates offered by the Mission Station. Scope of these operations is fixed at 20 tons per month which is the back-loading capacity of the mission truck.

Mr. Timoney considers that if worked as a co-operative, a balanced production of 20 tons per month from Nos. 1 and 3 deposits should yield a wage of £10 per week for eleven men.

Despite the primitive methods of working, the continuation of this industry would make a substantial contribution to the local native economy, as well as provide a useful form of employment in what would otherwise be an idle native community.

*Other Minerals.*

Minor forms of gold and silver mineralisation have been recorded about the area but as yet no economic deposits have been located.

Restricted occurrences of coarse grained basic and ultrabasic sills which may be related to the "Giles Complex" of South Australia, could contain minor amounts of nickel, chromite, and allied segregations.

The area has not been fully prospected for minerals but from similar occurrences recorded from the easterly extensions of this province, their concentrations into major economic deposits seem unlikely.

Remoteness of the locality would preclude any but higher grade ores being exploited.

*Oil Potentialities.*

The Paleozoic glacial beds which flank and transgress the Proterozoic rocks to the west and south-west form the northerly margin of the Officer Basin at present being investigated for oil along its south-easterly extension in South Australia.

Westerly these glacials are known to extend as far as the western edge of Lake Throssell where they unconformably overlie Proterozoic rocks and Archean granites. Little is known of the stratigraphic sequence across this 200 miles width and the possibility of older Palaeozoic or Proterozoic source beds occurring in deeper portions of the basin should not be overlooked.

On present indications, these beds appear as flat, structureless, thin aqueoglacial or fluvioglacial deposits which have negligible oil prospects.

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## REPORT ON SOME PEGMATITES NORTH OF YALGOO.

*By L. E. de la Hunty, B.Sc.*

### INTRODUCTION

On the 19th and 20th October, 1961, the writer inspected the pegmatites on Mineral Claims 26, 27 and P.A. 2571 on Dalgaranga Station also M.C.'s 34 and 35 at Warda Warra (near the Kylie Group).

These claims were pegged earlier this year, after the discovery by the Todd brothers of the presence of beryl, tantalite and tapiolite in and around some pegmatites on Dalgaranga Station.

The homestead on Dalgaranga Station is about 60 miles north-east of Yalgoo in the Yalgoo Goldfield and Warda Warra is 15 miles north-north-east of the homestead on the other (north-west) side of the No. 2 Rabbit Proof Fence.

### GENERAL GEOLOGY.

All of the ore-bodies visited are in country of low relief with a large amount of soil cover.

All of the rocks seen in the area are Archean in age and these include greenstones, gneiss and granite, and the pegmatite bodies. The pegmatites have intruded both gneiss and greenstone.

The pegmatites themselves have prominent quartz cores with pegmatitic envelopes which are often obscured by soil and they have preferred strikes of north-north-east or east.

The main economic minerals are beryl, tantalite and tapiolite.

### THE DEPOSITS.

*M.C. 26.*

This claim for 300 acres which was pegged by Don Todd is now being worked by Todd and Palmer. It is 3 miles east of Dalgaranga outcamp which is about 16 miles north-east of Dalgaranga Homestead (22 miles by track) and has about the same latitude as Mt. Palmer.

There is one main pegmatite reef and several smaller ones on the claim. The main reef was being mined at the time of inspection while several potholes have been dug in a smaller beryl-bearing pegmatite which runs north-east for about 200 yards from a point about 150 yards north of the centre of the main body.

The main reef which is about 380 feet long, striking N. 85° E. and dipping to the north at 45° (hanging wall), forms the southern edge of a plateau 50 feet above the lower creek flats. A cutting made along the hanging wall from the eastern end of the reef is 75 feet long, 3 feet to 10 feet wide and up to 10 feet deep.

The pegmatite has a lensing quartz core with a maximum width of 27 feet. The coarse-grained felspar outcrops in a band about 10 feet wide on the hanging wall of the quartz but on the southern side the felspar occurs in veins intruding the granitic country rock. The band of felspar on the hanging wall is zoned and the mineral associations with each zone are quite distinct.

The adjacent country rock is a black, highly micaceous gneiss while the outer shell of the pegmatite consists of felspar with onion-shaped muscovite and some quartz. The shell is three feet thick and the "onions" of muscovite which are two to three inches in diameter form in clusters. This same onion-shape was noticed in the mica occurrence in pegmatite to the north.

The second zone on the hanging wall, about 18 inches to two feet thick, contains felspar and beryl with some topaz. The beryl is white with occasional light colouring. Between this zone and the quartz core is a layer of quartz and felspar about five feet thick.

The pegmatite bands on the footwall side of the quartz show a beryl content, and some fluorite was identified at the western end of the body.

Some eluvial tantalite and tin was reported from the lower ground down the slope from the footwall but neither mineral has been found in the pegmatite so far.

There appears to be a considerable amount of beryl in this pegmatite but the dip of the ore zone may cause some difficulty in mining.

*M.C. 27.*

Dan Todd pegged this 300 acre claim about 3.7 miles south-east of Dalgaranga outcamp and about 3½ miles south-west of M.C. 26 (4.3 miles by track). Besides the main quartz-cored pegmatite there are several small pegmatite veins on the claim and these have yielded beryl in many places. A feature of the quartz and felspar occurrences on this claim is their grey colour. The grey felspar also shows creamy patches in crystallographic continuity with the grey material. The country rock is greenstone.

In the north-east part of the claim there is a prominent reef of grey quartz about 120 yards long. It strikes east-west, is about 30 feet wide and has a pegmatite envelope. About 25 yards south of the western end of the quartz is a pit (6 ft. x 6 ft. x 20 ft.) in pegmatite. The reported beryl production from this pit is six tons.

A shallow trench two feet deep and 40 feet long has been dug east along the northern edge of the quartz reef (in pegmatite) from a point 25 yards east of the western end. Some tantalite has been exposed in the partly decomposed pegmatite.

A deep trench 50 feet long has been dug east along the north wall of the main pegmatite from 60 feet east of the quartz outcrop. This trench, which varies in depth up to 15 feet, has an average width of about three feet. The trench exposes a vertical contact between decomposed greenstone to the north and the decomposed pegmatite. The outer zone of the pegmatite is of felspar and onion-shaped muscovite.

This trench has yielded a parcel of tapiolite (about 14 cwt. at 71 per cent. $Ta_2O_5$) from a narrow zone at the outer edge of the pegmatite. The West Australian Government Chemical Laboratories identified tapiolite, with some microlite and simposonite, (using X-ray methods) from samples submitted by the claim holder. The microlite (calcium pyrotantalate) and simposonite (calcium aluminium tantalate) are not highly desirable.

Tapiolite is dimorphous with tantalite. It has the same chemical composition ($Fe\ Ta_2O_6$) but belongs to the tetragonal crystalline system while tantalite is orthorhombic. The isomorphous tapiolite-mossite series range from iron tantalate to iron niobate in the same way as the tantalite-columbite series is isomorphous from iron tantalate to iron niobate.

The mineral is bought as tantalite and distinction between tapiolite and tantalite in the field—particularly in the case of eluvial and other small fragments—is impossible unless the crystalline shape can be identified.

There is quite a lot of scattered eluvial tantalite in the north-east corner of the claim and this shed extends into the Prospecting Area to the north.

M.C. 27 has good prospects for its tantalum pentoxide content and its potential as a beryl-producer must not be ignored.

*P.A. 2571.*

This area of 20 acres (J. Nevill) was being worked for its eluvial-alluvial tantalite content. It is downhill to the north of M.C. 27 and the soil was reputed to contain 4 lb. of tantalite to the yard. It was being shovelled on to a screen. Although some tantalite may be won in this way, the prospects of this P.A. are limited.

*M.C. 34.*

This 24 acre claim is about a mile south of the Kylie Group and just west of the road from Dalgaranga Station. (The Kylie Group which contains late G.M.L. 1001, "Western Queen", is about four miles north of Warda Warra).

The workings consist of three pits (the deepest being four feet deep) along the western edge of a narrow steeply-dipping quartz reef. The quartz outcrops at ground level, in greenstone country of low relief, over a length of about 100 yards and has a thin pegmatite envelope which does not outcrop.

Some six tons of beryl have been won from this claim by the holders (Palmer and Todd) and beryl crystals were still showing in one of the pits at the time of inspection.

*M.C. 35.*

This claim for 300 acres (C. Hodder and others) is about 3½ miles north of the Kylie Group and is reached by a track which runs west from the group, then north and east for a total distance of 6.2 miles.

The main ore-body on the claim has a quartz core which outcrops almost continuously over a length of more than 10 chains in the average direction N.30°E. The reef which dips steeply and varies in width up to 30 feet has a pegmatite envelope which is usually concealed by soil. The ground falls away to the north-west and north.

At the time of inspection there were 10 small pits along the ore-body. These exposed beryl and tantalite as well as some rather large mica flakes.

Beryl and tantalite were scattered around the surface of the claim with boulders of quartz, "billy" and silicified banded grit on red sandy soil. The underlying country rock is greenstone.

Beryl has been won from the pegmatite envelope on both sides of the reef but only eluvial tantalite has been found. Some floaters of tantalite were found on the eastern side of the reef in one place but the only tantalite mined has come from two holes on the western side. One hole near the north end of the reef and the other 90 yards south yielded high concentrations of eluvial tantalite in "cement," overlying pegmatitic felspar and mica. The pieces of tantalite were quite large (up to two cubic inches) and had obviously travelled very little distance since weathering from the pegmatite.

The deposit appears to have good prospects although only small quantities of beryl and tantalite have been recovered so far.

## CONCLUSIONS.

The pegmatites, which intrude Archean gneiss and greenstone, are probably Archean in age. They occur in country of low relief.

Beryl is common to many of the pegmatites—most of which have well-developed quartz cores—while other significant minerals are tantalite and tapiolite.

Further prospecting in this general area could result in the discovery of more pegmatite ore-bodies.

With beryl at the price of £13 10s. per unit f.o.b., the mining of beryl in the area should prove to be a profitable venture.

Tantalite is in such demand at present that it is difficult to quote a price for the ore. However, prices of 9 dollars per lb. have been quoted in America for material with a 60 per cent $Ta_2O_5$ content, and £60-£65 sterling have been paid in London for 60 per cent $Ta_2O_5$ (c.i.f.). This means that M.C. 27 must be considered an excellent prospect for $Ta_2O_5$ while M.C. 35 also shows promise. Other claims seen are not considered to be tantalite prospects.

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# REPORT ON NEW IRON DEPOSITS IN THE NORTH-WEST DIVISION.

*By L. E. de la Hunty, B.Sc.,*

## INTRODUCTION.

During the period 10th to 14th November, 1961, the writer accompanied Mr. D. O'Driscoll (Assistant Director of the Bureau of Mineral Resources) on an inspection of some newly pegged reserves for iron ore in the Ashburton, West Pilbara and Pilbara Goldfields, in the North-West Division of Western Australia. The inspection was made with the aid of a Bell helicopter and a Landrover—both of which were provided by the Bureau of Mineral Resources.

The main deposits visited were:—

(1) Along the valley of the Robe River in the vicinity of Deepdale Homestead, about 70 miles east of Onslow.

(2) Along Duck Creek in the vicinity of Duck Creek Homestead, about 100 miles south-east of Onslow.

(3) On Hamersley Station, about 40 miles west of Wittenoom.

(4) On Roy Hill Station, about 11 miles north of the homestead on the Great Northern Highway.

The Turner River deposit was not visited.

Plate IV shows the position, distribution and size of the pisolitic limonite deposits.

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## GEOLOGY.

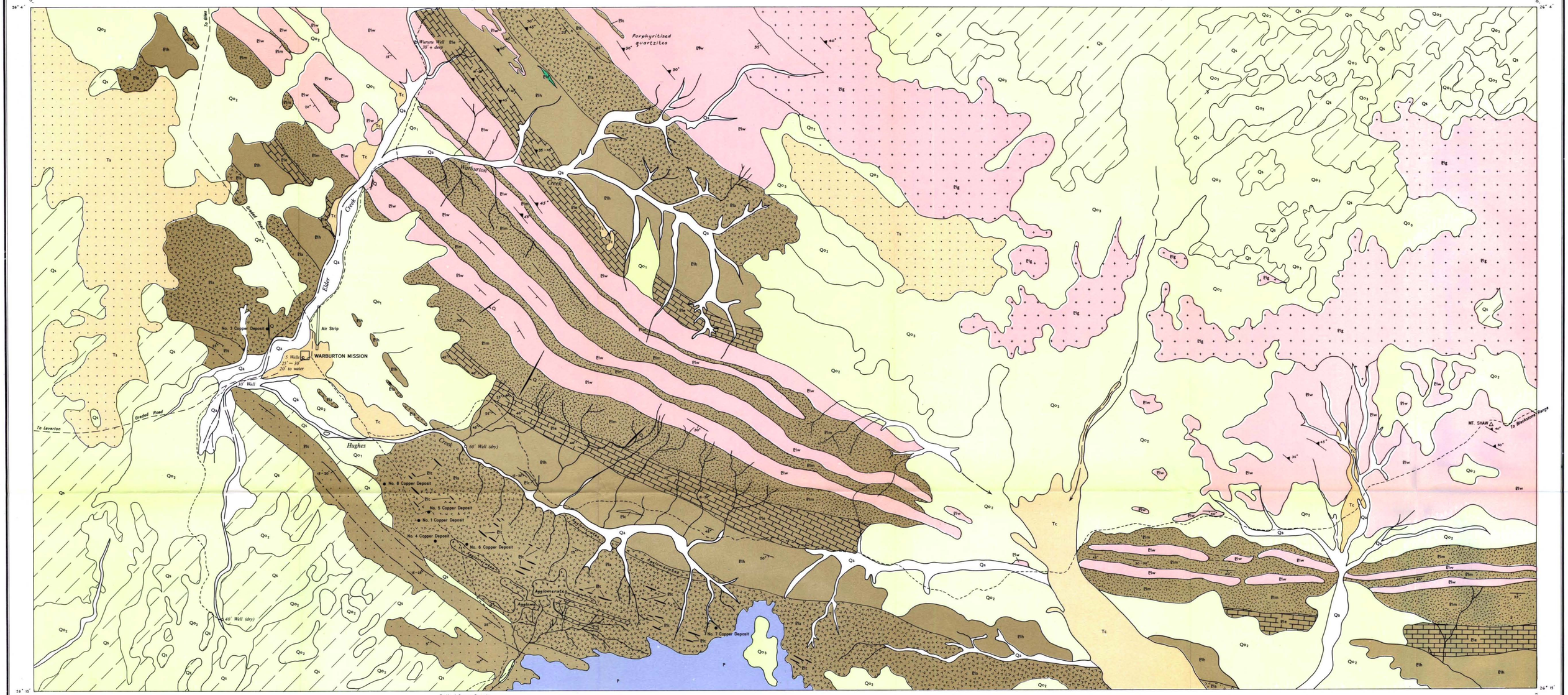
The hematite deposits on Hamersley and Roy Hill Stations are the result of Tertiary weathering of ferruginous (Proterozoic) sediments. The rocks contained a considerable percentage of iron on deposition and this has been increased by solution and removal of some of the silica content—with partial replacement by hematite. Original bedding (with varied low dips) has been preserved.

The deposits at Robe River and Duck Creek are of pisolitic limonite and they form caps on mesas along the valleys of those streams. The deposits are similar to (but larger than) those in the vicinity of Porth Hedland (de la Hunty, 1961).

The iron deposition took place, from surface drainage water, during Tertiary times, in bogs and lakes. The iron in solution in the surface water came mainly from the weathering of ferruginous sediments of the (Proterozoic) Nullagine Series, as well as from the weathering of other sediments and igneous rocks of Proterozoic and Archean ages.

Subsequent rejuvenation of the streams has resulted in the dissection of the limonite beds and underlying rocks—leaving lines of low, disconnected mesas, as well as some limonite-capped benches in valleys in the Hamersley Range.

None of the limonitic ore, and little of the hematitic ore appeared to contain more than 60 per cent. iron (Fe). Assays were done by the W.A. Government Chemical Laboratories.




## LEGEND

**CAINOZOIC**

**QUATERNARY**

- Qs — Sandy loamy alluvium : creek debris. Alluvial outwash soils : soil with patchy stony straw, fine mulga banding, local outcrops; soil with patchy pebble veneers, prominent mulga banding; soil with patchy pebble veneers, dense mulga thickets.
- Qc — Calcrete limestone
- Qs — Sand plain : reworked, with aeolean dunes ferruginous and siliceous cements common in interdune areas.

**TERTIARY**

- Ts — Sand plain

**PALAEOZOIC**

**PERMIAN**

- Wilkinson Range Beds — P — Glacial beds : felspathic grits, stillitic siltstones, sandy, clayey variations.

**PROTEROZOIC**

**? LOWER PROTEROZOIC**

- Q — Quartz bars : generally concordant, but also discordant.
- Etd — Dolerite : dyke, sill forms ; fine grained blackish-dark green.
- + Etg + — Granite : fine to coarse-grained, pink to grey, often porphyritic in albite, microcline and blue quartz.
- Warburton Porphyry — Etw — Porphyry : massive, or foliated, fine grained grey to black to brown groundmass, porphyritic in albite, microcline and blue quartz. Locally pyritic. Concordant sills or with porphyritised metamorphic remnants.

**LOWER PROTEROZOIC**

- Townsend Quartzite — Et — Quartzite : medium-grained, white to buff, thinly laminated blocky, current bedded. Thin pebble horizons towards base.
- Ainslie Volcanics — Eta — Dolerite and basaltic lavas, flows : greenish amygdaloidal varieties predominate. Thin pyroclastic and sedimentary members.
- Hughes Volcanics — Etc — Dolerite and basaltic lavas, flows : fine-grained, greenish. Thin pyroclastic and calcareous members. Plc : chert breccia.
- Elder Dolomites — Etb — Dolomitic limestones : ribboned argillaceous and cherty beds.
- Miller Volcanics — Etm — Dolerite and basaltic lavas, flows : fine to medium-grained, greenish. Intraformational volcanic breccias, tuffs, agglomerates and thin sedimentary bands (mainly calcareous).

## REFERENCE

- Geological boundary
- Dip and strike of bedding — 35° / 40°
- Dip and strike of foliation
- Bedding trend
- Water courses
- Tracks
- Copper Deposit Sites — ● No. 2 Copper Deposit

G. S. W. A.

# GEOLOGICAL MAP OF PORTION OF SHEET 468 TALBOT SG 52-9 INTERNATIONAL SERIES

WARBURTON RANGE AREA

WESTERN AUSTRALIA

NOMINAL SCALE: APPROX. 1 INCH TO 1 MILE

Geological reconnaissance and photo-interpretation by J. Sofoulis, Oct. 1961

INDIAN OCEAN

To Roebourne

MT. VIRCHOW

BOOYEEMA

FORTESCUE

YARRALOOLA

5703 65·3% Fe

RHE

WARRAMBOO

ROBE

B28

DEEPDALE

RIVER

YALLEEN

MILLSTREAM

TAMBREY

To Wittenoom

MT. ENID

5701 59·1% Fe

BUCKLAND HILLS

MT. DEMPSTER

MT. FLORA

RIVER

To Onslow

MT. DARNELL

PEEDAMULLA

MT. ELVIRE

RED HILL

MT. RIGA

ASHBURTON

WEST PILBARA

SILVER GRASS PEAK

HAMERSLEY

MT. MINNIE

RED HILL

GOLDFIELD

GOLDFIELD

RANGE

To Onslow

MT. AMY

Y13

HAMERSLEY

MT. McRAE

MT. SYLVIA

MT. BROCKMAN.

WS

MT. FARQUHAR

Y10

MT. STUART

MT. STUART

Y8

Duck Creek

DUCK CREEK

MT. BROCKMAN

MT. MURRAY

Y6

Y9

5704 47·7% Fe.

BOOLALOO

MT. PRICE

MT. HUBERT

Y7

MT. LIONEL.

MT. SAMSON

MT. EDITH

ASHBURTON RIVER

MT. ELIZABETH

WYLOO

MT. DE COURCEY

RED HILL

Y11

MT. TURNER

MEILGA

MT. DANVERS

MT. CLEMENT

MT. WALL

RIVER

Wannery Creek

GLENFLORRIE

KOOLINE

HARDEY

To Ashburton Downs

RIVER

TURNER

ROCKLEA

MT. FLORRY

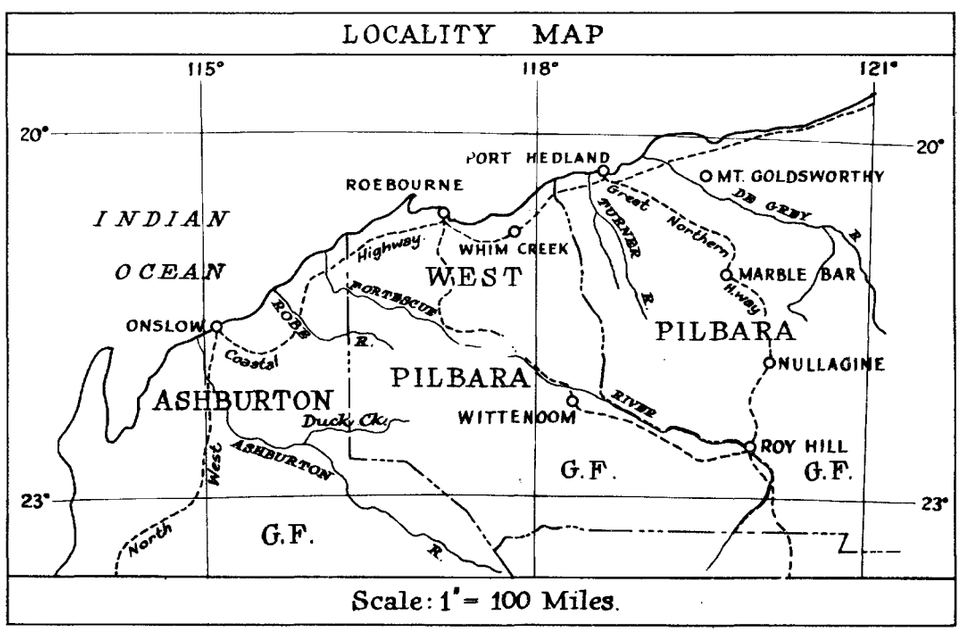
MT. JOPE

To Wyloo.

23°00'S

23°00'S

## LOCALITY MAP




Scale: 1" = 100 Miles.

G.S.W.A.

MAP OF

PORTION OF THE NORTH WEST DIVISION, W.A.

SHOWING

# PISOLITIC LIMONITE DEPOSITS

Scale : 10 Miles to an Inch

*Outlines of the Deposits traced from Aerial Photographs by L. de la Hunty November 1961.*

REFERENCE

- Roads
- Rivers (Non-Perennial)
- Station Homesteads — GLENFLORRIE
- Limonite Deposits with Sample. — 5701 59·1% Fe.
- Boundaries to Highlight Deposits only

B.R.G.

ASSAY RESULTS.

| Locality | Sample No. | Iron, Fe | Silica, $SiO_2$ | Alumina $Al_2O_3$ | Titanium Ti | Phosphorus P | Water $H_2O+$ |
|---|---|---|---|---|---|---|---|
| | | Per cent. on Dry Basis | | | | | |
| Robe River .... .... .... | 5701 | 59·1 | 3·99 | 1·22 | 0·04 | 0·06 | 9·01 |
| Robe River .... .... .... | 5703 | 55·3 | 4·98 | 3·47 | 0·10 | 0·03 | 11·60 |
| Duck Creek .... .... .... | 5704 | 47·7 | 12·9 | 6·28 | 0·18 | 0·06 | 11·60 |
| Hamersley .... .... .... | 5705 | 62·7 | 1·9 | .... | .... | .... | .... |

## THE DEPOSITS.

*Robe River.*

The deposits in this vicinity extend along the valley of the river in the form of flat caps (about 40 feet average thickness) on a line of mesas. The iron ore varies from reddish brown pisolitic material with pseudo fossil-wood fragments and a shiny fracture, at the top, to more earthy and sometimes tubular (vertical pipes) material underneath.

Several samples taken by Broken Hill Pty. Co. Ltd. indicated an average grade of 50-55 per cent. Fe. The writer's Sample No. 5701 from the eastern part of the area and Sample No. 5703 from the north-west part averaged 57.2 per cent. Fe, with 4.48 per cent. $SiO_2$, 2.35 per cent. $Al_2O_3$, 0.07 per cent. Ti, 0.05 per cent. P and 10.30 per cent. $H_2O$. Sample No. 5701 was from a small face, cut in what was probably the best grade of ore available. It showed 59.1 per cent. Fe which is very close to the theoretical maximum content (59.8) for limonite. However, since it contains only 9.01 per cent $H_2O$ and the theoretical maximum is 14.5 per cent, it seems likely that there could be some hematite in that sample.

Deepdale Homestead is roughly in the middle of the 50 mile long belt of mesas, several of which are more than a square mile in surface area (although most of them are smaller and the line is not continuous).

*Duck Creek.*

The deposits at Duck Creek are also of pisolitic limonite and are of comparable grade with those at Robe River, although the caps are thinner—probably less than 30 feet thick. The deposits extend about 30 miles upstream from Duck Creek Homestead along the main stream and several tributaries.

Sample No. 5704, from the eastern part of the deposits, assayed 47.7 per cent. Fe, 12.9 per cent. $SiO_2$, 6.28 per cent., $Al_2O_3$, 0.18 per cent. Ti. 0.06 per cent. P, 11.60 per cent. $H_2O$. This sample was of material which was slightly more earthy-looking than that sampled at Robe River. It was rather typical of the lower sections of the ore and its higher alumina and silica contents are noteworthy.

*Turner River.*

The deposits along the Turner River were not visited but aerial photographs indicate that they are in the form of limonite caps on a long narrow line of mesas parallel with the river bed—north-south at that point. The line is more than 10 miles long while the widths of the mesas are 20 chains and more. The thicknesses of the caps were not determined.

*Hamersley Station.*

K. R. Miles (1942) described the banded ferruginous cherts of the Nullagine Series in this area and the deposit on Hamersley Station consists of these rocks. (Miles also mentions the presence of these rocks in the vicinity of Mt. Newman in the Ophthalmia Ranges, where Temporary Reserves for iron have been applied for also.)

The Hamersley deposit consists of banded hematitic sediments and, although Sample No. 5705 assayed 62.7 per cent. Fe (and 1.90 per cent. $SiO_2$), most of the deposit seems to be of lower iron content.

The holders of the reserve were diamond drilling the deposit at the time of inspection but no drilling or surface sampling results were made available to the writer.

The deposit is in two outcrops running east-west with a low northerly dip and has a maximum thickness of about 50 feet. It occupies the northern flank of a faulted rather flat anticline. More than 10 million tons of ferruginous material are contained in the deposit but it is doubtful whether all of this material is iron ore.

*Roy Hill Station.*

Sofoulis (1960) mapped and sampled iron deposits in this area in 1959 and a Crown Reserve was created to include them. The Broken Hill Pty. Co. Ltd., has been granted Temporary Reserves on extensions of the deposits along the north slopes of the valley of the Fortescue River. The Company has embarked on a programme of diamond and percussion drilling, while pit-testing of the deposits is also planned.

The material sampled by Sofoulis was mainly hematite but the recent drilling has revealed a considerable quantity of limonite in patches. The deposits occur in low hills which show limonite under surface hematite—making assessment of the deposits quite difficult. The original ferruginous sediments, which have been involved in lateritic and replacement processes, extend for about 100 miles in the ground held. However, the ore bodies are discontinuous and it is doubtful whether they will occur over all of this length.

## CONCLUSIONS.

1. To date, none of the new occurrences have been proved to contain direct shipping ore (i.e. above 60 per cent. Fe) and only those deposits containing hematite (Hamersley Station and Roy Hill Station) may have potential in that direction.

2. The pisolitic limonite deposits could have reserves in excess of 1,000 million tons with a grade of 50-55 per cent. Fe. Under present economic conditions this is not a saleable grade and upgrading would be necessary before it could be exported. The upgrading could be achieved by dehydration (with consequent pelletising).

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# THE SEARCH FOR OIL IN WESTERN AUSTRALIA IN 1961.

*By G. H. Low, B.Sc.*

## DRILLING.

During the year only one deep bore was drilled in the search for oil in Western Australia. This was at Eneabba, in the northern part of the Perth Basin, eastwards of the Beagle Ridge Bore drilled in 1960. The Eneabba Bore was drilled by West Australian Petroleum Pty. Ltd. on its Licence to Prospect 95H.

This bore had some promising gas shows and oil staining in five zones between 8,000 and 12,100 feet, and penetrated coal-bearing formations, probably of Jurassic age, between 6,000 and 6,800 feet. It was completed at 13,712 feet in the Lower Triassic Kockatea Shale.

The Gulf Oil Syndicate completed the evaluation of the results of the Spirit Hill Well, 5 miles east of the eastern boundary of Permit to Explore 127H, in the first quarter of the year. Jackson Explorations (Permit to Explore 133H) and Hawkestone Oil (Permit to Explore 142H) continued negotiations to finance drilling operations in their respective areas.

The results of the Eneabba Bore may be summarised as follows:—

Company: West Australian Petroleum Pty. Ltd.

Licence to Prospect: 95H.

Well: Eneabba No. 1.

Location: Latitude 29° 34′ S. Longitude 115° 20′ E. Height of derrick floor above sea level—416 feet.

Spudded in: 12 June, 1961.

Status: Completed at 13,217 feet on 20th November, 1961 in Lower Triassic shales. Lower Cretaceous, Jurassic, and Triassic marine formations were penetrated. Jurassic coal horizons, the value of which have yet to be assessed, were penetrated between 6,000 and 6,800 feet. Gas and oil showings were detected in five zones between 8,000 and 12,100 feet.

## LIST OF PERMITS TO EXPLORE.

The following Permits to Explore were current on 31st December, 1961:—

| No. | Holder | Expiry Date | Area (Nearest Sq. Mile) |
|---|---|---|---|
| 27H | West Australian Petroleum Pty. Ltd., 251 Adelaide Terrace, Perth | 22/10/62 | 52,000 |
| 28H | do. do. do. | 22/10/62 | 51,000 |
| 29H | do. do. do. | 22/10/62 | 31,100 |
| 30H | do. do. do. | 22/10/62 | 151,600 |
| 106H | Westralian Oil Ltd., 44 Parliament Place, Perth | 28/9/62 | 11,800 |
| 127H | Oil Development N.L., 100 Collins Street, Melbourne, C 1 | 28/3/62 | 13,800 |
| 133H | Jackson Exploration, 74 Mounts Bay Road, Perth | 2/9/62 | 15,750 |
| 134H | Exoil Pty. Ltd., 237 Adelaide Terrace, Perth | 9/12/62 | 12,600 |
| 135H | do. do. do. | 9/12/62 | 12,600 |
| 136H | do. do. do. | 9/12/62 | 12,450 |
| 142H | Hawkstone Oil Co., 135 St. George's Terrace, Perth | 8/4/62 | 5,200 |
| 144H | Frome-Broken Hill Co. Pty. Ltd., 53 Flemington Road, North Melbourne, N.1 | 16/8/62 | 16,700 |
| 145H | do. do. do. | 16/8/62 | 12,950 |
| 146H | do. do. do. | 16/8/62 | 13,000 |
| 147H | Hunt Oil Co. & Placid Oil Co., c/o. Keall, McCall & Brisden, Solicitors, 29 Barrack Street, Perth | 16/8/62 | 12,850 |
| 148H | do. do. do. | 16/8/62 | 12,600 |
| 151H | Hackathorn Oils Pty. Ltd., c/o. Keall, McCall & Brisden, Solicitors, 29 Barrack Street, Perth | 7/2/62 | 14,200 |
| 152H | do. do. do. | 7/2/62 | 11,650 |
| 153H | do. do. do. | 7/2/62 | 13,050 |
| 156H | Hunt Oil Co. & Placid Oil Co., c/o. Keall, McCall & Brisden, Solicitors, 29 Barrack Street, Perth | 10/7/62 | 12,450 |
| 157H | do. do. do. | 10/7/62 | 12,600 |
| 158H | do. do. do. | 10/7/62 | 12,800 |
| 159H | do. do. do. | 10/7/62 | 12,800 |
| 161H | do. do. do. | 24/8/62 | 12,900 |
| 162H | Australian Oil Industries Pty. Ltd., c/o. Keall, McCall & Brisden, Solicitors, 29 Barrack Street, Perth | 12/2/63 | 11,300 |
| 163H | do. do. do. | 12/2/63 | 18,000 |
| 164H | do. do. do. | 12/2/63 | 12,950 |
| 165H | Vickers, Victor Ivor, c/o. R. J. Stoddart, Barrister & Solicitor, W.A. Trustee Buildings, 135 St. George's, Terrace, Perth. | 19/12/63 | 13,700 (approx.) |
| 166H | do. do. do. | 19/12/63 | 5,315 (approx.) |
| 167H | do. do. do. | 27/12/63 | 13,550 |
| 168H | M. A. Butler, J. A. Koeman, A. J. Butler, F. M. Butler, P. Koeman, c/o. Box 92, Post Office, Beverley, W.A. (Applied and not yet approved) | 4/12/61 | 9,000 |

## LIST OF LICENCES TO PROSPECT.

The following Licences to Prospect were current on 31st December, 1961:

| No. | Holder | Expiry Date | Area (Nearest Sq. Mile) |
|---|---|---|---|
| 51H | West Australian Petroleum Pty. Ltd., 251 Adelaide Terrace, Perth | 19/6/63 | 191 |
| 52H | do. do. do. | 6/10/62 | 190 |
| 53H | do. do. do. | 16/12/62 | 196 |
| 54H | do. do. do. | 7/5/62 | 198 |
| 55H | do. do. do. | 14/7/62 | 196 |
| 56H | do. do. do. | 22/2/62 | 200 |
| 57H | Westralian Oil Ltd., 44 Parliament Place, Perth | 29/9/62 | 196 |
| 58H | Associated Freney Oil Fields N.L., 31 Charlotte Street, Brisbane | 27/10/62 | 120 |
| 59H | do. do. do. | 27/10/62 | 113 |
| 60H | do. do. do. | 27/10/62 | 113 |
| 61H | do. do. do. | 27/10/62 | 113 |
| 62H | do. do. do. | 27/10/62 | 112 |
| 63H | West Australian Petroleum Pty. Ltd., 251 Adelaide Terrace, Perth | 29/9/62 | 118 |
| 66H | do. do. do. | 18/1/63 | 200 |
| 67H | do. do. do. | 20/4/62 | 199 |
| 68H | do. do. do. | 17/5/62 | 195 |
| 69H | do. do. do. | 17/5/62 | 175 |
| 70H | do. do. do. | 17/5/62 | 192 |
| 71H | do. do. do. | 17/5/62 | 187 |
| 72H | do. do. do. | 17/5/62 | 194 |
| 73H | do. do. do. | 17/5/62 | 189 |
| 74H | do. do. do. | 17/5/62 | 186 |
| 75H | do. do. do. | 17/5/62 | 191 |
| 76H | do. do. do. | 17/5/62 | 193 |
| 77H | do. do. do. | 17/5/62 | 196 |
| 78H | do. do. do. | 17/5/62 | 190 |
| 79H | do. do. do. | 17/5/62 | 199 |
| 80H | do. do. do. | 17/5/62 | 189 |
| 81H | do. do. do. | 17/5/62 | 193 |
| 82H | do. do. do. | 17/5/62 | 198 |
| 83H | do. do. do. | 17/5/62 | 193 |
| 84H | do. do. do. | 17/5/62 | 187 |
| 85H | do. do. do. | 17/5/62 | 187 |
| 86H | do. do. do. | 17/5/62 | 189 |
| 87H | do. do. do. | 5/1/63 | 189 |
| 88H | Hawkstone Oil Company Limited, 135 St. George's Terrace, Perth | 28/2/63 | 189 |
| 89H | West Australian Petroleum Pty. Ltd., 251 Adelaide Terrace, Perth | 27/2/63 | 192 |
| 90H | do. do. do. | 27/2/63 | 160 |
| 91H | do. do. do. | 27/2/63 | 134 |
| 92H | do. do. do. | 27/2/63 | 180 |
| 93H | do. do. do. | 27/2/63 | 195 |
| 94H | do. do. do. | 27/2/63 | 186 |
| 95H | do. do. do. | 12/6/63 | 200 |

A map showing these holdings is included with this report.

## OTHER ACTIVITIES.

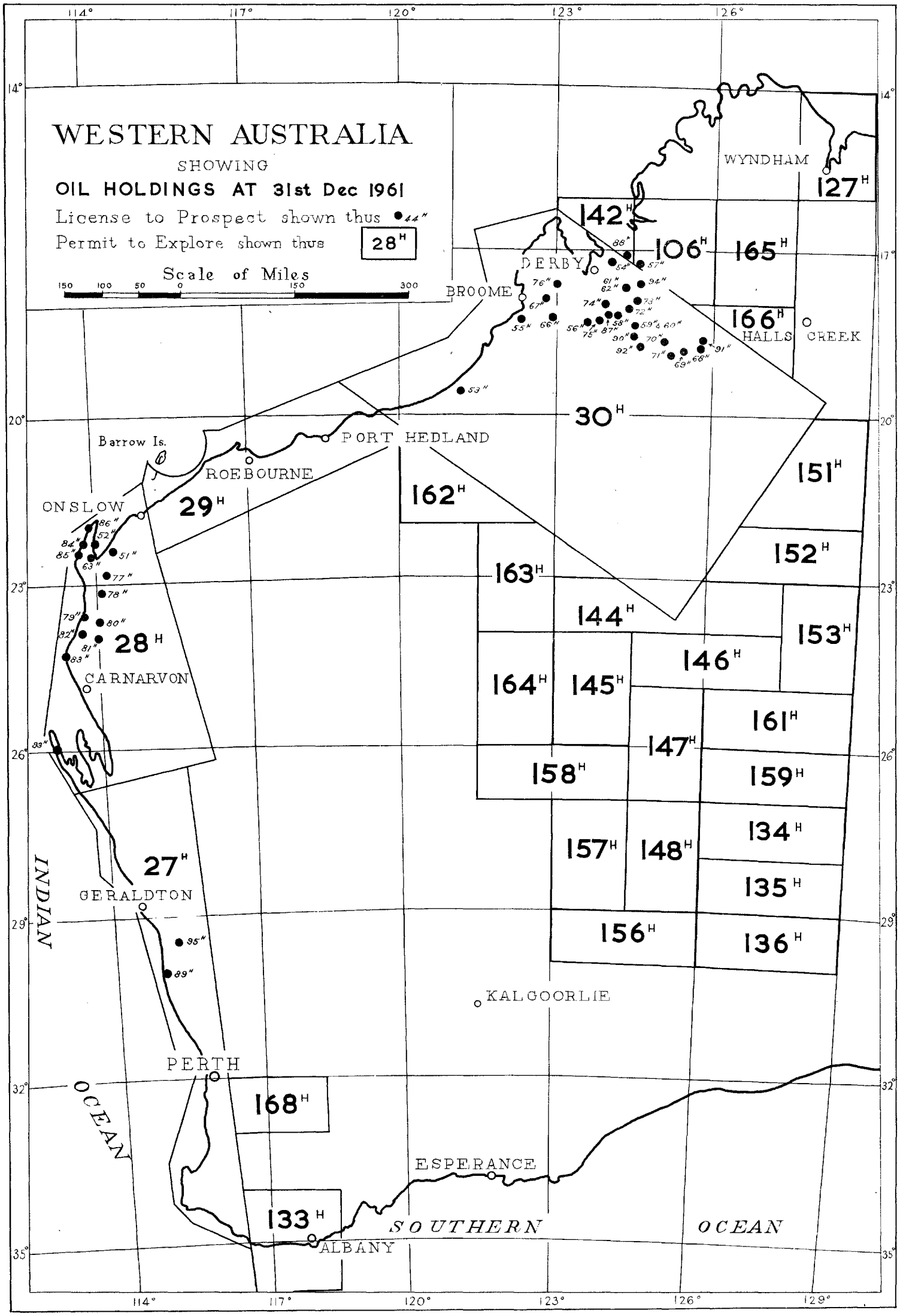
West Australian Petroleum Pty. Limited (Wapet) conducted a seismic survey in the Cockleshell Gully area in the Perth Basin from 1st-9th March, involving 29 reflection set-ups, 7.3 miles of shooting, 1,155 shot-holes, and 24,505 feet of drilling.

Land and marine seismic surveys were conducted in the Exmouth Gulf area from 9th January to 22nd February and 15th July to 20th August respectively. Further seismic surveys were commenced in December in the Salt Marsh area (100 miles north of Carnarvon) and in the Wandagee area (50 miles east of Salt Marsh). A seismographic survey in the area from Eneabba to the coast to follow up the gas showings detected in the Eneabba Bore was started late in the year, and a gravity survey northwards from Eneabba is planned to commence as soon as possible.

Wapet has stated its intention of following up the coal find in the Eneabba Bore to determine whether the coal measures are present close to the surface elsewhere. The Company intends procuring a drilling rig with a depth capacity of 2,000 feet for this purpose.

The Company also conducted a geological survey over 10,000 square miles of country south-east of Christmas Creek on its Permit to Explore 30H, and conducted a seismic survey in the Babrongan-Jarlemai area as a result of which it has been decided to spud-in a test well at Babrongan, about 120 miles south-east of Broome, in 1962.

The Gulf Oil Syndicate (Permit to Explore 127H) has completed its evaluation of the Spirit Hill Bore, and continued photo-geologic assessment of its


WESTERN AUSTRALIA
SHOWING
OIL HOLDINGS AT 31st Dec 1961
License to Prospect shown thus
Permit to Explore shown thus 28H
Scale of Miles
150 100 50 0 150 300
114° 117° 120° 123° 126° 129°
14° 17° 20° 23° 26° 29° 32° 35°
WYNDHAM
127H
142H
106H
165H
DERBY
BROOME
166H
HALLS CREEK
30H
Barrow Is.
PORT HEDLAND
ROEBOURNE
29H
151H
162H
152H
163H
144H
153H
146H
164H
145H
161H
147H
158H
159H
157H
148H
134H
135H
156H
136H
28H
CARNARVON
27H
GERALDTON
INDIAN
OCEAN
KALGOORLIE
PERTH
168H
ESPERANCE
133H
SOUTHERN
OCEAN
ALBANY

G.S.W.A.

# GEOLOGICAL PLAN OF LOGUE BROOK DAMSITE

Approx. 8 Miles N.E. of Harvey

SCALE OF FEET

100 50 0 50 100

## LEGEND

Porphyritic Granite

Hornblende Schist

Acid Gneiss

J.D.W. Feb. 1961.

Porph. Granite
N15E
Porphyritic Granite
DDH5
Oriented Porphyritic Granite
Hornblende Schist N10E 85
Basic foliated granite/gneiss
Hornblende Schist
N5E
DDH4
-45°
Boulders of foliated acid gneiss
Laterite cover with foliated acid gneiss and quartzite fragments
Foliated acid gneiss rubble
Quartzite and foliated acid gneiss boulders
DDH3
DDH3A
Hornblende Schist fragments
Foliated acid gneiss
℄ of cut off trench
N15E 80
N80E 80
Laterite cover with foliated acid gneiss fragments
Hornblende Schist fragments
Hornblende Schist Lenses
Gneissic and Strongly foliated Porphyitic granite
N5E 20°
N2E
Foliated acid gneiss
Quartzite rubble
N2E 75
Foliated acid gneiss Boulders
DDH2
Weathered Hornblende schist Fragments
Foliated acid gneiss
N S
Foliated acid gneiss
Foliated acid granite gneiss rubble
Foliated acid gneiss rubble
Foliated acid gneiss Boulders
Foliated acid gneiss rubble
W80E 20
N 75° S
N30E 40°
Foliated acid gneiss with quartzite lenses
Laterite cover with foliated acid gneiss fragments
N10W 85°
Foliated acid gneiss
Laterite cover with foliated acid gneiss and quartzite fragments
DDH1
N15E 70° Weathered foliated granite gneiss
N30E 70°
N10W
N30W
E 35° W
Foliated granite
acid gneiss
Porphyritic granite boulders
E W
N60W N30W 63°
N15E 15°
Fragments of Quartzite and foliated acid gneiss
Q Q
Foliated weathered acid gneiss
N 85° S
Fragments of Quartzite and foliated acid gneiss
N2E 80° N70W
Hornblende Schist
85° N2E 87°
Schist
Porphyritic granite
Schist

Fig. No. 4.—Northern Spillway looking East. Faulted contact between Quartzite Phyllite showing blocky characteristics of Phyllite.

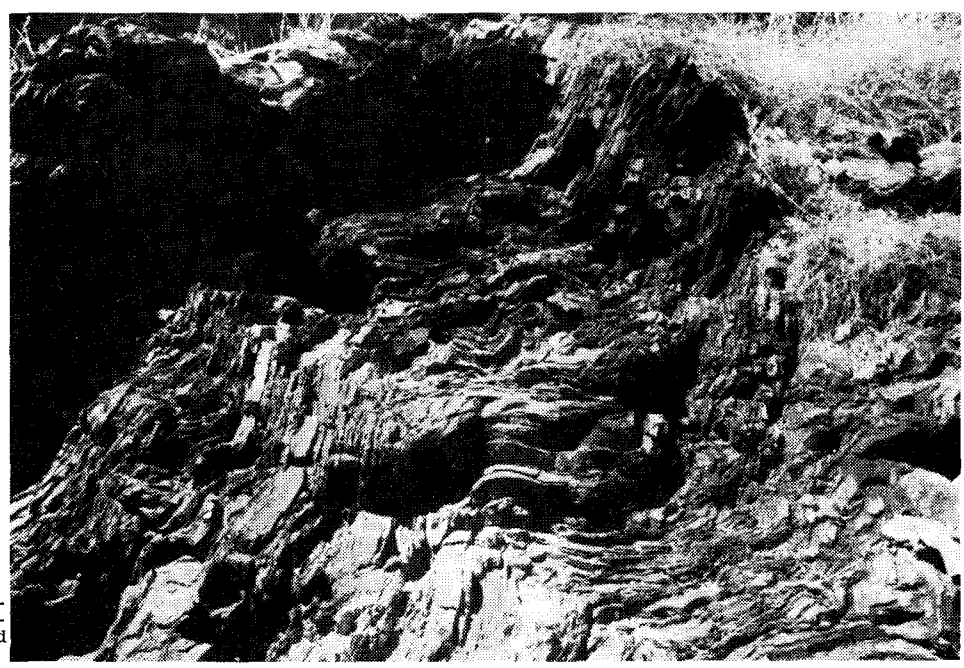


Fig. No. 5.—Western Abutment looking South showing folded and contorted Phyllite.

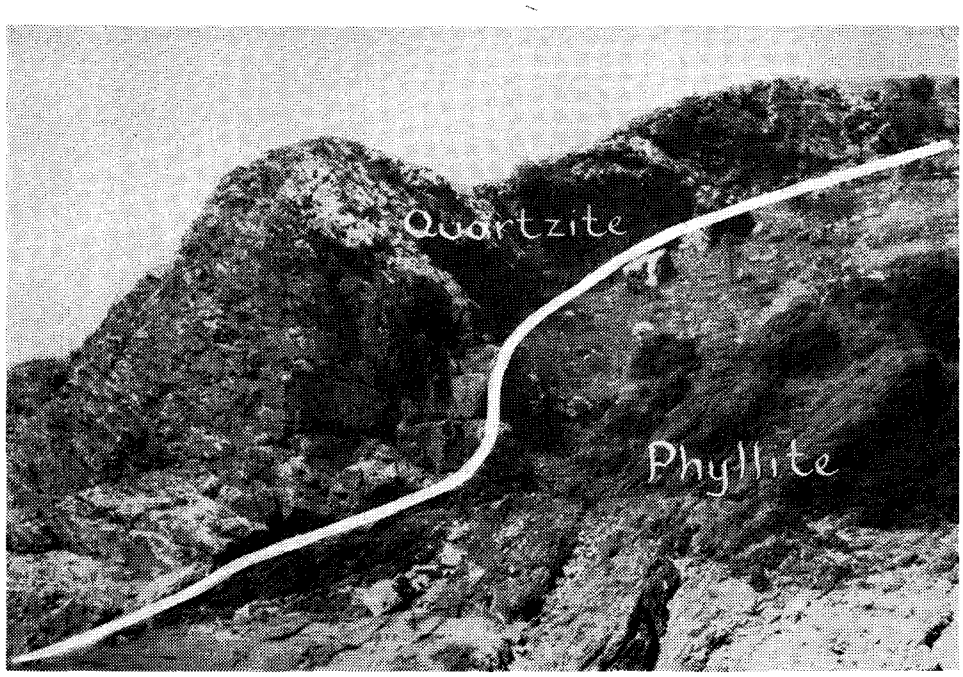



Fig. No. 6.—Western abutment looking South showing Quartzite capping overlying Phyllite. Note Monoclinal flexuring exaggerated due to photo angle.

permit area. Palaeontological and statigraphic studies were continued, and gravity surveys were conducted in the Carlton Embayment, and northwards of the Weaber Range. Topographic surveys have been carried out in conjunction with these.

The Hunt Oil Company and Placid Oil Company (Permits to Explore 156-159H, 147 and 148H, and 161H) has conducted an aerial magnetometer survey and photo-geological assessment of its permit area.

Other permitees have carried out assessment of previously obtained geological and geophysical data for their areas. The Commonwealth Bureau of Mineral Resources conducted an aero-magnetic and radio-metric survey over the Glenroy, Yarraloola, Yanrey, Geraldton, and Yalgoo 4-mile map areas in the northern and southern parts of the Carnarvon Basin, which completed the airborne coverage of this area. The Bureau commenced a reconnaissance seismic survey of the Giles and Carnegie 4-mile map areas in the southern part of the Canning Basin in September.

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## EXAMINATION OF LOGUE BROOK DAMSITE, HARVEY, SOUTH WEST DIVISION.

*By J. D. Wyatt, B.A.*

*Introduction.*

Following a request from the Hydraulics Section of the Public Works Department, the writer was instructed to visit the Logue Brook Damsite and carry out geological mapping.

Logue Brook is situated some 80 miles by road from Perth in the Darling Ranges.

It is proposed to erect in the foothills an earthen dam of some 20,000 acre feet capacity on the narrow, steep-sided valley of Logue Brook which flows from east to west off the Darling Ranges and on to the Perth coastal plain. When completed the dam will supply additional water to the Harvey Irrigation project.

The area was mapped during a four-day visit by the author and it should be noted that the information so obtained was only of a confirmatory nature to work already being carried out by the Public Works Department, which included diamond drilling and excavation along a portion of the dam centre line.

*Geology.*

The rocks in the vicinity of the damsite are confined to four types, foliated granite gneiss, quartzite, hornblende schist and porphyritic granite.

The main body of valley consists of granite gneiss containing beds and lenses of a basic hornblende schist and quartzite which weather to deep red-brown clays and light brown sandy soils respectively.

The granite gneiss varies in composition between these two extremes of schist and quartzite from a pale acid rock containing rare ferromagnesians to a darker intermediate type rock containing abundant dark minerals.

The basic schist beds occur either as wide bands of rock striking at approximately right angles across the brook or as smaller lenses completely contained within the main body of the gneiss.

The whole of this meta-sedimentary sequence has been intruded in various places by a porphyritic granite which, for the most part, has a strong orientation of the felspar phenocrysts, indicating that some of the folding at least was post granite or contemporaneous with the granite intrusion.

The rocks of the area generally strike slightly east of north and dip steeply to the south-east at angles in excess of 80°.

Outcrop conditions are poor, except at either end of the area under consideration, also exposures are better on the northern side of the valley than on the southern side.

An examination of a portion of the exposed centre line cut off revealed the lens-like character of the hornblende schist which was previously seen only as beds of varying thickness crossing the valley at right angles to the creek bed.

It is apparent from the mapping that the area was originally composed of interbedded sandstones and mudstones of a lenticular character, which underwent granitization. This resulted in the formation of hornblende schists and quartzites. Where granitization was carried to a further stage, granite gneisses resulted. The porphyritic granite outcropping at various places can be considered part of the original invading body.

*Structures.*

As outcrop is so poor, especially in the vicinity of the actual site, no large scale structures can be identified. It is sufficient to say that the area consists of a suite of folded meta-sedimentary rocks intruded by a porphyritic granite. Minor drag folds give conflicting evidence, so it is not possible to indicate the position of the major fold axes. In any case from an engineering point of view this is not of any importance.

There is no evidence of major faulting, shearing, or quartz intrusion.

Jointing throughout the area mapped is not abundant and will no doubt prove watertight.

*Conclusions.*

From an examination of the visible outcrops diamond drill cores available and the partially exposed cut off trench it is concluded that there is no visible evidence which could cause any concern over the construction of the proposed earthern dam at Logue Brook.

In drill cores examined, the basic hornblende schists so exposed are not an intrusive dyke rock as previously logged by the driller, and therefore are not to be regarded as a possible source of leakage below the dam wall.

Diamond drill holes put down along the bywash channel also confirm the lens-like character of the hornblende schist and also the solid character of the granite gneiss.

It is regrettable that no drill hole information was considered necessary along the centre line, or elsewhere within the limits of the foundations of the dam, especially as this would have increased the knowledge regarding excavation depths to solid rock and the condition of the foundations at depth.

Generally, however, from the information available the site can be considered quite suitable as regards both strength and water tightness for the erection of the proposed dam.

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## FINAL REPORT ON THE DIAMOND DRILL EXPLORATION OF THE ORD RIVER No. 2 MAIN DAMSITE.

East Kimberley Division. Approx. Lat. 16° 7′ Long. 128° 15′.

*By J. D. WYATT, B.A.*

### INTRODUCTION.

This report completes the results of the diamond drill investigation of the proposed Ord River Dam, carried out during the 1960 and 1961 field seasons.

The preliminary account of activities published in 1960 should be read in conjunction with the following, particularly as regards the 1960 individual diamond drillhole information and general details on location of the damsite.

Drilling and supplementary mapping in the 1961 season has added a great deal of additional information and only the following facts should be considered for a final interpretation of the geology and structure of the dam foundations.

During 1961 a further 16 drillholes and two adits were completed together with detailed mapping in the immediate vicinity of the dam and regional mapping to the east and north.

The diamond drilling was again carried out on a contract basis by Ausdrill Ltd., Darwin, work commencing on the 3rd June, 1961, and being completed on the 20th September, over one month inside the contract deadline of 31st October.

Three drilling rigs were used, two Mindrill petrol driven, screw feed, E1000 machines and one small portable E100 rig.

A total of 1611′ 8″ of drilling was completed with an overall recovery of 96.95%, but out of this footage 54′ was unpaid for as the holes in question, 13M and 26M, were abandoned by the contractor.

Adit excavation was carried out by the Public Works Department using their own labour and during the year two adits were completed totalling approximately 240′ in length.

## GENERAL GEOLOGY.

The general geology of the area embracing the main damsite consists of a series of interbedded massive to thin bedded quartzites and phyllites which have been subjected to strong faulting, folding, shearing and quartz vein intrusion.

These Precambrian metasediments overlie both the porphyritic granites and gneisses of the Lamboo Complex and the highly metamorphosed lavas and metasediments of the Halls Creek Metamorphics.

The granitic terrains which outcrop approximately one mile due east of the main dam occur as relatively flat lying sandy plains with occasional weathered granite boulders and ridges of intrusive quartz and dolerite dykes.

Almost completely surrounding this granite, are highly dissected remnants of the Halls Creek Metamorphics which have been protected by the overlying shallow dipping younger quartzites and phyllites.

The above metamorphics are very similar in appearance to those of the Warrawoona System of the Pilbara and consist of highly altered schists, lavas and jaspilites (banded ironstone formations).

*Structure.*

The granite is wedge-shaped and is bounded on the east and west by two large faults. The lack of granitised margins and the shape of the granite suggests it has been block faulted into its present position.

The western fault strikes in a general north-north-easterly direction and separates the Archean granite from the younger Proterozoic quartzites and phyllites (see Plate No. VII).

It has a visible length of some 14 miles and a probable horizontal displacement of one and a half miles, east side south.

The eastern fault bifurcates to form a southern extension of the Cockatoo Fault which has a known length of some 40 to 50 miles.

## DETAILED GEOLOGY.

The rock types both mapped on the surface and intersected by the diamond drilling are confined to quartzites and phyllites of Proterozoic age.

These quartzites vary from massive to thin bedded, medium grained, strongly jointed rocks which in places have been intruded by quartz veinlets.

Surface outcrops are brown in colour due to weathering and oxidation but at depth they invariably give way to a massive, dense, white rock in which cross bedding and ripple marking are common.

On the north-east side of the river the phyllites are a massive, strongly jointed rock exhibiting blocky characteristics, whilst on the south-east side they are represented by a highly contorted, thin bedded rock containing numerous quartz veinlets. (See figures Nos. 4 and 5.)

Surface outcrops are red in color but at depth they are either black or grey.

Pyrite is locally developed in the areas of intense silification and folding.

Both horizons are conformable and right side up except in one instance where probable overturning of the quartzite has occurred against a fold or fault.

The beds strike in a general north-westerly direction and dips vary from 5°-4° north-east.

*Structure.*

The geological structure west of the fault which separates the Proterozoic sediments from the granite is that of a syncline, plunging and widening to the north at about 10°-15°, and with a closure in the vicinity of the No. 1 Damsite. (See Plate No. VII.)

The syncline is upturned against the eastern fault with a local steeping of dip from 20° to 60°. Relative vertical movements are east side up, west side down.

Additional faulting of probable similar movement parallels this main fault, whilst shears and tension cracks adjacent to the fault zones roughly conform to the fracture patterns expected from this type of movement.

## WESTERN ABUTMENT.

During the 1961 season this abutment was further investigated by three drill holes and two adits (See Plate No. XIII).

These holes, plus a detailed examination of recently uncovered exposures along the river banks revealed several important facts about the structure of the abutment.

Geologically the abutment consists of a thin 50′-80′ capping of quartzite overlying an unknown thickness of phyllite.

These rocks vary from brown, for the quartzites to deep reddish brown, for the phyllites. They strike approximately N25°W and dip generally 25°-35° east.

Local folding and strong jointing are a feature of the abutment. (See figure No. 6.)

*Structure.*

Surface mapping has revealed numerous brecciated zones striking N15°W and dipping 45°-60° west. Additional parallel jointing occurs dipping 45° east. Locally some joint faces show openings up to 15 inches apart. (See figure No. 7.)

A careful examination of surface attitudes from the river bed up the abutment, along the toe in line of the proposed dam, has revealed the following changes in dip.

| | |
|---|---|
| RL. 160′ | 30° |
| RL. 190′ | 40° |
| RL. 200′ | 50° |
| RL. 210′ | 46° |
| RL. 220′ | 47° |
| RL. 250′ | 45° |
| RL. 290′ | 42° |

These dips are indicative of monoclinal folding, that is a local steepening in a generally uniform dip.

The phyllite/quartzite contacts intersected in Diamond Drill Holes tend to support this theory of at least one flexure in the western abutment.

Surface examination of the contact along the northern edge of the abutment, again confirms the above evidence, but the mapping of additional faults suggests minor faulting to have been a contributing factor. (See figures Nos. 8 and 9). Using the few quartzite/phyllite contacts as intersected in the diamond drillholes a structure contour plan was constructed.

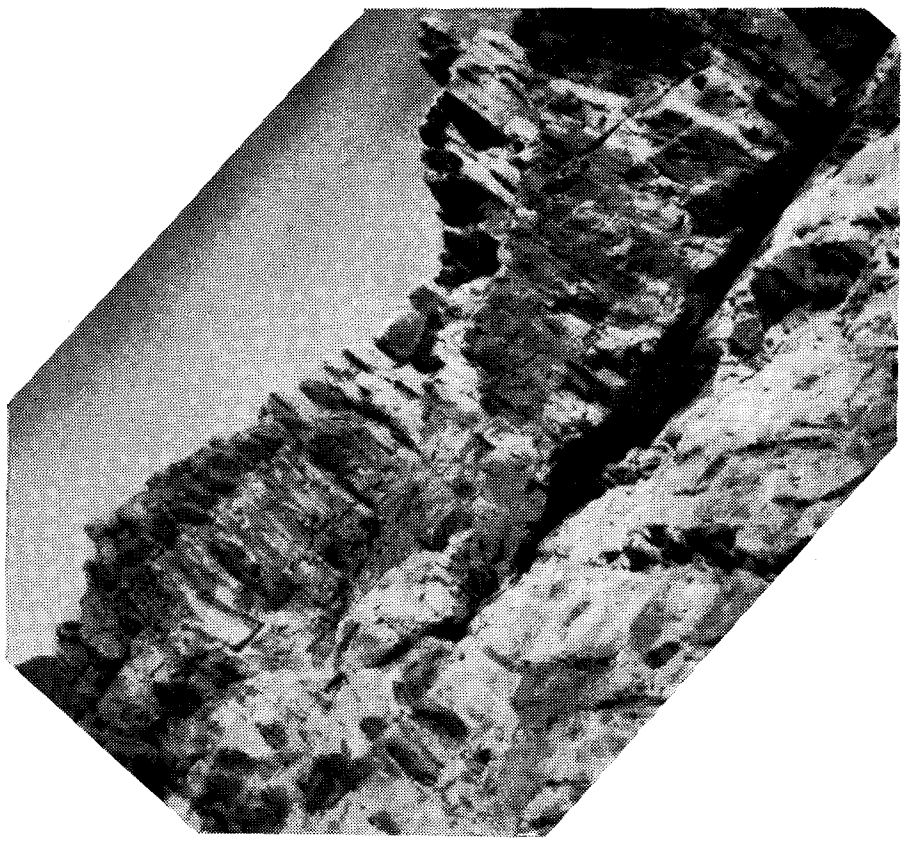

Fig. No. 7.—Western Abutment looking South showing open jointing in Quartzite.

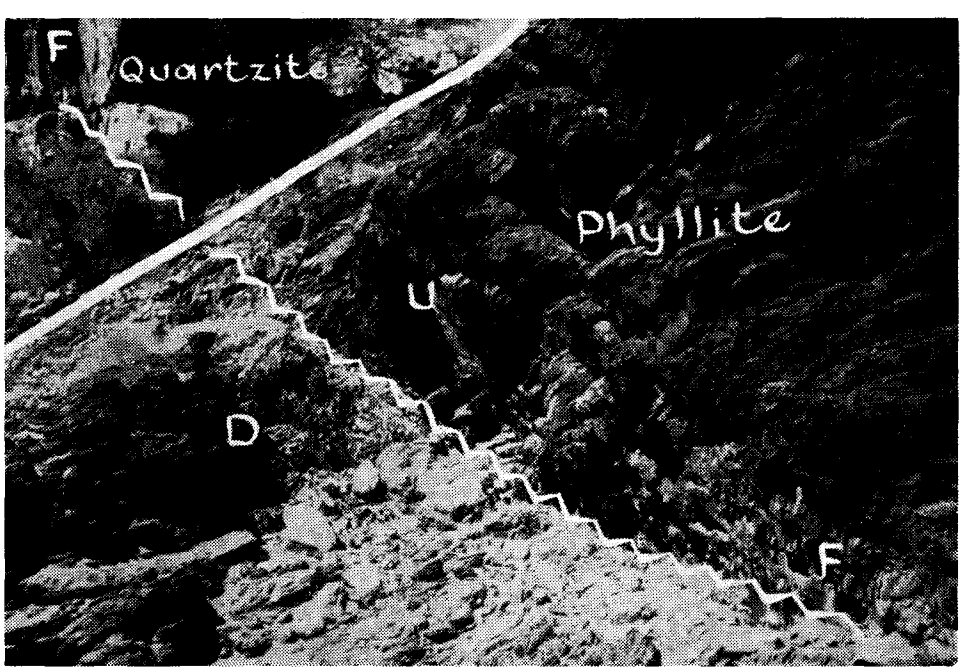


Fig. No. 8.—Western Abutment looking South showing minor faulting.

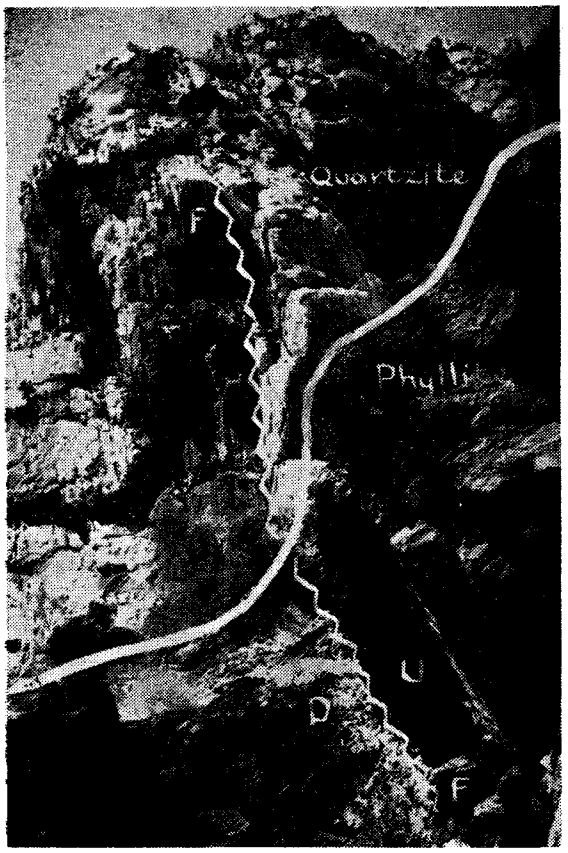


Fig. No. 9.—Western Abutment looking South showing minor faulting and quartzite phyllite contact.

This plan shows quite clearly the monoclinal roll of the contact and further indicates a minor cross folded synclinal structure within the abutment and at right angles to the major syncline already mentioned in the general structure of the area.

This subsurface syncline was already noted as a surface roll in the quartzite but in mapping was thought to be an erosional feature.

A careful examination of the lowest adit reveals brecciation which on dip projection conforms with zones already mapped on the surface.

A disturbing feature of these brecciated zones is that at depth, the oxidised and cemented surface gives way to a puggy clay material which would be susceptible to scouring by water action.

The sequence of events most probable in the production of this monoclinal flexure in the western abutment is as follows:—

(1) The gradual development of a fold in the brittle quartzites and softer phyllites caused by movement along the large fault to the east and smaller parallel faults within the syncline.

(2) Relief of the tension in the quartzites by the formation of a series of small brecciated slips and in the phyllites by complex minor folding.

(3) The imposition of the various joint patterns associated with this movement.

Mention was made earlier of faulting parallel to the main movement which separates the granite from the sediments.

One such fault is visible as a series of strong shears which have given the quartzite a sheeted appearance some distance upstream from the western abutment and about half way between No. 1 and No. 2 Damsites. (See figure 10.)

Attention is drawn to the fact that when the reservoir is filled this zone could become a point of leakage.

Scree material covers the lower slopes which will be eventually water covered so it is not possible to see if this open sheared area is as prominent in the underlying phyllite section.

RIVER BED.

The drilling of three diamond drill holes namely 20M, 22M and 24M in the 1961 season, along the downstream toe of the proposed dam, confirmed the quartzite/phyllite contact to be uniformly dipping below the river at approximately 30° to the east. (See Plate No. XVII.)

The thinnest cover of quartzite over phyllite which could be expected to occur below the actual dam wall would be in the vicinity of 30 feet.

This is based on readings of the river bed levels as supplied by the Public Works Department and the quartzite/phyllite contacts intersected in DDHs 20, 22 and 24M.

No evidence was disclosed supporting the possibility of a large fault parallel to the river and beneath its bed. It would therefore appear that any flexuring or displacement would be confined to a narrow zone in the vicinity of the western abutment.

EASTERN ABUTMENT.

During 1961, drilling on the eastern abutment consisted of four drillholes along the line of the underground power station and tunnel.

The rock encountered was made up of a sequence of quartzites of varied characteristics.

Diamond drill holes 12M and 15M merely confirmed the 1960 results which showed the quartzite at depth to be a dense white rock, entirely suitable for the work proposed.

Diamond drillhole 18M however, which was commenced at a much higher R.L. penetrated 179′ of thin bedded quartzite containing numerous softer phyllite lenses. (See figure 11.)

The more massive, white variety was penetrated at 179′ and extended to the end of the hole at 250′ 4″.

Diamond drillhole 23M drilled vertically and immediately above the tunnel portal penetrated 42′ of talus before the denser more massive quartzite was encountered.

The contact between this thin bedded and the massive quartzite shows up the tendency of the beds to roll over to the south-east, a tendency which becomes an acute flexure along the southern and south-eastern end of the abutment where the quartzite is well exposed in a small tributary of the Ord River.

Whilst the strike of this flexure can be roughly lined up with the strike of vertically dipping thin bedded quartzites at the base of the southern spillway, it is also possible that this dip increase was the result of fault movements further to the east. (See Plate No. VII.)

*Structure.*

Detailed mapping in the vicinity of drillholes 12M and 15M disclosed three new faults of no great magnitude. However, it should be noted that if continuous on their present strike they will intersect the underground power station chamber and inlet tunnel with the possibility of additional grouting treatment. (See Plate No. IX.)

Close to the outlet of the tunnel the quartzite which rises steeply from the river bed, exhibits a very strong joint system, the most prominent being N. 25° W. and dipping 70° west, into the river.

This jointing carries an appreciable amount of water as evidenced by the numerous seepages that were noted in the cliff face during the drilling of 12M.

NORTHERN SPILLWAY.

In addition to the single 150' vertical hole drilled in 1960, six more holes were completed during 1961, being sited across the width of the spillway at both the outlet and inlet ends.

*Outlet Drilling.*

The results obtained from the western outlet were as expected, revealing the underlying rock to be open jointed quartzite for the most part thin bedded.

Diamond drillhole 13M, laid out for the purpose of testing a zone of faulting had to be abandoned after three attempts to reach target depth.

*Structure.*—Detailed surface mapping resulted in the discovery of two more faults and the postulation of a new theory as to the type of movement which terminates the quartzite against the phyllite. (See Plate No. X.)

The discovery of phyllite underlying the edge of the quartzite at the rivers edge and the arcuate nature of the mapped fault line suggests the type of movement to have been in the nature of a low angle rather than a high angle fault as first suggested in 1960.

Although the above evidence is by no means conclusive the possibility of underlying phyllite closer to the surface than first suggested, should be noted.

At the outlet end of the spillway a very strong jointing, striking N20°W and dipping steeply to the south-west, was responsible for large water losses during drilling, therefore this complete face of quartzite should be considered to be very open jointed.

*Inlet Drilling.*

The drilling of the inlet side of the spillway disclosed an anomaly in the geology as mapped initially on the surface.

Whilst each hole encountered quartzite in the early stages of the drilling, they were all completed in a soft sandy material containing phyllite fragments.

Unfortunately 100 per cent. water losses and bad caving resulted in very poor core recoveries throughout, with practically none in the sandy sections. The use of drilling mud had to be resorted to before any worthwhile material could be recovered.

No conclusion could be drawn as to the subsurface geology and it is recommended that a small shaft be sunk in the vicinity of DHH 27M where sand was encountered at a depth of some two feet. A shaft of 10 feet maximum depth should prove adequate to explain the significance of this sandy horizon.

## DIAMOND DRILLING

As in 1960, the diamond drilling in 1961 was carried out under private contract by Ausdrill Pty. Ltd. Darwin.

A total of 16 holes were drilled, commencing on the 3rd June and being completed on the 20th September, a little over one month inside the contract deadline.

Three machines were used, all Mindrill equipment and all petrol driven. Two of the rigs were screw feed E1000's and the third a small portable E100, for the more inaccessible sites.

This portable rig, whilst performing adequately, was too small to handle anything but the minimum size bits and was not satisfactory in caving ground where extra power was required.

Core size was again limited to AX minimum and the percentages for each size are as follows:

| | |
|---|---|
| AX | 94.4 per cent. |
| BX | 5.6 per cent. |
| NX | Nil. |

Core recovery figures for individual holes are tabulated below.

Diamond Drilling Results, Ord River, 1960.

| D.D.H. No. | Size | | Footage Drilled | Footage Recovered | Per cent. Recovery |
|---|---|---|---|---|---|
| | AX | BX | | | |
| | ft. in. | ft. in. | ft. in. | ft. in. | |
| 12M | 146 1 | 10 4 | 156 5 | 155 5 | 99·36 |
| 13M | 7 0 | 12 0 | 19 0 | 15 6 | 82·00* |
| | 5 6 | 10 0 | 15 6 | 15 6 | 100·00* |
| | 13 0 | .... | 13 0 | 6 6 | 50·00* |
| 14M | 39 4 | 11 0 | 50 4 | 49 8 | 98·66 |
| 15M | 266 6 | 18 6 | 285 0 | 282 1 | 99·00 |
| 16M | 33 9 | .... | 33 9 | 25 4 | 75·10 |
| 17M | 30 0 | .... | 30 0 | 24 4 | 82·90 |
| 18M | 250 4 | .... | 250 4 | 248 0 | 99·10 |
| 19M | 111 3 | .... | 111 3 | 108 0 | 97·08 |
| 20M | 54 6 | .... | 54 6 | 53 10 | 98·77 |
| 21M | 80 2 | 5 1 | 85 3 | 84 1 | 98·62 |
| 22M | 215 6 | 2 6 | 218 0 | 218 0 | 100·00 |
| 23M | 42 7 | 8 3 | 50 10 | 39 10 | 78·35 |
| 24M | 152 0 | .... | 152 0 | 151 8 | 99·77 |
| 25M | 40 0 | 10 0 | 50 0 | 48 6 | 97·00 |
| 26M | 6 6 | .... | 6 6 | 6 6 | 100·00* |
| 27M | 30 0 | .... | 30 0 | 30 0 | 100·00 |
| 16 Holes | 1,524 0 | 87 8 | 1,611 8 | 1,562 9 | 96·95 |

* Abandoned.

Using various bits, but mainly in the four carat range with 80-110 diamonds per carat, the average footage per bit was 6 ft., an increase of 1.3 ft. over last year's average.

A change in the contract terms from payment for core recovered to payment for footage drilled, with the addition of bonus and penalty rates, led to more satisfied crews and was no doubt a major contributing factor to the improved results.

As the drillers were paid the bonus over and above their wages, there was no attempt made to force footage to the detriment of core recovery.

The following is a brief examination of each hole area by area.

EASTERN ABUTMENT HOLES.

*D.D.H. 12M.*

This was the first of four holes designed to test the rock types in the vicinity of the underground power station and tunnel. It was drilled at a depressed angle of 60° on a bearing of S.71°W. to a depth of 156 ft. 5 in.

Quartzite was the only rock type intersected over the full length of the hole, although its characteristics were variable.

Numerous softer ferruginous quartzite layers were encountered parallel to the bedding at various intervals. An indication of the relative softness of the rock is that each bit averaged 12.5 ft., which is over twice the average footage for the year's drilling.

Core examined at the approximate level of the tunnel outlet, showed the quartzite to be suitable for the proposed excavation, although at the outlet point in the cliff face which is traversed by a strong joint pattern, greater weathering effects can be expected in the form of open, water damaged joint faces. (See earlier figure No. 14.)

The 100 per cent. water loss, which was recorded in this drillhole from a depth of 28 ft. 3 in. was noted as a strong seepage through the numerous joints and also down a fault some 53 ft. south of this hole. (See Plate No. IX.)

The most prominent jointing system strikes N.25°W. and dips 70°SW. into the river.

*D.D.H. 15M.*

This hole was drilled at a depressed angle of 38° on a bearing of N.71°E. and passed through well jointed quartzite during its complete length of 285 ft.

Water losses and returns were numerous, the first occurring at 11 ft. and the last at 285 ft.

Although the initial 20 ft. of drilling was through softer ferruginous sandstone the rock gradually passed into a good quality quartzite and at the approximate depth of the proposed tunnel was a tight jointed, dense, white rock.

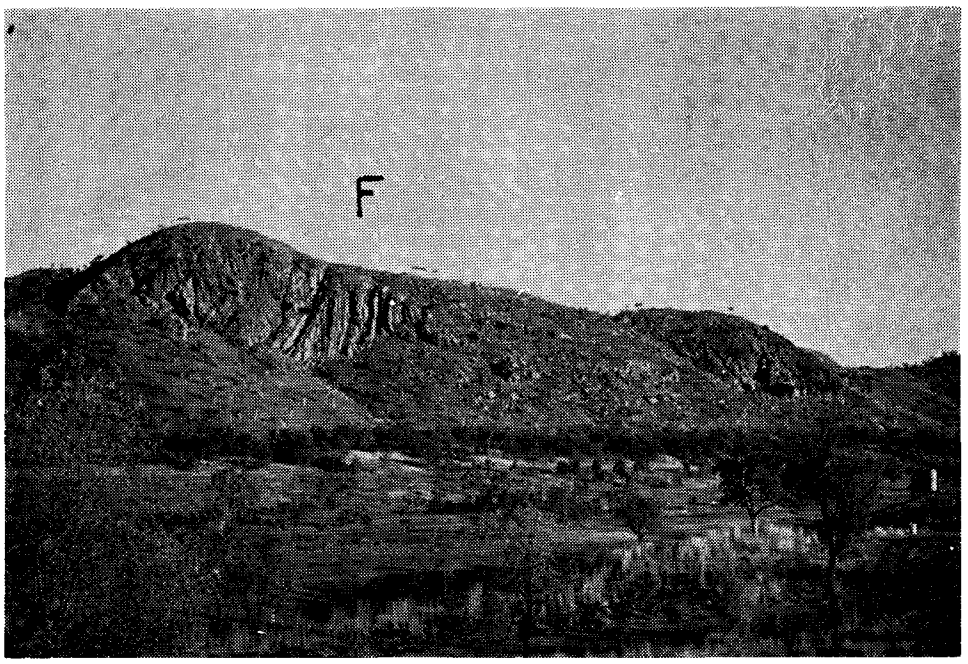


Fig. No. 10.—Fault Zone West Side of River. Showing vertical sheeting.

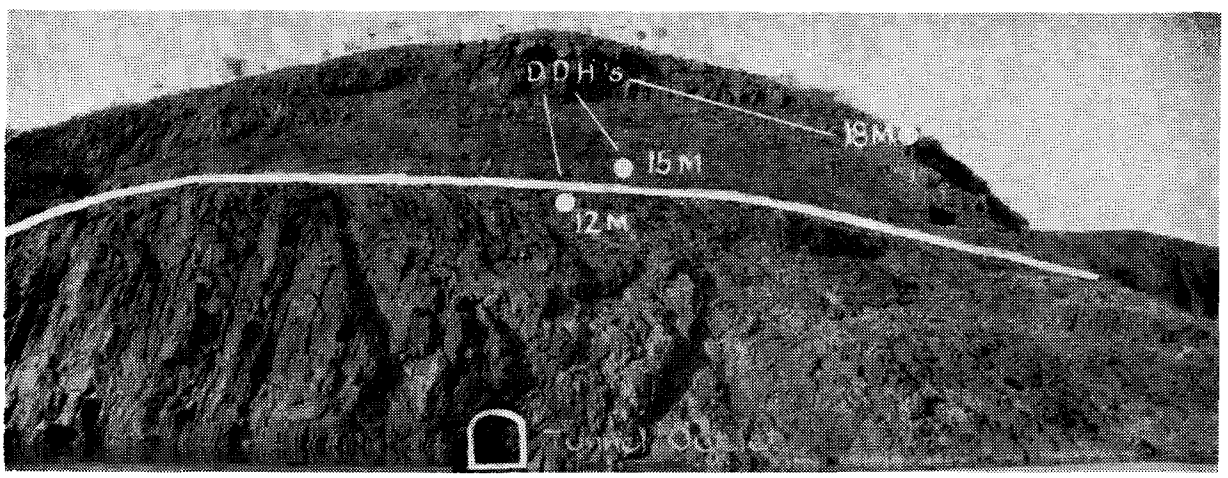


Fig. No. 11.—Eastern abutment showing approximate contact between thinly bedded and more massive varieties of quartzite.

Fig. No. 12.—East Abutment looking North East showing quartzite steepening in dip.

Fig. No. 13.—East Abutment looking North East showing steeply dipping Quartzite.

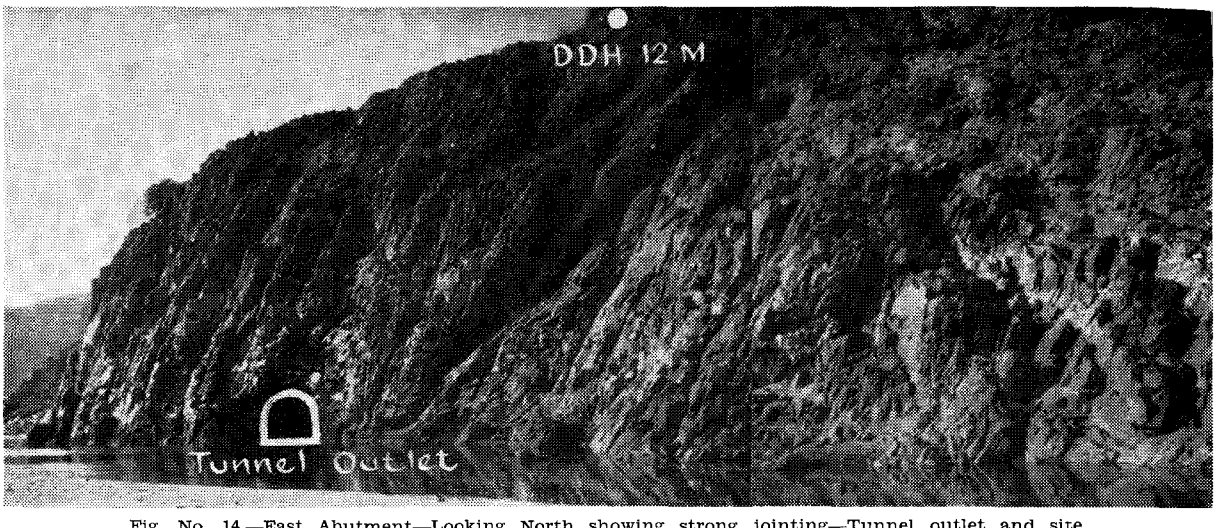


Fig. No. 14.—East Abutment—Looking North showing strong jointing—Tunnel outlet and site of DDH 12M.

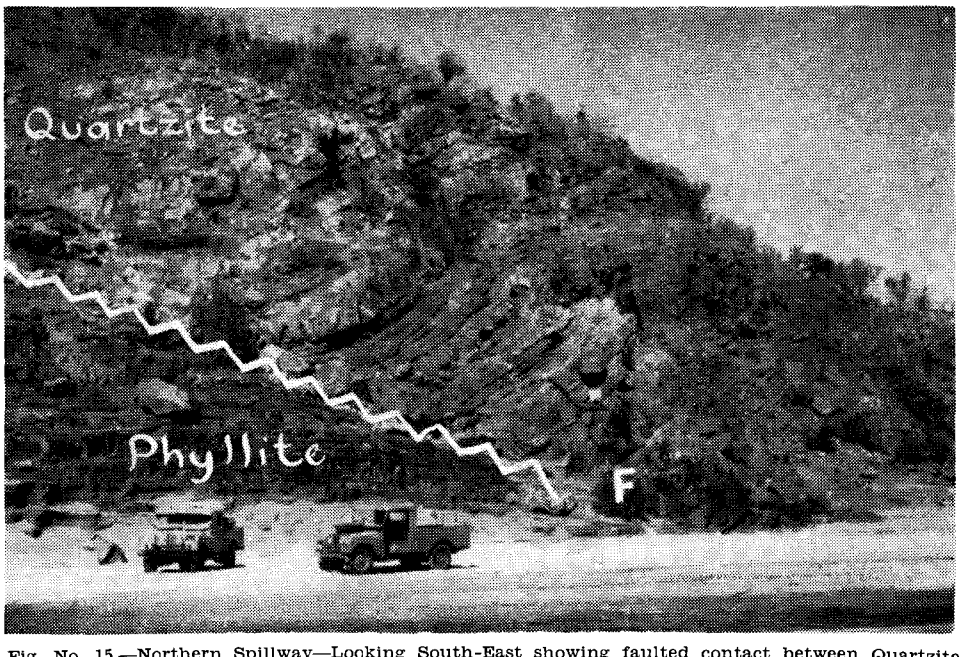


Fig. No. 15.—Northern Spillway—Looking South-East showing faulted contact between Quartzite and Phyllite.

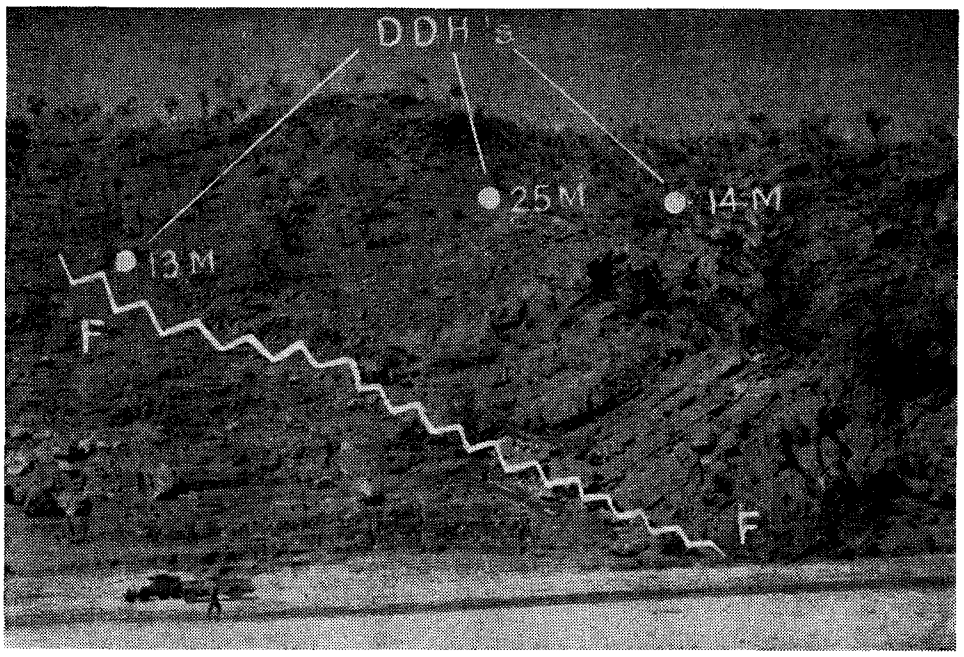


Fig. No. 16.—Northern Spillway—Looking East, showing suggested fault line between Quartzite and Phyllite. Probable movement shown by arrows.

Notice should be taken of the numerous water losses and returns in relation to grouting requirements.

*D.D.H. 18M.*

This hole was drilled vertically from the vicinity of survey station "E" to a depth of 250 ft. 4 in., and was planned to intersect the inlet tunnel of the proposed underground power station.

This was the first hole drilled from the top of the abutment, all holes drilled previously having taken advantage of the hill slope and commenced at a much lower level drilling obliquely below the talus.

D.D.H. 18M proved that the top 170 ft. of cover consisted of a thin bedded quartzite containing numerous lenses of phyllite.

However, from 170 ft. until the hole was completed at 250 ft. 4 in., the quartzite gradually improved to a hard, white variety.

Some of the weathered characteristics can be attributed to the fact that this hole was drilled vertically, close to the cliff face, however this thin bedded capping can also be expected over the rest of the abutment to variable depths.

*D.D.H. 23M.*

This was a short vertical hole drilled above the power station tunnel entrance.

Material intersected consisted of talus giving very poor core recoveries.

As in D.D.H. 18M, thin bedded quartzite was the prevailing rock type to a depth of 43 ft.

From 43 ft. until the end of the hole at 50 ft. 10 in., the quartzite gradually improved to the more massive variety.

An examination of Plate XVI, which is a cross-section through D.D.Hs. 18M and 23M, shows a dip steepening of the beds which are folded to the south east. (See figures 12 and 13.)

RIVER HOLES.

*D.D.H. 22M.*

This hole was drilled below the river bed at a depressed angle of 58° on a bearing of S.62°W. to a depth of 218 ft.

Its aim was to prove the constant dip of the phyllite-quartzite contact at depth and to test the rock below the downstream toe of the dam.

The quartzite-phyllite contact was intersected at 209 ft.

The initial 32 feet of drilling was in ferruginous, open-jointed quartzite but as the jointing became tighter the ferruginous quality of the rock became less evident and the hole was completed in the dense white variety.

The first and only water loss of 80 per cent. occurred at 22 ft. and this decreased return continued until the end of the hole.

*D.D.H. 24M.*

This hole was drilled at a depressed angle of 60° on a bearing of S71°W to a depth of 152 ft.

It was designed to test the foundation conditions below the downstream toe of the dam and to help establish the position of the quartzite-phyllite contact.

As in D.D.H. 22M the contact was intersected very close to its expected position at a drill depth of 142 ft. 6 in.

The quartzite was of good quality, only slightly ferruginous and tight jointed.

Water losses were confined to surface seepages, emerging from jointing in the immediate vicinity of the drillhole.

WESTERN ABUTMENT.

*D.D.H. 19M.*

This hole was sited to test for the quartzite-phyllite contact along the upstream edge of the dam wall and to help clarify the anomalous position of this contact as intersected by D.D.Hs. 7M and 8M during the 1960 season.

The hole duly intersected the phyllite at 111 ft. and indicated that a minor flexuring occurred between this point and the intersection in D.D.H. 8M.

The quartzite is massive but contains numerous quartz veinlets, which are indicative of some flexuring or faulting in the near vicinity.

*D.D.H. 20M.*

This hole was sited for the dual purpose of testing the downstream toe foundations by again confirming the quartzite-phyllite contact and to establish if any serious rock movements have occurred in the western abutment.

The intersection of the phyllite at 50 ft. almost certainly proves that the dip is constant below the river as evidenced by the other intersections in D.D.Hs. 22M and 24M.

Furthermore, this result when coupled with those obtained from D.D.Hs. 19M and 21M is sufficient evidence to show that the western abutment has suffered flexuring and minor faulting.

The quartzite throughout the hole was white, dense and strongly jointed. Water losses were noted as surface seepages from adjacent joint planes.

*D.D.H. 21M.*

This hole was the last of three sited parallel to the river along the base of the western abutment.

It was drilled at a depressed angle of 58° on a bearing of S85°W to a depth of 85 ft. 3 in.

The phyllite intersection at 77 ft. adds further to the assumption that there is a monoclinal flexure or a series of minor slips along the western abutment and parallel to the river (see Plate XVIII).

The quartzite in this vicinity was on the whole softer than normal, whilst bad caving occurred particularly towards the end of the hole.

ADITS.

As a knowledge of the strength and properties of the quartzite overlying the phyllite on the western abutment is of great importance, in addition to the five drillholes already completed, two adits were driven into the abutment at right angles to the bedding until contact was made with the phyllite horizon.

These adits were so placed that they will eventually be used as inspection and grouting galleries in the completed dam structure.

Excavation of the lowest adit commenced at the site of D.D.H. 7M and was completed after 132′ of driving. The grey phyllite contact being intersected at 127′.

Geological mapping revealed a continuation at depth of the brecciated zones already mapped on the surface in 1960.

A disturbing feature about these zones is that instead of being recemented and tight jointed, as was expected at this depth, they show up as 1″-2″ seams of puggy clay containing brecciated quartzite fragments.

These clay filled shears are definite water passages and in the event of a raised water table could become lubricated and highly susceptible to sliding.

Another point which was confirmed on mapping was the presence of numerous and complex joint systems. The most prominent system strikes almost at right angles to the adit line and dips from 45°-55°W into the abutment and away from the river.

Whilst being excavated neither the quartzite nor the phyllite required timbering despite complex jointing systems.

The second adit 50′ above the first intersected the phyllite at 93′ and conforms to the suggested monoclinal fold.

*D.D.H. 26M.*

One hole was sited in the lower adit as an additional check on the phyllite/quartzite contact, however after drilling for 6′ 6″ the machine broke down and the hole was abandoned.

NORTHERN SPILLWAY.

*D.D.H. 13M.*

This hole was drilled vertically on the river or outlet side of the northern spillway and close to the edge of the faulted contact between the quartzite and the phyllite. (See figure No. 16.)

A target depth of 50′ was aimed for but after three attempts to reach this depth the hole was abandoned.

The main cause of the trouble was continual caving in unconsolidated talus, the only core recovered being broken, thin bedded quartzite with numerous phyllite lenses.

It was hoped to prove or disprove a newly postulated thrust theory for the quartzite/phyllite contact but unfortunately this was not possible.

Water was lost continually through the surface rubble and jointing. Several seepages were noted down the hillside particularly along the vertically dipping set of joints striking N55°E.

*D.D.H. 14M.*

This hole was also drilled vertically to a depth of 50′, in broken well jointed quartzite. Complete water loss was recorded from 17′.

Seepage from the cliff face was most noticeable along joints running parallel to the river, striking N20°W ad dipping west and from a prominent fault line situated only a few feet south of the drill hole and striking at right angles to the river.

*D.D.H. 25M.*

This hole was drilled vertically to a depth of 50′, and was sited between 13M and 14M in order to obtain information missed when 13M was abandoned.

Core recovered was very broken, thin bedded phyllitic quartzite for the whole length of the hole.

Water losses were recorded from the commencement of drilling either as surface seepages, or along jointing in the cliff face.

Fig. No. 17.—Western Abutment showing Freestanding Quartzite in Adit.

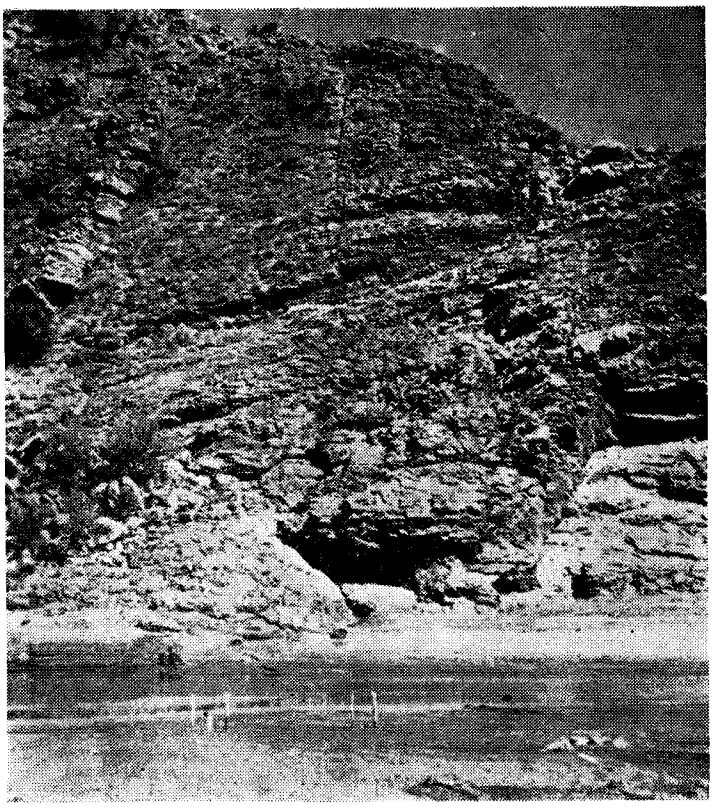

Fig. No. 18 West Abutment showing blocky jointing characteristics. Looking West.

*D.D.H. 16M.*

This is one of three short 30′ vertical holes laid out on the inlet side of the spillway.

It was drilled in broken, well-jointed ferruginous quartzite to a depth of 33′ 9″, the last 10 feet being in sandy material.

*D.D.H. 17M.*

This hole was drilled vertically to a depth of 30 feet. Quartzite rubble was intersected for the first fourteen feet whilst the remaining material recovered was of a soft sandy nature.

No core was recovered in the last 16 feet but when drilling mud was used to prevent caving a sludge was returned.

*D.D.H. 27M.*

This final hole was also vertical and 30′ deep and again a softer horizon was intersected from 1′ 4″ - 30′.

As this is anomalous to the surface mapping, it is recommended that a shallow 10 feet deep shaft be sunk in the vicinity of this hole, in order to examine the rock type *in situ.*

## CONCLUSIONS.

At the end of the 1961 field season a total of 27 drillholes and two adits had been completed in an investigation of the damsite, power station and spillway foundations.

Whilst the 1960 drilling went a long way towards confirming the surface mapping, the 1961 programme was designed to further confirm the strength of the rocks at depth, outline the subsurface contact between the two rock types which make up the geology of the area and test the subsurface geology along the line of the underground power station tunnel.

## WESTERN ABUTMENT.

The geological structure of the quartzite/phyllite contact has now been adequately outlined over all the area in the immediate vicinity of the proposed dam wall.

The rocks have been proved to be locally folded into a small monoclinal flexure. (See Plate No. XIII.) Surface mapping indicates that this flexure is the result of minor folding of the quartzite and phyllite during the period of deformation which gave rise to the large faults to the east.

This minor fold was further accentuated by small slips in the competent quartzites which failed under stress. The relatively incompetent phyllite further relieved this stress by the formation of complex folds and crenulations.

The strong joint and shear patterns which are so prominent throughout the abutment conform with those which would be expected to result from major fault movement to the east.

Considering the fact that the surface mapping has not revealed any large vertical displacement it should be noted that the presence of clay seams along shear planes could be indicative of horizontal movement. Plate VIII suggests that any such movement would be north-east side south.

A close examination of the adits did nothing to inspire confidence in the ability of the abutment to withstand great directional forces parallel to the river in the event of saturation of the brecciated clay filled zones mentioned above.

With the eventual rise in the water table on completion of the dam it will be important to assure that these shears are completely protected against water seepage.

It should also be noted that three other strong block forming joints exist which could be prone to movement if they became water logged and developed internal pressures.

The photograph below shows an example of river action and the resultant removal of quartzite blocks.

## RIVER BED

All the drill holes which explored the rock foundations below the main body of the proposed dam have indicated sound quartzite overlying phyllite.

The thinnest cover of quartzite over phyllite which could occur below the dam would be in the vicinity of 30 feet. This estimate is based on information provided by Public Works Department probing carried out some years previously together with drillhole information.

The drill hole intersections have shown that the phyllite/quartzite contact dips uniformly under the river and gives no indication of any faulting parallel to the river below its bed.

EASTERN ABUTMENT.

All the holes which have tested this abutment have been completed in sound quartzite, and on present dip information it is expected that the phyllite horizon will be present well below the level of any proposed excavations.

It should be noted that a horizon of thin bedded quartzite of variable thickness overlies the more massive variety. Should this rock be encountered in any large excavation it is considered that some additional treatment in the form of roof pinning and grouting would be necessary to improve the structural stability.

From the information contained in D.D.H. 23M it is definite that the underground power station tunnel will commence in loose talus material and weathered quartzite which can be expected to extend to a vertical depth of 50 feet.

In a horizontal direction 25 feet of poor ground is probable before reasonably free standing rock is encountered.

NORTHERN SPILLWAY.

The spillway outlet drillholes proved that whilst the bedrock is mainly thin bedded and highly jointed, it is sound enough for its intended purpose as a concrete covered overflow channel.

However, during construction particular attention will have to be given to an open set of joints which run parallel to the river along the edge of the cliff face.

The poor results obtained in diamond drillholes 13M, 25M and 14M drilled vertically along this cliff face must be related in part to the increased rock deterioration which would be normal under such conditions.

The spillway area has been subjected to minor faulting, but only one fault can be considered severe, that which occurs on the northern side, between the quartzite and the phyllite.

The intake section of the spillway is still not completely understood, but at the moment it must be assumed that softer material exists at shallow depths below at least a portion of the spillway.

As the rock type in this spillway has consistently proved to be thin bedded it is unlikely that any great quantity of suitable sized quartzite for rock fill would be available from this source.

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## EXAMINATION OF IRON ORE—POMPEYS PILLAR.

East Kimberley Division—Lat. 16° 14′ Long. 128° 20′

*By J. D. Wyatt, B.A.*

*Introduction.*

On completion of the 1961 field season in the East Kimberley Division, the writer spent a short time examining an occurrence of iron ore at Pompeys Pillar, over which a 50 square mile Temporary Reserve had been taken out by Messrs. Bell Bros.

*Location.*

Pompeys Pillar is located approximately ninety-seven miles south by road from Wyndham, and is reached by way of the Great Northern Highway to Halls Creek.

The deposit in question is then approached by travelling a further 5.2 miles east off the main road along the roughest of bush tracks, through granite boulder terrain to a point about one mile east-south-east of Pompeys Pillar itself.

From here, further approach by vehicle is impossible, and an additional one-and-a-half hours' walk is then necessary up an approximately 800 feet high slope (the last 200 feet being almost vertical) to the relatively flat plateau level on which the iron rich bed crops out. (See section and plan below.)

*Geology.*

The ore deposit consists of a hematitic sandstone bed, interbedded with other sandstone and shales of Proterozoic age, which strike approximately due north and dip 20° to the east. These rocks unconformably overlie granites and porphyries of the Lamboo Complex.

The hematitic sandstone bed forms a capping along a prominent escarpment and, at the point where specimens were collected, is exposed as a surface outcrop. However, to the north, the bed is overlain by sandstone and shales only a short distance back from the western edge of the plateau.

Whilst the plateau level is generally flat, stream erosion has taken place parallel to the strike forming gullies and, in some places, the 20° dip slope is exposed, forming a fairly rugged terrain.

The hematitic sandstone bed is approximately 30 feet thick, and the grade of ore appears to vary both in a vertical and lateral direction, the deposit varying from almost pure, fine-grained hematite, through sandy hematite to a limonitic surface capping.

*Size of Ore Body.*

The area covered by the report is centrally placed within the Temporary Reserve of 50 square miles and occupies a plateau some two miles long by one mile wide, but the hematite bed is not exposed over the whole of this area.

Overlying sediments cover the hematite horizon for varying distances up to the western edge of the escarpment.

Therefore any estimation of the available tonnage must be based on the assumption that the ore is of uniform thickness throughout its extent, namely 30 feet thick.

From an examination of specimen assay results, it can be assumed that there is an appreciable tonnage available for mining.

*Specimen Assay Results.*

Three specimens were collected for assay purposes from the best accessible section through the hematitic sandstone bed.

Sample No. 6218 was taken from the surface and showed some limonite; Specimen No. 6220 was taken from the middle of the bed and contained an appreciable amount of silica in the form of sand grains, and Specimen 6221 was taken from the base of the bed and was almost pure hematite.

From the above it must not be assumed that the base of the bed consistently contains good ore. Surface indications are that the best ore is lenticular within the hematite bed itself.


G. S. W. A.

## DIAGRAMMATIC SKETCH PLAN

SHOWING GEOLOGY, REGIONAL FAULTING AND STRUCTURE

IN VICINITY OF

## ORD RIVER MAIN DAMSITE

EAST KIMBERLEY

Scale : Approx. 60 chains to 1 inch

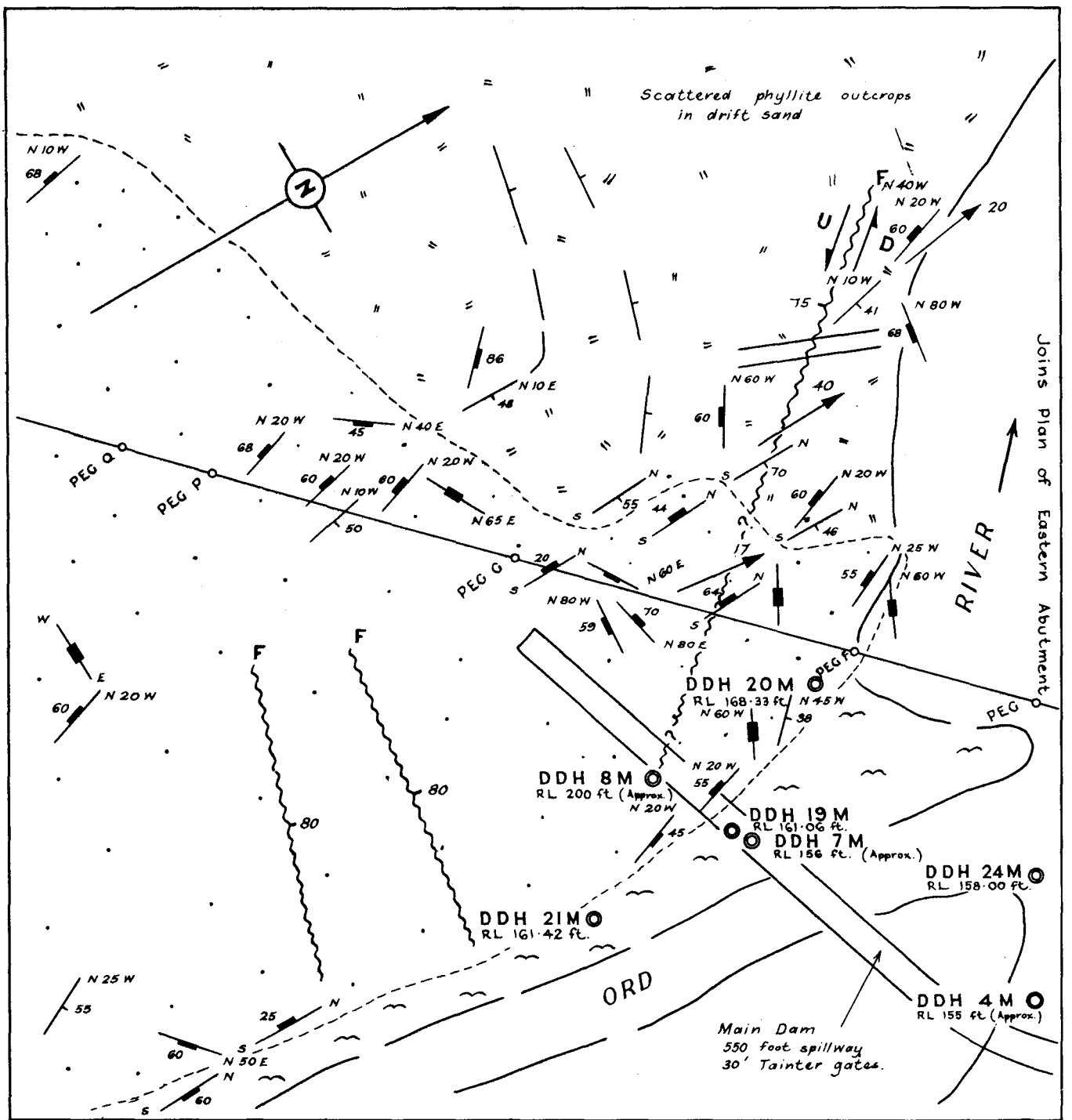
REFERENCE

| | |
|---|---|
| P | Proterozoic quartzites and phyllites |
| AGr | Archean granite |
| W | Archean metamorphics |

LEGEND

| | |
|---|---|
| F | Fault |
| | Shear |
| | Low angle fault |
| Q | Quartz shear |
| | Structure lines |

PLATE VIII




## REFERENCE

- Quartzite
- Phyllite
- Observed geological boundary
- Assumed geological boundary
- Dip and strike of jointing
- Dip and strike of bedding
- Horizontal bedding
- Shear or Fault
- Thrust
- Quartz veinlets
- DDH's (with RL's)

G. S. W. A.

# GEOLOGICAL PLAN

OF

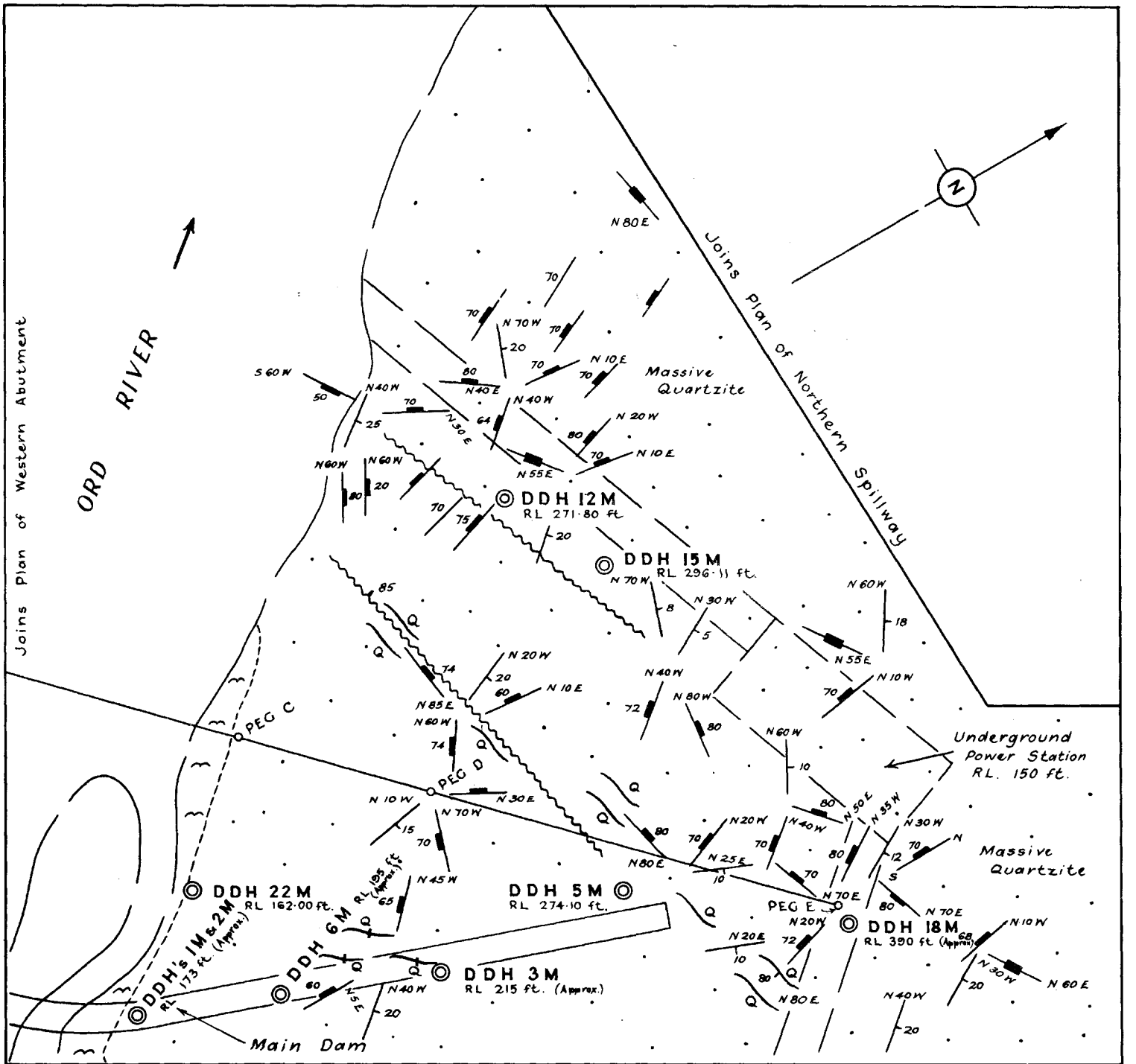
# WESTERN ABUTMENT

# ORD RIVER MAIN DAMSITE

SCALE : 150 FEET TO 1 INCH

150 0 150 300

DATE : JAN. 1962




## REFERENCE

- Quartzite
- Phyllite
- Observed geological boundary
- Assumed geological boundary
- Dip and strike of jointing
- Dip and strike of bedding
- Horizontal bedding
- Shear or fault
- Thrust
- Quartz veinlets
- DDH's (with RL's)

G. S. W. A.

# GEOLOGICAL PLAN
OF
# EASTERN ABUTMENT
# ORD RIVER MAIN DAMSITE

SCALE : 150 FEET TO 1 INCH

150 0 150 300

DATE : JAN. 1962

ORD RIVER

DDH 13M N°3
RL 295·99 ft.

DDH 13M N°s 1 & 2
RL 306·14 ft.

DDH 25M
RL 333·55 ft.

Interbedded massive and platy quartzite

Rubble covered

Massive jointed quartzite

Slickensiding

Massive jointed quartzite

Northern Spillway
800 foot Entry. RL. 290'
Grade 1 in 60
Ungated crest

Platy quartzite with phyllite bands.

DDH 14M
RL 372·55 ft.

DDH 9M
RL 439·77 ft.

Interbedded, massive and platy quartzite

Quartzite rubble

Blocky massive quartzite

DDH 27M
RL 296·09 ft.

Massive quartzite

Massive quartzite

Platy quartzite rubble

DDH 17M
RL 243·70 ft.

Joins plan of Eastern Abutment

Quartzite rubble

Rubble

Phyllite

DDH 16M
RL 279·96 ft.

Quartzite rubble

## REFERENCE

| | |
|---|---|
| Quartzite | Observed geological boundary |
| Phyllite | Assumed geological boundary |
| Quartz veinlets | Dip and strike of jointing |
| Thrust | Dip and strike of bedding |
| Shear or fault | Horizontal bedding |
| | DDH's (with RL's) |

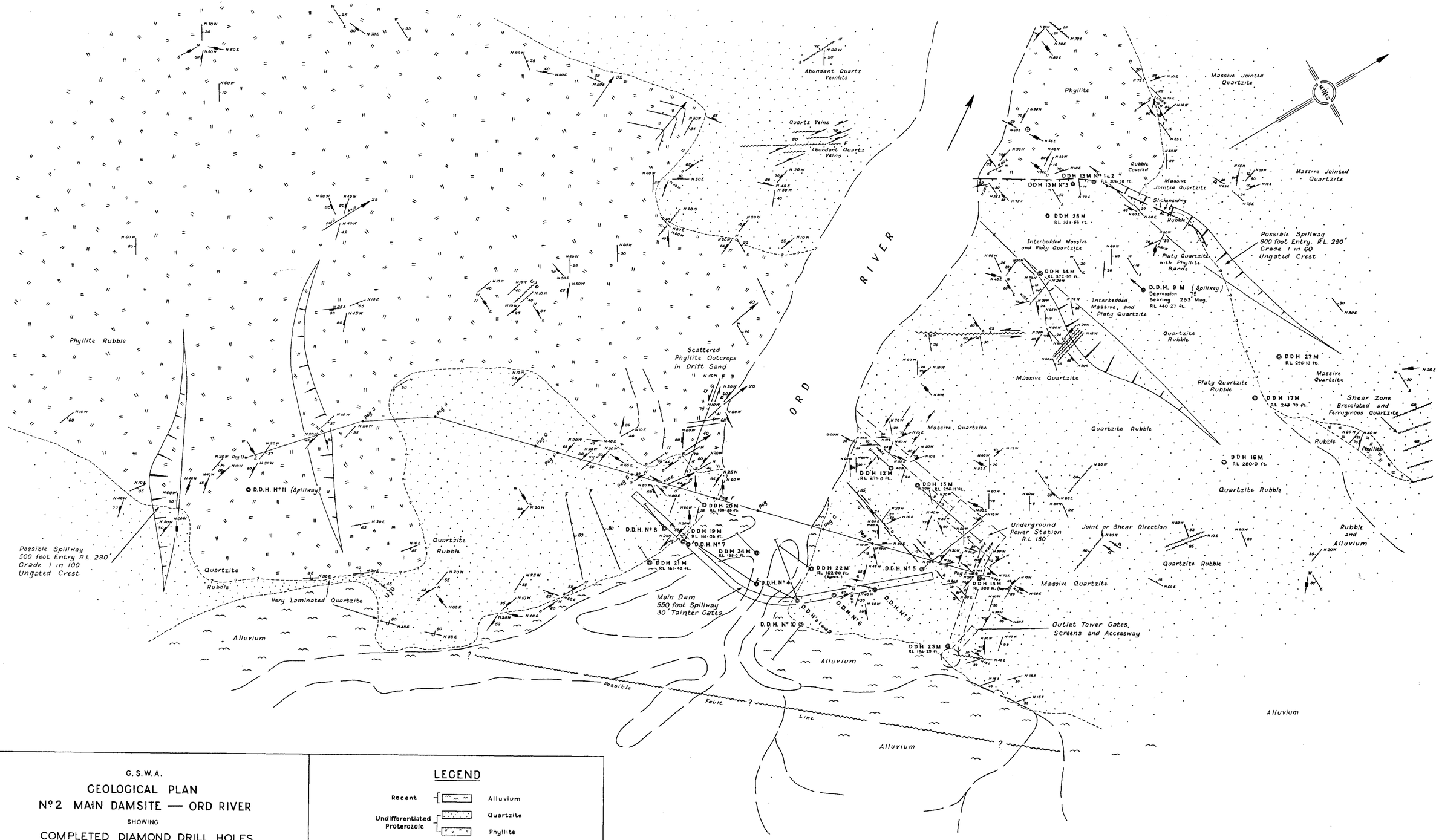
G. S. W. A.

# GEOLOGICAL PLAN
OF
# NORTHERN SPILLWAY
# ORD RIVER MAIN DAMSITE

SCALE : 150 FEET TO 1 INCH

150 0 150 300

DATE : JAN. 1962




G.S.W.A.

# GEOLOGICAL PLAN
# Nº2 MAIN DAMSITE — ORD RIVER

SHOWING

## COMPLETED DIAMOND DRILL HOLES

KIMBERLEY GOLDFIELD

SCALE : 200 FEET TO AN INCH

100 0 100 200 300 400 500

Base sheet from P.W.D. Contour Plan 34959
Plane Table and Telescopic Alidade Survey by J. D. Wyatt and A.J. Smith
May – June 1960, and 1861.

## LEGEND

Recent — Alluvium

Undifferentiated Proterozoic — Quartzite

Undifferentiated Proterozoic — Phyllite

- Observed or intersected geological boundary.
- ?-?-? Assumed geological boundary.
- Dip and strike jointing.
- Dip and strike bedding.
- Horizontal bedding.
- Dip and strike of overturned bedding.
- Shear or fault.
- Quartz veinlets.
- Direction and plunge of folds.
- Direction and dip of drillholes.
- Thrust.

G. S. W. A.

# STRUCTURE CONTOUR MAP

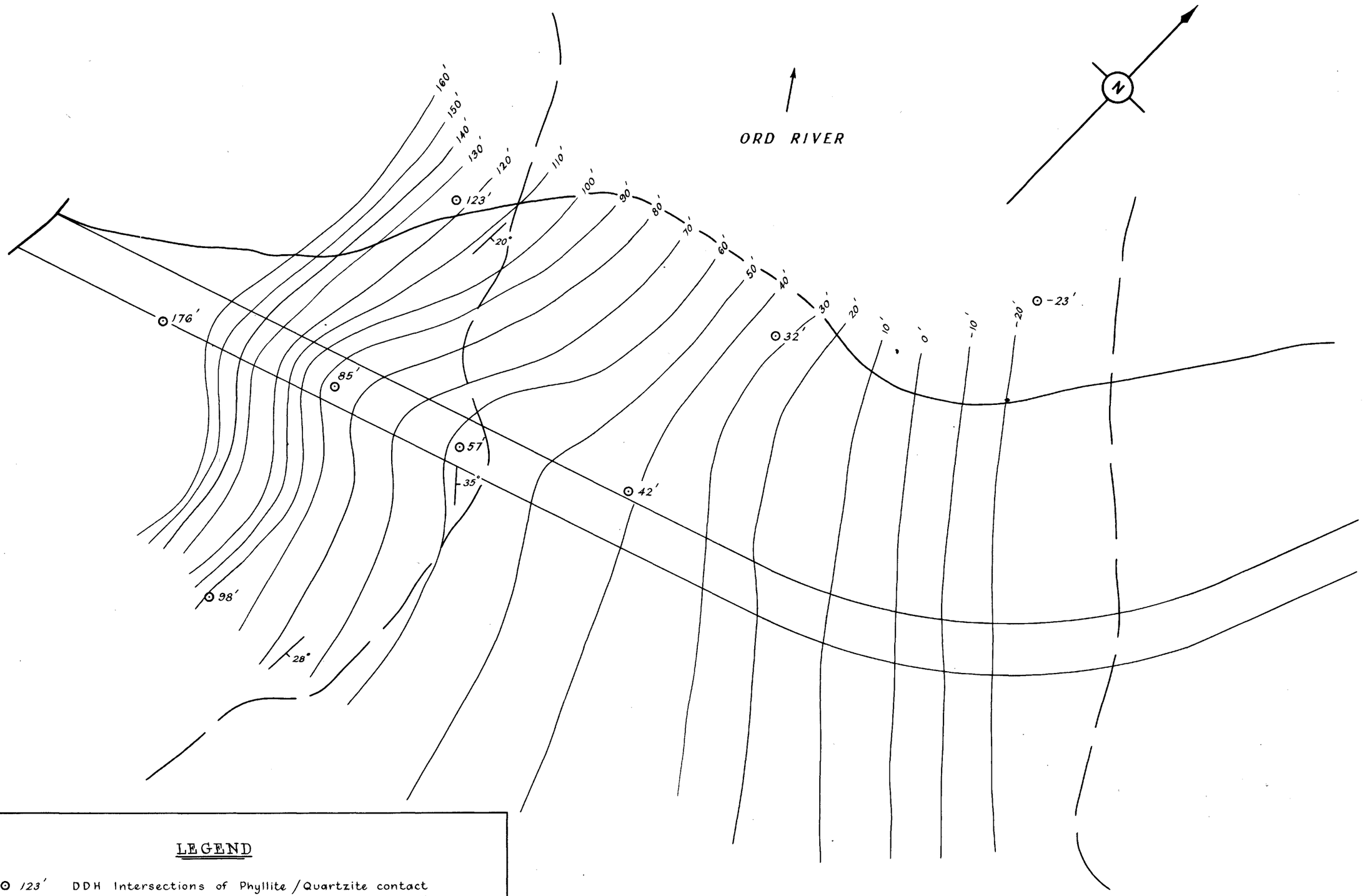
## ORD RIVER MAIN DAMSITE

SHOWING

PROBABLE POSITION OF PHYLLITE / QUARTZITE CONTACT

KIMBERLEY G.F.

Scale : 40 feet to 1 inch




## LEGEND

⊙ 123' DDH Intersections of Phyllite / Quartzite contact

10' Structure contour [ Heights are taken from P.W.D. plan 34959 and are related to sea level. ]

G. S. W. A.

# CROSS SECTION THROUGH D.D.H's 7M, 8M, 19M and 26M.

LOOKING NORTH — SECTION BEARS 260° Mag.

## ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY C. F.

Scale : 1 inch to 20 feet.

Prepared by J.D. Wyatt, Aug. 1961

## LEGEND

- Quartzite
- Phyllite
- S — Shear
- Fault zone
- W — Joint (W – Water Bearing)
- Q — Quartz vein
- W.L. — Water loss

NOTE :- Only representative jointing shown on D.D.H's.

W

?

Very prominent joint and shear pattern.

D.D.H. 8M 1960

Strongly jointed and sheared quartzite
[Joints fairly open and shears filled with puggy clay]

95'6"

55°

26M ABANDONED

D.D.H. 19 M
Vertical Hole, R.L. 162·09 ft.

ORD RIVER

Silt and river shingle

0-38'0" Numerous quartz veinlets

Bedding

D.D.H. 7M 1960

Open jointed quartzite

Grey Phyllite

113'0"

Massive fairly tight jointed non ferruginous quartzite

Black phyllite, contorted, strongly cleaved and injected with quartz veinlets.

Grey Phyllite

111'3"

?

?

?

## PLAN IN VICINITY OF D.D.H's 7M, 8M AND 9M

Showing Relationship Between Bedding And Jointing.

Scale : 1 inch to 50 feet.

N

43°

50°

50°

50°

47°

Quartzite.

45°

60°

40°

N 45° W

45°

46°

50°

8M
Dep. -25° Bearing 263° Mg.

60°

36°

N 55° E.

7 M Dep. -52° Bearing 260° Mg.
19 M Vertical

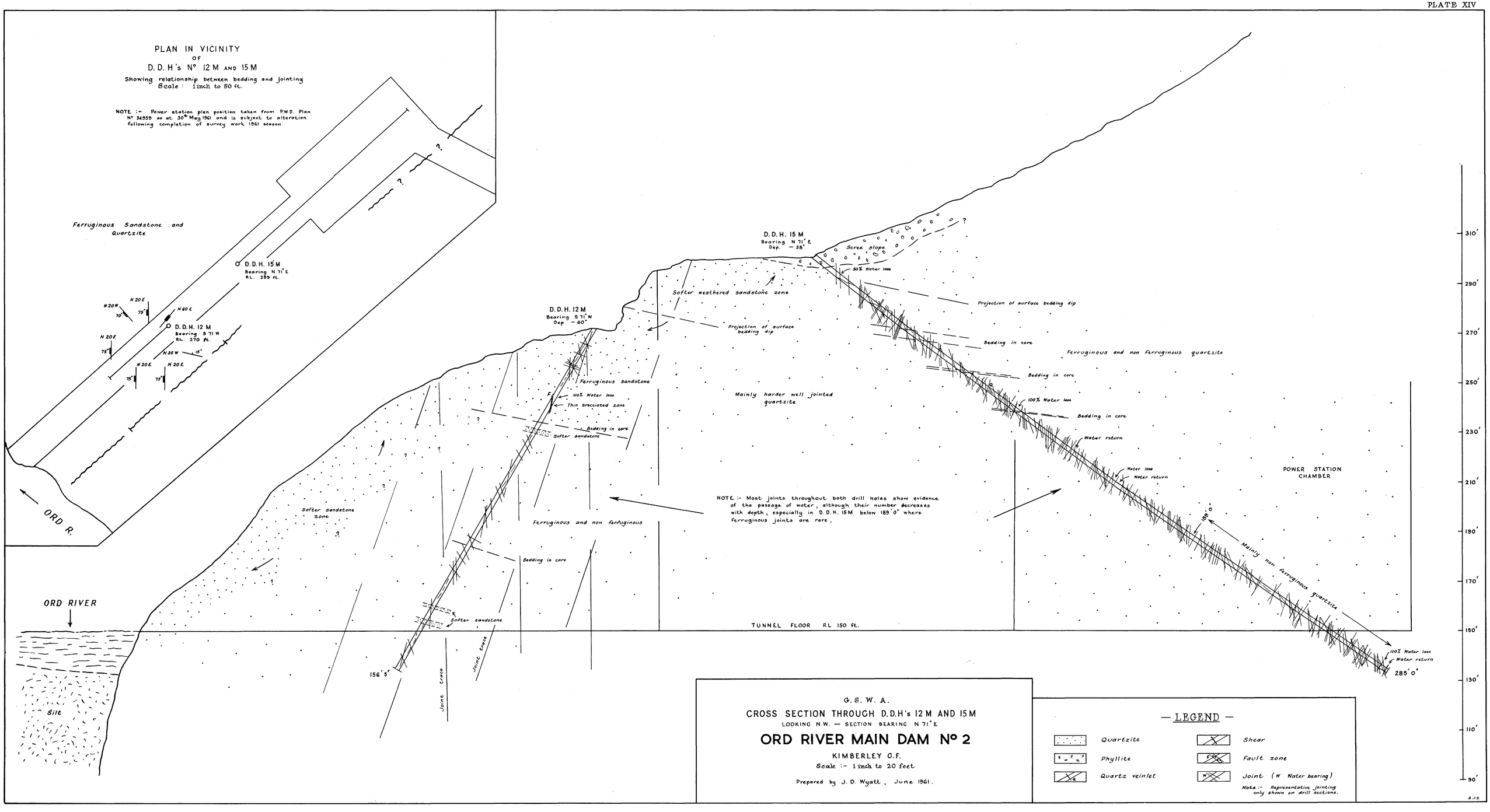
55°

Very strong joint and shear direction.

N 15° W

45°

N 60° W


PLAN IN VICINITY
OF
D. D. H's Nº 12 M AND 15 M
Showing relationship between bedding and jointing
Scale : 1inch to 50 ft.
NOTE :- Power station plan position taken from P.W.D. Plan Nº 34559 as at 30th May 1961 and is subject to alteration following completion of survey work 1961 season.
Ferruginous Sandstone and Quartzite
D.D.H. 15 M
Bearing N 71° E
RL. 259 ft.
D.D.H. 12 M
Bearing S 71 W
RL. 270 ft.
N 20W 70°
N 20 E 75°
N 60 E
N 20 E 75°
N 35 W 15°
N 20 E 75°
N 20 E 75°
ORD R.
D.D.H. 15 M
Bearing N 71° E
Dep. — 38°
Scree slope
50% Water loss
Softer weathered sandstone zone
Projection of surface bedding dip
D.D.H. 12 M
Bearing S 71° W
Dep. — 90°
Projection of surface bedding dip
Bedding in core
Ferruginous and non ferruginous quartzite
Bedding in core
Ferruginous sandstone
100% Water loss
Thin brecciated zone
Mainly harder well jointed quartzite
100% Water loss
Bedding in core
Softer sandstone
Water return
Water loss
Water return
POWER STATION CHAMBER
Softer sandstone zone
NOTE :- Most joints throughout both drill holes show evidence of the passage of water, although their number decreases with depth, especially in D.D.H. 15M below 189'0" where ferruginous joints are rare.
189'0"
Ferruginous and non ferruginous
Bedding in core
Mainly non ferruginous quartzite
ORD RIVER
Softer sandstone
TUNNEL FLOOR RL 150 ft.
100% Water loss
Water return
285'0"
156'5"
Joint trace
Joint trace
Silt
310'
290'
270'
250'
230'
210'
190'
170'
150'
130'
110'
90'
G. S. W. A.
CROSS SECTION THROUGH D.D.H's 12 M AND 15 M
LOOKING N.W. — SECTION BEARING N 71° E.
ORD RIVER MAIN DAM Nº 2
KIMBERLEY G.F.
Scale :- 1inch to 20 feet
Prepared by J. D. Wyatt, June 1961.
— LEGEND —
Quartzite
Phyllite
Quartz veinlet
Shear
Fault zone
Joint (W Water bearing)
Note :- Representative jointing only shown on drill sections.
A.J.S.

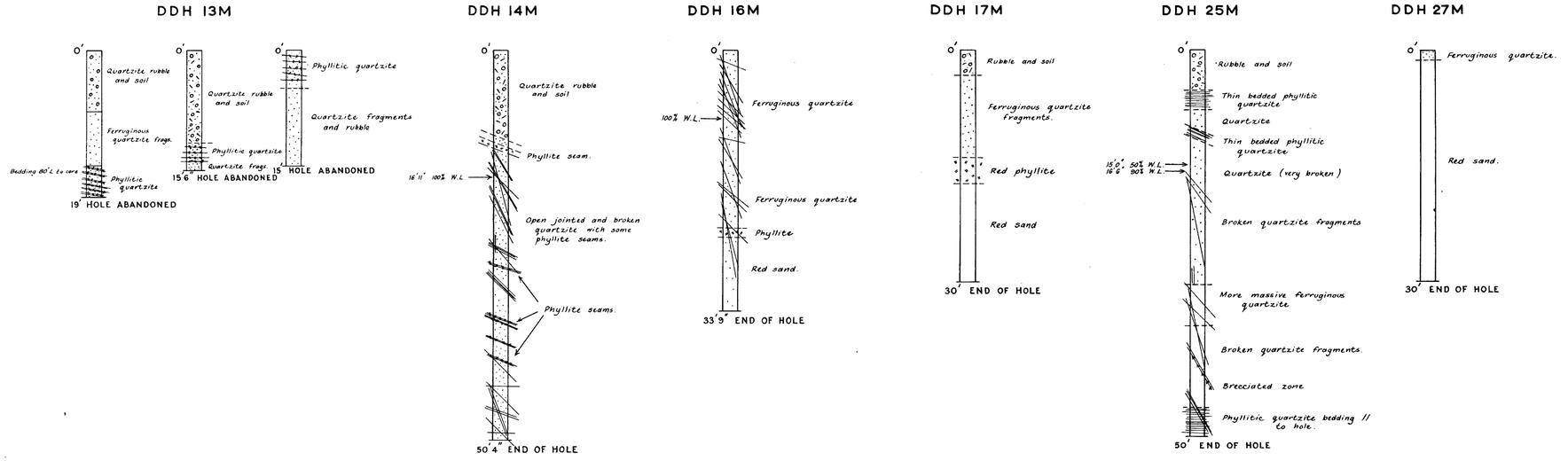
G. S. W. A.

# ORD RIVER MAIN DAMSITE Nº 2

## CROSS SECTION THROUGH D.D.H's 13M, 14M, 16M, 17M, 25M, 27M.

KIMBERLEY G. F

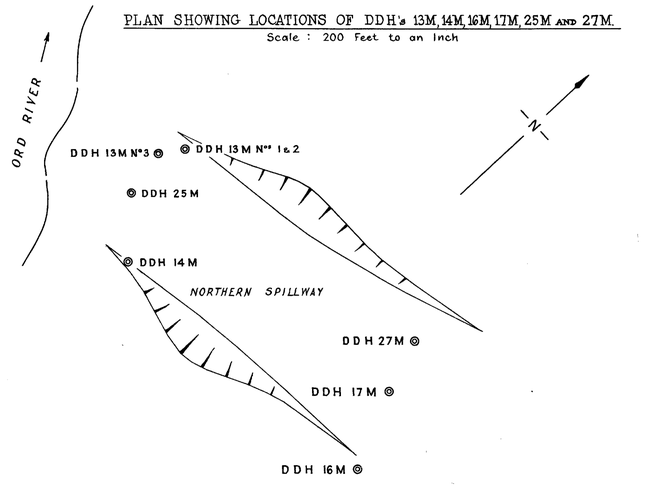
Scale : 10 Feet to an inch




Prepared by J. Wyatt Sept. 1961.

## PLAN SHOWING LOCATIONS OF DDH's 13M, 14M, 16M, 17M, 25M AND 27M.

Scale : 200 Feet to an Inch



G.S.W.A.

# CROSS SECTION THROUGH D.D.H's 18 M AND 23 M

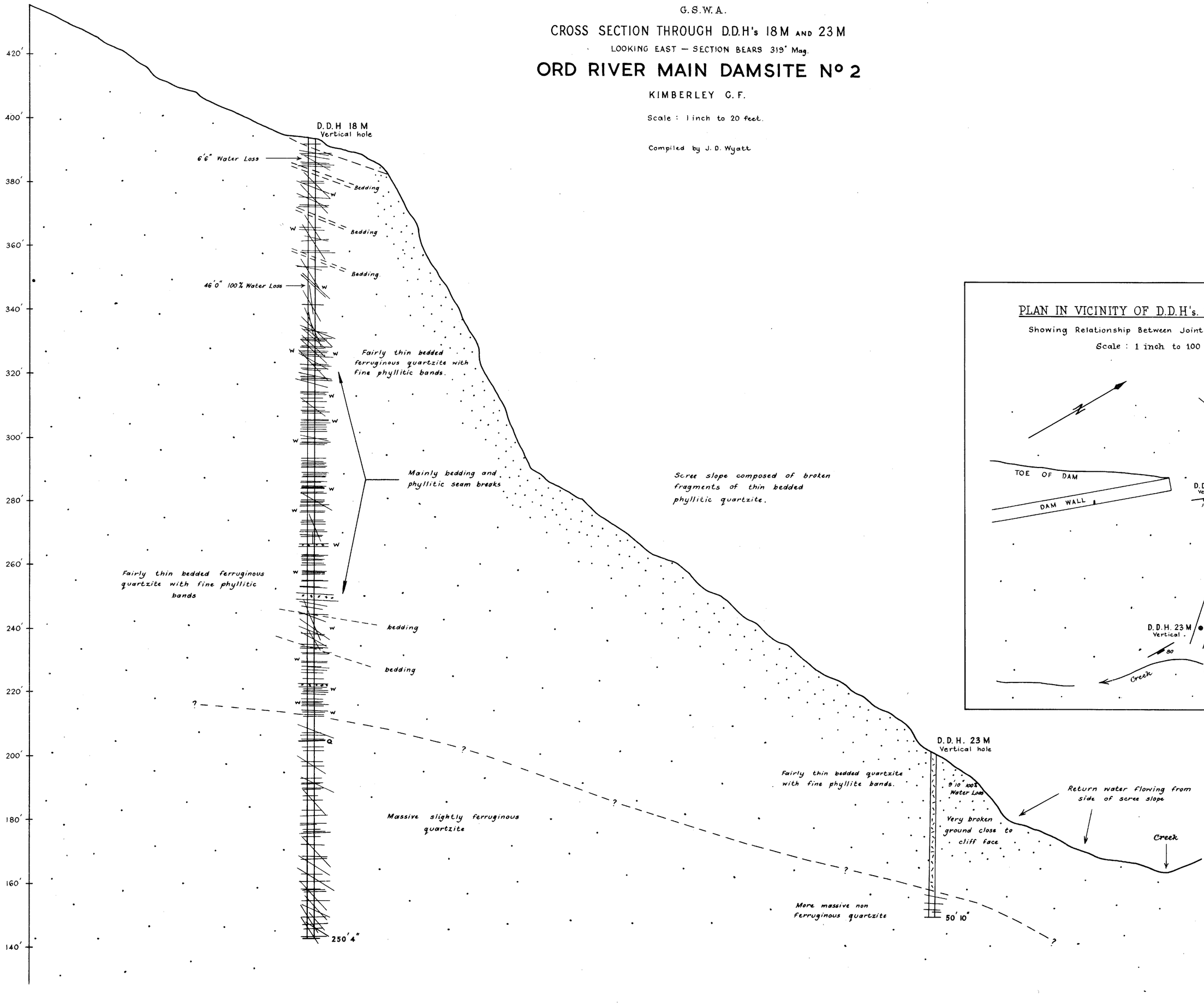
LOOKING EAST — SECTION BEARS 319° Mag.

# ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY C. F.

Scale : 1 inch to 20 feet.

Compiled by J. D. Wyatt




## PLAN IN VICINITY OF D.D.H's. 18 M AND 23 M

Showing Relationship Between Jointing and Bedding

Scale : 1 inch to 100 feet

D.D.H. 20 M
Bearing 246° Mag.
Dep. −58°, R.L. 168·44 ft.

D.D.H. 24 M
Bearing 251° Mag., Dep. −60°
D.D.H. projected 10 ft. N.W. onto section line.

D.D.H. 22 M
Bearing 242° Mag., Dep. −58°
D.D.H. projected 44 ft. S.E. onto section line.

Water return to surface

River sand and shingle

Open jointed slightly ferruginous quartzite

Grey phyllite with quartzite lenses

54·6'

Black phyllite strongly cleaved and contorted

Joint

Strongest joint trace

More massive non ferruginous quartzite

Black phyllite showing strong cleavage

152'

Grey phyllite with numerous quartz lenses

Black phyllite strongly cleaved with some quartz veinlets and pyrite.

218'

100% Water loss

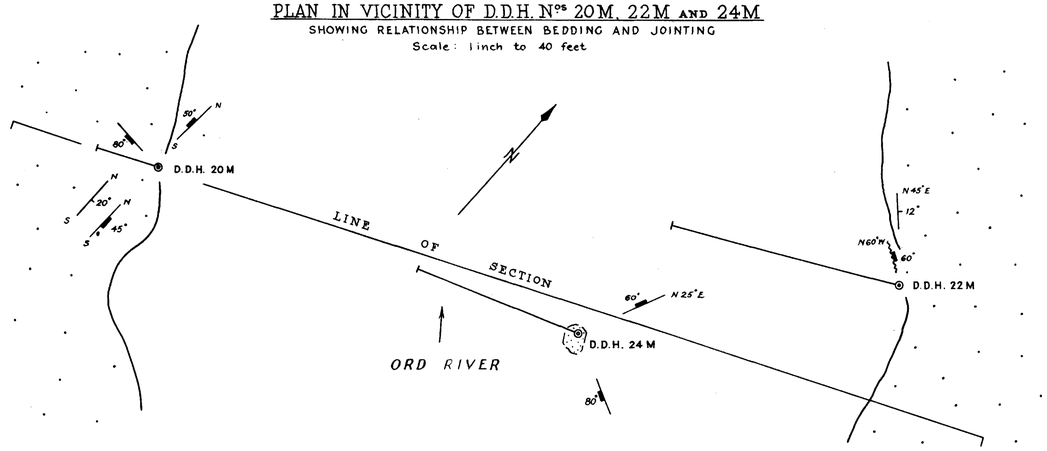
50% Water loss

Bedding

## PLAN IN VICINITY OF D.D.H. Nos 20M, 22M AND 24M

SHOWING RELATIONSHIP BETWEEN BEDDING AND JOINTING

Scale: 1 inch to 40 feet




G. S. W. A.

## CROSS SECTION THROUGH D.D.H's 20M, 22M AND 24M

LOOKING NORTH WEST — SECTION BEARS 246° Mag.

ORD RIVER MAIN DAMSITE N° 2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. D. Wyatt, Aug. '61.

G. S. W. A.

# CROSS SECTION THROUGH D.D.H. 21 M

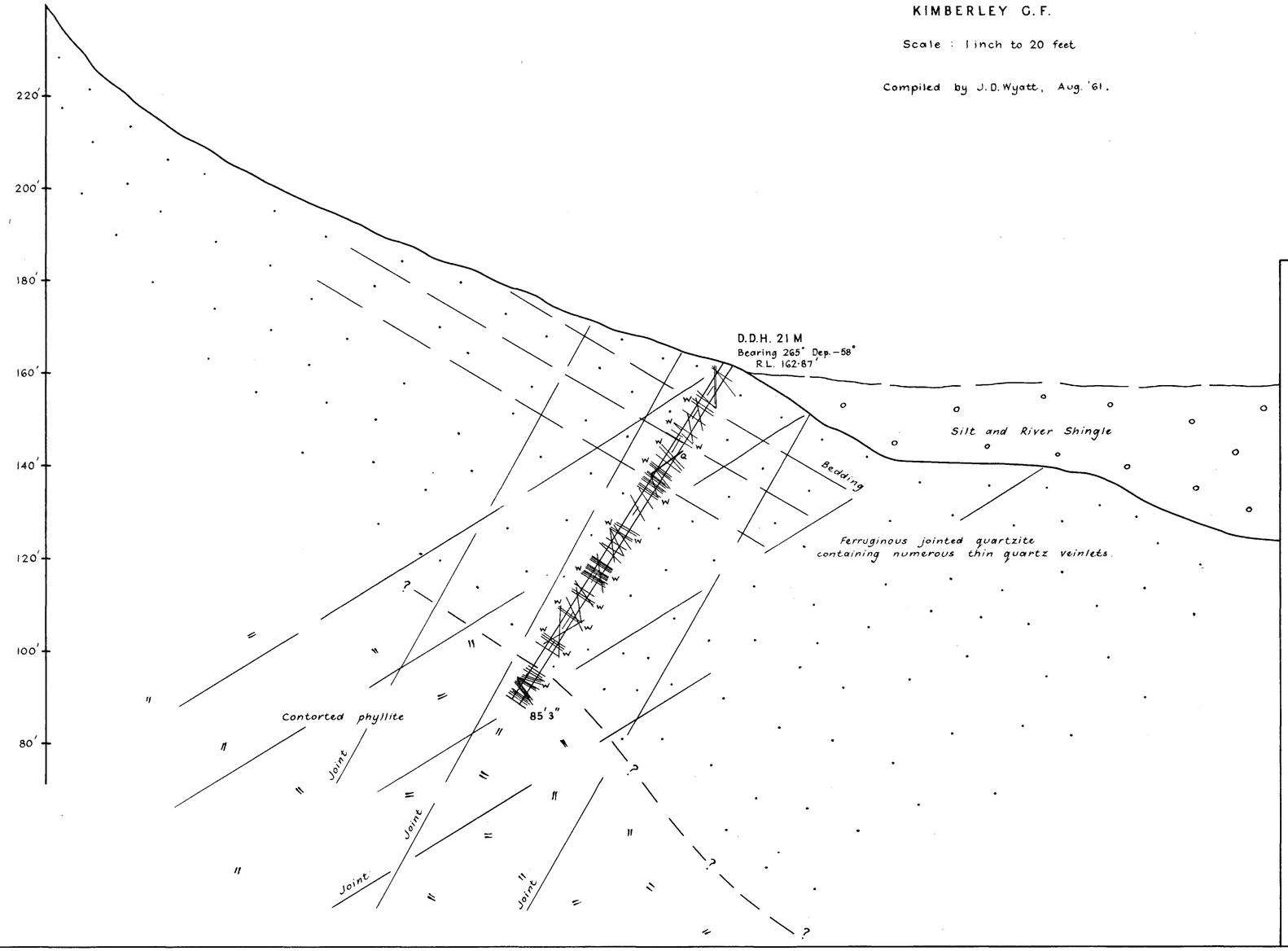
LOOKING NORTH WEST — SECTION BEARS 265° Mag.

# ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G. F.

Scale : 1 inch to 20 feet

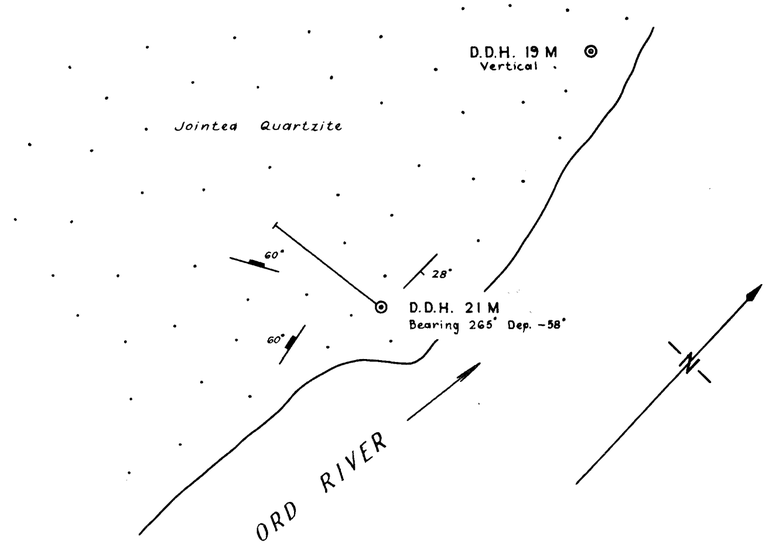
Compiled by J. D. Wyatt, Aug. '61.




## PLAN IN VICINITY OF D.D.H. Nº 21M

SHOWING RELATIONSHIP BETWEEN BEDDING AND JOINTING

Scale : 1 inch to 40 feet



G. S. W. A.

# ORD RIVER MAIN DAM Nº 2 SITE

KIMBERLEY G.F.

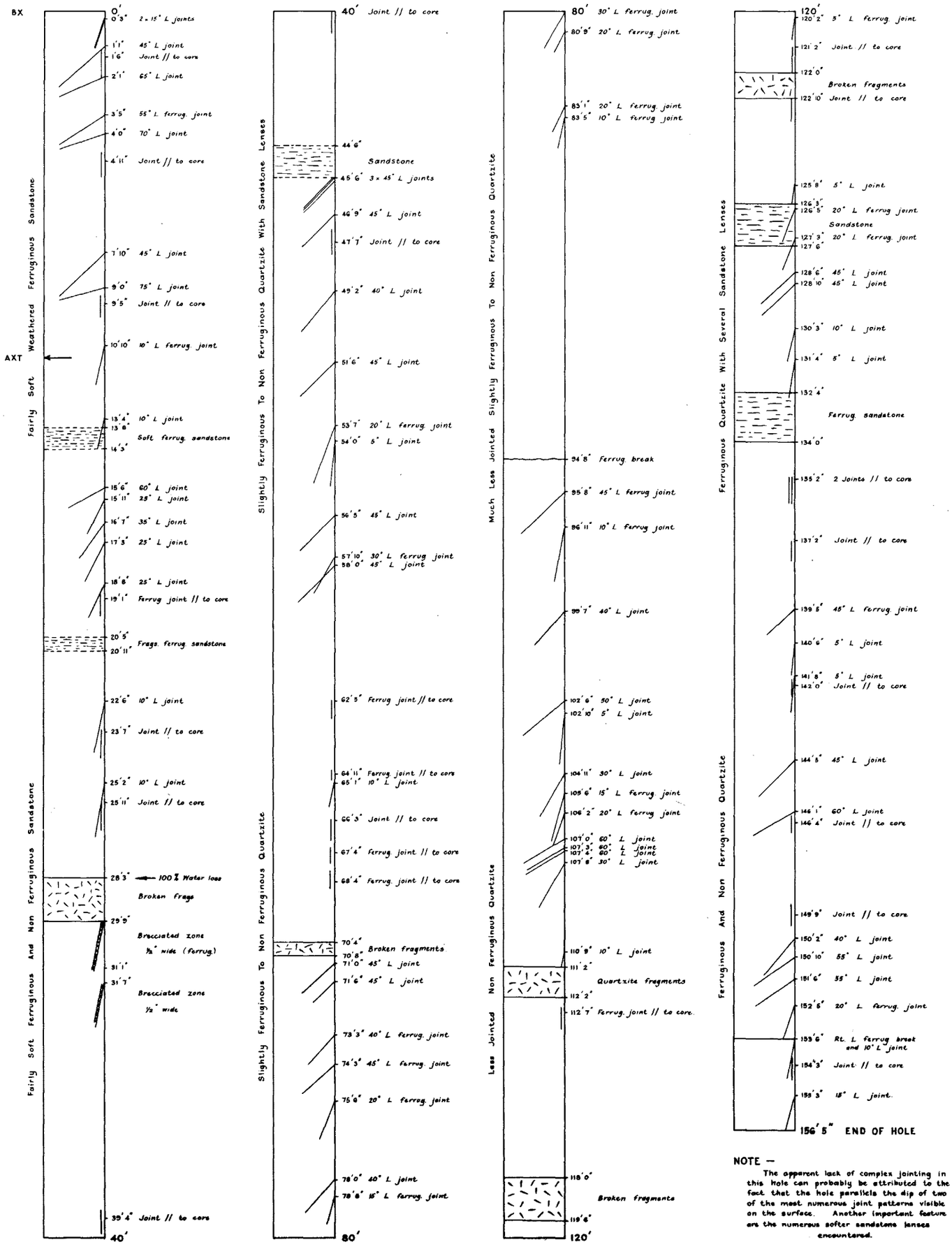
## COLUMN LOG D.D.H. 12 M

BEARING S 71° W Mag., LENGTH 156'5"
ANGLE OF DEP. −60°

COMMENCED 3·6·61 COMPLETED 15·6·61

**SCALE :- 1 INCH TO 4 FEET**

MACHINE E 1000




**NOTE —**

The apparent lack of complex jointing in this hole can probably be attributed to the fact that the hole parallels the dip of two of the most numerous joint patterns visible on the surface. Another important feature are the numerous softer sandstone lenses encountered.

G. S. W. A.

# ORD RIVER MAIN DAM Nº 2 SITE

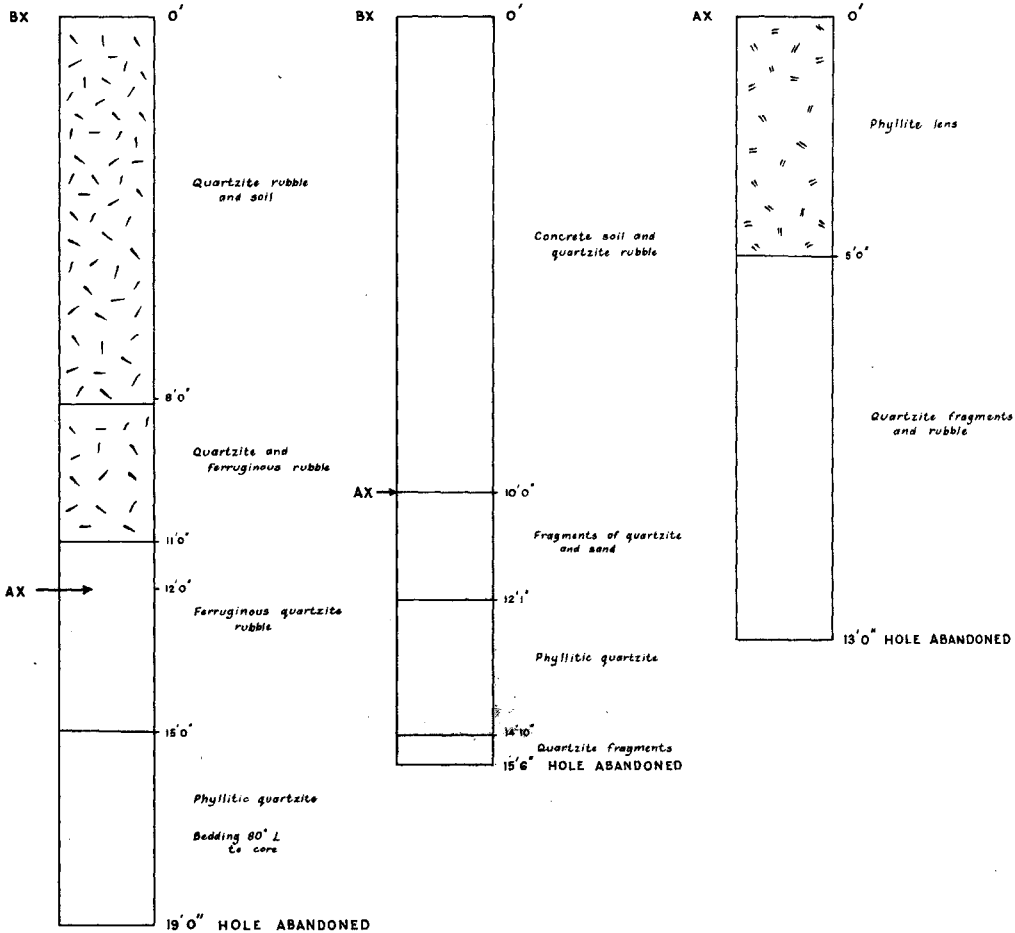
KIMBERLEY G. F.

## COLUMN LOG D.D.H. 13 M

3 VERTICAL HOLES

COMMENCED 9.6.61 , ABANDONED 15.6.61 , LENGTH 19'0"
COMMENCED 21.6.61 , ABANDONED 28.6.61 , LENGTH 15'6"
COMMENCED 28.6.61 , ABANDONED 30.6.61 , LENGTH 15'0"

SCALE : 1 INCH TO 4 FEET



G. S. W. A.

# ORD RIVER MAIN DAM Nº 2 SITE

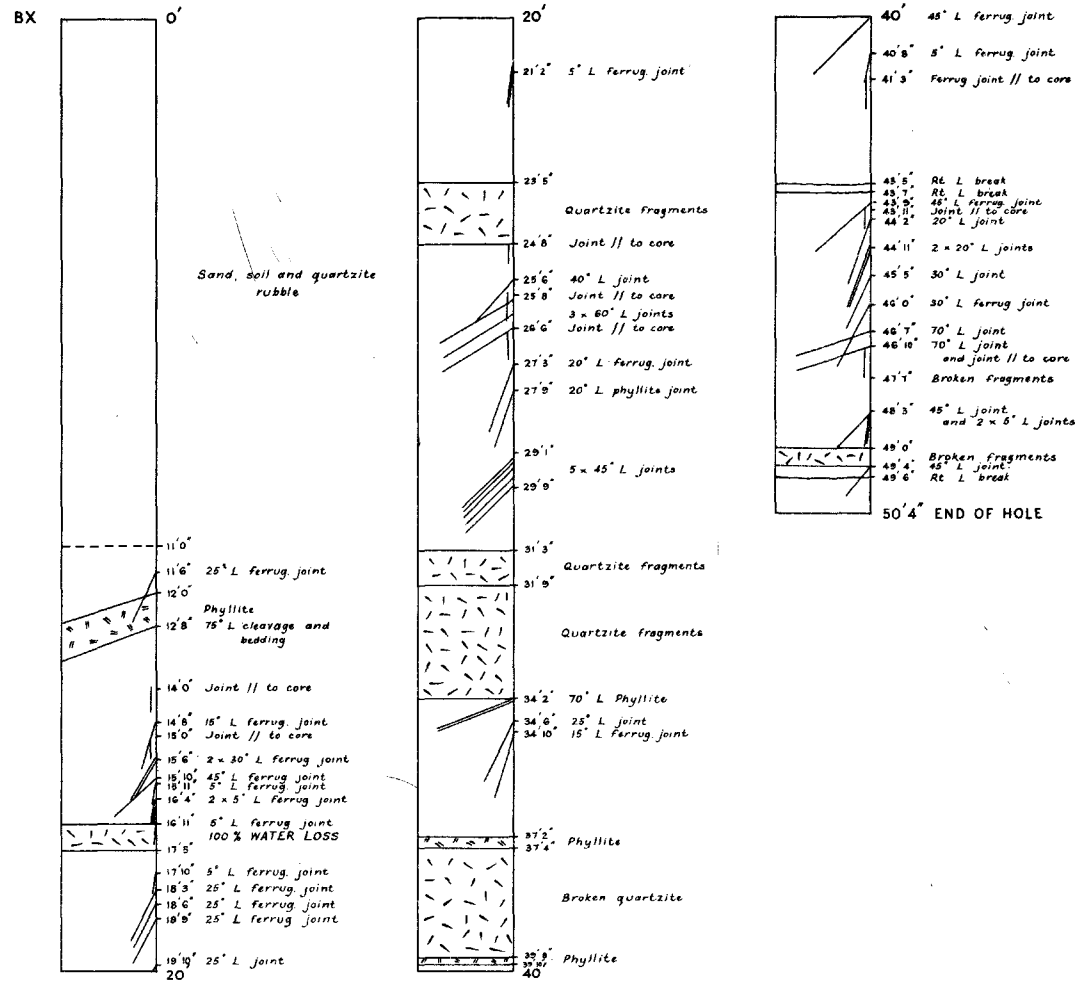
KIMBERLEY G. F.

## COLUMN LOG D.D.H. 14 M

VERTICAL HOLE LENGTH 50'4"

COMMENCED 15·6·61 COMPLETED 20·6·61

SCALE : 1 INCH TO 4 FEET



G. S. W. A.

# ORD RIVER MAIN DAM Nº 2 SITE

KIMBERLEY G.F.

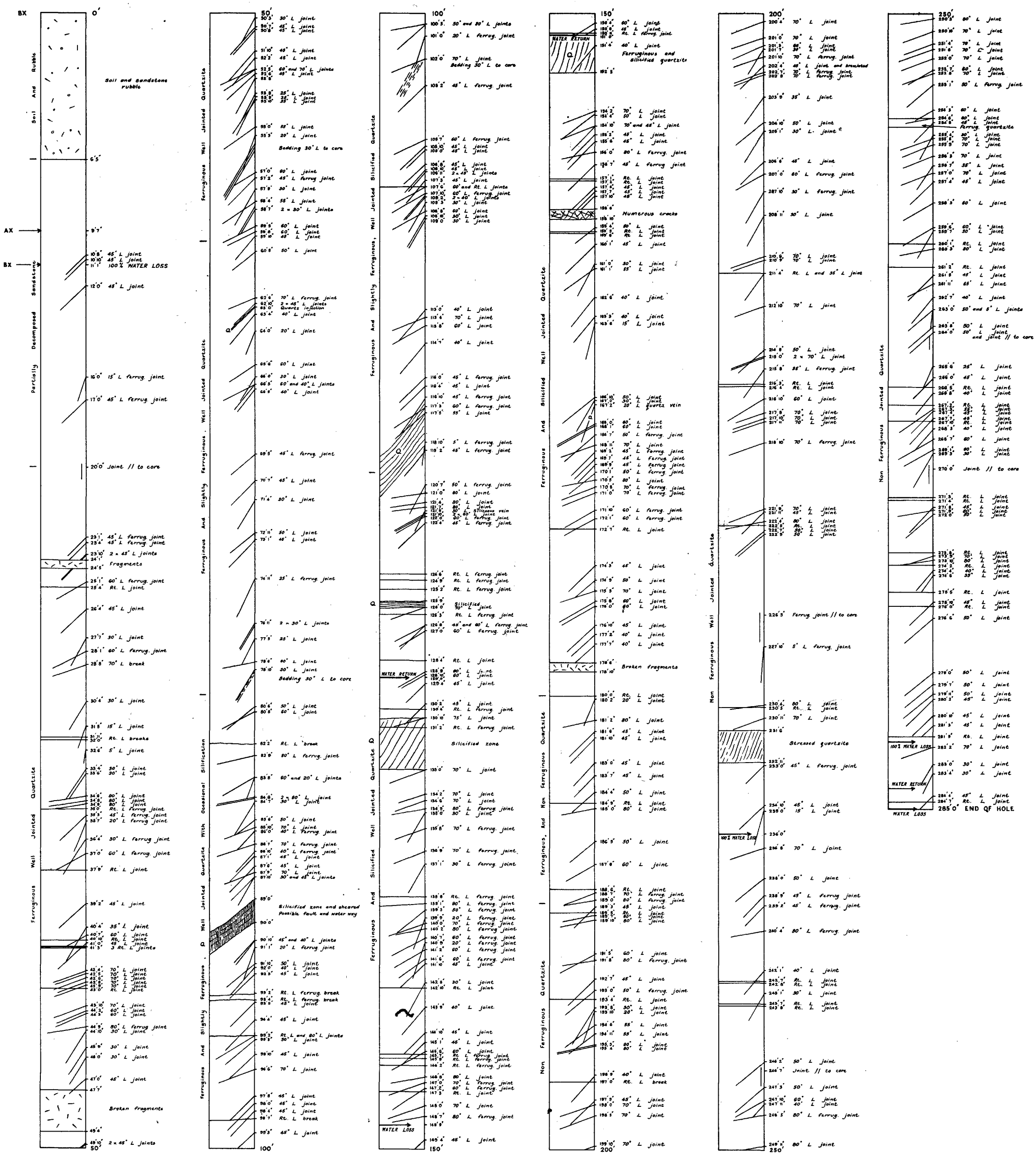
## COLUMN LOG D.D.H. 15M

BEARING N 71° E DEPRESSION – 38°

LENGTH 285' 0"

COMMENCED 21. 6. 61 COMPLETED 12. 7. 61

SCALE 1 INCH TO 4 FEET



G. S. W. A.

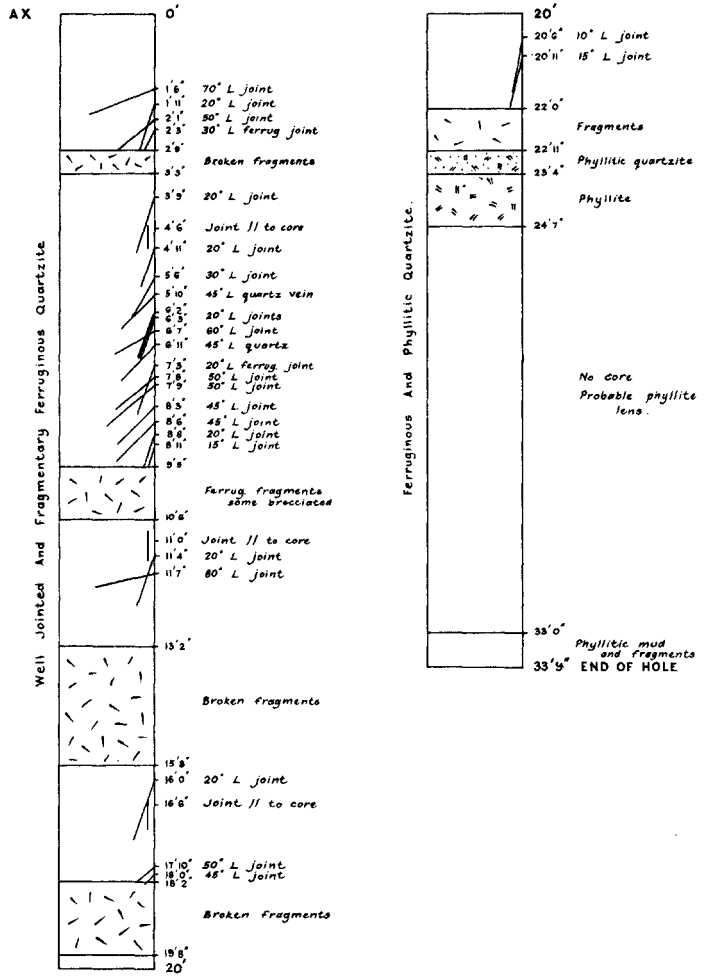
# ORD RIVER MAIN DAM Nº 2 SITE

KIMBERLEY G. F.

## COLUMN LOG D.D.H. 16M

VERTICAL HOLE LENGTH 33'9"
COMMENCED 2·7·61 COMPLETED 6·7·61

SCALE : 1 INCH TO 4 FEET



G. S. W. A.

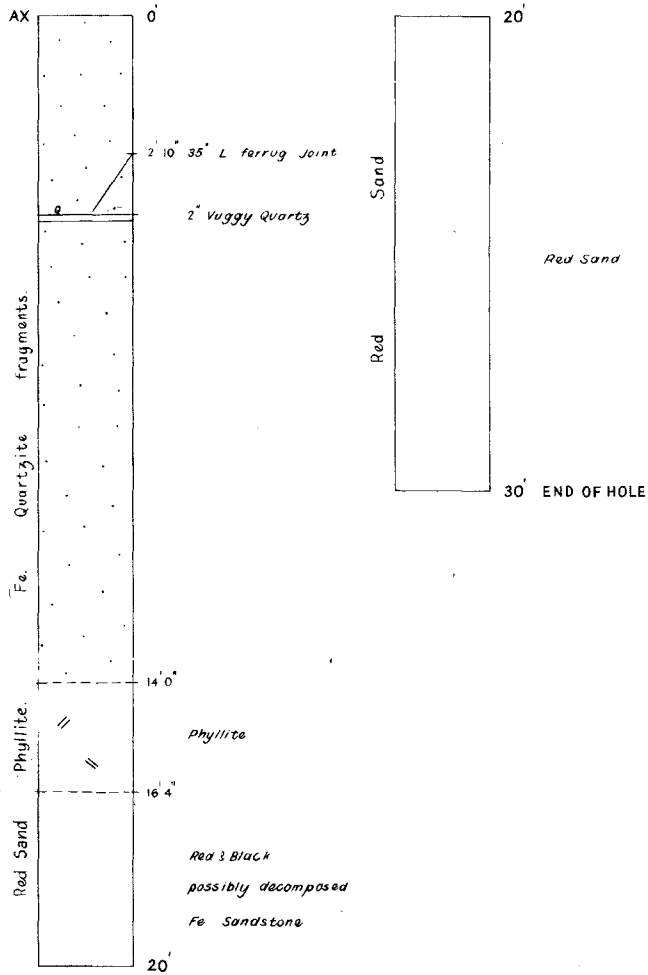
# ORD RIVER MAIN DAM Nº2 SITE

KIMBERLEY G. F.

## COLUMN LOG D.D.H. 17 M

VERTICAL HOLE LENGTH 30'0"
COMMENCED 4.9.61 COMPLETED 13.9.61

SCALE : 1 INCH TO 4 FEET



G.S.W.A.

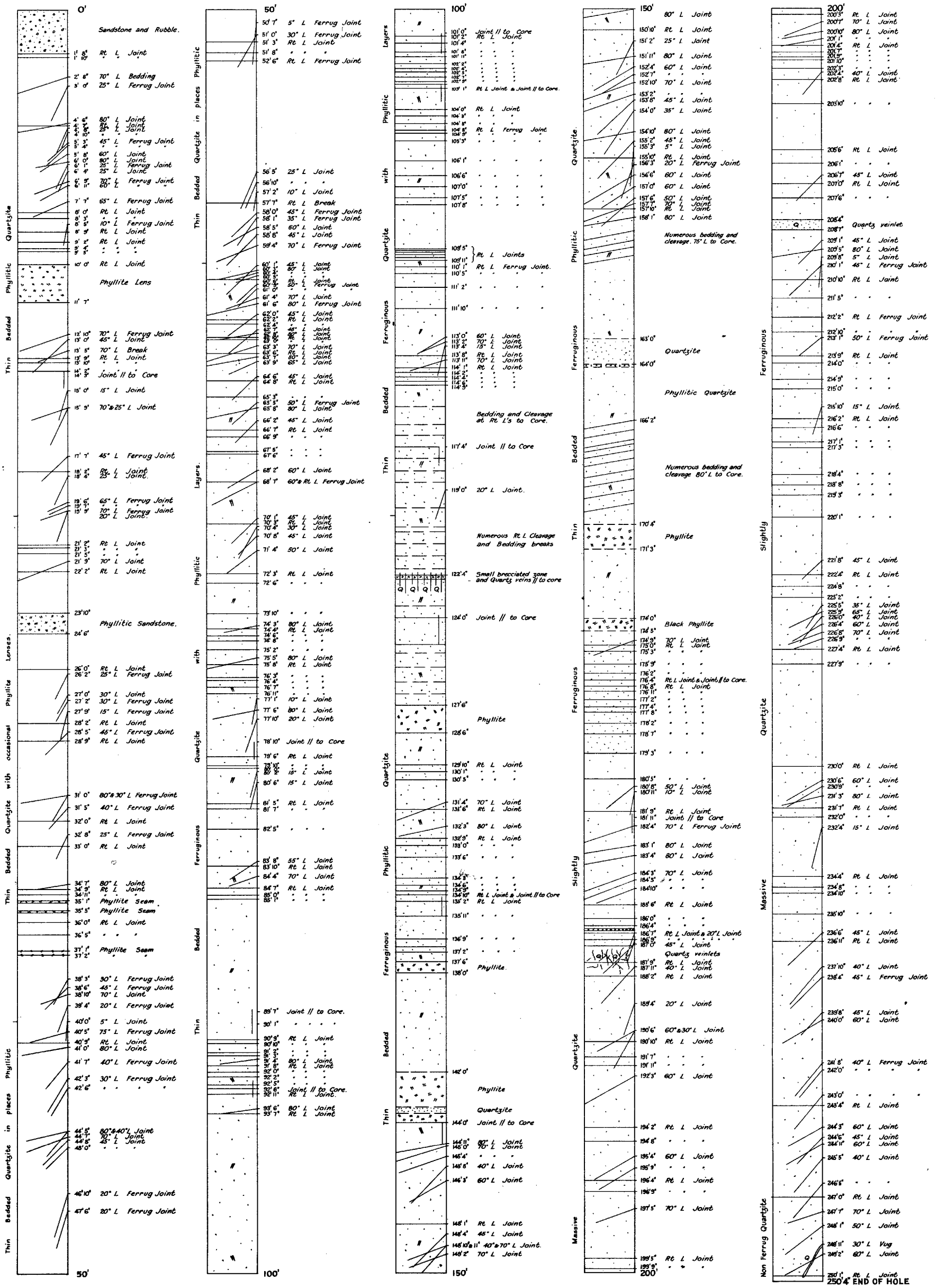
# ORD RIVER MAIN DAM Nº 2 SITE

KIMBERLEY G.F.

## COLUMN LOG D.D.H. 18M

VERTICAL HOLE LENGTH 250'4"
COMMENCED 19.7.61 COMPLETED 3.8.61.

SCALE : 1 INCH TO 4 FEET



G. S. W. A.

# ORD RIVER MAIN DAM Nº 2 SITE

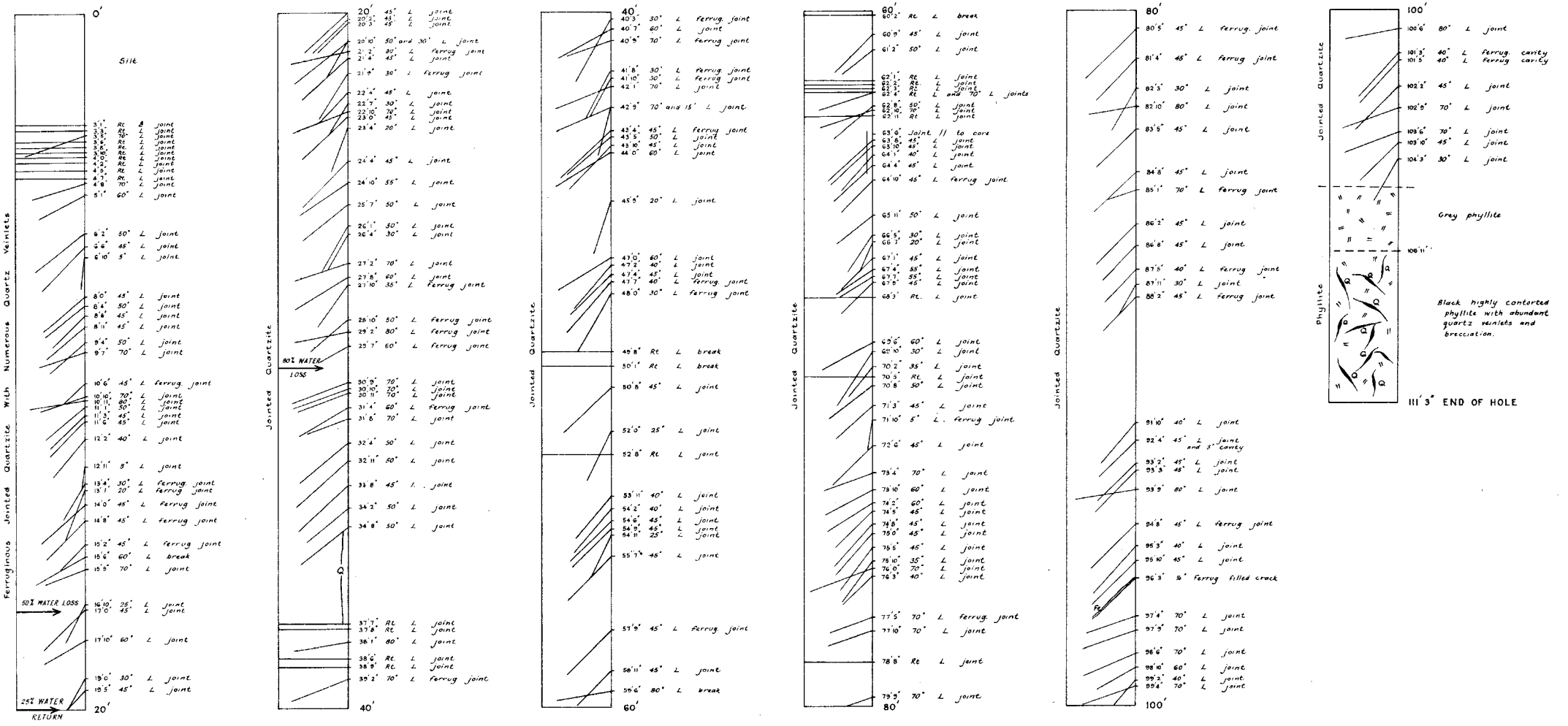
KIMBERLEY G.F.

## COLUMN LOG D.D.H. 19M

LENGTH 111' 3" VERTICAL HOLE

COMMENCED 16. 7. 61 COMPLETED 24. 7. 61

SCALE : 1 INCH TO 4 FEET



G.S.W.A.

# ORD RIVER MAIN DAM Nº 2 SITE

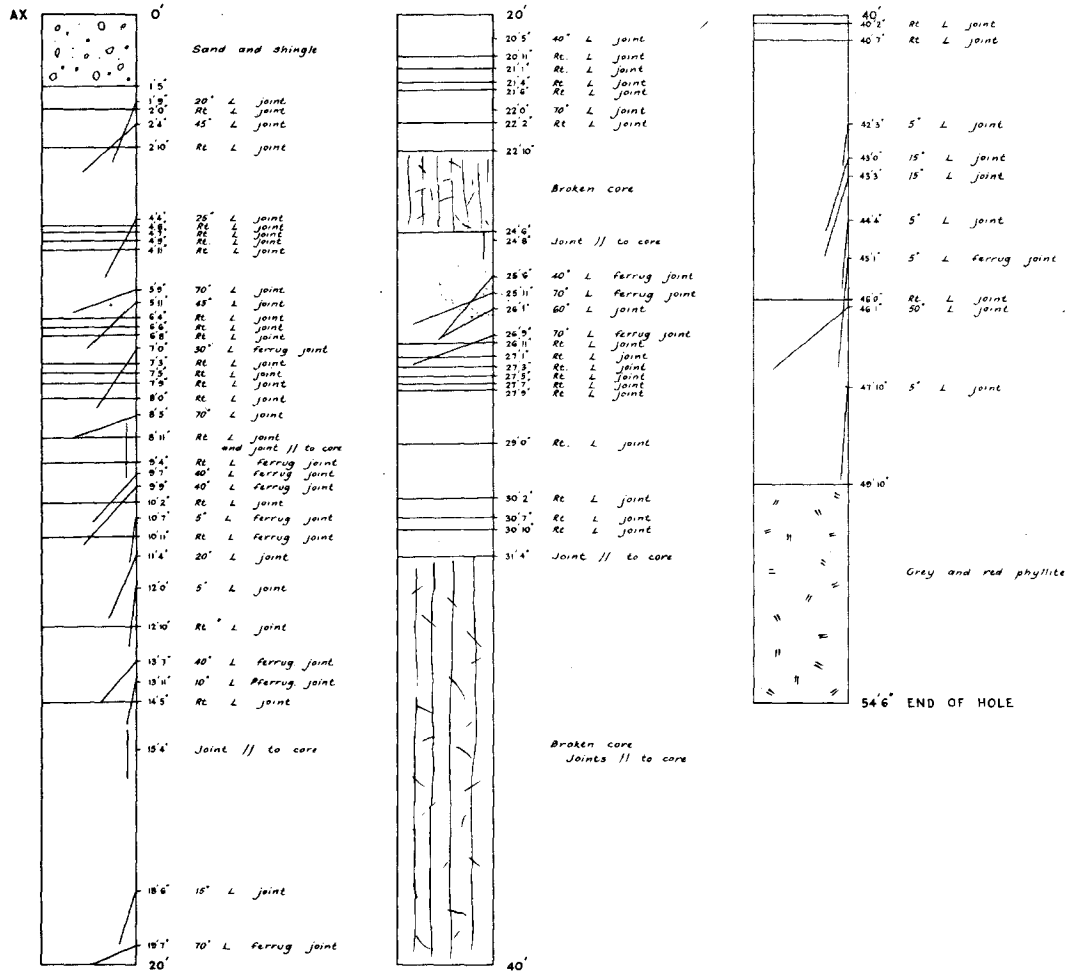
KIMBERLEY G.F.

## COLUMN LOG D.D.H. 20M

BEARING 246° Mag LENGTH 54'6"
ANGLE OF DEP. −58°

COMMENCED 26·7·61 COMPLETED 28·7·61

SCALE : 1 INCH TO 4 FEET



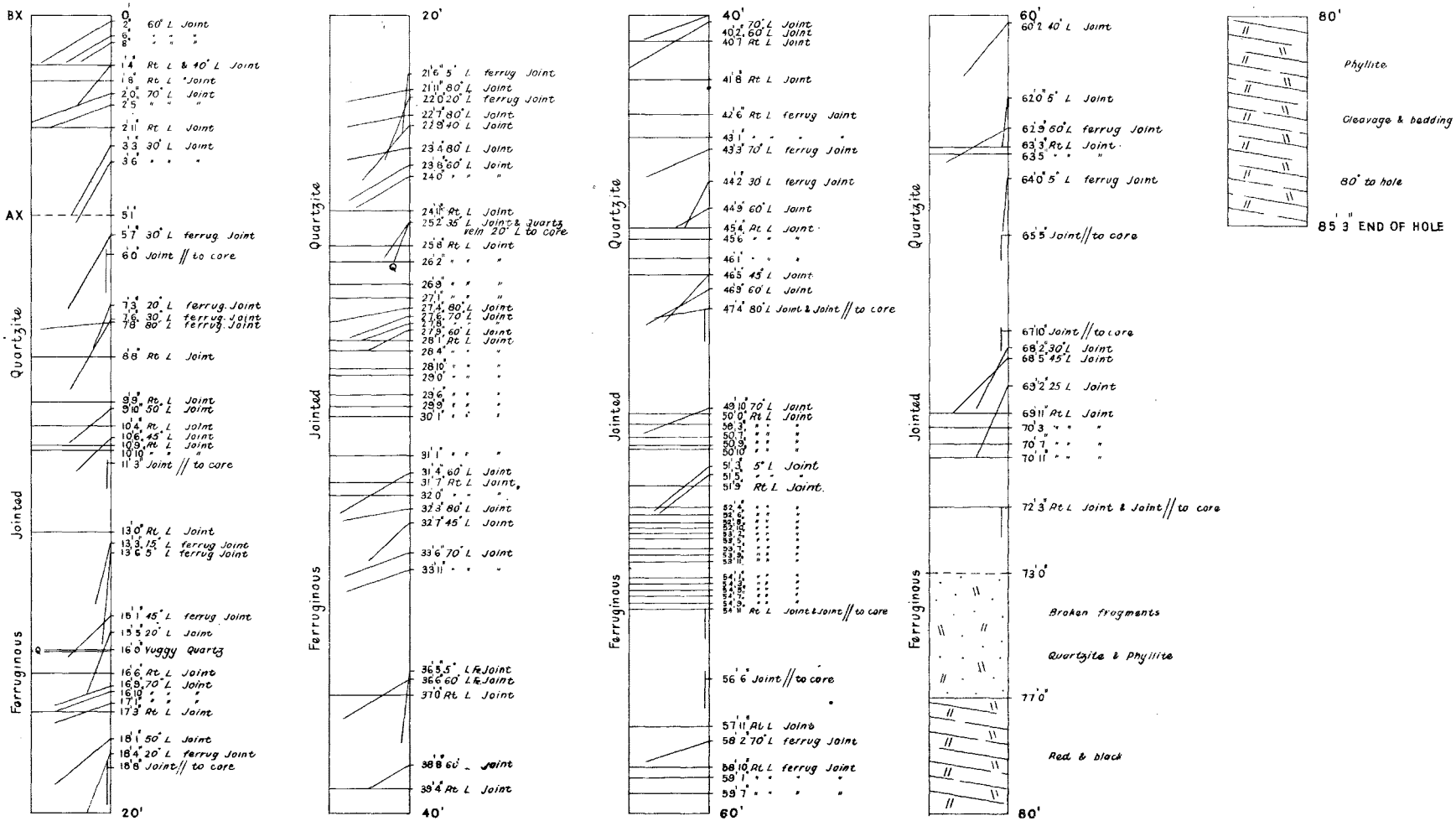
G. S. W. A.

# ORD RIVER MAIN DAM No2 SITE

KIMBERLEY G. F.

## COLUMN LOG D.D.H. 21 M.

BEARING 265° Mag LENGTH 85'3"
ANGLE OF DEP -58°
COMMENCED 31-7-61 COMPLETED 11-8-61
SCALE: 1 INCH TO 4 FEET



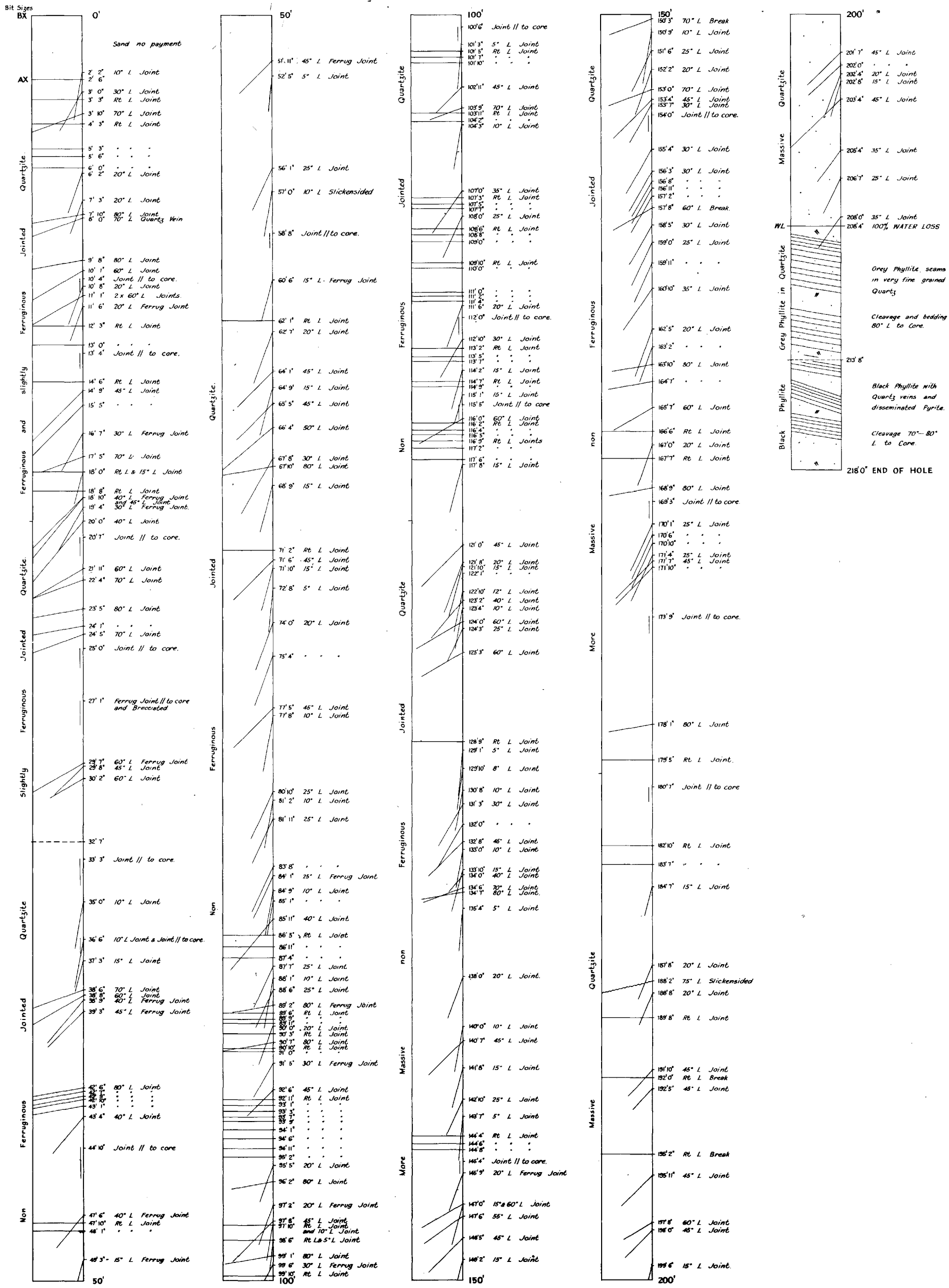
G.S.W.A.

# ORD RIVER MAIN DAM Nº 2 SITE

KIMBERLEY G.F

## COLUMN LOG D.D.H. 22M

BEARING 242°Mag. LENGTH 218'0"
ANGLE OF DEP −58°
COMMENCED 10.8.61 COMPLETED 26.8.61
SCALE : 1 INCH TO 4 FEET



G S. W A.

# ORD RIVER MAIN DAM No2 SITE

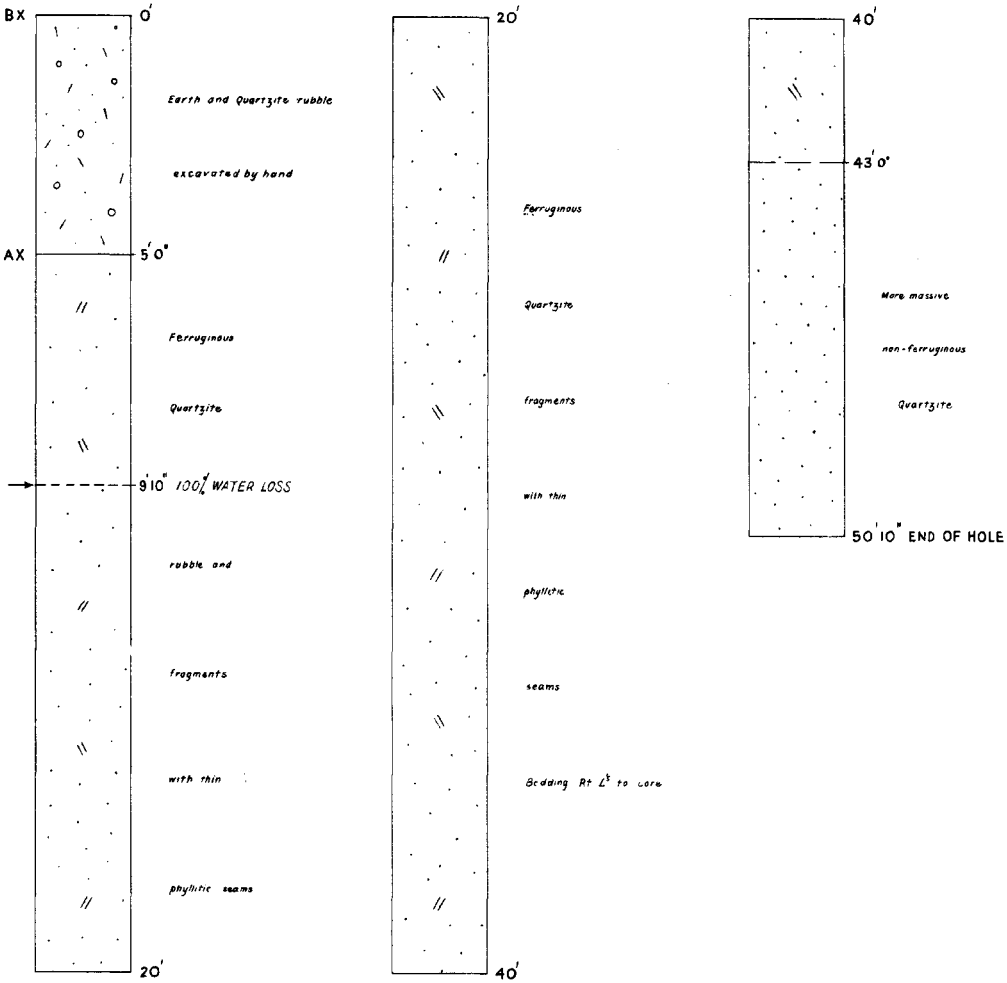
KIMBERLEY C. F

## COLUMN LOG D.D.H. 23 M

VERTICAL HOLE LENGTH 50'10"

COMMENCED 18-8-61 COMPLETED 27-8-61

SCALE : 1 INCH TO 4 FEET



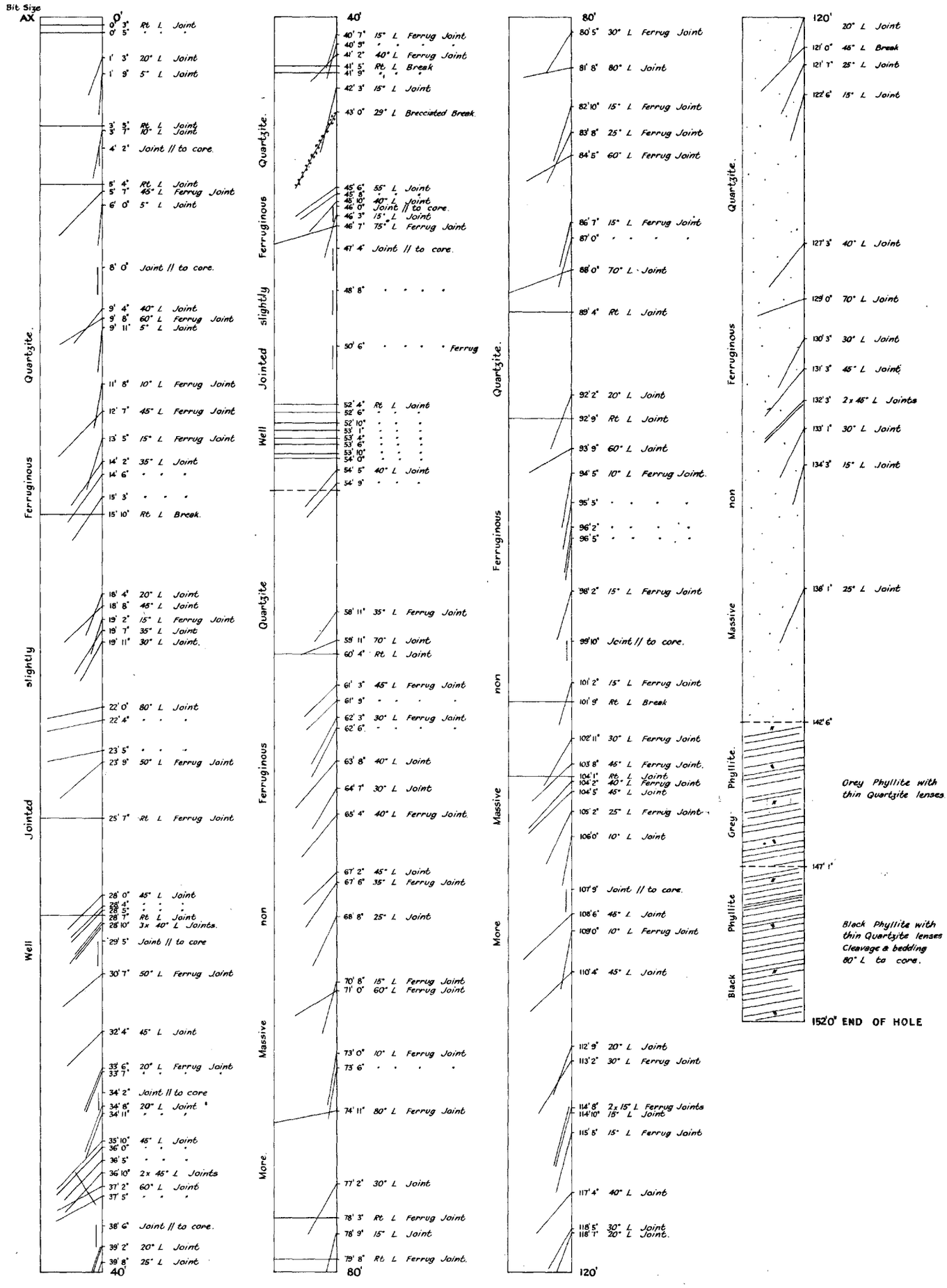
G.S.W.A.

# ORD RIVER MAIN DAM No. 2 SITE

KIMBERLEY G.F.

## COLUMN LOG DDH.24M

BEARING 251°Mag LENGTH 152'0"
ANGLE OF DEP −60°
COMMENCED 27.8.61. COMPLETED 3.9.61.
SCALE : 1 INCH TO 4 FEET



G. S. W. A.

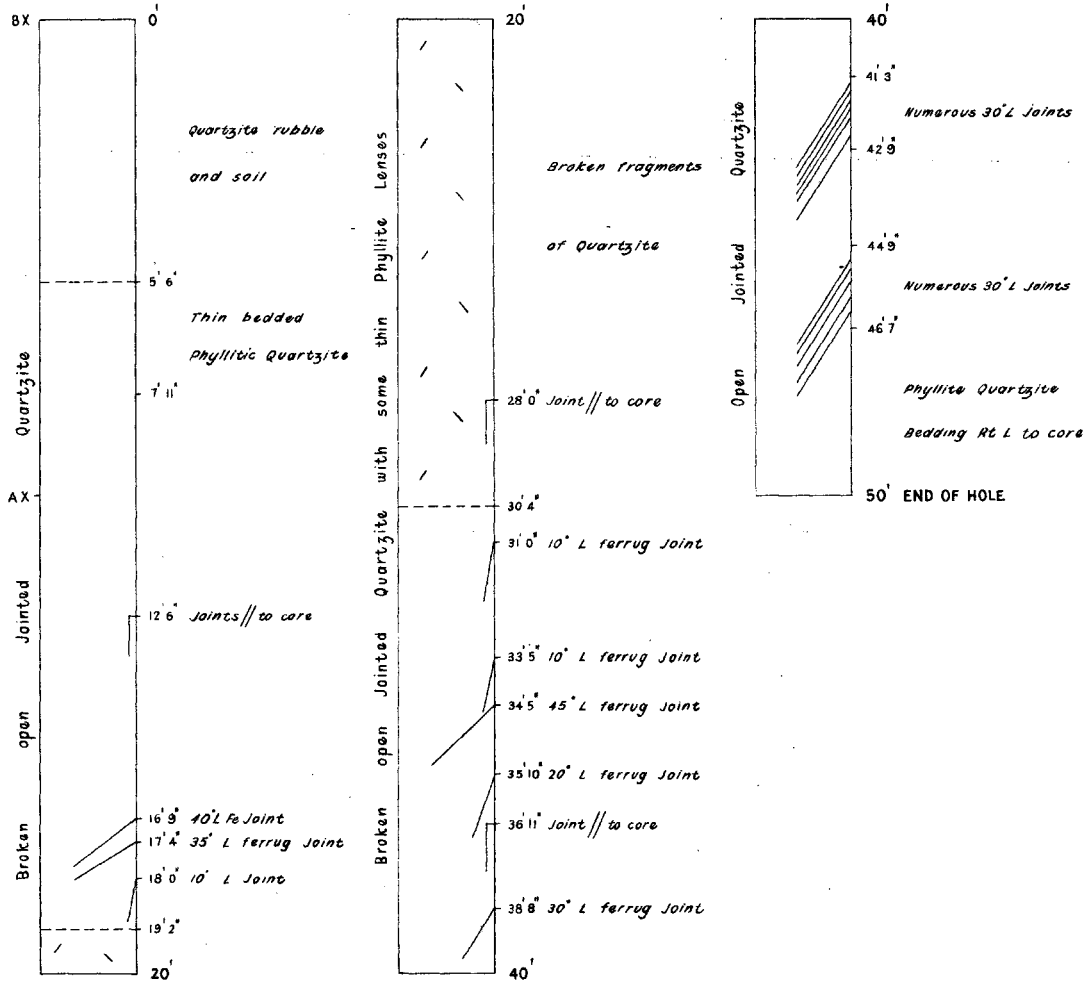
# ORD RIVER MAIN DAM Nº2 SITE

RIMBERLEY O F.

## COLUMN LOG D.D.H. 25M

VERTICAL HOLE LENGTH 50'0"
COMMENCED 7·9·61 COMPLETED 18·9·61

SCALE : 1 INCH TO 4 FEET



C. S. W. A.

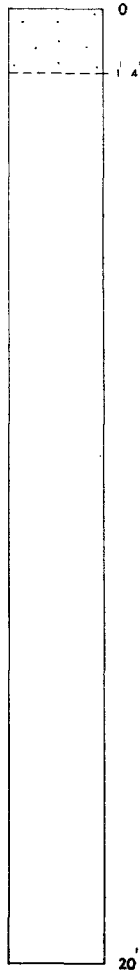
# ORD RIVER MAIN DAM No2 SITE

KIMBERLEY C. F.

## COLUMN LOG DDH 27 M

VERTICAL HOLE LENGTH 30' 0"
COMMENCED 14 9 61 COMPLETED 20 9 61

SCALE : 1 INCH TO 4 FEET




G. S. W. A.

# POMPEY'S PILLAR IRON ORE DEPOSIT

## EAST KIMBERLEY DIVISION

## DIAGRAMATIC SKETCH

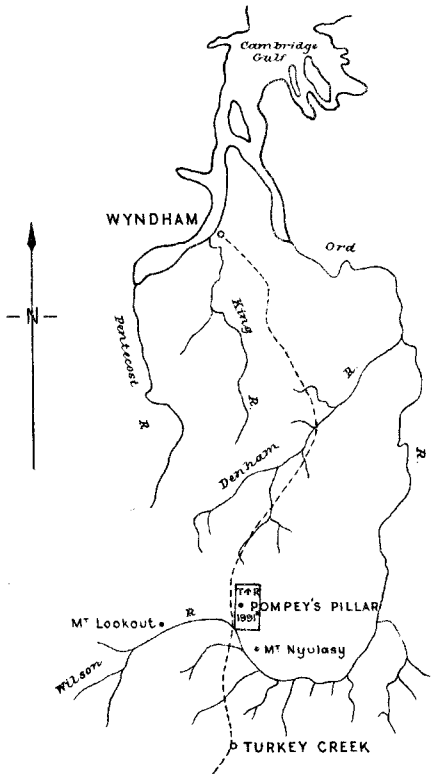
Approx. Scale: Vertical 160 feet to 1 inch
Horizontal 480 feet to 1 inch

N.B. Section Drawn at Point Bearing 289° Mag. to Pompey's Pillar Spine

Prepared by J. D. Wyatt Sept 1961

PLAN

Scale: 40 mile to 1 inch



Below are the assay results from the three specimens submitted to the Government Chemical Laboratories:—

| GSWA No. | Iron (Fe) Per cent on dry basis | Acid Insoluble Material |
|---|---|---|
| 6219 .... | 64.4 | 2.92 |
| 6220 .... | 63.5 | 7.03 |
| 6221 .... | 67.2 | 2.36 |

*Conclusions.*

From the above assay results, it can be concluded that the hematite bed has definite prospects as an iron ore deposit. However, a detailed sampling, drilling and geological mapping programme would be necessary over the whole of the area likely to be mined, in order to assess more accurately the probable tonnage, overall grade and amount of overburden.

Additional factors which would need consideration are:—

(1) The relative inaccessibility as a handicap to initial mining of the deposit.

(2) The amount of overburden likely to be encountered, especially to the east.

(3) The possible offsetting of the ore horizon by faults visible in aerial photographs of the area.

(4) Possibility of severe grade changes within the ore horizon.

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## THE GEOLOGY OF THE NORTHAMPTON MINERAL FIELD AND ENVIRONS, WESTERN AUSTRALIA.

*By W. R. Jones, B.Sc., (Hons.), and A. J. Noldart, B.Sc.*

### INTRODUCTION.

The mapped area is bounded by latitude 27° 45′ S. and longitude 114° 30′ and 115° E. covering the four 1-mile Army sheets of Ajana, Hutt, Northampton and Nanson. The accompanying geological map is on a scale of 1 inch = 4 miles and separate geological sheets of the new 1 : 50,000 series will be available from the office of the Geological Survey. A narrow strip of the northern end of the mineral field is excluded from this presentation.

The main town is Northampton which is 343 miles north of Perth. Local Authorities administer the area from Northampton, Nanson and Geraldton, which adjoins the southern margin of the map.

The most important mining centres are Northampton, Protheroe and Galena. The first mine opened in Australia followed the discovery of copper at Wanerenooka Hill in 1842. Lead was found at Geraldine in the bed of the Murchison River in 1848.

Numerous roads serve the area which is farmed intensively except for the northern parts. The main occupations are grain growing and sheep raising with some cattle raising and market gardening nearer Geraldton.

Both authors were employed on the fieldwork from May to September, 1961, apart from an absence of six weeks by W. R. Jones on other work. The area was mapped on a scale of 1 inch to 30 chains using aerial photographs, line compilations and photomosaics supplied at that scale by the Photogrammetry Section of the Lands and Surveys Department. W. R. Jones completed the report writing after the resignation of A. J. Noldart in December, 1961.

*Previous Work.*

Maitland (1903) was the first to outline the geology of any part of the Northampton Mineral Field although Gregory (1861, 1895) described some of the ore bodies and their relationship to the dolerite dykes. Many private and government reports have been written on individual mines at various periods of activity. The value of some early reports is doubtful as they are founded on hearsay. Berliat (1955) has written the most recent report on any of the mine openings. Prider (1958) described the granulites near Galena and published a map showing the distribution of the dolerite dykes near Galena.

*Present Mining Activity.*

The only lead mines operating during the period of the survey were: the Gurkha, Noooka, Wheal May, Yiapa, and Mary Springs. Most of these were on exploratory work and ore production was but a few tons per month in irregular parcels. There was virtually no prospecting.

### PHYSIOGRAPHY.

The area is a partly dissected sand plateau about 900 feet above sea level which joins the Swanland and Murchisonia Divisions of Jutson (1950). The sand plain has developed over laterite covering Jurassic, Permian, Lower Silurian and Precambrian rocks. Prominent low erosion scarps delimit most of the sandplain which drops away to the semi-mature topography of the Precambrian granulite basement. Mesas of horizontal Jurassic sediments make a strong contrast in the southern part of the area, but these rarely exceed 800 feet above sea level.

The main drainage units are the Murchison, Hutt, Bowes and Chapman Rivers and their tributaries. The annual rainfall ranges from about ten inches in the N.E. to nearly twenty inches near Geraldton. The stream pattern, and to a lesser extent the strike of the escarpments, reflect the strong influence of the faults and fracture system of the Precambrian granulites. The most frequent control is by tension fractures in the Precambrian rocks. These are remarkedly parallel with a N.E. trend and are the loci of numerous dolerite dykes.

Vegetation on the sand plain is low scrub, banksias and occasional scrub pines. The granulites support a thick jam growth in the south and mulga near the Murchison River. Stunted eucalypts are confined to the sediments, laterite and kaolinised granulite with a few large eucalypts along the rivers.

### GENERAL GEOLOGY.

The oldest rocks are Precambrian metasediments which underlie about 40 per cent. of the mapped area. These are granulite, gneiss, felspathic quartzite and pegmatite of Archean age, intruded by swarms of steeply dipping dolerite dykes which maintain parallelism for long distances in a N.E. direction. Coarse sandstones and conglomerate of probable Lower Silurian age flank the central uplifted Precambrian block on the eastern and western sides partly in fault contact. Permian rocks cover small areas in the eastern parts overlying the Lower Silurian rocks. Nowhere are they seen on the central granulite block. The area was deeply eroded prior to the deposition of Jurassic rocks which, although relatively thin, are the most widespread of the sediments.

Tertiary and Quaternary sand covers large areas of the eastern and northern sections, and minor Tertiary and Quaternary rocks are scattered throughout. The general distribution of the rocks is shown on the accompanying 4-mile map, and the detailed geology on the 1 : 50,000 map sheets which are printed separately.

No detailed work was done on the post-Precambrian sediments and the reader is referred to the works of various authors for full descriptions. The suggested rock classification and geological sequence is shown in Table I.



(8)—57785

Table I.

The Geological Sequence

| Age | Geological Units | Rocks | Processes |
|---|---|---|---|
| Quaternary .... | .... .... .... .... .... | Outwash, alluvium, soil, residual sand, estuarine sand, ferruginous deposits, " coastal limestone " | Eustatic sea level changes, estuarine and fluviatile deposition, river capture |
| Tertiary .... .... | Superficial deposits .... .... | Laterite, sand .... .... .... | Epeirogenic uplift, peneplanation formation of laterite |
| Jurassic .... .... | Yarragadee Formation .... .... | Sandstone, shale, conglomerate .... | Deposition in rivers, estuaries, near-shore basins and shallow seas |
| | Champion Bay Group { Kojarena Sandstone; Newmarracarra Limestone; Bringo Shale; Colalura Sandstone | Shale, sandstone, limestone .... | Extensive minor faulting and associated uplift. Faulting marked along old Pre-Cambrian weaknesses |
| | Chapman Group { Moonyoonooka Sandstone; Greenough Sandstone; Minchin Siltstone | Shale, sandstone, limestone | |
| Permian .... .... | Holmwood Shale Nangetty Formation | Shale, tillite and glaciated boulders | Marine transgression, deposition in shallow seas |
| ? Lower Silurian.... | Tumblagooda Sandstone .... | Fine to coarse-grained cross-bedded sandstone and conglomerate | Rapid sedimentation |
| Cambrian .... .... | .... .... .... .... .... | Lead and copper deposits .... | End stage activity of dolerite dyke intrusions, hydrothermal alteration of dolerite, formation of lead and copper deposits in tension openings. |
| Upper Proterozoic | .... .... .... .... .... | Dolerite dykes ? Pegmatite (transgressive) | Magmatic intrusion. Possibly some mobilisation of pegmatitic segregations into transgressive dykes. Retrograde metamorphism |
| Lower Proterozoic | .... .... .... .... .... | Granulite Pegmatite Quartzite .... | Deep seated metamorphism and recrystallisation of Archean metasediments |
| Archeozoic .... | .... .... .... .... .... | Regionally metamorphosed carbonaceous shale, greywacke, sandstone | Deposition of geo-synclinal sediments, folding and regional metamorphism |

## ARCHEAN.

*Garnet Granulite.*

The garnet granulites form the bulk of the Archean rocks which are discontinuously exposed in a central, meridional strip to the limits of the mapped area. Prider (1958) has described them from outcrops in the Murchison River as "fine-to coarse-grained garnet granulites, extensively pegmatised but otherwise rather uniform and monotonous in character." Overall the granulites are less uniform than this would suggest and Maitland (1903) observed the variations in rock type near Northampton and briefly described them as "granite, gneisses, mica schists, quartz schists, etc., intersected by veins and masses of pegmatite . . ." With few exceptions the pegmatites are coarsely crystalline segregations of quartz and felspar within the foliation of the granulite. They are commonly narrow and in large numbers over considerable areas. Where outcrop is poor the soil is usually crowded with fragments of quartz and felspar.

The granulite has alternating bands of contrasting grain size, the variation in which is best displayed by the garnet. The granulite is almost massive in the Waterloo Range east of Dindiloa and in other localities on the Naraling and Kojarena 1 : 50,000 sheets.

Prider (1958) has described a number of variants of the granulite, namely:—garnet granulite, cordierite-garnet-quartz-felspar granulite, sillimanite-cordierite-garnet-quartz-felspar gneiss and plagioclase - hornblende - diopside - hypersthene granulite. Playford (1959), in a brief description of the Precambrian rocks near the southern margin of Kojarena and Howatharra sheets, noted sillimanite as an accessory mineral, and garnet gneiss, quartz-felspar-cordierite-garnet gneiss, charnockitic granulite and hornblende granulite among the varieties of granulite.

All these rocks are represented throughout the mapped area. Graphite and sillimanite are widespread, usually as accessory minerals, but often in narrow concentrated zones. Hypersthene granulite is common but not usually in large outcrops.

Maitland (1903) says that he found it "impossible to draw any line separating each of the rocks . . ." We agree excepting the quartzite. Distinctive beds within the granulite could not be traced because of lensing, facies changes and paucity of outcrop.

The present survey revealed no granulite of demonstrable igneous origin. Essentially the remarks of Prider (1958) concerning the Galena granulites apply to the whole area viz: "The ubiquitous presence of graphite in these rocks, the occurrence of thin graphite-sillimanite bands in the quartz-felspar gneiss, . . . . the association of garnet, sillimanite and cordierite, the occurrence of rounded zircons and monazite and finally the chemical composition of these rocks which contain significant normative corundum all indicate a sedimentary parentage."

*Felspathic quartzite.*

Quartzite, interbedded with the granulite, forms distinctive bands from about four miles N.W. of Ajana to the southern margin of the area. The maximum development is in rugged hills E.N.E. of Northampton where the quartzite is strongly folded. Outcrop is discontinuous but most of the bands are easily traced on air photos.

The quartzite is fine-to medium-grained usually with abundant, prominent felspar laths and minor amounts of muscovite and graphite. In contrast to the granulites, garnet is an accessory mineral. Depending on the proportion of quartz and felspar, and the degree of recrystallisation the composition varies from a friable platy quartzite to a coarse graphic intergrowth of quartz and felspar and more rarely massive glassy quartz. Rapid alteration in texture near the faulted zones is particularly noticeable. Approaching the zones the small felspar laths increase in size to a maximum of 2-3 cm. The same thing is repeated on specimen scale where small shears cross the foliation.

The quartzites are metamorphosed siliceous sediments and, as Maitland (1903) suggests, "may be merely another form of those laminated quartzites (cherts?) which form such a pronounced feature in certain districts."

*Pegmatite.*

In addition to the concordant pegmatitic segregations there are a number of transgressive pegmatites in the N.E. fracture system. These are composed of coarse microcline and quartz, sometimes with large muscovite books, and often with coarse black tourmaline. It is possible that these pegmatites are the result of a Proterozoic mobilisation.

## PROTEROZOIC.

*Dolerite Dykes.*

Numerous sub-parallel basic dykes cut the basement rocks. These trend N.E. in remarkably straight lines for several miles, transgressive to the regional trend. The dykes range in width from a few feet to about two hundred and fifty feet and, where seen in mine openings, dip steeply N.W. Several earlier workers have studied them because of their close association with the ore deposits. Berliat (1955) and Maitland (1903) regarded the relationship as structural rather than genetic, however, there is little doubt that the dolerite magma was the parent of the ore solutions. Where seen underground near, or enclosing orebodies, the dykes show varying degrees of hydrothermal alteration. The dyke in the Wanerenooka mine is completely kaolinised.

Prider (1958) has published petrographic descriptions of typical dolerites near Galena.

## METAMORPHISM AND ORE DEPOSITION.

We agree with Wilson (1958 b) that the Northampton Block granulite is probably the result of more than one metamorphism. The original carbonaceous shale, greywacke and siliceous sediments were folded and regionally metamorphosed probably in Archean times. The granulose texture, and possibly the pegmatitic recrystallisation, was probably associated with an early Proterozoic metamorphism as dated on felspar which gave an age of 1,000 million years (Wilson *et al* 1960).

Retrograde metamorphism, seen in places throughout the granulite, was probably imposed between the late Proterozoic and early Cambrian by the heating associated with the intrusion of the innumerable dolerite dykes and the subsequent formation of the orebodies. Additional minor metamorphic effects are seen near some of the dolerite dykes.

## POST-PRECAMBRIAN.

No attempt was made to map in detail any of the younger sediments. Their distribution is shown on the accompanying map by simple subdivision into rocks of various periods. The works of previous authors should be consulted for detail.

## ORDOVICIAN—LOWER SILURIAN.

*Tumblagooda Sandstone* (Clarke and Teichert 1948) and (McWhae *et al* 1958).

Maitland (1903) briefly described the outcrops of sandstone and conglomerate in the vicinity of the Hardabut and Nine-mile Pools in the Murchison River flanking the basement rocks to the west and east respectively. He correlated the two outcrops and noted the fault contacts. The faults weaken going south until the sandstone is in normal uncomformable contact with the basement but still dipping at a low angle away from the central block. On the eastern side of the block minor faults shape the contact with the sandstone which extends to the southern margin of the mapped area. On the western side of the block the sandstone passes under Jurassic sediments south of the Bowes River.

The Tumblagooda Sandstone is a fine to medium-grained reddish sandstone with conglomerate bands. Much of it is strongly cross-bedded. Well-developed E-W jointing makes with the bedding a fine mesh texture clearly distinguishable on air photos. The sandstone is intruded by narrow (1 in.) quartz veins.

## PERMIAN.

The Holmwood Shale and Nangetty Formation overlie the Tumblagooda Sandstone on the eastern side of the Precambrian block. The best exposures are near Yuna. On the four-mile map soil derived from the Permian rocks is undifferentiated from the outcrops.

## JURASSIC.

The southern parts of the area are covered predominantly by thin Jurassic rocks and their outwash derivatives. The various members have been studied and formally named by Playford (1959) and in Arkell and Playford (1954) but a Jurassic age for the fossils was recorded by Moore in 1862.

The rocks are thin horizontal sandstones, shales and limestones of continental and shallow marine origin. They rest unconformably on the central irregular basement surface and more or less conformably on the Tumblagooda sandstone. Maximum thickness is about 430 feet.

## TERTIARY.

*Sand plain and laterite.*

Large tracts of the eastern and northern parts of the area are sand overlying laterite developed on all the younger rocks. The laterite has maximum initial slopes of 10°-15° and is at different elevations throughout the area. Variations in attitude were noted in the laterite flanking the drainage systems, and in general the slope is towards the present valleys. It is clear that the laterite was formed on an eroded surface.

The extent of the laterite is not shown completely on the maps; particularly where it overlies the Jurassic rocks on the southern 1: 50,000 sheets. The laterite varies somewhat in texture and colour with changes in the underlying rock.

The sand plain is essentially in situ. Surface movement by the wind has built dune formations which are typically braided and sometimes mobile in the north-eastern areas.

## QUATERNARY.

*Limestone.*

A thin deposit of typical coastal limestone fringes the coast north of Geraldton. It is partly covered by residual sand. Thin estuarine limestone outcrops in some of the present river valleys.

Estuarine or fluviatile deposits of small extent are scattered throughout, mainly in the present valleys. The sand of Lauder Hill ridge, S.W. of Northampton, is probably a deposit in an old course of the Bowes River. The deposits are of ferruginous sandstone, bog iron ore and poorly consolidated gravels.

The only reasonably extensive alluvium is in the valley of the Chapman River. Outwash fans are prominent around the Jurassic "table tops" on the southern map sheets.

Soil on the granulite has not been outlined, but on the 1:50,000 maps the soil types have been used to show the extent of the Lower Silurian and Permian rocks.

## STRUCTURE.

The Northampton block is an eroded high zone of the geanticlinal structure west of the Perth Basin. Its outline in plan is largely shaped by a number of faults of comparatively small magnitude. The fault system is shown on Plate XXXV B at four miles to an inch. The main components trend N.E. and N.N.W. The best known member of the N.E. component is the Hardabut fault which forms the contact of the granulite and Tumblagooda Sandstone. This fault has produced a strong topographic feature where it crosses the Murchison River and it can be traced on aerial photographs N.E. across the sand plain. South-westerly its expression weakens quickly and the Tumblagooda Sandstone overlaps the projected fault position. Hence there is no post-Silurian displacement at the southern end of the fault and an increasing and progressively younger displacement going N.E. with the downthrow on the western side.

There is no surface expression of faults bounding the S.E. margin of the granulite block. A large N.E. fault from near Dongara to near Eradu has been postulated by Thyer (1956) from an interpretation of gravity data. At its northern end at least this fault would be pre-Jurassic as according to Playford (pers. comm.) marine Jurassic rocks overlap its plotted postion.

Within the granulite the N.E. component is represented by the prominent joint pattern accentuated in a remarkable way by the dolerite dykes. Numerous dykes are along small faults which are only recognised where they offset the quartzite beds.

The N.N.W. component of the fault system is not as prominent as the N.E. component. Members are the Geraldton fault, the Yandi fault group and the tear faults so prominent on the aerial photographs near Galena. The Geraldton fault is not exposed but from bore data near Geraldton it has a post-Jurassic movement of 750 feet, downthrown on the western side. Its strike is reflected by the Moresby Flat Topped Range and it is suggested that it shapes the coastline near Geraldton (Howatharra 1:50,000 Sheet).

The Yandi fault group is a series of small faults limiting the granulite outcrop on the eastern side of the block. Eastwards the sediments are thin, in particular in the country east of Binnu where the granulite shows through the sediments in a number of places. This N.N.W. component is subparallel to the Darling and Urella faults. A strong lineament on aerial photographs on the Mongeragabbie 1:50,000 Sheet may be the extensions of the Urella fault.

Small adjustments along these Precambrian weaknesses have produced the prominent joint patterns in the Tumblagooda Sandstone and Jurassic sediments.

The numerous quartzite beds within the basement granulites were traced sufficiently well to show that the granulite has been complexly folded. Generally the trend is N.N.W. in common with the trend in the Archean rocks of the S.W. of Western Australia. Foliation is well marked and is usually conformable to the bedding of the original sediments. Lineation is well developed in places, particularly in the quartzites, but no attempt was made to study it in detail.

## ECONOMIC GEOLOGY.

### *Lead and Copper Deposits.*

The lead and copper deposits are confined to the N.E. tension fractures near or alongside the dolerite dykes. The host rocks are garnet granulite, quartzite and rarely dolerite, although there are numerous small ore bodies along the dolerite-granulite contacts.

The ore bodies dip at 65-85°, range in length from 50 to 900 feet, with widths between two and eight feet and have a vertical depth of 20 to 400 feet. The five most important lead mines have produced from 75,000 tons to 140,000 tons of ore of 9-20 per cent. lead for 10,000-14,000 tons of metal. The lead is high grade and contains less than 1 oz. of silver per ton. The production of individual mines is shown in Table 2.

Siliceous brecciated gangue and numerous vugs up to 2-3 feet diameter are characteristic of the ore. The main sulphide minerals are galena, sphalerite, pyrite, marcasite and chalcopyrite. Octahedral galena of 5 cm. maximum size, and quartz crystals are usual in the vug linings of the lead ore. Sphalerite is not intimately mixed with the galena and does not affect the grade of the gravity concentrate. Barite is common in the gangue of the lead ore. In some veins it is an accessory; in others it forms most of the vein as in the Surprise mine at Galena.

Chalcopyrite is unmixed with the galena but it, and its oxidation products, have been mined independently of the galena from the same vein. The Narra Tarra mine is the most notable for the production of lead and copper and records the largest copper production of the Field (Table 2). Copper ore also has been produced from a large number of small copper mines of relative unimportance. Records of production are incomplete of the Wanerenooka copper mine which was worked to about 200 feet in the early days of the Field.

The copper mines are described in detail in a Mineral Resources Bulletin now being prepared.

The zone of oxidation is usually shallow and sulphides have been found at the surface. Early production records do not distinguish between primary and secondary ore although the grade of the copper ore suggests that it, at least, was largely secondary.

As noted above the association of the ore with the N.E. fractures is well known. It was hoped in this survey to identify some localising cross-structure to provide prospecting targets. Prider (1958) and F. Campbell (unpubl. rept.) demonstrate a partial control by the N.W. tear faults. Unfortunately these cannot be mapped south of Ajana. No significant variations in the granulite near the ore are apparent and it seems unlikely that there are favourable beds for ore deposition.

Tension and shear stresses have formed the ore-bearing structures, which are usually open brecciated zones bounded by well-defined shear planes. Figure 19 shows the probable mode of formation of the ore loci by shear movement along a curved plane.

The shape and S. plunge of the ore shoots are controlled in part by faults intersecting the N.E. fractures at a low angle. Figures 20 and 21 are longitudinal sketches of the Gurkha and Prothero ore bodies respectively. The southerly plunging legs are clearly seen. A northerly plunging component is secondary and unidentified. In no mine has more than one shoot been mined and it was not possible to suggest a repetitive pattern which could be cheaply prospected.

### *Graphite.*

Accessory graphite is widespread in the granulite. It is concentrated in narrow zones many of which have been sampled by shallow pits. A prospect at Isseka six miles south of Northampton produced a concentrate of 80 per cent. carbon from concentration tests on two samples (Simpson 1951). Other near surface samples have been too contaminated by limonite. Generally the small size of the deposits discourages prospecting at depth.

### *Barite.*

Barite is common with the lead ore. However, the Surprise mine at Galena is the only known occurrence where it is in sufficiently large masses to be considered as a possible commercial by-product to lead mining (Simpson 1951).

### *Mica.*

Matheson (1944) has summarised the information on the old mica diggings. In general good quality mica is in the relatively unimportant transgressive pegmatites of N.E. trend. Little work has been done and the deposits are probably too small for worthwhile production.

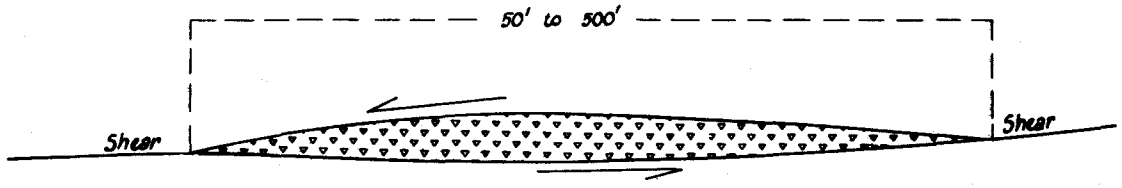


Fig. 19. Diagrammatic Sketch showing probable origin of breccia lenses by movement along a curved shear plane.

*Bauxite.*

In view of the large area of laterite exposed or under shallow cover a number of samples were assayed for soda-soluble alumina, but the best result was 13 per cent.

*Building Stone.*

The attractively-coloured Jurassic sediments are used in local buildings but transport costs preclude a wider use. Tumblagooda Sandstone is less commonly used and is not as suitable.

*Aggregate.*

Local earth roads are formed with laterite and pebbles from the Tumblagooda Sandstone. Dolerite dykes have been quarried for metal surfacing of the N.W. coastal highway.

*Water Supply.*

The hydrological section of the Geological Survey conducted a water survey in 1960. The information is being compiled and will be available at the head office.

## FUTURE EXPLORATION.

The present low price of lead (£85A/ton, Feb. 1962) discourages exploration. Individual prospectors and small syndicates can expect to find ore near old workings but the outlook for the discovery of new ore bodies is bleak at the prospectors' level. Targets are restricted to the zones of brecciation and alteration along known mineral lines.

A Geophysical Survey in the Protheroe area (Keunecke 1956) attempted to indicate zones of mineralisation. Highly conductive shears produced strong indications and at present geophysical methods are probably not sufficiently specific for this Field. The small size of the known ore bodies is no incentive to prospecting by large companies.

## CONCLUSION.

The primary objective of the survey was the recognition of structural controls which could serve as prospecting guides. Unfortunately, this could not be achieved. However, the 1:50,000 maps show in detail the distribution of the dolerite dykes, and the extent of the cover of younger rocks above areas of potential mineralisation. The best known ore lines can be identified and followed.

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Table 2

## PRODUCTION OF COPPER AND LEAD

*Copper Ore and Concentrates*

| Mining Centre | No. of Lease, Claim, or Location | Name | Period | Ore and Concentrates | Per cent. Cu | Copper | | Silver | | Total Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tons | Value | Ozs. | Value | |
| | | | | Tons | | | £ | | £ | £ |
| Galena .... .... | M.L's. 10, 11 .... .... .... | Geraldine Copper Mines .... .... | 1899–1901 | 136·50 | 26·41 | 36·05 | 1,992·0 | 490·0 | 55·15 | 2,047·15 |
| | P.A. 186 .... .... .... .... | Carter, J. .... .... .... .... | 1940 | 7·08 | 8·61 | 0·61 | 45·75 | .... | .... | 45·75 |
| Northampton .... | M.L. 60PP .... .... .... .... | Roger Malray .... .... .... | 1957 | 9·44 | 14·94 | 1·41 | 201·4 | 21·52 | 8·75 | 210·15 |
| Nabawa .... .... | Loc. 833 .... .... .... .... | Narra Tarra : Fremantle Trading Co. Ltd. | 1922–25 | 23,766·67 | 7·51 | 1,784·64 | 116,485·0 | .... | .... | 116,485·0* |
| | Loc. 833 .... .... .... .... | Narra Tarra .... .... .... .... | 1929 | 116·0 | 10·44 | 12·11 | 974·0 | .... | .... | 974·0 |
| | Total to 31st December, 1960 .... .... .... .... .... | | | 24,035·69 | .... | 1,834·82 | 119,698·15 | 511·52 | 63·9 | 119,762·05 |

*Cupreous Ore (Fertiliser)*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Units | | | | |
| Northampton .... | Crown Lands .... .... .... | Lorne and Andressen .... .... | 1955 | 21·79 | 6·96 | 151·69 | 185·55 | .... | .... | 185·55 |
| | Total to 31st December, 1960 .... .... .... .... .... | | | 21·79 | 6·96 | 151·69 | 185·55 | .... | .... | .... |

* Gold 91·51 fine ozs. and silver 20,718·76 fine ozs. reported during 1922–23.

*Lead Ore and Concentrates*

| Mining Centre | No. of Lease, Claim, or Location | Name | Period | Estimated Mine Treatment | | Realised Production | | | | | Total Value F.O.B. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ore | Concentrate | Ore and Concentrates | Pb | Lead | | Silver | |
| | | | | | | | | Tons | Value | Fine ozs. | Value | |
| | | | | Tons | Tons | Tons | % | | £ | | £ | £ |
| Galena, Ajana.... | M.L. 112 .... .... | Kingdom Come .... | 1908 | .... | .... | 57·0 | 73·0 | 41·61 | 461·0 | .... | .... | 461·00 |
| | M.L. 234 (ex M.L. 112) | Mary Springs .... .... | 1951–60 | 2,274·0 | 355·05 | 341·9 | 73·83 | 252·43 | 21,472·61 | 139·5 | 41·35 | 21,513·96 |
| | Loc. 1 .... .... .... | Geraldine .... .... | 1917–19 | .... | .... | 774·59 | 33·2 | 257·13 | 5,139·00 | .... | .... | 5,139·00 |
| | | | 1951 | 235·0 | 6·60 | 6·0 | 67·5 | 4·05 | 632·00 | .... | .... | 632·00 |
| | | | 1957–58 | .... | .... | 87·97 | 62·95 | 55·38 | 3,238·5 | .... | .... | 3,238·5 |
| | M.L. 150 .... .... | Surprise .... .... .... | 1918–1922 | .... | .... | 25,393·53 | 25·87 | 6,570·53 | 187,065·00 | .... | .... | 187,065·00 |
| | M.L's. 148, 150, 154, 158, 20PP | Surprise Leases .... | 1923–26 | .... | .... | 68,440·5 | 9·42 | 6,448·8 | 205,544·00 | .... | .... | 205,544·00 |
| | M.L's. 205, 209, 214, 216–219 | Surprise Mine 1955 .... | 1955–57 | 6,619·0 | 757·5 | 501·77 | 68·82 | 345·31 | 34,146·04 | 94·8 | 8·6 | 34,154·64 |
| | M.L. 158 .... .... | Surprise South .... .... | 1919–34 | .... | .... | 19·00 | 44·26 | 8·41 | 231·0 | .... | .... | 231·0 |
| | M.L. 153 .... .... | Three Sisters .... .... | 1918–25 | .... | .... | 8,732·25 | 10·27 | 896·82 | 30,731·0 | .... | .... | 30,731·0 |
| | M.L. 159 .... .... | Welcome .... .... | 1918 | .... | .... | 5·74 | 62·54 | 3·59 | 68·0 | .... | .... | 68·0 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M.L. 202 .... .... | Welcome .... .... | 1926–27 | .... | .... | 1,263·00 | 9·12 | 115·21 | 3,274·00 | .... | .... | 3,274·0 |
| | M.L. 19PP .... .... | Wheal Lily .... .... | 1920–21 | .... | .... | 44·75 | 68·81 | 30·79 | 742·0 | .... | .... | 742·0 |
| | Loc. 7 .... .... .... | Block 7 .... .... .... | 1921–29 | .... | .... | 3,538·38 | 31·21 | 1,104·25 | 25,728·0 | .... | .... | 25,728·0 |
| | M.L. 189 .... .... | Long Lode .... .... | 1922 | .... | .... | 38·0 | 30·58 | 11·62 | 86·0 | .... | .... | 86·0 |
| | M.L. 23PP .... .... | Wheal Ina .... .... | 1923–27 | .... | .... | 513·00 | 16·62 | 85·27 | 1,877·0 | .... | .... | 1,877·0 |
| | M.L. 197 .... .... | Two Boys .... .... | 1925–27 | .... | .... | 9,745·25 | 9·67 | 942·16 | 28,492·00 | .... | .... | 28,492·00 |
| | M.L. 24PP .... .... | Springvale : Tarcoola Block Mines N.L. | 1925–27 | .... | .... | 5,640·00 | 10·97 | 618·79 | 18,533·00 | .... | .... | 18,533·00 |
| | M.L. 200 .... .... | Grand Junction .... | 1926–29 | .... | .... | 267·5 | 19·88 | 53·19 | 887·0 | .... | .... | 887·0 |
| | M.L. 207 .... .... | Grand Junction : Wiluna G.M. Ltd. | 1936–37 | .... | .... | 7,348·0 | 4·65 | 342·19 | 9,106·5 | .... | .... | 9,106·5 |
| | M.L. 203 .... .... | Geraldine South .... | 1929 | .... | .... | 155·0 | 32·26 | 50·0 | 450·0 | .... | .... | 450·0 |
| | M.L's. 205, 209, 214, 216–219 | Galena Lead Mines N.L. | 1946–1953 | 6,795·0 | 712·0 | 733·6 | 63·08 | 462·79 | 33,865·98 | 595·13 | .... | 33,865·98* |
| | P.A. 188 .... .... | Jenkins and Camp .... | 1947–48 | .... | .... | 34·36 | 68·07 | 23·39 | 1,977·80 | .... | .... | 1,977·8 |
| | P.A's. 202, 208, 209 .... | Murchison View Syndicate | 1949 | .... | .... | 12·03 | 72·73 | 8·75 | 640·10 | 20·33 | 2·05 | 642·15 |
| | M.L. 222 .... .... | Geraldine North .... | 1949–1956 | 3,545·0 | 237·8 | 232·03 | 70·89 | 164·49 | 19,422·38 | 65·6 | .... | 19,422·38† |
| | P.A. 198 .... .... | Sutton, A. .... .... | 1949 | .... | .... | 1·69 | 72·78 | 1·23 | 133·0 | 0·34 | .... | 133·0† |
| | P.A. 200 .... .... | McCarthy and O'Brien .... | 1949 | .... | .... | 2·24 | 61·61 | 1·38 | 88·35 | 2·01 | .... | 88·35† |
| | P.A. 218 .... .... | Martin, C. H. .... .... | 1949 | .... | .... | 1·02 | 62·74 | 0·64 | 64·7 | 1·02 | .... | 64·7 † |
| | P.A. 50PP .... .... | Salter, Davies and Salter | 1949 | .... | .... | 15·57 | 75·27 | 11·72 | 1,237·97 | 10·27 | .... | 1,237·97† |
| | M.L. 224 .... .... | Ethel Maud .... .... | 1949–1950 | .... | .... | 105·36 | 53·53 | 56·4 | 3,983·05 | 120·83 | 1·35 | 4,087·2 * |
| | M.L. 235 .... .... | Victory .... .... .... | 1950–51 | 230·0 | 17·00 | 16·57 | 69·95 | 11·59 | 1,454·65 | 12·48 | .... | 1,454·65† |
| | M.L. 33PP .... .... | Wheal Ina .... .... | 1950–56 | 627·0 | 47·82 | 48·36 | 66·34 | 32·08 | 3,347·1 | .... | .... | 3,347·1 |
| | M.L. 239 .... .... | Dingo .... .... .... | 1951 | 235·0 | 6·6 | 6·0 | 67·5 | 4·05 | 632·0 | .... | .... | 632·0 |
| | M.L. 253 .... .... | Great Western .... .... | 1952 | .... | .... | 1·98 | 73·74 | 1·46 | 165·07 | 1·19 | .... | 165·07† |
| | M.L. 252 .... .... | Three Sisters North .... | 1953–55 | 882·0 | 69·0 | 68·02 | 79·84 | 54·31 | 5,018·96 | 10·78 | .... | 5,018·96† |
| | M.L. 265 .... .... | Chequers .... .... | 1957–58 | .... | .... | 9·64 | 69·61 | 6·71 | 558·0 | .... | .... | 558·0 |
| | Sundry claims .... .... | .... .... .... .... | 1917–1929 | .... | .... | 657·04 | 45·61 | 299·65 | 4,350·0 | .... | .... | 4,350·0 |
| Northampton .... | M.L. 51 .... .... .... | Alma .... .... .... | 1899 | .... | .... | 19·0 | 66·0 | 12·54 | 212·0 | .... | .... | 212·0 |
| | M.L. 256 .... .... | Gurkha Lead Mines Pty. Ltd. (Alma) | 1952–1960 | 33,232·75 | 6,470·32 | 6,424·28 | 77·63 | 4,986·99 | 432,800·31 | 3,257·7 | 1,243·95 | 434,044·26 |
| | M.L. 54 .... .... .... | Lady Maud .... .... | 1899–1900 | .... | .... | 76·75 | 66·54 | 51·07 | 853·0 | .... | .... | 853·0 |
| | M.L. 62 .... .... .... | Yiapa .... .... .... | 1900 | .... | .... | 30·0 | 50·0 | 15·0 | 195·0 | .... | .... | 195·0 |
| | M.L. 38PP .... .... | Yiapa .... .... .... | 1949–1955 | 123·75 | .... | .... | .... | .... | .... | .... | .... | .... |
| | M.L. 80 .... .... .... | Ethel Maud .... .... | 1907 | .... | .... | 10·0 | 65·0 | 6·5 | 128·0 | .... | .... | 128·0 |
| | Loc. 1472 .... .... | Baddera .... .... .... | 1910–15 | .... | .... | 75,783·26 | 11·14 | 8,439·48 | 150,313·0 | .... | .... | 150,313·0 |
| | Loc. 1472 .... .... | Baddera (Fremantle Trading Co. Ltd.) | 1916–1920 | .... | .... | 53,481·3 | 10·19 | 5,448·85 | 167,318·0 | .... | .... | 167,318·0 |
| | Loc. 1472 and M.L's. 31PP, 220 | (Northampton Mining and Development Co. Pty. Ltd.) | 1948–1956 | 16,993·0 | 1,088·0 | 1,059·04 | 68·02 | 720·38 | 64,654·0 | 558·63 | .... | 64,654·0* |
| | M.L's. 127, 128, 129 .... | Kirtons .... .... .... | 1915–19 | .... | .... | 2,136·76 | 17·78 | 379·89 | 7,572·0 | .... | .... | 7,572·0 |
| | M.L. 250 .... .... | Kirtons .... .... .... | 1952–53 | 340·0 | 16·0 | 24·52 | 73·3 | 17·98 | 1,453·13 | 7·45 | .... | 1,453·13† |
| | M.L. 12PP .... .... | Kirtons main lode .... | 1916 | .... | .... | 15·39 | 65·1 | 10·02 | 227·0 | .... | .... | 227·0 |
| | M.L. 140 .... .... | Surprise .... .... .... | 1916 | .... | .... | 0·71 | 61·97 | 0·44 | 9·0 | .... | .... | 9·0 |
| | M.L. 126 .... .... | Uga .... .... .... | 1916 | .... | .... | 121·03 | 69·24 | 83·8 | 1,996·0 | .... | .... | 1,996·0 |
| | M.L. 223 .... .... | Uga .... .... .... | 1949 | .... | .... | 7·11 | 59·77 | 4·25 | 419·35 | 5·9 | .... | 419·35† |
| | Loc. 436 .... .... | Wheal of Fortune Extended | 1917–18 | .... | .... | 125·82 | 34·28 | 43·13 | 793·0 | .... | .... | 793·0 |
| | Loc. 436 .... .... | Wheal of Fortune Extended (Fortuna Exploration Co. N.L.) | 1918–1920 | .... | .... | 123·38 | 41·47 | 51·17 | 1,316·0 | .... | .... | 1,316·0 |
| | Loc. 436 .... .... | Wheal of Fortune Extended (Fortuna Exploration Co. N.L.) | 1949–1953 | 9,399·0 | 1,417·5 | 1,226·94 | 74·6 | 915·28 | 139,819·1 | 185·11 | .... | 139,819·1 † |

Table 2—*continued.*

*Lead Ore and Concentrates—continued.*

| Mining Centre | No. of Lease, Claim, or Location | Name | Period | Estimated Mine Treatment | | Realised Production | | | | | | Total Value F.O.B. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ore | Concentrate | Ore and Concentrate | Pb | Lead | | Silver | | |
| | | | | | | | | Tons | Value | Fine ozs. | Value | |
| | | | | Tons | Tons | Tons | % | | £ | | £ | £ |
| | Loc. 436 .... .... | Wheal of Fortune Extended (Paringa Wheal Fortune Pty., Ltd.) | 1952–56 | 24,629·0 | 2,954·55 | 2,952·75 | 74·58 | 2,202·2 | 156,184·11 | .... | .... | 156,184·11 |
| | Loc. 436 .... .... | Wheal of Fortune Extended (Paringa Wheal Fortune Pty. Ltd.) | 1957–1960 | 8,097·5 | 1,493·99 | 1,409·92 | 73·33 | 1,033·86 | 70,207·22 | 697·55 | 275·53 | 70,482·75 |
| | Loc. 1146 .... .... | Wheal Ellen (Fremantle Trading Co. Ltd.) | 1917–1924 | .... | .... | 22,033·28 | 8·25 | 1,818·71 | 52,456·0 | .... | .... | 52,456·0 |
| | Loc. 1146 .... .... | Corderoy Mines Ltd. .... | 1954–56 | 129·25 | 6·88 | 7·42 | 63·21 | 4·69 | 462·47 | .... | .... | 462·47 |
| | M.L. 142 .... .... | Nooka Lead Mining Co. N.L. | 1917–18 | .... | .... | 876·12 | 20·13 | 176·4 | 3,349·0 | .... | .... | 3,349·0 |
| | M.L. 276 .... .... | Nooka .... .... .... | 1960 | 801·5 | 119·45 | None | Realised | .... | .... | .... | .... | .... |
| | L.T.T. 1281H on late M.L. 132 | Nooka .... .... .... | 1954–55 | 32·0 | 1·48 | 1·4 | 71·43 | 1·0 | 76·93 | .... | .... | 76·93 |
| | M.L. 27PP .... .... | Lady Samson .... .... | 1926 | .... | .... | 45·0 | 16·11 | 7·25 | 132·0 | .... | .... | 132·0 |
| | L.T.T. 1125H (on late M.L. 27PP) | Shanks, E. .... .... | 1949 | .... | .... | 8·79 | 69·97 | 6·15 | 416·05 | .... | .... | 416·05 |
| | P.A. 149 .... .... | Normans Well .... .... | 1930 | 436·0 | 38·0 | 38·0 | 67·0 | 25·46 | 509·0 | .... | .... | 509·0 |
| | M.C. 6 .... .... .... | Normans Well .... .... | 1950–51 | 310·0 | 40·0 | 38·88 | 66·02 | 25·57 | 3,432·9 | 16·73 | .... | 3,432·9 † |
| | L.T.T. 1287H on late M.C. 6 | Camp and Party .... | 1954–55 | 169·5 | 26·38 | 24·4 | 70·49 | 17·2 | 1,498·77 | 14·54 | .... | 1,498·77† |
| | M.L's. 227, 37PP .... | Gabalong Asbestos Co. Pty. Ltd. | 1949–1956 | 1,698·0 | 103·96 | 100·07 | 70·4 | 70·45 | 6,924·39 | 42·82 | 2·4 | 6,926·79 |
| | M.L. 39PP .... .... | Mulligans .... .... | 1949–1952 | 711·0 | 114·06 | 112·56 | 76·28 | 85·86 | 9,648·45 | 30·31 | .... | 9,648·45† |
| | L.T.T. 1321H on late M.L. 39PP | Camp, S. G. .... .... | 1955–56 | 41·25 | 3·49 | 2·69 | 65·06 | 1·75 | 185·65 | 1·43 | 0·65 | 186·3 |
| | P.A. 210 .... .... | Beaton, D. C. .... .... | 1949 | .... | .... | 6·41 | 54·91 | 3·52 | 243·95 | 2·21 | .... | 243·95† |
| | P.A's. 211, 212 .... | Merritt and Coates .... | 1949 | .... | .... | 2·02 | 66·34 | 1·34 | 142·65 | 1·82 | .... | 142·65† |
| | P.A. 51PP .... .... | Yiapa Syndicate .... | 1949 | .... | .... | 2·86 | 67·83 | 1·94 | 211·0 | .... | .... | 211·0 |
| | M.L. 268 .... .... | McGuires Lead Mine .... | 1950–59 | 4,371·55 | 744·76 | 763·43 | 74·04 | 565·26 | 51,379·37 | 156·02 | 38·1 | 51,417·47 |
| | Loc. 334 .... .... | Wheal Fortune .... | 1950–51 | 816·78 | 56·04 | 83·73 | 67·81 | 56·78 | 5,197·15 | 32·06 | .... | 5,197·15† |
| | Loc. 437 .... .... | Simpson and Hyde .... | 1951 | 30·0 | 2·73 | 2·73 | 67·76 | 1·85 | 255·8 | .... | .... | 255·8 |
| | P.A. 244 .... .... | Woodcock and Chisholm | 1951 | .... | .... | 0·74 | 64·86 | 0·48 | 58·55 | .... | .... | 58·55 |
| | M.L. 257 .... .... | South Baddera .... .... | 1951–53 | 387·0 | 78·69 | 78·28 | 72·04 | 56·39 | 4,139·21 | 39·63 | .... | 4,139·21* |
| | P.A. 73PP .... .... | Simpson and Hyde .... | 1952–53 | 321·0 | 64·75 | 61·59 | 72·54 | 44·68 | 3,783·79 | 30·79 | .... | 3,783·79† |
| | M.C. 28 .... .... .... | Chiverton .... .... | 1955–56 | 34·25 | 4·68 | 4·0 | 65·0 | 2·6 | 289·62 | 2·12 | 0·85 | 290·47 |
| | P.A. 251 .... .... | Reynolds, P. .... .... | 1955–56 | 161·75 | 10·67 | 8·57 | 52·98 | 4·54 | 359·4 | .... | .... | 359·4 |
| | M.L. 58PP .... .... | Lucy .... .... .... | 1956 | 133·75 | 7·16 | 7·07 | 75·81 | 5·36 | 267·3 | .... | .... | 267·3 |
| | M.L. 263 .... .... | Kathleen Hope .... | 1957–59 | .... | .... | 27·54 | 67·83 | 18·68 | 1,320·3 | 26·51 | 10·4 | 1,330·7 |
| | P.A. 257 .... .... | A.G.M. Syndicate .... | 1957–58 | .... | .... | 7·78 | 50·64 | 3·94 | 268·36 | 63·52 | 23·34 | 293·9 |
| | M.L. 71PP .... .... | Roger Malray .... .... | 1958 | .... | .... | 11·74 | 39·78 | 4·67 | 273·05 | 22·21 | 8·95 | 282·0 |
| | M.L. 66PP .... .... | Lucky Strike .... .... | 1959 | .... | .... | 81·71 | 76·67 | 62·65 | 3,499·0 | .... | .... | 3,499·0 |
| | Sundry claims .... .... | .... .... .... .... | 1915–1929 | .... | .... | 437·12 | 39·15 | 171·14 | 3,167·0 | .... | .... | 3,167·0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nabawa .... | Loc. 833 .... .... | Protheroe Lead Mine : Heinsen Bros. | 1946–1951 | 11,516·0 | 2,789·0 | 2,825·94 | 77·61 | 2,193·34 | 187,726·1 | 24·82 | .... | 187,726·1* |
| | Loc. 833 .... .... | Protheroe Lead Mine : Anglo-Westralian Mining Pty. Ltd. | 1950–58 | 73,990·0 | 14,562·0 | 14,661·28 | 77·95 | 11,427·95 | 1,458,803·25 | 272·8 | .... | 1,458,803·25† |
| | Loc. 833 .... .... | Narra Tarra .... .... | 1913–14 | .... | .... | 744·05 | 72·59 | 540·13 | 10,318·0 | .... | .... | 10,318·0 |
| | Loc. 833 .... .... | Narra Tarra .... .... | 1916–1926 | .... | .... | 125,685·45 | 9·42 | 11,837·14 | 351,427·0 | .... | .... | 351,427·0 |
| | Loc. 833 .... .... | Jupp and Others .... | 1927 | .... | .... | 846·0 | 15·32 | 129·6 | 2,293·0 | .... | .... | 2,293·0 |
| | Locs. 118, 119 .... .... | Lauder and Raven .... | 1918–1920 | .... | .... | 106·21 | 56·51 | 60·02 | 1,345·0 | .... | .... | 1,345·0 |
| | Loc. 119 .... .... | Heinsen Bros. .... .... | 1937–1943 | .... | .... | 1,950·5 | 9·28 | 181·0 | 2,060·0 | .... | .... | 2,060·0 |
| | Sundry claims .... .... | .... .... .... .... | 1900–1920 | .... | .... | 238·16 | 14·35 | 34·18 | 442·0 | .... | .... | 442·0 |
| Oakagee .... | Loc. 311 .... .... | Oakagee .... .... .... | 1955–56 | 159·5 | 18·7 | 17·68 | 73·92 | 13·07 | 1,524·47 | .... | .... | 1,524·47 |
| | P.A. 71PP .... .... | Elphick and Monk .... | 1953 | 25·0 | 2·83 | 2·78 | 79·86 | 2·22 | 163·83 | 1·08 | .... | 163·83† |
| White Peak .... | Loc. 470 .... .... | Saxon .... .... .... | 1954–55 | 742·0 | 115·34 | 126·17 | 62·07 | 78·32 | 7,026·03 | 15·68 | 6·35 | 7,032·38 |
| | Sundry Producers .... | .... .... .... .... | .... | .... | .... | 1·83 | 67·21 | 1·23 | 150·85 | .... | .... | 150·85 |
| | | | | .... | .... | 451,990·05 | .... | 73,559·85 | 4,029,624·11 | 6,583·73 | 1,666·07 | 4,031,392·98 |

* Also records minor quantities of zinc.

† Silver content by assay only—not payable.

*Note :* Production records were not kept by the Mines Department prior to 1900. Maitland (1903) shows that exports from the Field in the period 1850–1901 totalled 9,349·78 tons of copper ore and 33,643·85 tons of lead ore. Much of this copper ore probably was mined from the Gwalla, Wanerenooka and Wheal Fortune ore bodies.

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## SUMMARY REPORT ON THE MENDEL WONGOONDY TEST HOLE, VICTORIA DISTRICT.

### SOUTH WEST DIVISION.

*By K. H. Morgan, B.Sc.*

### INTRODUCTION.

The area to the north of the Upper Irwin River has been one of poor underground water yield and subject to frequent enquiry from settlers for many years. Fairly extensive test boring has been carried out. All indicate that very few aquifers exist in the sequence, and when found, water is generally too saline even for stock use. The general conclusions, prior to the current drilling, in this region (particularly following publication of the Bulletin 108 G.S.W.A. 1954) is that if large supplies of water are required other than the localised surface occurrences, then deep drilling of the section is necessary.

The succession may contain aquifers hereto unknown, or certain older rocks known to outcrop northwards could occur deeper in the section. Proposals for a deep test also included consideration of the possible structural configurations of the region. In this case, structure is of equal importance to lithology as a control of water accumulation and salinity.

A test hole was sited on Reserve 22/21141 (State Lithograph 127/80) . four miles west from the Mendel-Wongoondy hall site and thirty yards north of the road.

### DRILLING EQUIPMENT.

The Mines Department Failing rotary rig was used with minimum casing and mud control. Water testing was carried out with a 16.5 gallon bailer on the rig sand line.

### GEOLOGY.

#### REGIONAL CONSIDERATIONS.

Following mapping by W. D. Campbell (Bulletin 38 G.S.W.A. 1916) the Irwin River Lower Permian inlier was indicated to extend northwards below the Mendel Wongoondy area. This work was confirmed and refined by many investigators since. The last comprehensive survey was published in Bulletin 108 G.S.W.A. by Johnson *et al.* (1954). The general features of the area are as follows:

It is bounded to the east and partially to the west by outcropping Precambrian granitic rocks. These boundaries follow the general north-north-west and south-south-east structural lineaments typical of the bounds of the sedimentary areas, as well as the enclosed sediments. The Precambrian granitic rocks abut a thick sequence of sediments through steep (most likely gravity type) faults. On the western side of the sedimentary inlier are sandplains underlain by Mesozoic arenite facies. The eastern area contains Lower Permian of mainly argillite facies. (This Permian facies generalisation is particularly evident in the deeper parts of the section). Although most of the area in the vicinity of the Mendel-Wongoondy estates are covered by alluviums, sand and lateritic deposits, it is evident that the Lower Permian sequence exists at shallow depth. This conclusion is evident as far back as Campbell's mapping in 1909.

*Stratigraphy.*

A summary of the known stratigraphy expected with modification in the vicinity of the test hole site is represented in the following stratigraphic table (see Table I).

TABLE I

Stratigraphic Sequence

| Age | Stage | Rock Unit | Maximum Thickness |
|---|---|---|---|
| Permian .... | Sakmarian | Holmwood Shale | 1,820 feet |
| | | Nangetty Formation | 1,500 feet (+) |
| Lower Palaeozoic | | Tumblagooda Sandstone / ? / ? / ? / Yandanooka* ? / Group | 6,000 feet (+) - - - - - 30,000 feet (+) ? |
| Archeozoic | | Mullingarra Gneiss | |

* The relationship between the Yandanooka Group (Group Status) and the Tumblagooda Sandstone (Formation Status) is not fully known.

NORTHAMPTON

MINERAL

FIELD

INDIAN OCEAN

AJANA TOWNSITE

NORTHAMPTON TOWNSITE

NANSON TOWNSITE

YUNA TOWNSITE

NARRA TARRA

MT SOMMER

MT WILLOUGHBY

MT ERIN

GALENA MINE

DRUMMOND COVE

2 Miles to Geraldton.

## LEGEND

CAINOZOIC — QUATERNARY — PLEISTOCENE — RECENT
- Superficial deposits : alluvium, outwash gravels, residual sand, estuarine deposits.
- Calcareous sandstone ( coastal limestone ).

CAINOZOIC — TERTIARY
- Laterite, lateritic soil and sand plain.

MESOZOIC — JURASSIC
- Sandstone, shale, limestone.

PALAEOZOIC — PERMIAN
- Shale and mudstone. ( Holmwood shale ).

PALAEOZOIC — ? LOWER SILURIAN
- Sandstone and conglomerate, fine to coarse grained, pink to red, current bedded in part. ( Tumblegooda Sandstone ).

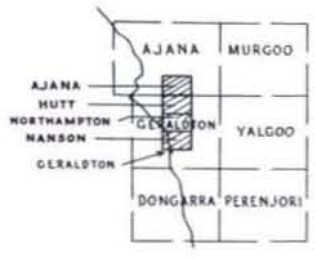
ARCHAEOZOIC PROTEROZOIC
- Dolerite dykes.
- Quartzite : includes felspathic, platy and massive quartzites, recrystallised glassy quartz and quartz-felspar intergrowths. Granulite : garnet granulite, sillimanite granulite, hypersthene granulite.

## REFERENCE

- Geological boundary
- Fault
- Dip and strike of bedding
- Vertical dip
- Horizontal dip
- Rivers and streams
- Trigs
- Hills — e.g. NONGA HILL
- Highway
- Roads
- Railway
- Railway siding — e.g. Halba Siding
- Pipeline — Pipe Line
- Telegraph line
- Mine — e.g. GALENA
- Mineral Field Boundary

## LOCALITY MAP


INDEX TO ADJOINING 1 & 4 MILE SHEETS




G. S. W. A.

# GEOLOGICAL MAP OF THE NORTHAMPTON MINERAL FIELD AND ENVIRONS

SCALE : 1 INCH TO 4 MILES

Mapping by A.J. Noldart and W.R. Jones, 1961.

G.S.W.A.

# STRUCTURAL SKETCH MAP OF THE NORTHAMPTON BLOCK

4 0 4

1 inch = 4 miles

REFERENCE

Trend Line

Watercourses

Fault

Dykes & Joints

114° 30'

115°

27° 45'

28° 45'

1842 - III

1842 - II

1841 - IV

1841 - I

1841 - III

1841 - II

1840 - IV

1840 - I

Hardabut Probable increasing downthrow fault

Murchison R.

Yandi

(Urella ?) Fault

Hutt R.

Fault

Chapman R.

Geraldton Group

from gravity data

Geraldton

Fault

Greenough R.

BMR Fault

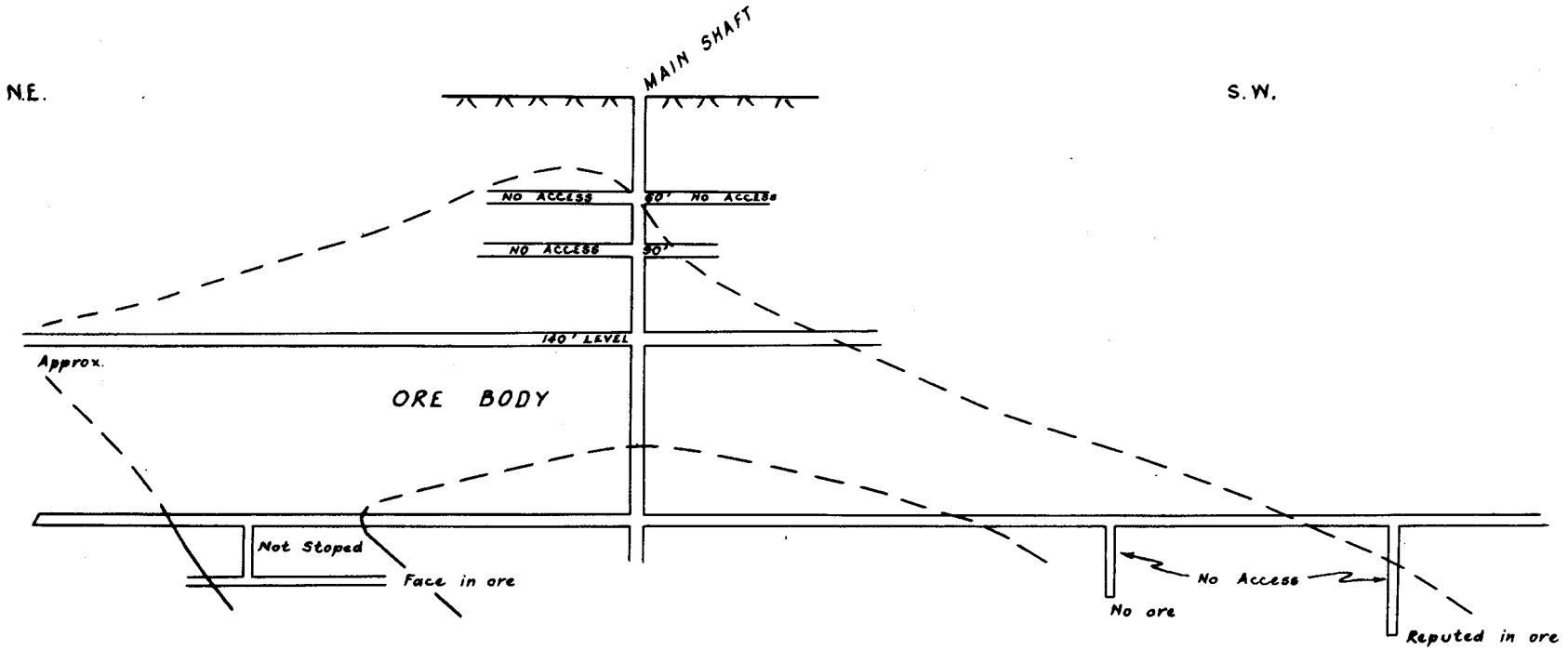
Probable increasing downthrow

NORTHAMPTON BLOCK

INDIAN OCEAN

GERALDTON

DM




Old workings not shown.

FIGURE 20

G. S. W. A.

# LONGITUDINAL SECTION

OF

# GURKHA LEAD MINE M.L. 256, NORTHAMPTON

Scale : 100 Feet to an Inch

W. R. Jones, November 1960.

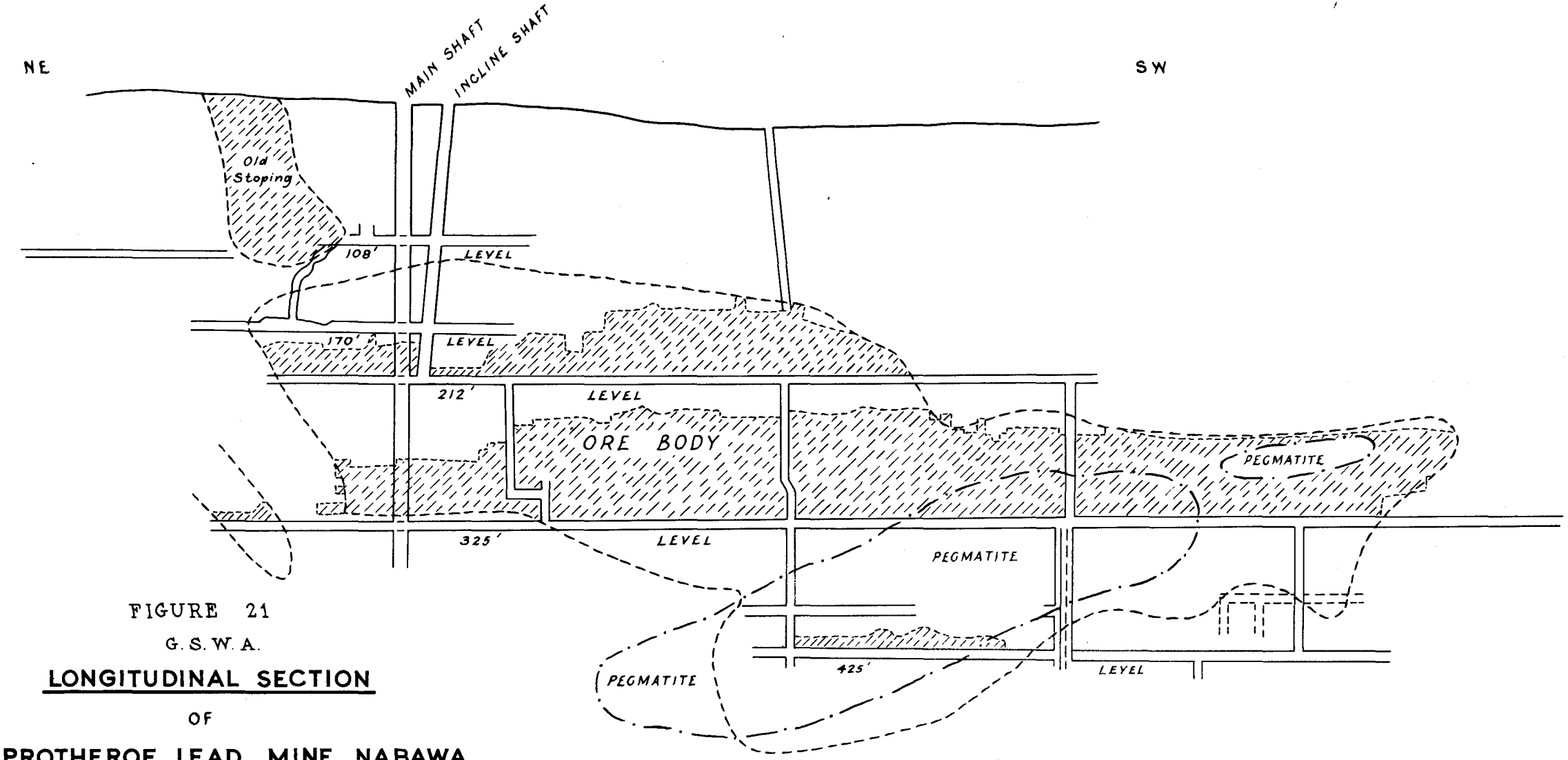



FIGURE 21

G. S. W. A.

## LONGITUDINAL SECTION

OF

## PROTHEROE LEAD MINE, NABAWA

Scale : 100 Feet to an Inch

*Unpublished Report by F. A. Campbell, 1952*

*Structure.*

Structure of the region is mentioned only in brief. Geo-hydrological considerations include the structural elevation of any aquifer intake and the down dip structural configurations.

The first and most prominent feature is the north-north-west and south-south-east trending Darling fault line separating Precambrian granitic rocks to the east from the sedimentary section to the west. Local structural elevation of the sediments is likely against this contact in the form of up drags or up-warps. Corresponding topographic elevation also occurs eastwards (approximately 400 feet) across this contact. It is possible therefore that any bed high in the section, capable of being an aquifer, could have intake near the Darling fault line. A head of water could develop.

The second main structural feature is the Urella fault line. This parallels the Darling fault twelve to fourteen miles westwards. Large relative down throw westwards is known across this fault south from the area. Outcrop of Jurassic rocks is controlled eastwards by this fault line.

The third main structural feature is the Mullingarra gneissic inlier. Its expression is possibly revealed as the nose in the Nangetty Formation in the vicinity of Bugalie Hill. A trace of the crestal line through this nose passes within four miles west of the drill site. Gneissic rocks of the Ajana Block and Tumblagooda sandstone outcrops eighteen miles westwards from the Urella fault. The interpretation is of two gravity fault blocks bounded eastward by the Darling fault and the Urella fault. The greatest amount of down throw of the blocks is against the western side of the fault. This results in an easterly tilt to the blocks in a normal gravity step fault pattern. (Only the major faults have been given. The eastward tilt is no doubt magnified by many smaller basement faults). The intensity of faulting appears to decrease northwards, where several unconformable sedimentary contacts appear to occur. The regional sedimentary dip from the vicinity of the Mullewa railway line, is thought to be south-eastwards and east of the Urella fault whereas the regional dip in the Irwin River area is north-east. This explanation of structure would place thhe Mendel-Wongoondy test hole on the south-west side of a structural depression.

*Location of the Bore Site.*

The bore was located on a site well down in the Holmwood shales. The object was to test the section below this formation. There was the possibility that a reduced section would bring the Tumblagooda Sandstone, or its equivalent, within reach of the drilling plant. The bore site was located topographically low to take full advantage of any hydrostatic head. Although artesian water was not expected higher up in the section, preparation for an artesian flow was made.

## RESULTS OF DRILLING.

*Palaeontology.*

Samples of core were examined by B. E. Balme, University of Western Australia. A Lower Permian age is indicated from the core below 1,024 feet (see Plate XXXVII) in a preliminary investigation (pers comm.) This age is also indicated in the cuttings sample from 860 feet. The sandstone between 880 feet and 1,024 feet is included within the determined samples. This rules out the possibility of it being part of the Tumblagooda Sandstone (the facies beneath the sandstone also indicates Lower Permian fluvio-glacial like sediments.)

*Stratigraphy.*

The bore section has been tentatively divided into the stratigraphic units indicated in Table II. The sandstone below 880 feet (see Plate XXXVII) has not been recognised previously, and for reasons outlined below it is included within the Nangetty Formation. It would appear from the bore hole section that glacial erratics are restricted to the section above 820 feet. The tendency to assign formation status to the 880-1,024 feet sandstone (Mendel Sandstone Member, Table II) would have been stronger had not the core below 1,024 feet been a glacial-like sediment. There is little doubt that as the results of deeper bores (and possibly closer field work) become available, a group status will be applicable to the Nangetty Formation and perhaps some direct correlations be made with the Lyons Group. The Mendel Sandstone Member at the moment is thought of as a Harris-like sandstone (basal Lyons Group). Formal recognition of these names is not suggested until some lateral extent is demonstrated. Particular reference is made here to the units between 535-820 feet (Plate XXXVII) where the division based on boulder content may prove very local.

TABLE II

Bore Hole Stratigraphic Table

| Age | Stage | Correlative | Bore Formation | Member | Thickness |
|---|---|---|---|---|---|
| PERMIAN | SAKMARIAN | HOLMWOOD SHALE | -?-?-?-?-?-?- | | ----- |
| | | | HOLMWOOD SHALE | | 515 feet |
| | | NANGETTY FORMATION | NANGETTY FORMATION | Wye | 205 feet |
| | | | | Illino | 80 feet |
| | | | | Yanga | 60 feet |
| | | | | Mendel Sandstone | 144 feet |
| | | | | Wongoondy | 10 feet (+) |
| | | | —?—?—?—?— | ?—?—?—?— | ?—?— |

*Hydrology.*

Many of the hydrological factors of the region have been mentioned in previous sections. The region was included in the Kokatea Groundwater Province (Johnson *et al.* Bulletin 108 G.S.W.A. 1954). It was defined on characters of high salinity of underground water. There was reasonable grounds to assume this characteristic would hold for the complete Lower Permian section, if not the full sedimentary section. The present drilling has partially confirmed this. High salinity is thought to be due both to litho-facies as well as both local and regional structure. The hole was tested after a definite region of potential aquifer was penetrated, namely the 880-1,024 feet Mendel Sandstone Member. Testing was carried out firstly by releasing upper mud pressure by baling from the top. This was followed by alternated baling and sampling from various intervals lower down the mud column. Although only 750 feet of sand line was available for the test, it was quite clear that nearly all the water was coming from below this depth. It could be assumed, with fair reliability, that the water was coming from the full section of the Mendel Sandstone Member. After baling for 12 hours, at rates up to 950 gallons per hour, the water level was induced to rise to approximately 103 feet. The final sodium chloride content tested on site was 790 grains per gallon. A complete analysis is given in Table III.

Table III.

*Water Analyses.*

pH 5.4 weakly acid.

| Mineral Matter | Grains per gallon |
|---|---|
| Calcium | 39.6 |
| Magnesium | 5.6 |
| Sodium | 229.0 |
| Potassium | 1.6 |
| Bi-carbonate | 2.6 |
| Carbonate | — |
| Sulphate | 15.4 |
| Chloride | 427.0 |
| Nitrate | 1.1 |
| Silica | 0.5 |
| Iron oxide | 0.5 |
| Aluminium oxide | 0.1 |
| Total | 723.0 |

Assumed Combination on evaporation at N.T.P.

| | |
|---|---|
| Calcium carbonate | 2.1 |
| Magnesium carbonate | — |
| Sodium carbonate | — |
| Calcium sulphate | 21.8 |
| Magnesium sulphate | — |
| Sodium sulphate | — |
| Calcium chloride | 89.5 |
| Magnesium chloride | 21.9 |
| Potassium chloride | 3.0 |
| Sodium chloride | 580.0 |
| Sodium nitrate | 1.5 |

Hardness calculated as sodium carbonate.

| | |
|---|---|
| Total hardness | 121.9 |
| Bi-carbonate (temporary) hardness | 2.1 |
| Non-carbonate (permanent) hardness | 119.8 |
| Calcium hardness | 98.9 |
| Magnesium hardness | 23.0 |

(Sgd.) R. C. GORMAN,
Deputy Government Agricultural Chemist.

*Abandonment.*

After testing the hole was reconditioned with mud, surface casing left in place and capped, then abandoned.

## RECOMMENDATIONS.

*Further work in the area.*

Little hope is maintained for obtaining water of low salinity deeper in the section. The best that could be hoped is artesian water of low enough salinity for stock use. It would be ideal to sink a deep test beyond the section penetrated in this bore to confirm stratigraphic and hydrological hypotheses presented in this report. However, the cost of sinking a deep bore would not be economic for general stock water supplies in the area. Furthermore, boring into the Lower Permian section is not recommended.

*Drilling and Logging Practice.*

Only fundamental information could be gained from this bore hole due to the limited techniques used. It is certain that a great deal more information would be available if a wider range of rotary drilling practices were used. It is recommended that future drilling for hydrological investigations include mud control, geographic records, electric logging, formation testing, and perforating tests.

It is felt certain that the expenditure for setting up these techniques is thoroughly justified. The high initial cost of a full scale rotary drilling plant will no doubt be off-set after a limited number of holes are drilled. This is obvious when costs are considered for obtaining the necessary mechanical services from outside firms. From past experience in this field, the author has no doubt of the value of rotary drilling for flexibility of use, speed, low cost and geological recording, when considered on long term programmes. Such programmes are evident in the future of hydrological investigation by drilling in this State.

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# REPORT ON THE HYDROLOGICAL INVESTIGATION AT THE WILUNA GROUNDWATER RESEARCH STATION.


by K. H. Morgan, B.Sc.


## INTRODUCTION.

Following recommendation in 1953 by Ellis, the former Government Geologist, that attempts be made to utilise the large volume of groundwater known to occur a few miles east of the Wiluna townsite, and from communication with C.S.I.R.O. workers in 1959, the Department of Agriculture selected a site to set up a research station. Its aim is to investigate suitable crops that may be grown under irrigation from underground waters of the alluviated river valleys known to occur widely throughout the district. The block selected has an area of 1,000 acres and is considerably elongated east-west (200 chains east-west by 50 chains north-south). This design is to cover as great a cross section of the alluviated water course as practical.

Berliat visited the area in 1960 and proposed an investigation programme with 1,000 feet of drilling as the minimum requirement to test the cross section of the alluviated valley and have at the same time reasonable chance of encountering sufficient supply for the requirements of a 35 acre experimental irrigation area.

The area is covered, in the most part, by a mantle of loose, red, sandy soil with spinifex and a sparse cover of mulga scrub. Denser mulga cover occurs in north-east to south-west lineated belts. These are thought to be on soils with a higher clay content. The Kukabubba water course on the eastern end of the block has a dense cover of mulga, despite considerable tree cutting of past years. This tree belt shows up well on air photos. The soil here has a distinct surface clay seal. The Kukabubba drainage line has no incised channel. The only visual evidence in the dry season is the clay surface seal and the dense tree line.

The present account is meant only as a summary of data obtained from the investigation. Particular emphasis has been placed on the use of electrical resistivity methods.

## GEOPHYSICAL METHODS.

Following the drilling and testing of bores 1 to 4, the location of bore sites was based partly on the results of resistivity traversing. Interpretation of resistivity data was based on comparison with results obtained from bores 1 to 4, and the known local hydro-geological setting from the Lorna Glen, Milbillillie Station and C.S.I.R.O. Land Surveys. With basic knowledge only of resistivity methods, an attempt was made to determine the significance of wide areas of differing electrical characteristics by experimentation.

The area was investigated by two resistivity techniques; resistivity mapping or profiling and resistivity depth probes. Both techniques are based on the Wenner configuration of four electrodes equally spaced and in a straight line. The current penetration is about one-third the separation of the current electrodes.

In resistivity mapping the electrode spacing is kept constant and the array moved to consecutive stations along a traverse. Horizontal changes in resistivity, at a depth roughly equal to the unit electrode separation are measured. The depth probing technique measures the variation in resistivity with depth as the electrode system is expanded from the midpoint. Three east-west traverses were mapped with electrode spacings of 25 and 50 feet and depth probes made at the bore sites and other selected points.

Within the limitations of the instrument used, a Megger Earth Tester Series I, some interesting results were obtained. However, as the geophysical survey was mainly experimental the empirical interpretations made at this stage should be accepted with caution. Considerable research into interpretation of the results is necessary before the true value of the method can be assessed.

## DRILLING AND TESTING RESULTS.

### BORE 1.

This bore was located as a convenient place to commence the drilling programme before any landmarks had been established in the area. The site is 150 feet north of an east-west centre line and 3,150 feet from the western boundary. The area is in sandy soil with spinifex and sparse shrubbery. Drilling commenced prior to geophysical surveying. Subsequently a 25 foot electrode separation traverse was run along the east-west centre line and a depth probe was made over the completed bore.

*Lithology.*

0-3 feet: Red-brown clay, silt, fine to medium grained sand grit of quartz and silica.

3-20 feet: Light brown to yellow-brown clay, silt, fine to medium grained sand grit of quartz and silica. Chips of white silicified, slightly calcareous clay.

20-43 feet: Yellow-brown clay, silt, sand-sized grit of quartz and silica. Chips of white calcareous, silicified clay.

43-50 feet: Yellow-brown coarse grained sand grit of quartz and chalcedony with minor matrix of white calcareous clay.

50-65 feet: Yellow, soft clay; pale yellow silicified clay chips; sand, grit of quartz and silica.

65-95 feet: Yellow-brown clay, quartz sand grit.

95-100 feet: White clay with approximately 50% medium grain sized sand, grit, quartz.

100-105 feet: Yellow-brown, weathered granitic rock.

Note.—In this report the term quartz is used to indicate clastic quartz derived from igneous rocks. The term silica is used for grains and chips of secondary silica. It is not known if this secondary silica is quartzose, opaline or chalcedonic. The term grit is used to denote angular, sand sized particles.

Lithologic evidence indicates that the base of the main aquifer is near 50 feet. Below this depth the matrix of the quartz grit consists of a soft (kaolinitic?) white clay. Its origin is most likely in a weathering profile on granitic rocks rather than transported sedimentaries.

Initially, bore 1 was pump tested for 24 hours to test equipment. This test was carried out at 4,600 gallons per hour with a final drawdown of 8.5 feet. Following the test on bore 11, bore 1 was retested using new equipment, setting the pump deeper in the hole and attempting to develop the bore further by overpumping. The final test was made at 4,700 gallons per hour for 38 hours with a resultant drawdown of 12.20 feet. No significant developing could be induced by overpumping.

Note.—Variations in sodium chloride content with depth, and complete chemical analyses for all bores are given in Tables I and II, appended to this report.

### BORE 2.

This bore is located 700 feet east of the western boundary of the block and on the east-west centre line. The bore was sited prior to geophysical traversing, in a sandy, spinifex and sparsely tree-covered area. The object was to test the depth of the aquifer at the western limit of the block and near the western limit of the alluviated valley indicated by ground studies.

*Lithology.*

0-5 feet: Red-brown clay, silt and fine to medium-grained sand grit of quartz and silica.

5-11 feet: Brown clay, fine to coarse grained sand grit of quartz.

11-16 feet: Brown weathered granitic rock.

16-17 feet: Slightly weathered granitic rock.

A resistivity depth probe was carried out at the bore site.

Water was first encountered at 12 feet below the surface. Supply was tested with a bailing tube on the drilling plant sand line. Supply was estimated to be less than 1,000 gallons per hour.

### BORE 3.

This is located 2,980 feet east of the datum peg (shown on the bore distribution map), 6,100 feet east of the western boundary of the block and on the east-west centre line. The area has sandy soil, locally white silicified clay outcrops, with vegetation varying from open spinifex grassland to moderate density of tree cover. The bore was located according to the east-west space arrangement suggested by Berliat.

*Lithology.*

0-5 feet: Red-brown, calcareous and ferruginous clay, fine to coarse grained sand grit of quartz and silica.

5-15 feet: Red-brown ferruginous concretionary gravels, chips of white silicified calcareous clay, sand grit of quartz and silica.

15-30 feet: Yellow-brown calcareous clay, fine to coarse grained sand grit of quartz and silica. Ferruginous granule to small pebble concretions.

30-70 feet: Brown to red-brown and yellow-brown calcareous clay, sand and pisolitic to massive ferruginous rock.

70-85 feet: Lithology as in the 30-70 feet interval, but non-calcareous.

85-105 feet: Yellow-brown to white clay; fine to medium grained sand-sized quartz.

105-130 feet: White kaolinitic clay with medium grained sand-grit of quartz.

130-135 feet: White coloured (kaolinised) weathered granite.

Water was first encountered at 14 feet below ground level. After development the static level was 10.8 feet below ground level. The bore was developed by overpumping and a short initial test was run to determine approximate maximum yield when the bore was near equilibrium conditions. This was found to be 5,500 gallons per hour with a drawdown of 27 feet after 1½ hours of pumping. The bore was subject to more development on the completion of bore 10 and a 48-hour pump test was run at 5,500 gallons per hour with a resultant drawdown of 39 feet. Near equilibrium conditions were reached within four hours of the commencement of pumping. A resistivity depth probe over the completed bore hole gave results similar to those over Bore 1. Lithology, type of porosity, and supply are similar to Bore 1.

### BORE 4.

Located on the east-west centre line and 300 feet west of the eastern boundary of the block, the bore was intended to test the depth of the aquifer of the eastern side of the area including the Kukabubba water course and the significance of the saline clay surface in depth. The bore was located, drilled and tested prior to geophysical surveying in this part of the area.

*Lithology.*

0-10 feet: Red-brown clay, silt, sand grit of quartz.

10-80 feet: Yellow-brown clay, silt and sand grit of quartz. The interval 65-70 feet contained some granule to pebble sized quartz.

80-85 feet: Yellow-brown silt, sand, and relatively high percentage of coarse grained grit of quartz.

85-95 feet: Yellow-brown clay, silt and sand grit of quartz.

95-105 feet: White clay with sand grit of colourless quartz.

105-110 feet: Yellow-brown clay with rare sand sized grit of colourless quartz.

110-115 feet: Grey clay with rare sand sized grit of colourless quartz.

115-120 feet: White, hard clay, thought to be weathered, quartz free, igneous rock.

Due to the high clay content generally throughout the section, the bore was expected to have a low yield. Bail testing indicated a supply in the order of 1,000 gallons per hour. This could mainly be from the 80-85 feet interval. Salinity was high by comparison to other bores in the area. The resistivity mapping revealed a generally uniform low resistivity over the Kukabubba water course. The low resistivity is attributed to a predominance of clay and the somewhat higher salinity of underground water. A fairly constant low resistivity was obtained also in the depth probe.

BORE 5.

This bore is located 6,960 feet east of the datum peg and on the east-west centre line. The positioning was selected to test the area between Bores 3 and 4 to continue the gauging of the valley profile and to demonstrate the westward limit of the clayey, saline, Kukabubba water course sediments. Two depth probes near the site showed variable resisitvities indicative of possible intercalated clays and sands.

*Lithology.*

0-10 feet: Red-brown clay, silt, and sand.

10-15 feet: Yellow-brown, calcareous clay, silt, sand of angular grains of quartz and silica. Chips of white silicified clay.

15-25 feet: Yellow-brown to brown calcareous clay, silt, sand and limonitic concretions.

25-30 feet: Yellow, calcareous clay, white silicified clay, silt, yellow sand sized chips of silica.

30-35 feet: Yellow calcareous clay, white silicified clay, yellow silica sand, massive limonitic fragments.

35-40 feet: Yellow-brown silica sand, pebble sized angular silica chips and ferruginous concretions.

40-65 feet: Yellow calcareous clay, silicified clay, silt, yellow sand sized chips of silica.

65-75 feet: White silicified clay chips, fine to coarse grained sand of silica.

75-80 feet: Yellow chips of calcareous and silicified clay, clean quartz and silica sand.

80-85 feet: Yellow chips of calcareous and silicified clay, minor amounts of yellow calcareous soft clay, quartz and silica sand.

85-95 feet: Calcareous clay and coarse grained sand grit.

95-97 feet: Salmon pink clay with sand of silica and clear quartz grit.

97-100 feet: Salmon pink clay with angular quartz sand. Probably a weathered granitic rock.

As is typical of sampling of percussion drilled open-hole wells, it was difficult to estimate the relative porosity-permeability factors of the section. There was some evidence to suggest that the intervals 35-40 feet, 65-70 feet, 75-80 feet and 85-95 feet may be good aquifers.

The first pump test was made on the bore when it was 50 feet deep. This was at 6,200 gallons per hour for 1½ hours with a drawdown of approximately 20 feet. The bore was then deepened to 100 feet, and after some developing by overpumping, tested for 48 hours at approximately 10,200 gallons per hour and with a final drawdown of 25 feet. At the completion of this test, and after recovery had been measured, it was found that the bore would yield 12,500 gallons per hour over a two-hour pump test period, with a drawdown approximating only 13 feet. At this drawdown the pump was at maximum revolutions, and there was evidence of aeration due to cavitation. With a larger capacity pump the bore may be tested at a higher yield.

BORE 6.

This was located 5,875 feet east of the datum point on the east-west centre line and 1,085 feet west from Bore 5. The object was to test the westward extensions of the good aquifer penetrated in Bore 5.

*Lithology.*

0-5 feet: Red ferruginous clay, sand grit with pebble size concretions of limonite.

5-15 feet: Yellow-brown clay, chips of white silicified clay, sand sized grains of quartz and silica, granule to pebble sized ferruginous concretions.

15-30 feet: Yellow to white, silicified clay, sand sized angular grains of quartz, ferruginous concretions.

30-55 feet: Mainly chips, white silicified clay with minor amounts of sand.

55-58 feet: Brown clay, with the major portion consisting of coarse grained quartz sand.

58-60 feet: Brown clay with some quartz sand.

Lithologies indicate that the only section with permeability is between 55-58 feet. Pump testing demonstrated a supply of not more than 2,000 gallons per hour.

The general higher resistivity in this locality, indicated by the mapping and depth probe, may be due either to the low salinity or a tight formation with little water. If the latter obtains then the aquifer in Bore 5 may end about 600 feet east of Bore 6 where a transistion from high to low resistivity value occurs.

BORE 7.

Located 8,500 feet east of the datum peg on the east-west centre line, the area has a sparse tree cover, and is part of the Kukabubba water course. Resistivity traversing indicated similar sub-surface conditions to those encountered in Bore 4. The site was chosen to test the westward extent of the sub-surface effects of the Kukabubba water course and as a means of estimating the eastward extent of the important aquifer penetrated in Bore 5.

*Lithology.*

0-5 feet: Red clay, silt and sand sized quartz.

5-20 feet: Yellow clay, silt and sand sized quartz.

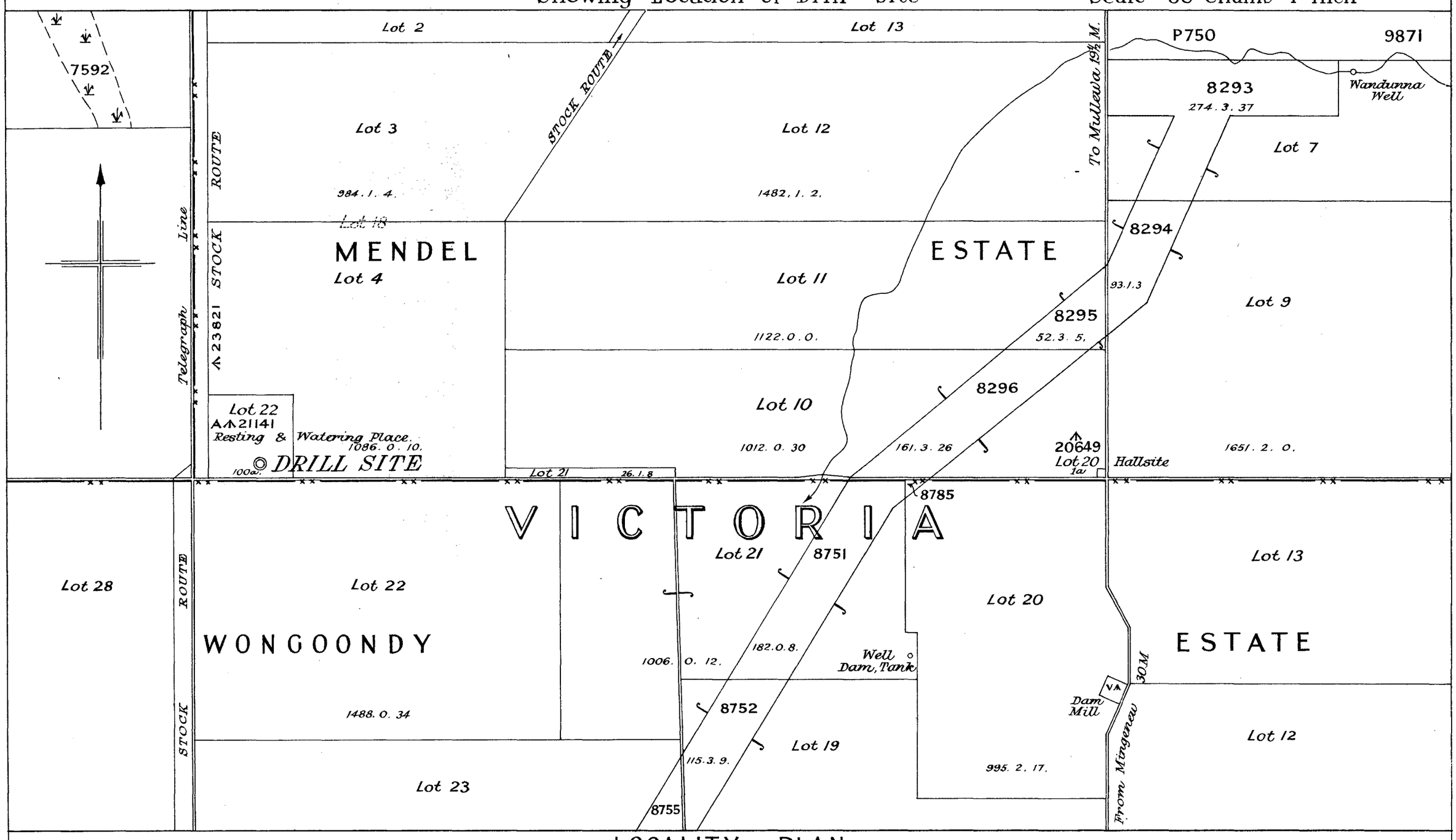
20-40 feet: Yellow clay, silt, sand sized quartz and ferruginous concretions.

40-45 feet: Yellow clay, silt, sand sized quartz, granules and small pebbles of quartz and limonitic concretions.

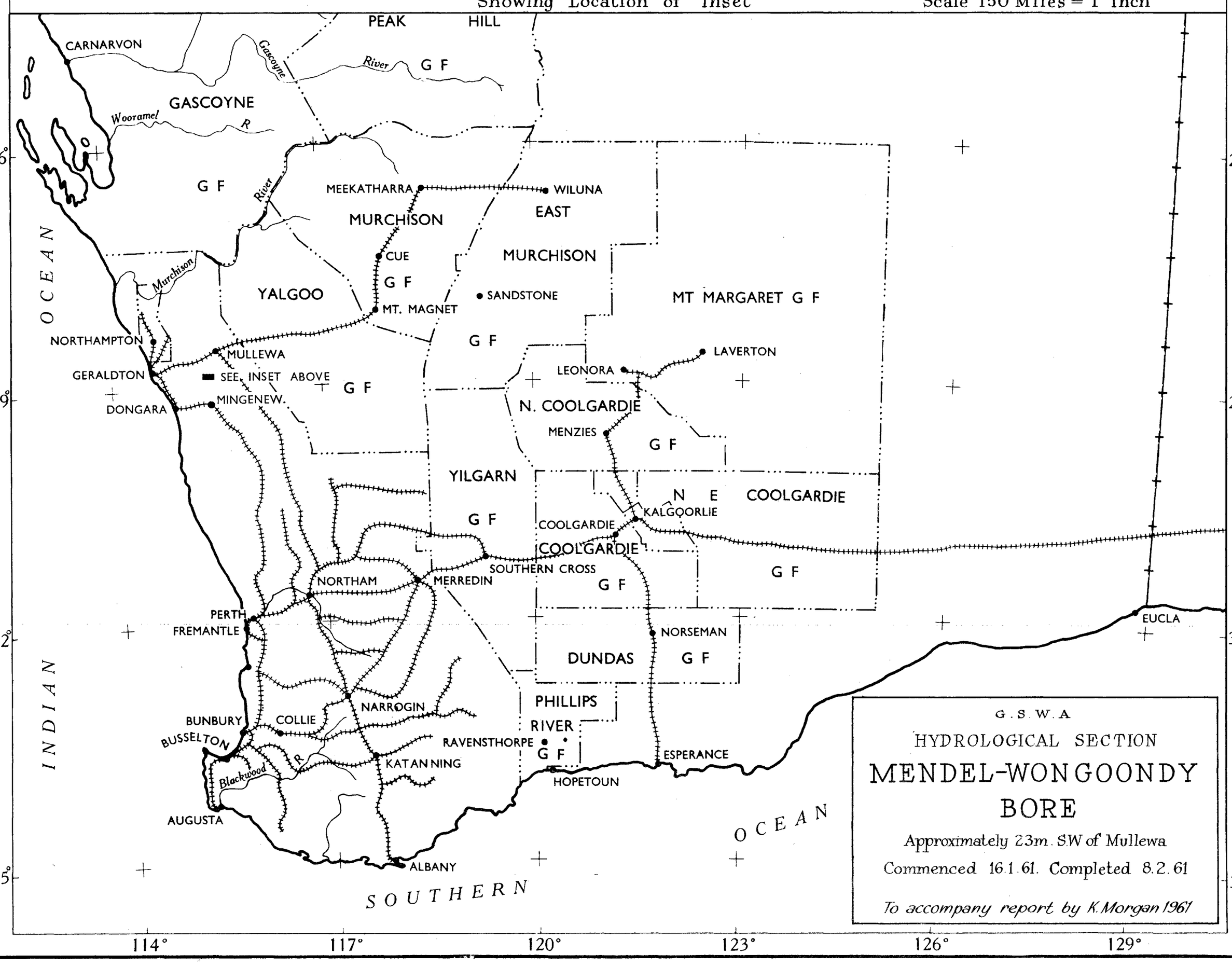
45-50 feet: Yellow clay, silt, sand sized quartz grit.

The lithology indicates a generally low permeability due to high clay content. Pump testing yielded a supply of less than 2,000 gallons per hour. Good correlation with resistivity data is evident. The area between 8,250 feet to 10,000 feet east of the datum peg can be included in the same hydrological province on the basis of resistivity results and drilling of bores 4 and 6. The eastward limit of the aquifer in Bore 5 can be placed near 7,500 feet east of the datum peg.

# INSET PLAN
Showing Location of Drill Site — Scale 80 Chains=1 Inch




# LOCALITY PLAN
Showing Location of Inset — Scale 150 Miles = 1 Inch




G.S.W.A

HYDROLOGICAL SECTION

## MENDEL-WONGOONDY BORE

Approximately 23m. SW of Mullewa

Commenced 16.1.61. Completed 8.2.61

*To accompany report by K. Morgan 1961*

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
HYDROLOGICAL SECTION

# MENDEL-WONGOONDY BORE

## COMPOSITE LOG

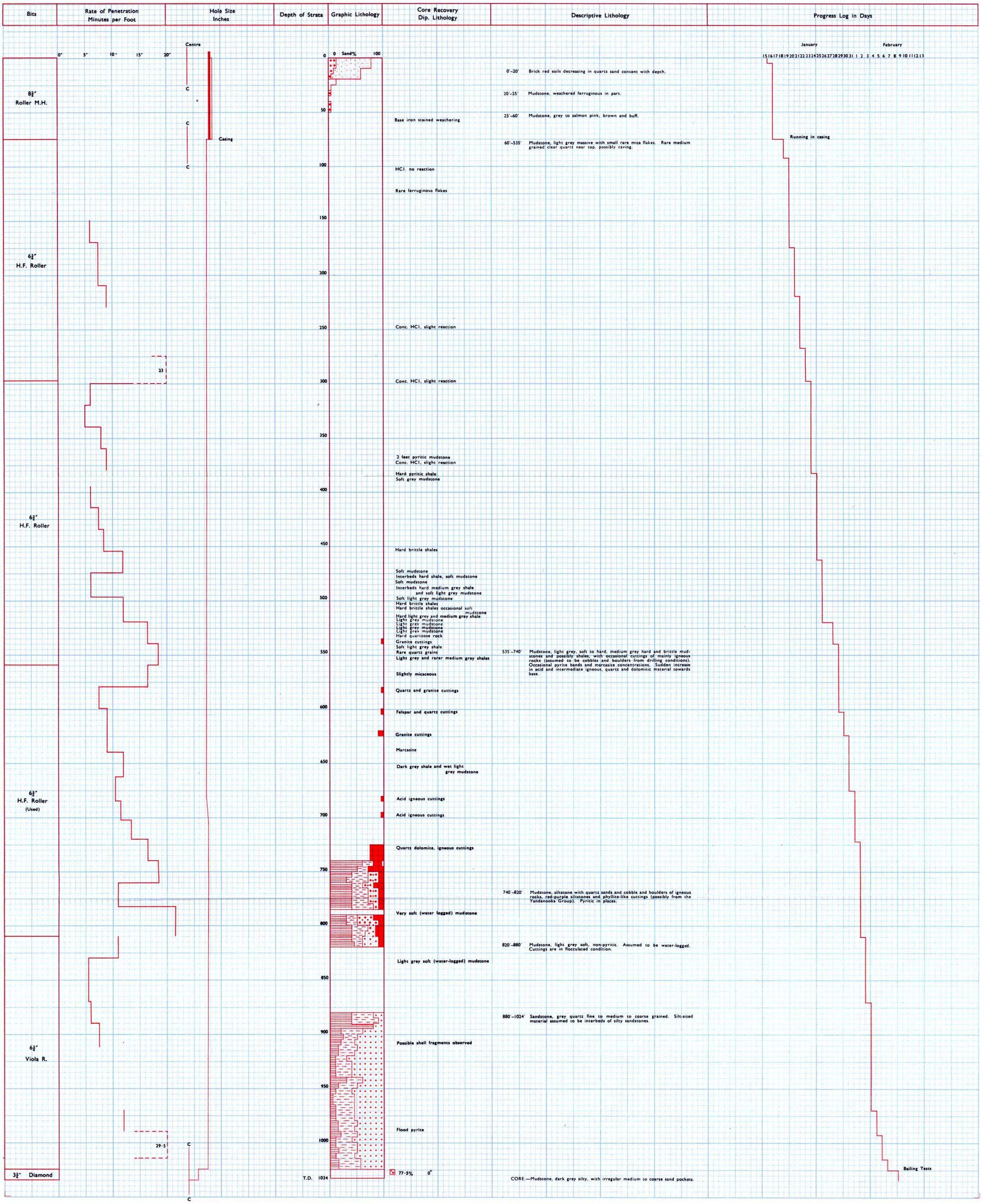
Lat. 28° 39'S.
Date spudded, 16/1/1961

Long. 115° 26' 40"E.
Date completed, 8/2/1961

Lot 22
Reserve A21141
Location : Litho 127/80

Rig : Failing M.1.
R.L. 730' ± 5'
Total Depth, 1034 Feet

Well-site Geologist : K. H. Morgan




Lithologic Reference

- Mudstone
- Rock chips
- Siltstone
- Shale
- Sand
- Medium and Coarse grained sandstone

HYDROLOGY.—Bailing the mud at the completion of the hole indicated the main supply to be from the sandstone, 880 feet to 1024 feet. One day's bailing, at the rate of about 950 gallons per hour, induced a rise to 103 feet. Final sodium chlorinity tested on the site was 790 grains per gallon. The sand content of the section between 740 feet to 820 feet was assumed to be tight formation and of low water yielding potential. This section was not tested separately after it was demonstrated that most, if not all, of the water was rising from 880 feet.

After the final core run, the hole was abandoned ; filled with low density formation mud and the casing capped and left in place.

Halophytes

Clay sealed

Treeless area

calc(?)

Clay sealed surface soil, salt encrustations, open scrub.

Deep sands, spinifex cover, no trees.

Sandy soil with spinifex and open scrub.

Sandy surface, moderate tree cover

Sandy surface, clay surface cake in places, moderate cover.

Sandy soil with spinifex and open scrub

Sandy surface, clay in places, moderate cover.

Sandy surface, moderate tree cover

Clay sealed surface dense tree cover

Nº 1 Datum point 0

Nº 2 -3000 -2000 -1000

Nº 11 1000 2000

Nº 3 3000 Nº 10

4000 5000

Nº 6 6000

Nº 9 C.P. Nº 8

Nº 5 7000

8000 Nº 7 9000

Nº 4 10000

Mid Point

Mid Point

M.H.L. 89°

N

— LOCALITY MAP —

N

Agricultural Research Station

Wiluna Townsite

M.H.L. 89°

Scale of miles 0 1 2 3

Milbillillie Hsd.

Lucerne Patch

REFERENCE

- Fence line
- Track
- Traverse line
- Vegetation boundries
- Approx position of block boundries
- ● Nº 1 Bore sites

G.S.W.A.

GROUNDWATER BORE SITES

AGRICULTURAL RESEARCH STATION

WILUNA

Scale 800 feet to an inch

To accompany report by K.H. Morgan 1961

TABLE I

Sodium Chloride Content in Grains per Gallon Measured with Depth Progress in Bores

| Bore No. | Average Salinity | Depth of Bore in Feet at Sampling | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 |
| 1 | 37 | .... | .... | .... | 35 | .... | .... | 38<br>39* | .... | .... | 35 | .... | .... | .... | .... | .... | .... | .... | .... | 35 | .... | .... | .... | .... | .... |
| 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 3 | 43 | .... | .... | .... | .... | .... | .... | 38 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 43* |
| 4 | 104 | .... | .... | .... | .... | .... | .... | 100*<br>108 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 48<br>.... |
| 5 | 75 | 90 | .... | 60 | .... | 60 | .... | 60* | .... | 65 | .... | 57 | .... | 55 | .... | .... | .... | 55* | .... | .... | .... | .... | .... | .... | .... |
| 6 | 30 | .... | .... | 40 | .... | .... | .... | 60<br>20 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 60<br>.... | .... | .... | .... | .... | .... | .... | .... |
| 7 | 60 | .... | 60 | .... | 60 | .... | 60 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 8 | 60 | 67 | .... | .... | .... | 53 | .... | .... | .... | 55 | .... | .... | .... | 55 | .... | .... | .... | 50 | .... | .... | .... | .... | .... | .... | .... |
| 9 | 40 | 40 | .... | .... | .... | 40 | .... | .... | .... | 37 | .... | .... | .... | 40 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 10 | 45 | 50 | .... | .... | .... | 45 | .... | .... | .... | 45 | .... | .... | .... | 40 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 11 | 67 | 55 | .... | .... | .... | 75 | .... | .... | .... | 72 | .... | .... | .... | 65 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |

* Determined at completion of pump test. Mean salinity tested—56 g.p.g.

*Note* :—Sodium chloride content was determined in the field. Each reading consists of a mean between 4 readings within 5 grains per gallon.

## TABLE II

*Complete Chemical Analyses*

| Bore No. | Lab. No. | G.S.W.A. No. | Specific conductivity (micromhos) | Reaction and pH | Mineral Matter (Parts per million) | | | | | | | | | | | | Assumed Combination on Evaporation at N.T.P. (parts per million) | | | | | | | | | | Hardness calculated as calcium carbonate | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Calcium Ca | Magnesium Mg | Sodium Na | Potassium K | Bicarbonate $HCO_3$ | Carbonate $CO_3$ | Sulphate $SO_4$ | Chloride Cl | Nitrate $NO_3$ | Silica $SiO_2$ | Iron Oxide $Fe_2O_3$ | Aluminium Oxide $Al_2O_3$ | Total Solids | Calcium Carbonate $CaCO_3$ | Magnesium Carbonate $MgCO_3$ | Sodium Carbonate $Na_2CO_3$ | Calcium Sulphate $CaSO_4$ | Magnesium Sulphate $MgSO_4$ | Sodium Sulphate $Na_2SO_4$ | Magnesium Chloride $MgCl_2$ | Potassium Chloride KCl | Sodium Chloride NaCl | Sodium Nitrate $NaNO_3$ | Total Hardness | Bicarbonate (temporary) Hardness | Non-carbonate (permanent) Hardness | Calcium Hardness | Magnesium Hardness |
| 1 | 9022 | 13713 | 1,610 | Neutral 7·7 | 66 | 68 | 202 | 27 | 270 | 0 | 286 | 243 | 70 | 50 | <0·1 | 8 | 1,290 | 165 | 48 | .... | .... | 268 | 106 | .... | 51 | 360 | 96 | 445 | 221 | 224 | 165 | 280 |
| 1* | 10431 | 13717 | 1,630 | Faintly alkaline 7·9 | .... | .... | .... | .... | .... | .... | .... | 250 | 64 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 3 | 9023 | 13710 | 1,750 | Faintly alkaline 8·0 | 68 | 65 | 239 | 36 | 285 | 0 | 297 | 295 | 53 | 64 | <0·1 | 10 | 1,412 | 170 | 54 | .... | .... | 245 | 150 | .... | 69 | 432 | 73 | 438 | 234 | 204 | 170 | 268 |
| 3* | 10432 | 13718 | 1,840 | Faintly alkaline 8·6 | .... | .... | .... | .... | .... | .... | .... | 320 | 62 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 4† | 458 | 9801 | .... | Faintly alkaline 8·1 | .... | .... | .... | .... | .... | .... | .... | .... | 47 | .... | 0 | .... | 2,210 | .... | .... | .... | .... | .... | .... | .... | .... | 1,330 | .... | .... | .... | .... | .... | .... |
| 5 | 9024 | 13711 | 1,960 | Faintly alkaline 8·0 | 68 | 66 | 268 | 44 | 267 | 0 | 264 | 388 | 49 | 48 | <0·1 | 14 | 1,476 | 170 | 41 | .... | .... | 268 | 75 | .... | 84 | 574 | 67 | 442 | 219 | 223 | 170 | 272 |
| 6† | 459 | 9802 | .... | Neutral 7·5 | .... | .... | .... | .... | .... | .... | .... | .... | 51 | .... | 0 | .... | 1,150 | .... | .... | .... | .... | .... | .... | .... | .... | 428 | .... | .... | .... | .... | .... | .... |
| 7† | 460 | 9803 | .... | Faintly alkaline 8·0 | .... | .... | .... | .... | .... | .... | .... | .... | 75 | .... | 0 | .... | 1,340 | .... | .... | .... | .... | .... | .... | .... | .... | 686 | .... | .... | .... | .... | .... | .... |
| 8 | 10433 | 13719 | 1,850 | Faintly alkaline 8·4 | 63 | 65 | 261 | 44 | 244 | 13 | 249 | 369 | 58 | 86 | <0·1 | 22 | 1,474 | 157 | 54 | .... | .... | 244 | 79 | .... | 84 | 543 | 79 | 425 | 222 | 203 | 157 | 268 |
| 9 | 9025 | 13712 | 1,590 | Neutral 7·3 | 62 | 60 | 222 | 35 | 233 | 0 | 244 | 283 | 53 | 50 | <0·1 | 50 | 1,306 | 155 | 65 | .... | .... | 204 | 120 | .... | 67 | 414 | 73 | 402 | 232 | 170 | 155 | 247 |
| 10 | 10434 | 13720 | 1,860 | Faintly alkaline 7·8 | 66 | 61 | 265 | 45 | 277 | 0 | 246 | 369 | 56 | 91 | <0·1 | 27 | 1,503 | 165 | 53 | .... | 227 | .... | 96 | .... | 86 | 541 | 77 | 416 | 227 | 189 | 165 | 251 |
| 11 | 10435 | 13721 | 2,640 | Faintly alkaline 7·9 | 88 | 106 | 387 | 51 | 262 | 0 | 539 | 510 | 82 | 91 | <0·1 | 26 | 2,142 | 215 | .... | .... | 7 | 525 | 171 | .... | 97 | 765 | 112 | 656 | 215 | 441 | 220 | 436 |

* Bores 1 and 3 were retested for chlorides and nitrates after a second long pump test.

† Complete analyses were not made on bores 4, 6 and 7.

(6)—57785

TABLE III

Generalised Summary of Drilling and Testing Results

| Bore No. | Total Depth | Depth water struck below ground level in feet | Water level below ground level before pumping in feet | Yield for pump tests in gallons per hour | Duration of pump tests in hours | Draw down in feet | Time taken for complete recovery to a static level in hours | Recovery time to —1·0 feet of original level in minutes | Salinities at completion of pump tests in parts per million | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Chlorinity | Total dissolved solids |
| 1 | 105 | 12 | 10·60 | 4,700 | 43½ | 12·20 | .... | 5 | 243 | 1,290 |
| 2 | 17 | 14 | .... | 1,000— | Approx. 1 hour (bail test) | 5 | .... | .... | .... | .... |
| 3 | 135 | 14 | 11·00 | 5,500 | 48 | 39 | 30 | 8 | 295 | 1,412 |
| 4 | 120 | Approx. 12 | .... | Approx. 1,000 (bail test) | Approx. 2 hours (bail test) | .... | .... | .... | .... | .... |
| 5 | 100 | 16 | 12·92 | 10,200 | 48 | 25 | Approx. 50 | 30 | 388 | 1,476 |
| 6 | 60 | .... | 12·4 | Between 1,500–2,000 | 2 | 46 | .... | .... | .... | 1,150 |
| 7 | 50 | Approximating 14 or 15 feet. | 10·5 | Between 1,500–2,000 | 2 | Approx. 35 | .... | .... | .... | 1,340 |
| 8 | 100 | | 12·92 | 4,450 | 48 | 35 | 40 | 6 | 369 | 1,474 |
| 9 | 100 | | 12·10 | 5,450 | 48 | 37 | 81 | 4 | 283 | 1,306 |
| 10 | 93 | | 10·60 | 2,000— | 2 | 50 | .... | .... | 369 | 1,503 |
| 11 | 80 | | 12·50 | 11,000 | 48 | 39 | 100+ | 10 | 510 | 2,142 |

BORE 8.

This bore is located 1,100 feet north of No. 5 The object was to test the area north of bore 5. Actual location was designed at testing a point where a transition occurs between the surface characters of the Kukabubba water course province and those of the sandy areas further to the west.

*Lithology.*

0-10 feet: Red clay, silt and sand. Slightly calcareous between 5-10 feet.

10-25 feet: Brown to yellow-brown, calcareous clay, chips of white silicified clay, silt and sand.

25-30 feet: Yellow, slightly calcareous silt, sand and granule to pebble, rounded, quartz.

30-50 feet: Yellow, highly calcareous clay, silt, sand and angular quartz, pebble and small cobble size rounded quartz.

50-55 feet: Yellow-brown, slightly calcareous clay in minor amounts, coarse sand and rounded quartz pebbles.

55-65 feet: Yellow, highly calcareous clay, silt, sand and pebbles of quartz.

65-85 feet: Yellow-brown clay, chips of silicified white clay, silt, fine to coarse sand.

85-95 feet: Yellow-brown to white non-calcareous soft clay with angular sand sized grains of quartz.

95-100 feet: White, non-calcareous clay with angular, sand sized quartz grains. Weathered igneous rock.

An attempt to estimate relative formation factors from cuttings indicates that the 25-30 foot and 45-55 foot sections may be good aquifers. The porosity and permeability conditions of the carbonate sections are unknown. Pump testing over 48 hours at 4,450 gallons per hour gave a final drawdown of 35 feet. A two inch drop in the level of bore 5 was recorded near the end of 48 hours pumping.

The variations in resistivity obtained from the depth probe at Bore 8 indicated surface clays overlying relatively sandy strata. No detailed interpretation has been attempted.

BORE 9.

Located 1,925 feet west of bore 8, the object was to test permeable carbonate rocks in this area.

*Lithology.*

0-5 feet: Red-brown clay, silt and sand of quartz and silica up to 50% of sample bulk.

5-15 feet: Yellow calcareous clay, silt, sand.

15-20 feet: Light brown calcareous clay, silt, medium to coarse grained angular sand.

20-35 feet: Light brown calcareous clay with minor part sand.

35-40 feet: Light brown calcareous clay, moderately clean medium to coarse grained sand.

40-65 feet: Yellow calcareous clay with minor amounts of silica cuttings and quartz sand.

65-75 feet: Yellow to yellow-brown calcareous clay with more than 50% sand content.

75-85 feet: Red-brown clay, silt and sand grit.

85-100 feet: Yellow to yellow-brown clay and sand grit. Slightly calcareous near 85 feet. Appearance like weathered igneous rock 95-100 feet.

The lithologies of the bore cuttings indicate that the section is essentially carbonate.

Following development by overpumping, a test was run for 48 hours at 5,450 gallons per hour with a resultant drawdown of 37 feet. The bore showed considerable development during the pump test. A final short test indicated that a steady flow of more than 6,500 gallons per hour could be expected. Recovery figures indicate an aquifer of limited size. The large supply encountered in this bore is most likely resultant from solution permeability in carbonate rocks. In antithesis is bore 10, a carbonate sequence with low permeability.

The depth probe gave increasingly high resistivity readings with increased separation. It is thought that high contact resistances at the electrodes may have caused erroneous results.

BORE 10.

Located 3,175 feet east of the datum peg on the east-west centre line with the object of testing a section thought to be mainly carbonates. The site is 175 feet east of Bore 3 and adjacent to an outcrop of white, silicified and calcareous clay. Electrical characteristics are identical to those encountered in the saturated clays of the Kukabubba water-course province.

*Lithology.*

0-5 feet: Red-brown calcareous clay, silt and sand grit.

5-20 feet: Yellow to yellow-brown highly calcareous clays.

20-60 feet: Yellow, highly calcareous clay and white silicified clay.

60-70 feet: Red-brown clay, sand grit.

70-80 feet: Grey clay, sand grit.

80-90 feet: White clay sand grit.

90-93 feet: White clay, medium sized sand of quartz grit. This is thought to be weathered granite. Green stains could be weathered epidote.

Pump testing indicated the supply to be less than 2,000 gallons per hour. The bore failed to develop. As indicated by the cuttings the section is a calcareous clay of low permeability.

Bore 3 was pump tested for 48 hours on the completion of Bore 10. Drawdown and recovery were measured in Bore 10 simultaneously with the measurements of drawdown and recovery made on Bore 3. After 48 hours of pumping Bore 3 to give a drawdown of 39 feet, the level of Bore 10 receded 3.1 feet.

BORE 11.

This is located 1,025 feet east of the datum point on the east-west centre line. The object was to test the wide area between Bores 1 and 3.

*Lithology.*

0-5 feet: Red-brown calcareous clay, sand grit.

5-30 feet: Yellow-brown to yellow, highly calcareous clay, silt, and sand grit.

30-40 feet: Yellow, slightly calcareous clay grit.

40-45 feet: Yellow, non-calcareous, clay, quartz grit.

45-75 feet: White clay, sand, quartz grit.

75-80 feet: Yellow weathered granitic rock.

A calcareous clayey section occurs between 0 and 45 feet. Below this are non-calcareous clays of weathered granitic rock. The base of the main aquifer is at 40 feet. Considerable caving occurred during drilling of the 32-40 feet section. This is the region of main supply. The bore was tested for 48 hours at 11,000 gallons per hour with a final drawdown of 39 feet.

The resistivity curve here is very similar to those of bores No. 2 and No. 8 but the resistivity excursions are much larger. There is no obvious correlation of resistivity with the lithology.

## CONCLUSIONS.

*Depth of Aquifer and Water Salinity.*

Eleven bores were put down during the programme with an aggregate of 960 feet of drilling. Depths ranged from 17 to 135 feet. With the exception of bores 6 and 7, all finished in rocks identifiable as weathered crystalline basement. Water salinities ranged between 20 and 108 grains per gallon of sodium chloride and minor variations in salinity could be detected with depth.

The mean salinity determined throughout the drilling area is 56 grains per gallon of sodium chloride. However bore 4, on the eastern side of the Kukabubba water course, deviated 186 per cent. from the mean with a sodium chloride content of 104 grains per gallon. Water was first encountered throughout the drilling area at approximately 14 feet. After drilling and developing the full aquifer section, levels in each bore approximated 11 feet below surface level.

*Formation Factors.*

The large variations in supply are a function of wide and rapid changes in effective porosity of the rocks.

Effective porosity is primarily due to detrital grain size, shape, and sorting. Grain sizes vary from clay to coarse sand and only rarely to pebble size. As a general rule sorting is poor. This results in generally low permeability throughout the area for an unconsolidated material. Sections with a low permeability due to high clay content were penetrated in bores 4, 6 and 7.

In places further reduction in permeability is due to chemical deposition of carbonates. These appear to have formation parameters similar to clay. In other places deduction in permeability has occurred by silicification of carbonates and deposition of iron oxides.

The formation conditions of most interest in the area are clean coarse grained sands and solution cavities in silicified carbonate rocks. Cavities, several feet in diameter filled with silica rubble are known in the area. Porosity developed by solution occurred in bores 1, 3, 5, 9 and 11. The large supplies from bores 9 and 11 are resultant from this type of formation.

*Pump Tests.*

Tests made on the complete bore holes, hence on complete aquifer sections, yielded maximums at near equilibrium conditions from less than 2,000 to 12,500 (+) gallons per hour. Drawdowns after 48 hour pump tests varied from 12 feet to 39 feet. Recovery times were generally very short. A generalisation of recovery to less than -1.0 feet of original level after 30 minutes shut-down would be typical. However, in some cases, recovery of the last few inches had taken several days. Maximum radius of influence detected between a pumped bore (8), and a reference bore (5), 1,100 feet apart was first observed after 30 to 36 hours. It is assumed that this distance would increase with further pumping.

*Geophysical Prospecting.*

The resistivity results have not been analysed fully and therefore have only been discussed briefly in the body of the report. However, even the preliminary study shows that the method has useful application in hydrological problems.

The following tentative conclusions are drawn from the results of the geophysical survey in the Wiluna area:

(a) The resistivity mapping technique can define areas of higher salinity and/or clay formations. The profiles show uniformly low resistivities in these sections.

(b) Where a clay lithology predominates and there is therefore less likelihood of obtaining an adequate water supply the depth probe curves exhibit uniformly low resistivities also.

(c) If the depth probe curve shows marked variations in resistivity the presence of sands and possible aquifers is indicated.

It is considered that the resistivity method can give significant results in water prospecting, particularly where existing bores give a measure of depth control and the local geology is known. Theoretical interpretative procedures are being studied.

*General.*

The investigation has confirmed reports that large supplies of water of suitable quality for restricted types of irrigation can be found in the alluviated valley seven miles east of Wiluna. Sufficient water was located during the programme for the initial requirements of the Department of Agriculture's proposed Groundwater Research Station. However, before further development of this Research Station can take place, more controlled drilling will be necessary to locate further pump sites.

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# Geological Survey Section Index.


Accommodation .... 53
Bureau of Mineral Resources—Activities in W.A. .... 54
Damsite—Logue Brook—Examination of .... 75
Diamond Drilling—Ord River Main Damsite .... 75
Field Work for 1961 and 1962.... .... 53
Geological Reconnaissance—Warburton Range Area .... 65
Geological Sequence—Northampton Area .... 90
Geophysical Prospecting—Water .... 107
Halloysite—Ryan's Find .... 56
Hydrology—Wiluna Area .... 100
Iron Deposits—
    North-West Division .... 70
    Pompey's Pillar .... 88
Logue Brook—Damsite Examination .... 75
Mendel Woongoondy—Water Test Hole .... 98
Northampton Mineral Field—Geological Investigation .... 89
Oil—
    Licenses to Prospect in W.A. .... 72
    Permits to Explore in W.A. .... 72
    Search for in W.A. .... 71
Ord River—No. 2 Main Damsite Investigation .... 75
Pegmatite—
    S.E. of Roebourne .... 54
    N. of Yalgoo .... 69
Pompey's Pillar—Examination of Iron Ore .... 88
Professional Officers—Activities .... 52
Publications .... 54
Regional Survey Widgiemooltha .... 57
Reorganization of Staff .... 52
Roebourne—Pegmatite 6 miles S.E. of .... 54
Search for Oil in W.A. (1961) .... 71
Services to the General Public .... 54
Staff .... 51
Stratigraphic Table—Widgiemooltha Sheet .... 58
Transport .... 54
Warburton Range—
    Water Supplies .... 61
    Geological Reconnaissance .... 65
Water Supplies—
    Warburton Range .... 61
    Wicherina .... 55
    Wiluna .... 100
Wicherina—Hydrology Investigations .... 55
Widgiemooltha—Regional Survey .... 57
Wiluna—Groundwater Investigation .... 100
Yalgoo—Pegmatite N. of .... 69

# DIVISION V

# *School of Mines, Western Australia*

# *Annual Report — 1961*

*The Under Secretary for Mines:*

I have the honour to submit for the information of the Honourable the Minister for Mines my report for the year 1961. The report covers the work done in Kalgoorlie, in Norseman, in Bullfinch, and in Wittenoom.

## KALGOORLIE.

*Enrolments.*

The number of students enrolled in 1961 was 310—a decrease of 22 by comparison with 1960. Table I gives the individual and class enrolments for 1961 and for the four previous years; Table II, the enrolments in the various subjects for 1961; and Table III, the enrolments in the various Courses. As in the previous year the total number of students enrolled decreased, but this decrease occurred almost entirely in the students not enrolled for any set course and not sitting for an external examination, i.e., those students included under the heading of "Others" in Table III.

*Revenue.*

The following moneys were received during 1961 and during the two previous years:

| — | 1959 | 1960 | 1961 |
|---|---|---|---|
| Class Fees | 1,253 4 0 | 1,339 9 6 | 1,232 3 6 |
| Registration Fees | 62 0 0 | 85 10 0 | 79 10 0 |
| Lecture Notes | 63 12 6 | 57 17 6 | 56 2 6 |
| Laboratory Deposits | 154 0 0 | 114 7 0 | 121 0 0 |
| Supplementary Examinations | 20 0 0 | 21 0 0 | 31 0 0 |
| Students' Association | .... | .... | 132 10 0 |
| Apparatus and Equipment Trust Fund | 1,000 0 0 | 1,000 0 0 | 1,000 0 0 |
| Metallurgical Laboratory Trust | 859 16 8 | 1,056 5 1 | 1,258 14 0 |
| Commonwealth Grants Trust | 1,151 10 0 | 2,500 0 0 | 2,700 0 0 |
| Mine Managers and Underground Supervisors | 60 0 0 | 32 0 6 | 42 19 0 |
| Sundries | 54 15 8 | 42 5 0 | 55 6 0 |
| Total | £4,714 18 10 | £6,248 14 7 | £6,709 5 0 |

The fees paid by students vary according to their ages, and the numbers of students in the various age groups are given in Table IV. The decrease in the number of students in the under 18 group noted in last year's report continued in 1961.

*Staff.*

The following staff changes occurred during the year:

| Name | Position | Date | Notes |
|---|---|---|---|
| Crocos, A. J. | Lecturer | 27/2/61 | Appointed |
| Jacobs, H. R. | Typist | 26/4/61 | Appointed |
| Jones, J. R. | Cadet | 20/2/61 | Appointed |
| King, R. M. | Cadet | 20/2/61 | Appointed |
| Miles, A. T. | Lecturer | 12/6/61 | Resigned |
| Mullins, H. D. | Storeman | 8/9/61 | Resigned |
| Rourke, B. L. | Typist | 7/4/61 | Resigned |
| Stewart, W. | Fitter and Turner | 5/4/61 | Appointed |
| Wallis, F. A. | Lecturer | 1/1/61 | Appointed |
| Willis, R. J. | Cadet | 8/12/61 | Completed term of service |

TABLE I.
Enrolments, Kalgoorlie.
1957-1961.

| Year | Individual | Class |
|---|---|---|
| 1957 | 387 | 951 |
| 1958 | 380 | 928 |
| 1959 | 365 | 916 |
| 1960 | 332 | 967 |
| 1961 | 310 | 804 |

TABLE II.
Class Enrolments, Kalgoorlie.
1961.

| Subject | First Term | Second Term |
|---|---|---|
| Preparatory Chemistry | 19 | 11 |
| Chemistry IA | 32 | 30 |
| Chemistry IB | 10 | 10 |
| Analytical Chemistry I | 3 | 3 |
| Analytical Chemistry II | 3 | 4 |
| Chemical Metallurgy II | 4 | 4 |
| Mineral Dressing I | 13 | 13 |
| Mineral Dressing III | 2 | 2 |
| Physical Metallurgy I | 3 | 3 |
| Assaying | 15 | 14 |
| Trade Metallurgy | 15 | 9 |
| Preparatory Mathematics | 37 | 17 |
| Mathematics I | 40 | 32 |
| Mathematics II | 50 | 47 |
| Applied Mathematics I | 40 | 33 |
| Preparatory Physics | 12 | 8 |
| Physics I | 37 | 35 |
| Physics II | 27 | 25 |
| Preparatory Engineering Drawing | 23 | 16 |
| Engineering Drawing I | 32 | 26 |
| Engineering Drawing and Design IIA | 24 | 16 |
| Engineering Drawing and Design IIB | 6 | 6 |
| Engineering Drawing and Design IIC | 10 | 9 |
| Engineering Drawing and Design IID | 6 | 7 |
| Surveying Drawing II | 7 | 6 |
| Mechanical Engineering I | 14 | 14 |
| Mechanical Engineering II | 5 | 5 |
| Practical Electricity | 12 | 6 |
| Electrical Engineering I | 14 | 13 |
| Electrical Engineering II | 5 | 5 |
| Internal Combustion Engines | 8 | 6 |
| Workshop Practice I | 9 | 4 |
| Workshop Practice II | 5 | 3 |
| Engineering Workshop Practice | 10 | 10 |
| Welding I | 29 | 21 |
| Welding II | 7 | 4 |
| Structural Engineering I | 7 | 7 |
| Structural Engineering II | 10 | 10 |
| Machine Design | 9 | 9 |
| Materials of Construction | 13 | 11 |
| Hydraulics | 7 | 7 |
| Preparatory Geology | 22 | 16 |
| Geology IA | 7 | 7 |
| Geology IB | 12 | 12 |
| Geology IIA | 9 | 9 |
| Geology IIB | 10 | 10 |
| Geology IIIA | 5 | 5 |
| Geology IIIC | 1 | .... |
| Mining I | 19 | 17 |
| Mining II | 9 | 8 |
| Mining IIA | 2 | 1 |
| Mining III | 2 | 2 |
| Mining IIIA | 2 | 1 |
| Mining IIIB | 1 | .... |
| Mine Ventilation | 10 | 10 |
| Surveying I | 30 | 25 |
| Surveying II | 12 | 12 |
| Totals | 787 | 656 |
| Totals, 1960 | 967 | 756 |

To replace Mr. Parker, who retired at the end of 1960, Mr. E. N. Johns was promoted to the position of Head of the Department of Engineering from February 20, 1961.

In April, 1961 Mr. Lloyd was transferred from Bullfinch to the Department of Mathematics and Physics in Kalgoorlie.

*Courses of Study.*

Consideration was given to these during the year and the following changes, which are to be effective in 1962, were made:

*Associateship Courses.*—The subjects set down for the first year of full-time study or the first two years of part-time study were taken out of the Courses and set down as Qualifying Subjects. The standard of these subjects is equivalent to that required for the Leaving Certificate in W.A. With the new arrangement students will be required to complete the qualifying subjects or to reach an equivalent standard before commencing an Associateship Course. Minor changes were also made in some of the subjects included in the Courses and the new Courses are printed in the 1962 Prospectus. These changes are in accordance with changes being made to many similar Courses throughout Australia.

*Certificate Courses.*—Two Certificate Courses—the Electrical Engineering Certificate Course and the Mechanical Engineering Certificate Course—were dropped and two Courses—the Assayer's Certificate and the Engineering Draughtsman's Certificate Course—were revised. The standard of these last two Courses was lowered a little, but was still kept sufficiently high to meet the needs of industry. The revised Courses are printed in the 1962 Prospectus.

*Technician Courses.*—The Engine Operation and Maintenance Course was dropped, and the Workshop and the Welding Courses were revised.

*Annual and Supplementary Examinations.*

The examination results are summarised in Tables V and VI. Table V is based on class enrolments and Table VI on individual enrolments. The figures are of the same order as in previous years and do not indicate any significant changes.

The results for individual subjects are given in Appendix 1.

TABLE III.

Number of Students Enrolled for Various Courses at Kalgoorlie.

| Course | Number enrolled | | | | |
|---|---|---|---|---|---|
| | 1957 | 1958 | 1959 | 1960 | 1961 |
| Associateship Courses— | | | | | |
| Mining | 27 | 29 | 35 | 37 | 24 |
| Metallurgy | 26 | 21 | 21 | 13 | 17 |
| Engineering | 37 | 43 | 43 | 49 | 49 |
| Mining Geology | 10 | 13 | 13 | 15 | 19 |
| Total | 100 | 106 | 112 | 114 | 109 |
| Certificate Courses— | | | | | |
| Assayer's | 2 | 2 | 5 | 3 | 3 |
| Mine Surveyor's | 10 | 18 | 23 | 25 | 30 |
| Mine Manager's | 1 | .... | .... | .... | 4 |
| Engineering Draughtsman's | 8 | 8 | 9 | 4 | 6 |
| Electrical Engineering | 2 | 4 | 7 | 2 | 2 |
| Mechanical Engineering | 3 | .... | .... | 4 | 1 |
| Total | 26 | 32 | 44 | 38 | 46 |
| Technician Courses— | | | | | |
| Engine Operation and Maintenance | 3 | 3 | 1 | 2 | 1 |
| Workshop Foreman's | 8 | 8 | 6 | 7 | 6 |
| Welding | 16 | 14 | 7 | 10 | 16 |
| Total | 27 | 25 | 14 | 19 | 23 |
| No Set Course— | | | | | |
| Preparatory Subjects | 50 | 52 | 61 | 47 | 44 |
| External Students | .... | .... | 3 | 6 | 3 |
| Junior and Leaving | .... | .... | 2 | 12 | 9 |
| University | .... | .... | 10 | 7 | 4 |
| Others | 184 | 165 | 195 | 89 | 72 |
| Total | 234 | 217 | 195 | 161 | 132 |
| Total for Year | 387 | 380 | 365 | 332 | 310 |

TABLE IV.

Numbers of Students Paying Fees at Kalgoorlie.

| Group No. | Description | 1961 | | | | 1960 |
|---|---|---|---|---|---|---|
| | | Full-time | Part-time | External | Totals | Totals |
| 1 | Students under 18. Lecture notes plus Students' Association | 11 | 66 | .... | 77 | 93 |
| 2 | Students 18–21 years. Registration plus Lecture Notes plus Students' Association | 4 | 78 | .... | 82 | 78 |
| 3 | Students over 21. Class plus Lecture Notes plus Student's Association | 1 | 113 | 3 | 117 | 113 |
| 4 | Returned Servicemen. Exempt Class Fees | .... | 27 | .... | 27 | 31 |
| 5 | Staff. Exempt Registration or Class Fees | 3 | 3 | .... | 6 | 8 |
| 6 | Scholarship holders. Exempt Registration or Class Fees | 1 | .... | .... | 1 | 9 |
| | Total | 20 | 287 | 3 | 310 | 332 |

NOTES—Group 3 includes :—
(a) Chamber of Mines Scholarship holders.
(b) Year's Fee Scholarship holders if over 21. Thus some students included in this group will not pay class fees for all subjects and a very small number will not pay any class fees.
Group 6 includes Mines Department Scholarship holders only.

*Scholarships and Prizes.*

One student held a Mines Department Senior Scholarship during 1961. He completed a satisfactory year's work and his scholarship was renewed for 1962.

Fourteen students held Chamber of Mines Scholarships during 1961. Twelve completed a good year's work and the remaining two a fair year's work. All Scholarships were renewed for 1962. Four students holding Scholarships completed Associateship Courses, which makes a total of 12 students who have completed Associateship Courses under the Chamber of Mines Scholarship Scheme.

The usual awards were made at the end of the year and a list is given in Appendix 2.

*Diplomas and Certificates.*

During the year 17 students completed Associateship Courses; 16, Certificate Courses; and 3, Technician Courses. The number of students completing courses during the past five years is shown in Table VII.

On Monday, May 29, a graduation ceremony was held in the Kalgoorlie Town Hall and Diplomas, Certificates, and Prizes awarded at the end of 1960 were presented to the successful students by the Honourable the Minister for Mines, Mr. A. F. Griffith. The Guest Speaker was Professor K. L. Cooper, Professor of Civil Engineering in the University of W.A. Professor Cooper selected as his subject: "The Engineer and Society." During the evening the Minister declared Technical Training Week on the Goldfields open, and because of the association of the School of Mines and the Technical School with Technical Training Week awards made to Technical School students at the end of 1960 were presented during the evening by the Minister. Further reference will be made to Technical Training Week in the next section of this Report.

TABLE V.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, 1957-1961, Kalgoorlie.

| —— | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Class enrolments = A | 951 | 928 | 916 | 939 | 804 |
| Number of entries for Annual Examinations = B | 577 | 577 | 605 | 596 | 544 |
| B/A Per cent. | 61 | 62 | 68 | 63 | 68 |
| Number of passes at Annual Examination as a per cent. of A | 48 | 52 | 52 | 54 | 51 |
| Number of passes at Annual Examinations as a per cent. of B | 79 | 84 | 79 | 85 | 76 |
| Number of passes at Annual Examinations and Supplementary Examinations as a per cent. of A | 52 | 53 | 54 | 55 | 53 |
| Number of passes at Annual Examinations and Supplementary Examinations as a per cent. of B | 83 | 85 | 80 | 87 | 79 |

TABLE VI.

Students Sitting for Annual Examinations, 1959, 1960, 1961.

| Course | 1959 | | 1960 | | 1961 | |
|---|---|---|---|---|---|---|
| | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting |
| Associateship .... | 112 | 86 | 114 | 85 | 109 | 93 |
| Certificate .... | 44 | 73 | 38 | 84 | 46 | 83 |
| Technician .... | 14 | 79 | 19 | 58 | 23 | 57 |
| No Set Course | 195 | 44 | 161 | 43 | 132 | 38 |
| Totals .... | 365 | 61 | 332 | 63 | 310 | 65 |

*Technical Training Week.*

At the suggestion of the then Acting Superintendent of Technical Education in Western Australia a Committee was formed in Kalgoorlie in November, 1960 to organize Technical Training Week on the Goldfields. The Committee was representative of many interests in Kalgoorlie and Boulder, and at its first meeting Mr. W. B. Blown was elected as Chairman. Technical Training Week was a British Commonwealth wide affair and was set down for May, 29 to June 4, 1961. The School was represented on the Committee by the Director. The Committee met seven times and interest in Technical Training Week was well sustained and the week was well received on the Goldfields.

The following activities were arranged:—

Monday, May 29.—Opening of Technical Training Week by the Minister for Mines in the Kalgoorlie Town Hall. Presentation of School of Mines Diplomas, Certificates, and Prizes and of Eastern Goldfields Technical School prizes.

The *Kalgoorlie Miner* published a supplement directing attention to Technical Training Week and to the facilities available for Technical Training in the Kalgoorlie district.

Tuesday, May 30.—Vocational films were shown in the R.S.L. Hall, Kalgoorlie. These films were also shown at various schools throughout the district during the week.

Wednesday, May 31.—Opening of a Careers Exhibition in the Kalgoorlie Town Hall. This Exhibition continued until the end of the Week.

Thursday, June 1.—Careers Exhibition, Demonstration Night at Eastern Goldfields Technical School, Vocational films at Boulder Town Hall.

Friday, June 2.—Careers Exhibition, Demonstration Night at School of Mines.

Saturday, June 3.—Free.

Sunday, June 4.—Church Services.

In addition to the above, interviews with young people who were training for a vocation were broadcast over a local radio station in the week prior to Technical Training Week, during the Week, and in the following week.

*Library.*

Although there is still some old material in the School which has not been catologued, we have now reached the stage where the bulk of our holdings are recorded and we can answer "yes" or "no" to requests for any specific item. Our subject cataloguing of books and periodical articles has also reached a stage where we can answer requests for information on specific subjects related to the mining industry, if the information is available in the School.

This means that we are now in a position to undertake some expansion of library services in the way of supplying up-to-date information to interested persons. Towards the end of the year a start was made in moving geology and general reference material into the new building—the transfer of all geology stock etc. will probably take some time, but will be a considerable improvement in availability of this large section of the School library.

The total number of new books added to the library in 1961 was 505—a small increase over the previous year which is mainly accounted for in the purchase of opening stock for the Wittenoom branch. The number of numbered items on the shelves at December 31 was 7137—there is an approximately equal amount of unnumbered material—pamphlets, serial items and unbound periodicals.

A photocopying machine was purchased during the year and this service is appreciated not only by staff members for the rapid copying of documents and printed matter, but also by mining companies and other users of our library facilities.

TABLE VII.

Diplomas and Certificates Awarded, 1957-1961.

| | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Associateship Courses— | | | | | |
| Mining .... .... .... | 3 | 7 | 6 | 3 | 2 |
| Metallurgy .... .... .... | 5 | 2 | 11 | 5 | 5 |
| Engineering .... .... .... | 3 | 3 | 4 | 4 | 10 |
| Mining Geology .... .... | .... | 1 | 1 | .... | .... |
| Total .... .... .... | 11 | 13 | 22 | 12 | 17 |
| Certificate Courses— | | | | | |
| Assayer's .... .... .... | 4 | 3 | 3 | 2 | 1 |
| Mine Manager's .... .... | 1 | .... | 3 | 1 | 1 |
| Mine Surveyor's .... .... | 2 | 9 | 5 | .... | 11 |
| Engineering Draughtsman's | 2 | .... | 1 | 2 | 2 |
| Electrical Engineering .... | .... | 1 | 1 | 3 | 1 |
| Mechanical Engineering .... | .... | 1 | 2 | 4 | .... |
| Total .... .... .... | 9 | 14 | 15 | 12 | 16 |
| Technician Courses— | | | | | |
| Engine Operation and Maintenance .... .... .... .... | 2 | 2 | 4 | 2 | 1 |
| Workshop Foreman's .... | 1 | 1 | 1 | 1 | 1 |
| Welding .... .... .... | 2 | 3 | 5 | 2 | 1 |
| Total .... .... .... | 4 | 6 | 10 | 5 | 3 |

*Services to the Public.*

The School continued to provide the usual services to the public in addition to its teaching activities. During the year 341 samples were received from prospectors for assay and/or mineral determination. This is 63 less than in 1960. Details are given in Table VIII.

TABLE VIII.

Work Done on Samples Received from Prospectors and Others—Kalgoorlie.

| | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Assay—gold .... .... .... | 106 | 105 | 220 | 263 | 177 |
| Assay—gold and other constituents | 6 | .... | 4 | 1 | 2 |
| Assay—metals other than gold .... | 42 | 18 | 16 | 35 | 23 |
| Assay plus mineral determination | 11 | 3 | 5 | 3 | 16 |
| Mineral examination .... .... | 223 | 130 | 140 | 94 | 117 |
| Rejected or transferred to Metallurgical Laboratory pay .... | 10 | 5 | 13 | 8 | 6 |
| Total .... .... .... | 398 | 261 | 398 | 404 | 341 |

*Buildings.*

During the year there was quite a lot of activity so far as buildings were concerned. Most buildings were painted both internally and externally and additions or alterations were made at four places in the School.

The office was reorganised to provide additional accommodation in the general office and a separate office for the Registrar.

In the Department of Metallurgy and Chemistry additional library space was provided and a new lecture room added.

A new Geology Library was provided and the building was further extended to provide a reading room and office for the Librarian, a work room, and store room for library use. These have been needed for some time.

Extensions to the Kalgoorlie Metallurgical Laboratory were commenced, but it is not expected that these will be completed until mid 1962.

*Requirements of the School.*

When the extensions to the Kalgoorlie Metallurgical Laboratory referred to above are complete, all the requirements of the School listed in earlier reports will have been satisfied.

In the post war years buildings were difficult to obtain and the School's requirements have been kept to a minimum. Furthermore, additions have generally been made without any overall plan. There is now very little space left on the School block and consequently careful consideration must be given to any further additions.

The Department of Mining and Mine Surveying badly needs additional accommodation. Generally additional space is required for departmental libraries, for more extensive and new laboratories, for some additional lecture rooms, and for staff accommodation. If much pilot plant work is to be done then an additional building will be required for the Kalgoorlie Metallurgical Laboratory. Consideration is now being given to these requirements and an overall plan will be prepared.

*Advisory Committee.*

The Committee met on ten occasions and attendances were as follows: Mr. Kay, 9; Mr. Blown, 7; Mr. Collard, 2; Mr. Collister, 6 (possible 6); Mr. Ewing, 2 (possible 2); Mr. Field, 8; Mr. Golding, 7 (possible 8); Mr. Hobson, 4 (possible 4); Mr. Mundle, 9.

Grants totalling £2,000 were received from the Chamber of Mines and from the Mines Department and were paid into the Trust Fund.

*Kalgoorlie Metallurgical Laboratory.*

Three Reports of Investigations and 469 Certificates were issued during the year. In addition numerous free assays were made for prospectors and many inquiries were answered by the Senior Research Metallurgist and by members of the Laboratory Staff. Five investigations were in progress at the end of the year. More details are given in Appendix 3, which has been prepared by the Senior Research Metallurgist.

The Senior Research Metallurgist continued as a member of the Chamber of Mines Metallurgical Committee and the Laboratory continued to do investigations for this Committee in association with the mine laboratories.

In December tenders were called for additions to the Laboratory buildings and work will commence early in 1962.

TABLE IX.

Kalgoorlie Metallurgical Laboratory—Summary of Work.

| —— | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Investigations outstanding (1st January) | 8 | 7 | 3 | 3 | 2 |
| Investigations asked for (714–718, 720 inclusive) | 13 | 7 | 3 | .... | 6 |
| | 21 | 14 | 6 | 3 | 8 |
| Investigations completed | 11 | 11 | 3 | 1 | 3 |
| Investigations outstanding (December 31) | 7 | 3 | 3 | 2 | 5 |
| Investigations cancelled | 3 | .... | .... | .... | .... |
| | 21 | 14 | 6 | 3 | 8 |
| Certificates issued (assays, analyses, etc.) | 70 | 106 | 481 | 395 | 469 |

*Students' Association.*

The Association was again active and in addition to organising the usual functions it continued to take a lively interest in student affairs.

NORSEMAN.

*Enrolments.*

The number of students enrolled during the year was 65—an increase of four by comparison with the previous year. Table X sets out the individual and class enrolments during the year and for the four previous years; Table XI, the enrolments in individual subjects; and Table XII, the numbers enrolled for the various courses. The figures are similar to those for previous years.

*Revenue.*

The revenue received was £268 2s.

*Staff.*

There were no changes in the full-time staff. Eight part-time lecturers were employed.

*Subjects Taught.*

Twenty-two subjects were taught at Norseman, and as in previous years use was made of mine workshops for practical instruction in Workshop Practice, in Practical Electricity, and in Welding.

*Examinations.*

The results of the Annual Examinations are summarized in Tables XIII and XIV—Table XIII is based on class enrolments and Table XIV on individual enrolments. Table XV makes a comparison of Kalgoorlie, Norseman, and Bullfinch results, and is based on class enrolments. The results do not differ significantly from those obtained in previous years.

The results for individual subjects are given in Appendix 1.

*Scholarships and Prizes.*

The Reg. Dowson Scholarships for 1961 were awarded to G. G. Prime and F. W. Rose. The two students who were awarded these Scholarships at the end of 1960 both completed a satisfactory year's work—A. J. Hill passed in three subjects and A. L. Benoit in two.

A list of Awards is given in Appendix 2.

TABLE X.

Enrolments, Norseman.

1957-1961.

| Year | Individual | Class |
|---|---|---|
| 1957 | 60 | 178 |
| 1958 | 67 | 180 |
| 1959 | 55 | 140 |
| 1960 | 61 | 146 |
| 1961 | 65 | 139 |

TABLE XI.

Class Enrolments, Norseman, 1961.

| Subjects | First Term | Second Term |
|---|---|---|
| Mineral Dressing I | 2 | 2 |
| Preparatory Mathematics | 6 | 5 |
| Mathematics I | 6 | 4 |
| Mathematics II | 6 | 5 |
| Trade Mathematics II | 10 | 9 |
| Preparatory Engineering Drawing | 5 | 6 |
| Engineering Drawing I | 6 | 6 |
| Engineering Drawing and Design IIA | 3 | 3 |
| Surveying Drawing II | 1 | 1 |
| Mechanical Engineering I | 5 | 4 |
| Practical Electricity | 11 | 11 |
| Electrical Engineering I | 5 | 5 |
| Internal Combustion Engines | 15 | 14 |
| Workshop Practice I | 4 | 4 |
| Workshop Practice II | 5 | 5 |
| Welding I | 11 | 11 |
| Welding II | 7 | 7 |
| Materials of Construction | 2 | 2 |
| Preparatory Geology | 9 | 8 |
| Geology IB | 4 | 4 |
| Mining IIB and IIC | 5 | 5 |
| Surveying II | 7 | 6 |
| Totals, 1961 | 135 | 127 |
| Totals, 1960 | 135 | 133 |

## TABLE XII.

Number of Students Enrolled for Various Courses at Norseman.

| Course | Number Enrolled | | | | |
|---|---|---|---|---|---|
| | 1957 | 1958 | 1959 | 1960 | 1961 |
| Associateship Courses— | | | | | |
| Mining | 3 | 6 | .... | 2 | 3 |
| Metallurgy | .... | .... | .... | .... | .... |
| Engineering | .... | 2 | 3 | 2 | 2 |
| Mining Geology | .... | 1 | .... | .... | .... |
| Total | 3 | 9 | 3 | 4 | 5 |
| Certificate Courses— | | | | | |
| Assayer's | .... | .... | .... | .... | .... |
| Surveyor's | 8 | 7 | 8 | 10 | 13 |
| Mine Manager's | 1 | .... | .... | .... | .... |
| Engineering Draughtsman's | 1 | .... | 1 | 2 | 2 |
| Electrical Engineering | .... | 1 | .... | 1 | 1 |
| Mechanical Engineering | .... | .... | .... | .... | 1 |
| Total | 10 | 8 | 9 | 13 | 17 |
| Technician Courses— | | | | | |
| Engine Operation and Maintenance | 22 | 18 | 14 | 6 | 17 |
| Workshop Foreman's | 2 | 4 | 3 | 8 | 3 |
| Welding | 4 | 6 | 4 | 5 | 4 |
| Total | 28 | 28 | 21 | 19 | 24 |
| No Set Course— | | | | | |
| Preparatory Subjects | 11 | 13 | 9 | 3 | 3 |
| Others | 8 | 9 | 13 | 22 | 16 |
| Total | 19 | 22 | 22 | 25 | 19 |
| Total for Year | 60 | 67 | 55 | 61 | 65 |

*Buildings.*

The buildings need painting externally, but are otherwise in good condition and adequate for the needs of the School.

*Advisory Committee.*

The Advisory Committee with Mr. Dutton as Chairman met twice during the year. Two new members—Messrs. A. J. C. Pritchard and W. G. Kerr—were added to the Committee during the year to replace Mr. E. L. Walker who died during 1960 and Mr. E. C. S. Kneebone who left Norseman. During the year the Committee approved of the purchase of a new 16 mm. projector and arranged for half the cost to be paid from the Mines Amenities Fund. The new projector was received late in the year.

## TABLE XIII.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, 1957-1961, Norseman.

| —— | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Class enrolments = A | 178 | 180 | 140 | 146 | 139 |
| Number of entries for Annual Examinations = B | 116 | 95 | 93 | 123 | 96 |
| B/A per cent. | 65 | 52 | 66 | 84 | 70 |
| Number of passes at Annual Examinations, as a per cent. of A | 52 | 37 | 53 | 65 | 48 |
| Number of passes at Annual Examinations, as a per cent. of B | 79 | 70 | 80 | 77 | 70 |
| Number of passes at Annual and Supplementary Examinations as a per cent. of A | 53 | 38 | 57 | 66 | 54 |
| Number of passes at Annual and Supplementary Examinations as a per cent. of B | 81 | 73 | 86 | 78 | 78 |

## TABLE XIV.

Students Sitting at Annual Examinations, 1959-1961, Norseman.

| Course | 1959 | | 1960 | | 1961 | |
|---|---|---|---|---|---|---|
| | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting |
| Associateship | 3 | 100 | 4 | 100 | 5 | 100 |
| Certificate | 9 | 89 | 13 | 93 | 17 | 82 |
| Technician | 21 | 76 | 19 | 95 | 24 | 83 |
| No Set Course | 22 | 41 | 25 | 76 | 19 | 26 |
| Totals | 55 | 65 | 61 | 87 | 65 | 69 |
| Kalgoorlie for Comparison | 365 | 61 | 332 | 63 | 310 | 65 |

## TABLE XV.

Examination Results Kalgoorlie, Noresman, Bullfinch.

Notes:

(1) Information based on class enrolments.

(2) The letters "A" and "B" have the same meaning as in Table XIII.

| —— | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| B/A per cent.— | | | | | |
| Kalgoorlie | 61 | 62 | 68 | 63 | 68 |
| Norseman | 65 | 52 | 66 | 84 | 70 |
| Bullfinch | 56 | 63 | 65 | 51 | 57 |
| Total passes as a per cent. of A— | | | | | |
| Kalgoorlie | 52 | 53 | 52 | 55 | 53 |
| Norseman | 53 | 38 | 53 | 66 | 54 |
| Bullfinch | 35 | 54 | 46 | 41 | 48 |
| Total passes as a per cent. of B— | | | | | |
| Kalgoorlie | 83 | 85 | 79 | 87 | 79 |
| Norseman | 81 | 73 | 80 | 78 | 78 |
| Bullfinch | 62 | 85 | 71 | 80 | 84 |

## BULLFINCH.

*Enrolments.*

The number of students enrolled was 60—a decrease of three by comparison with the previous year. Information about the numbers of students enrolled, the numbers in the various classes, and the numbers in the various Courses is given in Tables XVI, XVII, and XVIII. As in previous years most of the students did not enrol for a set course and in Table XVIII appear against the heading "Others."

*Revenue.*

The revenue received was £140 18s.

*Staff.*

In April Mr. Lloyd was transferred from Bullfinch to Kalgoorlie and Mr. Browne was appointed Officer-in-Charge and Registrar. Six part-time lecturers were employed.

*Subjects Taught.*

Eleven subjects were taught.

## TABLE XVI.

Enrolments, Bullfinch, 1957-1961.

| Year | Individual | Class |
|---|---|---|
| 1957 | 57 | 114 |
| 1958 | 47 | 87 |
| 1959 | 48 | 85 |
| 1960 | 63 | 98 |
| 1961 | 60 | 89 |

## TABLE XVII.

Class Enrolments, Bullfinch, 1961.

| Subjects | First Term | Second Term |
|---|---|---|
| Preparatory Mathematics | 8 | 4 |
| Mathematics I | 5 | 3 |
| Mathematics II | 1 | 1 |
| Physics I | 5 | 4 |
| Preparatory Engineering Drawing | 10 | 5 |
| Engineering Drawing I | 13 | 12 |
| Engineering Drawing and Design IIA | 1 | 1 |
| Workshop Practice I | 6 | 4 |
| Welding I | 22 | 16 |
| Welding II | 10 | 9 |
| Geology IB | 4 | 4 |
| Total | 85 | 63 |
| Totals, 1960 | 98 | 67 |

*Examinations.*

The examination results are summarised in Tables XIX and XX—Table XIX is based on class enrolments and Table XX on individual enrolments. A comparison of Bullfinch results with those of Kalgoorlie and Norseman is given in Table XV. The figures are generally comparable with those of previous years.

The results for individual subjects are given in Appendix 1.

*Scholarships and Prizes.*

No awards were made to Bullfinch students.

*Buildings.*

The buildings and quarters are in fair condition, but could do with painting externally and minor repairs. Only essential work was done on the buildings as it seemed likely that the School at Bullfinch would not continue beyond 1962 at the latest.

*Advisory Committee.*

This Committee did not meet during the year.

TABLE XVIII.

Number of Students Enrolled for Various Courses at Bullfinch.

| Course | Number Enrolled | | | | |
|---|---|---|---|---|---|
| | 1957 | 1958 | 1959 | 1960 | 1961 |
| Associateship Courses— | | | | | |
| Mining | .... | .... | .... | .... | .... |
| Metallurgy | 1 | 2 | 1 | 1 | 1 |
| Engineering | .... | .... | .... | .... | 1 |
| Mining Geology | 1 | 2 | 1 | .... | .... |
| Total | 2 | 4 | 2 | 1 | 2 |
| Certificate Courses— | | | | | |
| Assayer's | .... | .... | .... | .... | .... |
| Mine Surveyor's | 4 | 7 | 3 | 2 | 3 |
| Mine Manager's | .... | .... | 1 | .... | .... |
| Engineering Draughtsman's | .... | .... | 1 | 1 | .... |
| Electrical Engineering | 2 | .... | 1 | 1 | .... |
| Mechanical Engineering | .... | .... | .... | 1 | 1 |
| Total | 6 | 7 | 6 | 5 | 4 |
| Technicians' Courses— | | | | | |
| Engine Operation and Maintenance | .... | .... | .... | .... | .... |
| Workshop Foreman's | 1 | 4 | 2 | .... | .... |
| Welding | .... | .... | 1 | .... | .... |
| Total | 1 | 4 | 3 | .... | .... |
| No Set Course— | | | | | |
| Preparatory Subjects | 7 | 4 | 8 | 16 | 5 |
| Others | 41 | 28 | 29 | 41 | 49 |
| Total | 48 | 32 | 37 | 57 | 54 |
| Total for Year | 57 | 47 | 48 | 63 | 60 |

TABLE XIX.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, Bullfinch, 1957-1961.

| | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Class enrolments = A | 114 | 87 | 85 | 98 | 89 |
| Number of entries for Annual Examinations = B | 64 | 55 | 55 | 50 | 51 |
| B/A Per cent. | 56 | 63 | 65 | 51 | 57 |
| Number of passes at Annual Examinations as a per cent. of A | 33 | 54 | 46 | 36 | 48 |
| Number of passes at Annual Examinations as a per cent. of B | 59 | 85 | 71 | 70 | 84 |
| Number of passes at Annual and Supplementary Examinations as a per cent. of A | 35 | 54 | 46 | 41 | 48 |
| Number of passes at Annual and Supplementary Examinations as a per cent. of B | 62 | 85 | 71 | 80 | 84 |

TABLE XX.

Students Sitting for Annual Examinations, Bullfinch.

| Courses | 1959 | | 1960 | | 1961 | |
|---|---|---|---|---|---|---|
| | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting | Number Enrolled | Per cent. Sitting |
| Associateship | 2 | 50 | 1 | 100 | 2 | 100 |
| Certificate | 6 | 100 | 5 | 100 | 4 | 75 |
| Technician | 3 | 100 | .... | .... | .... | .... |
| No Set Course | 37 | 68 | 57 | 61 | 54 | 57 |
| Totals | 48 | 73 | 63 | 65 | 60 | 58 |
| Kalgoorlie for Comparison | 365 | 61 | 332 | 63 | 310 | 65 |
| Norseman | 55 | 65 | 61 | 87 | 66 | 68 |

WITTENOOM.

Following a visit by the Director to Wittenoom in September, 1960 and a request for a School from the Manager of Australian Blue Asbestos Ltd. in October, 1960, it was decided to commence certain School of Mines classes in February, 1961 and to endeavour to continue classes for a test period of two years.

Classes in six subjects were commenced in February, 1961. Enrolments were not quite as high as early inquiries had suggested, but nevertheless were satisfactory. Mr. J. P. Shanahan was appointed as part-time Officers-in-Charge and part-time staff were recruited from mine staff and others.

By mid-year the number of students attending classes had decreased considerably, and at the end of the year the number sitting for the Annual Examinations was quite small. This was very disappointing and it was apparent that many who had started classes had no real interest in the subjects and were not prepared to do the work required. The position is summed up in Table XXI.

TABLE XXI.

Students Enrolled at Wittenoom, 1961.

| Subjects | Number Enrolled in May | Number Sitting Mid-Year Examinations | Number Sitting Annual Examinations | Number Passing Annual Examinations |
|---|---|---|---|---|
| Trade Mathematics I | 7 | 4 | 1 | 1 |
| Preparatory Mathematics | 7 | 3 | 2 | .... |
| Preparatory Engineering Drawing | 8 | .... | 1 | 1 |
| Engineering Drawing I | .... | .... | 1 | 1 |
| Welding I | 10 | 3 | .... | .... |
| Preparatory Geology | 7 | 2 | 2 | 2 |
| Mining I | 6 | 2 | 2 | 2 |
| Total | 45 | 14 | 9 | 7 |

The seven passes in individual subjects at the Annual Examinations were obtained by three students—one student passed in three subjects and two in two subjects each. Two other students sat for one subject each at the Annual Examinations, but neither student was successful in passing.

Classes, except welding classes, were held in a house in the town. The welding classes were held in the mine welding shop. Furniture and equipment were supplied by the Mines Department, and accommodation was satisfactory.

Although the results for the first year were very disappointing it was decided to continue the classes in 1962 with the hope that interest would increase, and that the Company and the people of Wittenoom would appreciate the opportunities for study which the School offered.

ACKNOWLEDGMENTS.

During the second half of 1961 the writer was on long service leave. Thanks are due to the Acting Director, Mr. J. D. Collister, to Heads of Departments, to the Senior Research Metallurgist, to the Registrar, and to members of the Staff generally for co-operation with myself and with the Acting Director. In addition to their normal duties associated with the School, senior staff members have answered many questions and given much information to members of the public, particularly to those interested in mining. Much of the information in this report has been compiled by the Registrar and the Office Staff, particularly Miss H. Jacobs.

Thanks are also due to the Officers-in-Charge of Branch Schools and to the staffs of those schools, including the part-time members without whose co-operation the Branch Schools could not function.

Help has been received from the Advisory Committee, whose members have given of their time to assist the School. Mining companies at Norseman, Bullfinch, and Wittenoom have made their workshops available for practical classes.

Co-operation and assistance has been received from Head Office staff, from all sections of the Mines Department, and from many other Government Departments, e.g., Public Works Department, Government Stores, Government Printing Office.

R. A. HOBSON,
Director, School of Mines.

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School of Mines of Western Australia.

APPENDIX 1.

Annual Examinations.

1961.

PASS LIST.

Passes are in order of merit.

(E) denotes equal.

* denotes year fee scholarship.

Preparatory Chemistry.

*Credit:*
*Birrell, E. C.
McNally, B. T.

*Pass:*
Reid, R. H. J.
Wardell-Johnson, I. M.
Tarr, R. C.
Moriarty, M. T.
Hewitt, G. P.

Chemistry IA.

*Credit:*
*Devine, E. P.
King, R. M.
Brinsden, W. K.

*Pass:*
Ruane, M.
Kelly, J. P.
Dykstra, F. D.
Botica, G. G.
Manners, R. B.
Lawson, K. S.
Daws, D. C.
Judges, J. E. (E)
Slocomb, J. H. (E)
Ridley, R. H.
Karczub, L. M
Terrell, R. J. H.

*Supp. Exam. Granted:*
Jones, J. R.
Jongen, P. J. F. G.
Karczub, D. L.
Woolhouse, M. L.

Chemistry IB.

*Pass:*
Thornton, W. F.
Willcocks, P. W.
Campbell, I. H.
Black, N. C.
Lake, D. F.
Connelly, M. A.
Tonkin, D.

*Supp. Exam. Granted:*
Buckett, M. D.
Wills, M. F.

Analytical Chemistry I

*Credit:*
*Klose, W. F.

*Pass:*
Travis, G. A.
Lewis, R. P. J.

Analytical Chemistry II.

*Pass:*
Sceresini, B. J. S.
Kops, J. N.

Chemical Metallurgy II.

*Credit:*
*Campbell, A. D.
Bourne, R. W.

*Pass:*
Sceresini, B. J. S.
Kops, J. N.

Mineral Dressing I.

*Pass:*
Dykstra, F. D.
McGushin, P. J. (E)
Murphy, A. J .(E)
Loxton, I. W. (E)
van der Hoek B. J. D. (E)
Jongen, P. J. F. G.
Fraser, H. S.
Argus, J. C.
McNally, R. T.
Thornton, W. F.

*Supp. Exam. Granted:*
Hennessy, R. M.
Morel, F. R.

Mineral Dressing III.

*Credit:*
*Bourne, R. W.

*Pass:*
Campbell, A. D.

Physical Metallurgy I.

*Credit:*
*Campbell, A. D.

*Pass:*
Gray, D. J.
Kops, J. N.

Assaying I.

*Credit:*
*Klose, W. F.
Tonkin, D.

*Pass:*
Letts, I. R.
Buckett, M. D. (E)
Dykstra, F. D. (E)
McNally, R. T. (E)
Willcocks, P. W. (E)
Campbell, I. H.
Black, N. C.
van der Hoek, B. J. D.
Sands, D. J.
Hennessy, R. M.

Trade Metallurgy.

*Credit:*
*Mitchell, R. J.

*Pass:*
Regan, H. J.
Harvey, J. S.
Bryndzej, T.
Tindall, E. R.

*Supp. Exam. Granted:*
Kelly, C. D.

Preparatory Mathematics.

*Pass:*
Reid, R. H. J.
Tarr, R. C.
Venetis, K.
Fry, B. G.
Joyce, M. J.

Mathematics I.

*Credit:*
*King, R. M.

*Pass:*
Daws, D. C.
Wright, R. A.
McGee, A. R.
Lindfield, N. W.
Younger, B .A.
Mand, E. D.

*Supp. Exam. Granted:*
Ridley, R. H.
Taaffe, L. D.
Urich, P. G.
Ryan, W. B.

Mathematics II.

*Credit:*
*Fraser, B. J.
Lewis, C. J. B.

*Pass:*
Lewis, R. P. J.
Campbell, I. H.
Black, N. C.
Willcocks, P. W.
Fogarty, J. M.
Ghor, A. (E)
Hooker, N. R. (E)
Gray, D. J.
Botica, G. G. (E)
Kelly, J. P. (E)
Hobson, J. C. (E)
Softley, M. D. (E)
Banks, F. R.
Sands, D. J.
Fiegert, J.
Davey, C. R.
Flanagan, K. J.

*Supp. Exam. Granted:*
Bain, W. B.
Brinsden, W. K.
Buckett, M. D.
Falls, G. W.
Foong, K. H.
Magnus, E. R.
McRostie, B. L.

Applied Mathematics I.

*Credit:*
*Fraser, B. J.
King, R. M.

*Pass:*
Black, N. C.
Kelly, J. P.
Willcocks, P. W.
Klose, W. F.
Softley, M. D.
Dykstra, F. D.

Preparatory Physics.

*Credit:*
*Goldner, H.

*Pass:*
Joyce, M. J.
Keogh, A. G.

Physics I.

*Credit:*
*King, R. M.

*Pass:*
Devine, E. P.
Karczub, L. M.
Ruane, M.
Karczub, D. L.
Nesbitt, W. H.
Wright, R. A.
Colgrove, J. E.
Bayly, J. G. (E)
Fraser, H. S. (E)

*Supp. Exam. Granted:*
Keogh, J. T.
Lindfield, N. W.

*Exemption Granted from Practical Work for 1962:*
Keogh, J. T.
Lindfield, N. W.

Physics II.

*Credit:*
*Fraser, B. J.

*Pass:*
Miller, J. J.
Sceresini, B. J. S.
Weir, D. J.
Ghor, A.
Chamberlain, H. I.
Slocomb, J. H.
Softley, M. D.
Hennessy, R. M.

*Supp. Exam. Granted:*
Leslie, W. E.
Hobson, J. C.

Preparatory Engineering Drawing.

*Credit:*

*Hewitt, R. P.
Sands, D. J.
Russell, C. W.
McInerney, E.
Andrew, H. J.
Black, N. C.
Urich, P. G.

*Pass:*

Strahan, D. E.
Trembath, I. F.
Sheehan, W.
Keegan, P. R.
Sullivan, J. P.

Engineering Drawing I.

*Credit:*

*Hewitt, R. P.
Campbell, I. H.
King, R. M.
Wilkinson, E. A.
Johns, D. T.
Reid, R. H. J.
Jones, J. R.
Baldwin, M. D.
Miller, R. J.
Black, N. C.
Irving, G. H.
Bailey, J. R.

*Pass:*

McKenzie, R. R.
Keogh, A. G.
Fry, B. G.
Cotterell, R. G.
Ryan, W. B.
Tarr, R. C.
Stretton, B.

Engineering Drawing and Design IIA.

*Credit:*

*Bayly, J. G.
Fraser, B. J.
Lindfield, N. W.
Kelly, J. P.
Blurton, L. N.
Woolhouse, M. L.
Ruvidini, A.
Foong, K. H.
Ghor, A.
Maguire, D. W. (E)
Wilkinson, E. A. (E)

*Pass:*

Ward, W. S.
Meiklejohn, G.
McRostie, B. L.
Softley, M. D.
Wright, R. A.
Mand, E. D.

Engineering Drawing and Design IIB.

*Credit:*

*Hardy, R. J.
Forrest, R. N.
Murray, B. F.
Muncaster, I. M.

*Pass:*

McIntyre, A. T.

Engineering Drawing and Design IIC.

*Credit:*

*Buckett, G. A.
McDougall, D. D.
Bennett, V. G.
Hardy, R. J.
Murray, B. F. (E)
Hunter, S. T. (E)
Muncaster, I. M.
McIntyre, A. T.

Engineering Drawing and Design IID.

*Credit:*

*Buckett, G. A.
Hardy, R. J.
Bennett, V. G. (E)
Lawson, K. S. (E)
Murray, B. F.
Muncaster, I. M.

*Pass:*

Currie, E. G.

Surveying Drawing II.

*Credit:*

*Lewis, C. J. B.
Cruickshank, A. C.
Crew, W. J.

*Pass:*

McNally, B. T.
George-Kennedy, R. J.

Mechanical Engineering I.

*Pass:*

Miller, J. J.
Ghor, A.
Meiklejohn, G.
Argus, J. C.
Leslie, W. E.
Kilderry, T. J.
Leyland, E. C. (E)
Weir, D. J. (E)
Marshall, D. A.
Maguire, D. W.
Keogh, C. E.

*Supp. Exam. Granted:*

Dodge, G. J.

Mechanical Engineering II.

*Pass:*

Murray, B. F.
Bennett, V. G.
Muncaster, I. M.

Electrical Engineering I.

*Credit:*

*Forrest, R. N.
McIntyre, A. T. (E)
Willcocks, P. W. (E)

*Pass:*

Baldwin, W. E.
Meiklejohn, G.
Blurton, L. N.
Buckett, M. D.
Daws, D. C.
Ghor, A.
Shugg, P. J.
Nowland, L. G.

Electrical Engineering II.

*Credit:*

*Hardy, R. J.

*Pass:*

Bennett, V. G.
Willis, R. J.
Lawson, K. S.
Slocomb, J. H.

Internal Combustion Engine.

*Credit:*

*Martin, H. R.
Golding, J. T.

*Pass:*

Marwick, W. D.
Joyce, M. J.
Joyce, G. D.
Graham, B. W.

Workshop Practice I.

*Pass:*

Black, N. C.

Workshop Practice II.

*Pass:*

Johns, D. T.
Stretton, B.

Engineering Workshop Practice.

*Credit:*

*Hardy, R. J.
Willis, R. J.

*Pass:*

Fraser, B. J.
Pearson, C. A. L.
Softley, M. D.
McRostie, B. L.
Woolhouse, M. L.
Baldwin, M. D.
Egan, H. P.

*Exemption Granted from Practical Work for 1962:*

Law, A. D.

Welding I.

*Credit:*

*Cooper, L. E.
Daws, D. C.
Regan, H. J.
Bone, K. R.

*Pass:*

Jose, N. W.
Harvey, J. S.
Green, B. A.
Greenfield, J.
Kelly, C. D.
Crocker, F. R.

*Supp. Exam. Granted:*

Bryndzej, T.

Welding II.

*Pass:*

Tindall, E. R.
Joyce, G. D.

Structural Engineering I.

*Credit:*

*Willis, R. J.
Baldwin, W. E.

*Pass:*

Cruickshank, A. C.
Blurton, L. N.
Weir, D. J.
Leyland, E. C.

Structural Engineering II.

*Credit:*

*Buckett, G. A.
Bennett, V. G.
McDougall, D. D.
Muncaster, I. M.
Murray, B. F.
Hunter, S. T.
McIntyre, A. T.
Donovan, R. J.

Machine Design.

*Credit:*

*Willis, R. J.
Blurton, L. N. (E)
Miller, J. J. (E)

*Pass:*

Baldwin, W. E.
Leslie, W. E.
McDougall, D. D.
Egan, H. P.
Donovan, R. J.
Weir, D. J.

Materials of Construction.

*Credit:*

*Fraser, B. J.
Goldner, H.
Baldwin, W. E.
Pearson, C. A. L.
Ward, W. S.

*Pass:*

Wise, S. A.
Blurton, L. N. (E)
McRostie, B. L. (E)
Softley, M. D.
Keogh, C. E.

Hydraulics.

*Credit:*

*Hardy, R. J.
Willis, R. J.

*Pass:*

Forrest, R. N.
Lawson, K. S.
Donovan, R. J.
Mullins, H. D.
Currie, E. G.

Practical Electricity.

*Credit:*

*McGushin, P. J.
Bevans, E. T. (E)
Fraser, P. G. (E)

*Pass:*

Loxton, I. W.
Tarr, R. C.

Preparatory Geology.

*Credit:*

*Wright, R. A.
Jones, J. R. (E)
Tillotson, D. L. (E)
Sands, D. J.
Lindfield, N. W.
Willcocks, P. W.

*Pass:*

Black, N. C.
Strahan, D. E.
Patterson, B. S.
Hawker, B. C.
Thomas, G. N.

*Supp. Exam. Granted:*

Moriarty, M. T.

Geology IA.

*Credit:*

*Campbell, I. H.

*Pass:*

McNally, B. T.
Davey, C. R.

*Supp. Exam. Granted:*

Bain, W. B.

*Exemption Granted from Practical Work for 1962:*

Bain, W. B.

Geology IB.

*Credit:*

*Campbell, I. H.

*Pass:*

George-Kennedy, R. J.
Ryan, W. B
Fraser, H. S.
Curran, B. G. (E)
Foong, K. H. (E)
Hill, J. W. (E)
Loxton, I. W.
Andrews, D. N. M.

Geology IIA.

*Pass:*
Lubbock, F. N.
Murphy, A. J.
Cruickshank, A. C.
Hurley, B. J.
McGushin, P. J.
Banks, F. R.

*Supp. Exam. Granted:*
Morel, F. R.
Sloan, R. B.
Fraser, P. G.

Geology IIB.

*Credit:*
*Lubbock, F. N.

*Pass:*
Leyland, E. C.
Banks, F. R.(E)
Chamberlain, H. I. (E)
Hooker, N. R. (E)
Letts, I. R. (E)
van der Hoek, B. J. D.
Sloan, R. B.
Hurley, B. J.
Shugg, P. J.

Geology IIIA.

*Credit:*
*Schultz, K.
Travis, G. A.

*Pass:*
Frank, P. H.
Hopkins, G. M. F.
Goode, W. D.

Geology IIIC.

*No Passes.*

Mining I.

*Pass:*
Fogarty, J. M.
Campbell, I. H.
Lauri, J. M.
Mackay, I. D.
Patterson, B. S.
Falls, G. W.
Andrews, D. N. M.
Curran, B. G.
de la Hunty, R. D.
Lithgow, J. R.
Attrill, D. M.

*Supp. Exam. Granted:*
Foong, K. H.
Turner, B. C.

Mining II.

*Pass:*
Murphy, A. J.
Lewis, C. J. B.
Hopkins, G. M. F.
Colgrove, J. E.
Chamberlain, H. I.
Kozuh, D.
Flanagan, K. J.

Mining IIA.

*Pass:*
Cooper, G. H.
Crew, W. J.

Mining III.

*Credit:*
*Meiklejohn, G.

Mining IIIA.

*Credit:*
*Murphy, A. J.

*Pass:*
Fraser, P. G.

Mining IIIB.

*Pass:*
Jordan, A. F.

Mine Ventilation.

*Credit:*
*Hurley, B. J.
Letts, I. R.

*Pass:*
Lubbock, F. N.
Murphy, A. J.
Argus, J. C.
Leyland, E. C. (E)
Hennessy, R. M. (E)
Dodge, G. J.
Kozuh, D.
Morel, F. R.

Surveying I.

*Credit:*
*Fraser, B. J.

*Pass:*
Fogarty, J. M.
Willis, R. J.
Forrest, R. N.
Miller, J. J.
Daws, D. C.
Loxton, I. W.
Falls, G. W.
Lawson, K. S.
Curran, B. G.
Andrews, D. N. M.
Attrill, D. M.
Leslie, W. E.
McRostie, B. L.
Softley, M. D.
Egan, H. P.
Sands, D. J.
Lithgow, J. R.
Currie, E. G.
Perks, A. C. J.
George-Kennedy, R. J.

*Exemption Granted from Theory 1962:*
Ghor, A.
Lauri, J. M.

*Exemption Granted from Practical Work for 1962:*
Turner, B. C.

*Supp. Exam. Granted in Paper "B":*
Turner, B. C.

Surveying II.

*Credit:*
*Lewis, C. J. B.

*Pass:*
Schultz, K.
Cruickshank, A. C.
Mackay, I. D.
Shugg, P. J.
George-Kennedy, R. J.

*Supp. Exam. Granted Paper "B":*
Kozuh, D.
Crew, W. J.
McNally, B. T.

*Supp. Exam. Granted Paper "C":*
Connelly, M. A.

School of Mines—Norseman.

ANNUAL EXAMINATIONS.

PASS LIST.

Mineral Dressing I.

*Pass:*
Powell, P.
Hug, R. L.

Trade Mathematics II.

*Pass:*
Johnson, R.

*Supp. Exam. Granted:*
Coles, E. J.
Goodwin, H.
Murphy, R. J.

Preparatory Mathematics.

*Pass:*
Bottegal, J.
Wells, P. H.
Rose, F. W.
Horne, R. H.
Giles, K. W.

Mathematics I.

*No Passes.*
*Supp. Exam. Granted:*
Skinner, K. J.

Mathematics II.

*No Passes.*

Preparatory Engineering Drawing.

*Credit:*
Demarteau, H. J.
Freeman, P. G.

*Pass:*
May, R. I.
Dowsett, D. W.

Engineering Drawing I.

*Credit:*
Campbell, R. D.

Engineering Drawing and Design IIA.

*Credit:*
Hunter, D. R. C.

Surveying Drawing II.

*No Passes.*

Mechanical Engineering I.

*Pass:*
Hunter, D. R. C.
Kerr, P. H.

Electrical Engineering I.

*Credit:*
Hunter, D. R. C.

*Pass:*
Hill, A. J.
Lea, E. J.
Lea, R. J.
Powell, P.

Internal Combustion Engines.

*Pass:*
Sainsbury, J. A.
Hill, A. J.
Benoit, A. L.
Murphy, F. J.
May, C. F.
Prime, G. G.
Johnson, R.

Workshop Practice I.

*Pass:*
Giles, K. W.
Coles, E. J.
May, R. I.

Workshop Practice II.

*Pass:*
Hill, A. J.
Murphy, F. J.
Prime, G. G.

Welding I.

*Credit:*
Jones, E. J.
Conte, A. L.

*Pass:*
Underwood, J. W.
Dowsett, D. W.

Welding II.

*Pass:*
Prime, G. G.
Murphy, F. J.
Bottegal, J.
Coles, E. J.
Delamotte, R. C.
Johnson, R.
Graham, A. R.
Salmon, L. J.

Materials of Construction.

*Pass:*
Lea, E. J.

*Supp. Exam. Granted:*
Swain, G. B.

Practical Electricity.

*Pass:*
Rose, F. W.
Murphy, R. J.
Benoit, A. L.
Freeman, P. G.

*Supp. Exam. Granted:*
May, R. I.

Preparatory Geology.

*Credit:*
Denison, J. L.

*Pass:*
Cook, G. J. S.
Stewart, B. A.
Shave, D. A.
Wells, P. H.
Kleppe, G. K.

Geology IB.

*Pass:*
Lea, R. J. (E).
Brouwer, J. H. (E).
Daly, P. R.
Satapuntu, S.

Mining IIB and Mining IIC.

*Pass:*
Denison, J. L.
Brouwer, J. H.
Powell, P.
Lea, R. J.
Hug, R. L.

Surveying II.

*Pass:*

Brouwer, J. H.

*Supp. Exam. Granted Paper "A":*

Daly, P. R.
Denison, J. L.
Stewart, B. A.

*Supp. Exam. Granted Paper "B":*

Daly, P. R.
Denison, J. L.

*Exemption Granted from Practical Work for 1962:*

Daly, P. R.
Denison, J. L.
Stewart, B. A.

School of Mines—Bullfinch.

ANNUAL EXAMINATIONS.

PASS LIST.

Preparatory Mathematics.

*Credit:*

Smith, F. L.

*Pass:*

Dawson, W. D.
Bendotti, C.

Mathematics I.

*Pass:*

Annear, E. J.

Mathematics II.

*No Passes.*

Physics I.

*Pass:*

Blackley, T.
Harken, R. M.

*Exemption Granted from Practical Work, 1962:*

Annear, E. J.

Preparatory Drawing.

*Credit:*

de Vries, T.

*Pass:*

Lanfranchi, R. A.
Ding, P. W.
Capelli, J.
Cotton, W. F.
Graham, M. C.

Engineering Drawing I.

*Credit:*

Harken, R. M.
Annear, E. J.

*Pass:*

Ickeringill, G.
Williams, R. T.
Carroll, N. J.
Ding, T. W.
Crunkhorn, L. G.
Sawyer, D. J.
Virgin, V. A.

Engineering Drawing and Design IIA.

*Credit:*

Patrick, A.

Workshop Practice I.

*Pass:*

Williams, R. T.
Sawyer, D. J.
Lanfranchi, J. J.
Ickeringill, G. D.

Welding I.

*Credit:*

Armanasco, D.
Della Bosca, R. R.
Williams, R. T.

*Pass:*

Capitanio, R.
Sawyer, D. J.
Lanfranchi, J. J.

Welding II.

*Pass:*

Patroni, R.
Liddle, F. R.
Carstairs, G.
Greensill, W. A.
Ickeringill, G. D.
Beaton, K. M.
Faulkner, R. H.
Manacini, E.

Geology IB.

*Credit:*

Harken, R. M.

*Pass:*

Blackley, T.
Stokes, M. C.

School of Mines—Wittenoom.

ANNUAL EXAMINATIONS.

PASS LIST.

Trade Mathematics I.

*Pass:*

Drazic, K. W.

Preparatory Mathematics.

*No Passes.*

Mathematics II.

*Pass:*

Cooper, G. H.

Preparatory Engineering Drawing.

*Pass:*

Drazic, K. W.

Engineering Drawing I.

*Pass:*

Drazic, K. W.

Welding I.

*No Passes.*

Preparatory Geology.

*Pass:*

Mulholland, A.
Duffy, F. K.

Mining I.

*Pass:*

Duffy, W. J.
Mulholland, A.

SUPPLEMENTARY EXAMINATIONS.

February, 1961.

The following students passed in the subjects listed below:—

Kalgoorlie.

Chemistry IA.

Poole, R. H.

Preparatory Mathematics.

Thomas, G. N.

Mathematics I.

Lauri, J. M.
McDowell, J.

Mathematics II.

McNally, R. T.

Geology IA.

Jongen, P. J. F. G.

Geology IIA.

Veale, I. L.

Mining I.

Satapuntu, S.

Mining II.

van der Hoek, B. J. D.

Surveying I.

Magnus, E. R.

Surveying II.

Davey, C. R.
Lubbock, F. N.
Solomon, B. H.

English IA.

McNally, R. T.

Norseman.

Mining IIA.

Burgess, R. J.

Bullfinch.

Mathematics I.

Campbell, F. C.
Patrick, A. K.

Mathematics II.

Blackley, T.

Preparatory Physics.

Ryan, T. E.

Welding I.

Crunkhorn, L. G.

SCHOOL OF MINES OF WESTERN AUSTRALIA.

APPENDIX 2.

SCHOLARSHIPS AND PRIZES, 1961.

MINES DEPARTMENT.

Entrance Scholarship: No award made.
Senior Scholarship: L. M. Karczub, R. G. Pascoe.

CHAMBER OF MINES PRIZES.

Metallurgy: W. F. Thornton.
Mining: I. D. Mackay.
Engineering: J. J. Miller.
Mining Geology: No award.

SCHOOL OF MINES STUDENTS' ASSOCIATION SCHOLARSHIPS.

Metallurgy: W. F. Klose.
Mining: C. J. B. Lewis.
Engineering: R. N. Forrest.
Mining Geology: No award.

INSTITUTE OF MINING SURVEYORS' PRIZE.

£10: J. M. Fogarty.
£5: C: J. B. Lewis.

SOCIETY OF W.A. SCHOOL OF MINES ASSOCIATES' PRIZE.

R. M. King.

REG. DOWSON SCHOLARSHIPS.

G. G. Prime, F. W. Rose.

ROBERT FALCONER PRIZES.

No award.

C. A. HENDRY PRIZES.

C. J. B. Lewis.

"FINANCIAL STANDARD" PRIZES.

J. M. Fogarty, F. D. Dykstra.

WESLEY LADIES' GUILD PRIZE.

R. P. Hewitt.

## APPENDIX 3.

## KALGOORLIE METALLURGICAL LABORATORY.

*By E. Tasker, A.W.A.S.M. (Met.), A.M. Aust. I.M.M.*
*Senior Research Metallurgist.*

### INTRODUCTION.

Three reports of investigations and four hundred and sixty-nine certificates of testing or analyses were issued during the year. Brief descriptions of the investigations are included in this report.

For further information regarding these reports apply to:—

Secretary,
Commonwealth Scientific and Industrial Research Organization,
314 Albert Street,
East Melbourne, C.2, Victoria.

from whom copies of the reports can be obtained, usually six months after date of issue.

In addition to the reports issued, five other investigations were approved and test work was in progress.

Various inquiries dealing with the technical problems of people engaged in the mining industry were handled during the year, and a number of visits were made to various treatment plants by members of the Laboratory staff following requests for assistance.

### COMPLETED INVESTIGATIONS.

*Report No. 700.*

Beneficiation tests were carried out on samples of low-grade gypsum taken from various W.A. lakes for the Government Geolcgist.

Most samples could be upgraded to plaster of paris specifications by means of flotation.

*Report No. 714.*

Test work was carried out for the purpose of producing a relatively high-grade copper concentrate from an oxide copper ore from Thadoona area, W.A. By flotation it was possible to recover 70 per cent. of the copper in a concentrate assaying over 20 per cent. copper, and a plant is now under construction at the mine.

*Report No. 715.*

Test work was carried out in an endeavour to recover titanium oxide from a titanium-iron oxide sludge produced in the upgrading of ilmenite. Both the iron and titanium oxides were present as extremely fine particles and gravity and classification methods of treatment were not applicable. However, by means of flotation 75 per cent. of the titania could be recovered in a concentrate assaying 24 per cent. $TiO_2$.

### INCOMPLETE INVESTIGATIONS.

*Report No. 712.*

Gravity concentration tests and flotation tests were in progress on samples of zircon rich products from the Westralian Oil Company's ilmenite concentrating plant at Capel, W.A.

*Report No. 716.*

Test work was in progress on a sulphide gold ore from Fimiston, W.A. The object of this work was primarily the production of sufficient data for assessing the economics of flotation concentrate regrinding in a local treatment plant.

*Report No. 717.*

Batch and pilot scale test work was in progress on a pegmatite ore from Mt. Marion, W.A. with the object of producing a marketable grade of spodumene.

*Report No. 718.*

Treatment tests were being carried out on diamond drill core samples from Pinnacles Lease, in the Cue district.

*Report No. 720.*

Examination of plant residues from the Sons of Gwalia Gold Mine were in progress to determine the relationship between the high gold values and the sulphide minerals.

### KALGOORLIE METALLURGICAL LABORATORY.

Summary of Year's Work, 1961.

| Report No. | Owner | State | Locality | Ore Type | Type of Investigation | Confidential until | Number of Metallurgical Tests | Number of Assays | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Gold | Others |
| 700 | Government Geologist, Perth | W.A. | Various W.A. Lakes | Gypsum .... | Beneficiation tests | 12/11/61 | 35 | .... | 160 |
| 714 | British Metals Corporation (W.A.) Pty. Ltd., Perth | W.A. | Thadoona Area.... | Oxidised Copper | Treatment tests .... | 8/3/62 | 30 | .... | 108 |
| 715 | Director, Government Chemical Laboratories, Perth | W.A. | .... .... .... | Titanium-Iron oxide sludge | Titania recovery | 26/3/62 | 20 | .... | 60 |
| | Certificates Nos. 1232–1349, 1351–1658, 1660–1662, 1665–1704 | .... | .... .... .... | .... | .... .... .... | .... | .... | 816 | 2,123 |
| | Free Assays .... .... | .... | .... .... .... | .... | .... .... .... | .... | .... | 189 | 35 |
| | School of Mines .... | .... | .... .... .... | .... | .... .... .... | .... | .... | .... | 18 |
| | | | | | | Totals .... | 85 | 1,005 | 2,504 |
| | THE FOLLOWING INVESTIGATIONS WERE INCOMPLETE OR PENDING AT 31st DECEMBER, 1961 | | | | | | | | |
| 712 | Warman Equipment Company, Perth | W.A. | Capel .... .... | Zircon .... | Concentration .... | .... | 16 | .... | 6 |
| 716 | Gold Mines of Kalgoorlie, Fimiston | W.A. | Fimiston .... | Gold .... | Treatment tests .... | .... | 18 | 90 | 90 |
| 717 | Western Mining Corporation, Kalgoorlie | W.A. | Mt. Marion .... | Spodumene | Beneficiation tests | .... | 15 | .... | 30 |
| 718 | Government Geologist, Perth | W.A. | Cue .... .... | Gold .... | Treatment tests .... | .... | 2 | 10 | 2 |
| 720 | Sons of Gwalia G.M., Gwalia | W.A. | Gwalia .... .... | Gold .... | Examination of treatment plant residue | .... | 2 | 12 | 6 |
| | | | | | | Totals .... | 138 | 1,117 | 2,638 |

# DIVISION VI

# *Annual Report of the Inspection of Machinery Branch of the Mines Department for the Year 1961*

*The Under Secretary for Mines:*

For the information of the Hon. Minister for Mines I submit the report of the Deputy Chief Inspector of Machinery in the administration of the Inspection of Machinery Act, 1921-1958, for the year ending 1961.

E. E. BRISBANE,
Chief Inspector of Machinery.

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## Section 1.

## INSPECTION OF BOILERS, MAINTENANCE, ETC.

(See Returns Nos. 1, 2 and 3.)

Under the Act "Boilers" means and includes—

(a) any boiler or vessel in which steam is generated above atmospheric pressure for working any kind of machinery, or for any manufacturing or other like purpose:

(b) any vessel used as a receiver for compressed air or gas, the pressure of which exceeds 30 lb. to the square inch, and having a capacity exceeding five cubic feet; but does not include containers used for transport;

(c) any vessel used under steam pressure as a digester; and

(d) any steam jacketed vessel used under steam for boiling, heating, or disinfection purposes.

It also includes the setting, smoke stack, and all fittings and mountings, steam or other pipes; feed pumps and injectors and other equipment necessary to maintain the safety of the boiler.

*Return No. 1.*

In this return is recorded the number of boilers of the various types added to our registrations during the year: Those of Western Australian origin exceed by 161 the number of pressure vessels imported.

*Return No. 2.*

This return shows the number of each type, and overall total, in the register of useful boilers. Of the total, 2,250 were not in service.

*Return No. 3.*

This contains a summary of operations for the year. The manufacture of boilers in this State for export, remarked on in this report last year, continued. The numbers show a slight drop, being 90 to other Australian States and 3 to countries outside Australia. The reduction in numbers exported within Australia could probably be attributed to the general depression of economic conditions experienced throughout this country during the year.

RETURN No. 1.

Showing the Number of Boilers of each Type, and Country of Origin of New Registrations for the year ended 31/12/61.

| | Denmark | United Kingdom | U.S.A. | Eastern States | Western Australia | Unknown Sources | TOTAL |
|---|---|---|---|---|---|---|---|
| Ret. Multi. Stat. Int. Fired | .... | .... | .... | .... | 100 | .... | 100 |
| Digester | .... | .... | .... | 4 | 5 | .... | 9 |
| Vulcaniser | .... | .... | .... | 15 | 2 | 12 | 29 |
| Steam Jacketed Vessels | .... | .... | .... | 10 | 25 | 1 | 36 |
| Sterilizer | .... | .... | .... | 11 | 38 | .... | 49 |
| Air Receiver | .... | 24 | 3 | 41 | 58 | 14 | 140 |
| Gas Receiver | 1 | 8 | 2 | 6 | 28 | .... | 45 |
| Autoclave | .... | .... | .... | 8 | 6 | .... | 14 |
| Vert. Stat. | .... | .... | .... | .... | 5 | .... | 5 |
| Ret. Multi. Stat. U/fired | .... | .... | .... | .... | 1 | .... | 1 |
| Cornish | .... | .... | .... | .... | 3 | .... | 3 |
| Sectional | .... | .... | .... | .... | 2 | .... | 2 |
| Vert. Multi. Stat. | .... | .... | .... | 1 | .... | .... | 1 |
| | 1 | 32 | 5 | 96 | 273 | 27 | 434 |

RETURN No. 2.

Showing Classification of Various Types of useful Boilers in Proclaimed Districts on 31/12/61

| Types of Boilers | Districts Worked from Perth | Districts Worked from Kalgoorlie | Total |
|---|---|---|---|
| Lancashire | 44 | 23 | 67 |
| Cornish | 224 | 59 | 283 |
| Semi-Cornish | 14 | 1 | 15 |
| Vert. Stationary | 417 | 43 | 460 |
| Vert. Port. | 38 | 10 | 48 |
| Vert. Multi. Stat. | 47 | 4 | 51 |
| Vert. Multi. Port. | 8 | 1 | 9 |
| Vert. Pat. Tubular | 49 | .... | 49 |
| Loco. Rect. F/Box Stat. | 76 | 20 | 96 |
| Loco. Rect. F/Box Port. | 158 | 17 | 175 |
| Loco. Circ. F/Box Port. | 91 | 2 | 93 |
| Locomotive | 81 | 11 | 92 |
| Water Tube | 559 | 61 | 620 |
| Ret. Multi. U/fired Stat. | 259 | 7 | 266 |
| Ret. Multi. U/fired Port. | .... | 5 | 5 |
| Ret. Multi. Int. Fired Stat. | 155 | 6 | 161 |
| Sterilisers | 505 | 35 | 540 |
| Autoclaves | 66 | 1 | 67 |
| Digesters | 300 | 7 | 307 |
| Gas Receivers | 383 | .... | 383 |
| Air Receivers | 1,928 | 589 | 2,517 |
| Vulcanizers | 463 | 9 | 472 |
| Steam Jacketed Vessels | 647 | 15 | 662 |
| Not Elsewhere Specified | 191 | 5 | 196 |
| Total Registration Useful Boilers | 6,703 | 931 | 7,634 |
| Total Boilers out of use, 31/12/61 | 1,671 | 579 | 2,250 |

(10)—57785

RETURN No. 3.

Showing Operations in Proclaimed Districts during year ended 31/12/61.

| Boilers | Districts Worked from Perth | Districts Worked from Kalgoorlie | Total 1961 | Total 1960 |
|---|---|---|---|---|
| Total number of useful boilers registered | 6,703 | 931 | 7,634 | 7,341 |
| New boilers registered during year | 426 | 8 | 434 | 377 |
| Boilers inspected, thorough | 4,113 | 352 | 4,465 | 4,336 |
| Vessels exempt under Act constructed for export, thorough | 2 | .... | 2 | 14 |
| Boilers inspected working | 919 | .... | 919 | 892 |
| Boilers condemned during year temporarily | 10 | .... | 10 | 14 |
| Boilers condemned during year permanently | 51 | 7 | 58 | 69 |
| Boilers sent to other States during year | 90 | .... | 90 | 108 |
| Boilers sent from other States during year | 96 | .... | 96 | 79 |
| Boilers sent from other countries during year | 38 | .... | 38 | 19 |
| Boilers sent to other countries during year | 3 | .... | 3 | 9 |
| Transferred to other Departments | .... | .... | .... | .... |
| Transferred from other Departments | 10 | .... | 10 | 6 |
| Re-instated | .... | .... | .... | 1 |
| Converted | .... | .... | .... | .... |
| Number of notices of repairs issued during year | 548 | 32 | 580 | 595 |
| Number of certificates issued including those issued under Section 30 during year | 4,108 | 352 | 4,460 | 4,347 |

## MAINTENANCE AND MISCELLANEOUS.

The favourable trend of the last few years of greater attention to the care and maintenance of boilers by owners appears to have continued during the year. Reports indicate that attention continues to improve, more feed water treatment and quality control is being exercised and more owners are taking advantage of condensate return to feed tanks. This is due to the continued efforts of officers of this Department and several water treatment suppliers in pointing out that in most instances the boiler is the heart of a production set-up and without it there is no production. Boiler break downs cause unscheduled hold ups which owners are now realising are more expensive than preventative care and maintenance.

Availablity of several chemical descaling processes has given more results with neglected boilers which had become heavily encrusted over long periods. These descaling methods properly applied remove inaccessible and stubborn deposits rapidly thus restoring the vessel to almost original condition.

Not all deposits during this year can be blamed on neglect, particularly in country districts. In some instances the water supplies from bores, wells, etc. are affected by the composition of the ground in which they are sunk. A very dry year was also experienced so that owners dependent on rivers and creeks for water supply, found their levels dropping with consequent deterioration in purity and increases in solid and salt contents. In these cases the owner is largely at the mercy of the elements.

"Automatic" boilers, which have been the subject of comment in previous reports continue to be the type most favoured for installation in W.A. During the year there were several instances of leaking tubes brought about by low water conditions. One instance because an obstruction on the water level control float arm fouled the float arm stop and hung up. Unfortunately this defect had been previously located in other boilers and it was thought that all with that type of float arm had been modified but this one was overlooked. The boiler was unattended at the time of the mishap, being exempt from that requirement, otherwise the shortage of water in the boiler would have been apparent from checking of the glass water gauges.

Two other low water incidents are thought to have been due to the ports in the three-way control cock on the float chamber becoming sealed with a thin wall of grease. The lubrication of these cocks is made by forcing grease down the centre of the plug with a screw, the grease then spreading along grooves between the plug and the shell. If too much grease is pushed through it can form a diaphragm in the ports. If the cock is not blown through after this the level of the water in the boiler can drop without a corresponding drop in the float control chamber, thus allowing the boiler to become short of water.

Generally it seems that owners and boiler attendants are becoming more conscious of the limitations of the term "Automatic" as applied to boilers. I feel this is due to concentration by Inspectors of this Branch in carrying out a number of working inspections and explaining to the operators of the boilers what was required, educational programmes undertaken by the boiler manufacturers, and in some measure to a course instituted by the Technical Education Branch in Boiler Attendance together with emphasis on this phase in Departmental examinations of applicants for Boiler Attendant's Certificates of Competency.

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## Section 2.

## EXPLOSIONS AND INTERESTING DEFECTS.

There was no explosion of any pressure vessel during the year but the following occurrence seems worthy of note:—

Single Door Double Shell Autoclave.

This vessel was installed in a maternity hospital theatre and was being used to sterilize instruments, etc.

The Inspector's report after investigation is as follows:—

> Sister was sterilizing instruments and stainless steel trays in the autoclave while also tending a patient in the labour ward. When she heard the alarm on the timer ring she returned to the theatre, turned it off and at the same time thought she had switched off the power to the vessel. It was then necessary for her to return to her patient in the labour ward. Approximately half an hour later Sister returned to the autoclave and tried to open the door but could not turn the door locking handle. Thinking it was jammed she placed a steel bar $\frac{3}{4}$ in. diameter x 3 ft. long between the spoke and hub of the wheel to force the wheel around. At this stage Nurse came into the theatre so both women grasped the bar, one on each side of the door, and commenced to turn the handle. They had only succeeded in turning it a slight distance when the door flew open knocking the Sister to one side when she collided with a cupboard. The nurse was knocked to the floor and struck on the nose by the stainless steel tray ejected from the autoclave. Nurse suffered a broken and lacerated nose which required stitches. The Sister suffered bruising of the back and left arm. The injuries under the circumstances could have been much more serious.
>
> I asked Sister had she checked the pressure gauge before attempting to open the door. She said "No." I then asked what position was the control handle in and she said she thought it was in the "off" position but later recalled that she had turned both the power and the control handle from "sterilize" to "off" after the accident.
>
> It appears that the autoclave was at full pressure when the door was opened. I checked the pressure gauges, door gasket, hinge and automatic locking device. The pressure gauge was out 3 p.s.i., the door gasket too thick, the door hinge sprung from the explosion, and the automatic door lock defective. The automatic door lock ratchet teeth were chewed away for 16th in. on one side and the teeth were not true with the centre spindle thus only giving partial engagement of the teeth. I believe damage to the ratchet teeth was caused either when the bar was used to force the handle

at the time of the accident or more probably when the bar was used on other occasions to open the door.

This mishap is noteworthy in that it contains the basic causes listed below of most mishaps with hospital pressure sterilizers and autoclaves particularly where they are, as in most instances, under the control of the female staff.

1. Distraction due to having several matters to attend to at once.
2. Absence of basic check and precautions before attempting to open the door, due probably to lack of elementary training in the operation of the vessel and understanding of various steps and functions in the process.
3. Lack of knowledge of the safety devices and brutal application of force to overcome these.
4. Inefficient maintenance apparent from the condition of safety devices and also the fact that the door joint was too thick. This latter fault has been noted before and it leads to insufficient engagement of the door locking bars. They are either just entered in the slots with a tendency to disengage under pressure, or as in this case there was no chance of seeing or hearing a warning escape of steam before the door flew open.

---

## Section 3.

## INSPECTION OF MACHINERY.

(See Returns Nos. 4, 5 and 6.)

At the expiration of the year 45,170 groups of machinery were in the register. This indicates an increase of 1,800 groups in comparison with the figure, for the previous year. Lift figures reveal an increase of 21 installations.

### RETURN No. 4.

Showing Classification according to Motive Power of Groups of Machinery in use or likely to be used by Proclaimed Districts and which were on the Register during the year ended 31st December, 1961.

| Classification | Districts Worked from Perth | Districts Worked from Kalgoorlie | Total 1961 | Total 1960 |
|---|---|---|---|---|
| Number of Groups driven by Steam Engines | 125 | 375 | 500 | 502 |
| Number of Groups driven by Oil Engines | 3,253 | 799 | 4,052 | 3,817 |
| Number of Groups driven by Other Power | 72 | 212 | 154 | 280 |
| Number of Groups driven by Electric Motor | 37,341 | 3,123 | 40,464 | 38,771 |
| | 40,791 | 4,509 | 45,170 | 43,370 |

### RETURN No. 5.

Showing operations in Proclaimed Districts during year ended 31st December, 1961. (Machinery only).

| — | Districts Worked from Perth | Districts Worked from Kalgoorlie | Total 1961 | Total 1960 |
|---|---|---|---|---|
| Total Registrations Useful Machinery | 40,791 | 4,509 | 45,170 | 43,370 |
| Total Inspections made | 25,219 | 4,144 | 29,363 | 28,627 |
| Certificates (Bearing Fees) | 5,624 | 574 | 6,198 | 6,659 |
| Number of Extension Certificates issued under Sec. 42 of Act | .... | .... | .... | .... |
| Notices issued (Machinery dangerous) | 880 | 12 | 892 | 541 |

### RETURN No. 6.

Showing Classifications of Lifts on 31st December, 1961.

| Types | How Driven | Total 1961 | Total 1960 |
|---|---|---|---|
| Passenger | Electrically driven | 266 | 257 |
| Passenger | Hydraulically driven | 1 | 1 |
| Goods | Electrically driven | 122 | 121 |
| Goods | Hydraulically driven | 1 | 1 |
| Goods | Belt driven | 3 | 3 |
| Service | Electrically driven | 100 | 88 |
| Service | Hydraulically driven | 1 | 1 |
| Escalators | Electrically driven | 24 | 25 |
| | | 518 | 497 |

## ACCIDENTS TO MACHINERY.

There were five accidents worthy of note but as these involved injuries to persons reports of these accidents are contained in references to Case A, B. C, D and E under Accidents to Persons, Section 5 hereafter.

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## Section 4.

## PROSECUTIONS FOR BREACHES OF THE ACT.

No prosecutions to report.

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## Section 5.

## ACCIDENTS TO PERSONS.

(See Returns Nos. 7, 7A and 7B.)

Returns 7 and 7A record accidents to persons with which machinery subject to the Act was involved, the former relating to those of serious nature and the latter to incidents classified as being of minor character.

Return 7B shows accidents caused by machinery not subject to registration by this Department but investigated under a provision of Section 50. The overall total of the occurrences shown in the three returns number 97.

It is regretted that I have to report that five of the accidents resulted in fatalities. Three (3) in the former category and two (2) in the latter.

### Case A.

### FERTILISER DUMP EXCAVATOR.

The machinery involved in this fatality is unique and has been specially designed and adopted for the digging of superphosphate from a stock pile and transferring it to an underground conveyor belt. The machinery is powered by a number of electric motors and consists of crawler tracks on which are mounted the turntable. To the turntable is fitted a jib which supports over its length an endless belt of scrapers whose function is to scrape down the superphosphate from the pile to the bottom of the jib. Here is erected a bucket elevator which picks up the material so scraped and lifts it up into the body of the turntable where it drops down a chute, through a hole in the floor and onto the underground conveyor belt. At the same time as the previous operations are carried out the whole turntable and jib scraper mechanism is oscillating so that the super is removed from the pile in an inclined, uniform cut.

The normal controls for the machine are mounted on the turntable, one set in a position which necessitates the operation being on the machine and the duplicate set which can be operated from ground level beside the machine.

There were no eye witnesses of the mishap but it was discovered by the underground conveyor operator when he went to the machine to find out why the supply of super to the conveyor belt had ceased. He found the deceased lying on the floor at the side of the machine with his head badly crushed. Evidence was later found that deceased's head had been caught between a drive belt guard on the frame mounted on the tracks and the turn-

table mounted main frame which pass within a few inches of each other as the machine oscillates.

No logical reason could be found to explain the presence of the deceased in the position where he was injured. Normal operation did not require him to be there and it does not seem likely that had he fallen from the machine he could have been there.

The following is the conclusion reached by the investigating officer:—

> It is therefore suggested as a possibility for the cause of this accident that the deceased may have been injured by say a fall or bump on the head immediately prior to the accident and in an injured or dazed condition lay against or raised himself up on the side of the excavator into the position in which he was crushed.

### Case B.

### MOBILE CRANE.

This accident was also fatal and occurred when a mobile jib crane overturned. It was doubly unfortunate in that the victim had nothing to do with the crane but happened to be working with his back to it at the prestressing bed and was struck by the head of the jib as the crane toppled over.

The report of the inspector who investigated the mishap is as follows:—

> On 4th April, 1961, two mobile cranes driven by certificated drivers were being used together to transport reinforced concrete piles from the casting section to the stacking and curing section, a distance of about 150 feet.
>
> The concrete piles are 45 ft. long, have a cross section 14 in. square and weigh approximately 4 tons. One crane was lifting each end. After ten piles had been successfullly transported both cranes were between the prestressing bed and the stacking and curing section. The eleventh pile being transported was slung from the cranes and an assistant was stationed at each end of the pile to steady and guide it. One crane was stationary while the other moved slowly towards the stacking section to parallel with it before they drove together to the stack for unloading. As the moving crane proceeded the right hand rear wheels went down into a slight depression in the ground causing the jib to lean towards the prestressing bed. The pile was pulled by the leaning jib and moved horizontally in the direction of the prestressing bed and the crane overturned.

The cranes involved were almost identical with jib lengths approximately 35 ft. mounted on the back of 4 x 4 trucks and were non slewing. Lifting and luffing movements of the jib were powered through wire rope winches driven from the power take off from the engine of the truck unit. At the time of the accident each crane was loaded almost to capacity and the jibs were luffed well up.

Following investigation the following circumstances are believed to have caused the accident:—

(1) The fact that the rear set of wheels were on uneven ground causing the crane to lean over sideways in the direction in which it overturned. Levels taken of the tyre impressions revealed the right hand side rear wheels to be at a level 3½ in. below that of the left hand side rear wheels.

(2) The inadequacy of the resistance to sideways overturning of this type of crane with its relatively long jib in an elevated position. This resistance being inadequate to cope with such sideways loadings as could be reasonably expected when using two cranes together to transport the concrete piles in the abovementioned manner.

(3) The probability of slight inaccuracy in the positioning and maintaining the cranes at the required distances apart to suit the load being transported. Inaccurate spacing of the cranes thus would cause them to push or pull sideways one against the other and coupled with the factor (1) above, an adverse error of assessment of spacing distance would need only to be about 7 per cent. in order to render the crane unstable in a sideways direction.

This accident serves to show how a basically unsound practice can be instituted and used for some time until a number of adverse circumstances occur simultaneously resulting in an accident. The inherent hazards in the system were not realised by the drivers and due to their careful driving did not appear until the system had been used a number of times.

### Cases C & D.

### MOBILE CRANES.

Accident case C involving a mobile crane also ended fatally. The accident occurred in an isolated area approximately 1,500 miles from Perth on a dam construction site. At the time of the accident shuttering was being prepared for the concrete pour of a section of the dam sill. Preparations include the placing of weights on top of the shuttering to prevent it moving during the pour and oiling of the underside of the shuttering to make it easily removable after pouring.

The deceased was working on the abovementioned duty of oiling the shuttering and as he was mostly out of sight during this time his presence there was overlooked. The crane was being used to place the weights. These consisted of half 44-gallon drums filled with concrete (est. wt. 500 lb.) into which one leg of a lifting lug bent out of ½ in. diameter reinforcing rod was embedded. The other leg was not embedded thus forming a hook of very light section.

When the mishap occurred two of these weights had been lifted on bridle gear by the crane and were swinging over the shuttering. One of the hooks in the weights straightened out allowing that weight to fall, and as this happened the other weight dropped and also disengaged from the bridle. The weights fell on the shuttering, one went through it and hit the deceased killing him.

The cause of this accident appears to be due to two factors—

(1) The poor design and lack of strength in the weight lifting hook.

(2) Insufficient care taken to ensure that personnel were clear of the area over which the crane loading was being lifted.

Case D is a further accident with a crane on the same construction site resulting in the crane overturning and the driver suffering serious lacerations to the right leg and both feet. The crane jib was also damaged.

When this accident occurred the crane, on crawler tracks, was located with tracks at right angles to the line of a 1 in 10 slope. The driver picked up the load on the uphill side of the crane with the jib well luffed out. He then slewed the load without luffing the jib in and as it came round approximately 180° to the downhill side the load overcame the stability and the crane tipped over.

The driver could have been much more seriously injured as he was thrown out of the cab but he fell between two rocks which supported the crane above him.

These two mishaps emphasise the difficulty in exercising proper surveillance over driving techniques and standards of lifting gear on construction sites in isolated areas and increases the responsibility of all concerned with the job.

The latter accident shows the danger inherent with mobile cranes when working on sloping, rough or bad ground such as is always present on construction and building sites. The need for drivers

to be constantly alert to the changing conditions and consequent lack of stability engendered cannot be stressed too forcefully.

Case E.

SAMMYING MACHINE.

This accident resulted in the right arm of the victim being badly crushed necessitating amputation above the elbow. The machine is uncommon and is peculiar to tanneries. For a description of the machine and the accident I quote from our Inspector's report and the account of the injured man:—

"The machine consists of a fixed position driven roller, another roller mounted on a swinging arm which only turns when in contact with the driven roller, and a scraping roller. The rotation of the rolls tend to move the skin out while the rotation of the scraper is in the opposite direction, the top arm of the machine when forced down on bottle jacks by hydraulic rams, is in the operating position.

"The operator stands at the front of the machine, he drapes the hide in between the rolls then smoothes the end he is holding on the idler roll. he presses the clutch pedal the crank makes a half turn and pulls the idler roller against the driven roller. This lifts the end of the top arm off the jacks against the force exerted by the hydraulic rams which is equivalent to four tons weight. The hide rolls out of the machine, the scraper scrapes the skin. then after it has travelled approximately 18 in. the clutch pedal is again pressed and this opens the rolls and the hide and the sleeves on the rolls are straightened. the pedal is pressed, the rolls closed and this procedure is carried out until the skin is completely through the rolls."

The injured man stated he had operated the machine for four and a half months. During this time he had on a few occasions reported to the maintenance fitter that the rolls had closed without his touching the clutch pedal, and each time the fitter had adjusted the clutch and it had performed satisfactorily.

On the day of the accident he was operating the machine, he put the skin between the rolls and while spreading it over the idler roll noticed that one of the legs of the skin had caught in the rough edge of the bottom of the splash board. He put his right arm down between the rolls to free the skin and the rolls closed on his arm. He was definite that he had not slipped and touched the clutch pedal.

The inspector examined the clutch and watched the machine operating. There was no creep or slipping of the clutch during this time and a distinct pressure was required on the pedal to make the clutch operate.

When the manager and maintenance staff were queried concerning the faulty clutch it was stated that there had been trouble with the clutch but a complete set of spares had been obtained and installed, since when there had been no further complaint. The operator who had been using the machine since the mishap said it had worked satisfactorily and he had noticed no fault in the clutch.

Further examination did reveal that there was an appreciable amount of wear in the clutch locking pin and the corresponding slot in the clutch assembly. Our inspector considers that if the clutch grabbed momentarily the locking device would slip and if this occurred the clutch would be held in until the clutch forcing the roller up completed half a revolution.

The clutch locking mechanism was replaced with a spare set and the set taken out was to be built up to its original profile. The splash board was ordered to be sheeted over with steel plate.

Case F.

This accident, unfortunately fatal, occurred with a roto Hay Baler, agricultural machinery, which is not subject to the provisions of the Act.

The machine by a series of rollers and wide belts compresses the hay which is fed into the belts and led by them to the rollers. It is slightly compressed by the rollers and after being bound with twine discharges as a round bale.

Our inspector remarks that a feature of these machines is the excellent guarding by the makers of all possible moving parts and the specific instructions and warning signs painted on the machine. It is not practical to guard the entry point of the hay to the rollers as it would make the machine useless.

At the time of the accident deceased was working alone in a paddock removed from any other habitation. It was his custom to work alone all day. This was certainly a contributory fact in his death.

As there were no witnesses one suggestion is that the hay was damp, clogged the rollers and deceased while attempting to clear it without stopping the machine was dragged into the rollers by the arms. A second possibility, thought more likely, is that trouble was experienced with the binder twine and deceased was attempting to re-thread it through a bobbin like fitting in an oscillating arm when one arm was picked up by a moving belt and the other arm was caught as he tried to free himself. The result was that the victim was crushed and pinned with both arms trapped in the rollers of the machine. Had help been immediately available prompt attention may have saved his life. It is thought the mishap occurred soon after he commenced work and unfortunately he remained trapped till late afternoon when he was missed and later freed. Although still alive at this time he died in hospital some hours later.

Case G.

This accident, also fatal, again involves machinery not subject to the provisions of the Act. The machine in question is a tractor powered front end loader with hydraulic operation of the bucket.

The victim of the accident was a tractor service mechanic employed by the agents for the machine and at the time was working on the machine which was owned by a local government body.

When replacing a side panel deceased sheared off a holding stud located on the driver's side behind the right hand bucket operating hydraulic leg. In order to replace the broken stud he raised the bucket some 4 feet above ground level to clear it. The controls for the bucket ram are situated immediately behind the side panel and consist of simple hand levers directly coupled to the hydraulic control valves. It appears that deceased was using a short bar to lever the side panel out when it slipped and his hand knocked the control lever into the fast lowering position. This allowed the bucket to drop suddenly and the victim was crushed between the ram casing and the front tyre of the vehicle.

Two facts are pointed out by our Inspector who made the investigation:—

(1) The necessity for blocking or shoring up any mechanical part when working underneath it so that there is no possibility of it falling accidentally.

(2) That a positive locked neutral position on the central lever might be an additional safeguard.

(Here follow returns 7, 7A, 7B.)

Return No.7.

Showing Number of Serious Accidents, both Fatal and Non-Fatal, which Occurred n Proclaimed Districts during the Year ended 31st December, 1961.

"F" denotes Fatal.

| Industry | Circular Saw | Bandsaw | Buzzer (Planer) | Spindle Moulder (Shaper) | Thicknesser | Belts and Shafting | Gearing | Hoist (Builders) | Conveyors (Belt Slat. Screw) | Crane (Gantry) | Crane (Mobile) | Elevator (Tray Spiral) | Dump Excavator | Abrasive Wheels | Wiredrawing or Working | Rolls | Press Metal) | Press (Other) | Concrete Mixer | Bending Machine (Metal) | Bending Machine (Other) | Printing Machine | Lift | Bottlemaking Machine | Biscuit Filler | Crown Seal Machine | Wool Press | Grinding Pan | Sterilizer | Fan | Totals per Inudstry |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Woodworking and Furniture | 1 | .... | 9 | 1 | 1 | .... | .... | .... | .... | .... | .... | .... | .... | 4 | 4 | 3 | 3 | .... | 1 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 12 |
| Metal Working and Engineering | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | 18 |
| Printing and Allied Industries | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 1 (F) | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 (1F) |
| Fertiliser Manufacture | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 3 (2F) | .... | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | 1 | .... | 8 (2F) |
| Food and Drink Processing | .... | .... | .... | .... | .... | 2 | 1 | 1 | .... | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 |
| Building Materials and Building | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Mining | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Glass Making | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 | .... | .... | .... | .... | .... | .... | 3 |
| Other | .... | 1 | .... | .... | .... | 1 | .... | .... | 2 | .... | 1 | 1 | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | .... | 2 | .... | .... | 1 | 1 | .... | 1 | .... | 13 |
| Totals per Type of Machine | 3 | 1 | 9 | 1 | 1 | 3 | 1 | 1 | 4 | 1 | 4 (2F) | 2 | 1 (F) | 4 | 4 | 6 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 69 (3F) |

Return No. 7a.

MINOR ACCIDENTS

Showing Number of Accidents not Classed as Serious under the Act and not included in Return No. 7 but were Reported and Investigated during the Year ended 31st December, 1961.

| Industry | Circular Saw | Buzzer (Planer) | Spindle Moulder | Thicknesser | Belts | Monorail Hoist | Wire Drawing or Working | Press (Metal) | Lathe Lathe | Totals per Industry |
|---|---|---|---|---|---|---|---|---|---|---|
| Woodworking and Furniture .... | 1 | .... | 2 | 2 | .... | .... | .... | .... | .... | 5 |
| Metalworking and Engineering | .... | .... | .... | .... | .... | 1 | 4 | 1 | .... | 6 |
| Food and Drink Processing .... | .... | 1 | .... | .... | 1 | .... | .... | .... | 1 | 3 |
| Mining .... .... .... .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Other .... .... .... .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| Totals per type of Machine | 2 | 2 | 2 | 2 | 1 | 1 | 4 | 1 | 1 | 16 |

Return No. 7b.

Accidents involving Machinery not subject to the Provisions of the Inspection of Machinery Act, Reported to and Investigated by the Department in Compliance with Section 50 of the Act during the Year ended 31st December, 1961.

| Industry | Circular Saw | Bandsaw | Buzzer (Planer) | Abrasive Wheels | Rolls | Bacon Slicer | Linotype | Haybaler | Front End Loader | Totals per Industry |
|---|---|---|---|---|---|---|---|---|---|---|
| Woodworking and Furniture .... | .... | .... | 2 | .... | .... | .... | .... | .... | .... | 2 |
| Metalworking and Engineering | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 1 |
| Printing and Allied Industries | 3 | .... | .... | .... | .... | .... | 1 | .... | .... | 4 |
| Food and Drink Processing .... | .... | .... | .... | .... | 1 | 1 | .... | .... | .... | 2 |
| Other .... .... .... .... | .... | 1 | .... | .... | .... | .... | .... | 1F | 1F | 3(2F) |
| Totals per type of Machine | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1F | 1F | 12(2F) |

## Section 6.

## EXAMINATION OF ENGINE DRIVERS, CRANE DRIVERS AND BOILER ATTENDANTS.

The Board of Examiners granted 109 engine drivers', 199 crane drivers' and 74 boiler attendants' certificates.

Compared with the previous year these figures constitute a decrease 3, increase 14, and decrease 6, respectively in the number of certificates granted.

## Section 7.

## AMENDMENTS TO ACT.

No amendments to be reported.

## Section 8.

## STAFF.

The year was a difficult one as far as the staff position is concerned. Firstly the Deputy Chief Inspector of Machinery, Mr. Winzar was absent on sick leave for approximately three months at the beginning of the year, followed by his retirement in August. Mr. Remkes resigned from the Department in November.

I was Acting D.C.I.M. for some weeks and then my appointment to the position was confirmed. This leaves the Senior Inspector's item vacant as well as the position vacated by Mr. Remkes.

As was noted in this report last year the number of Inspectors is inadequate to cope with the increased amount of work occasioned by the general expansion of industry, building and construction work in this state.

A submission for additional inspection staff by Mr. Winzar, led to an investigation by an Inspector from the Public Service Commissioner's Office, some re-arrangement and change in the clerical side of the Machinery Inspector's work and in the first instance the approval of the creation of a temporary position for one Inspector, which was later made permanent.

A further submission supported by factual data was made by myself which pointed out that a further increase of three more Inspectors was desirable. This matter is still under consideration.

Numbers in the clerical staff remain unchanged but with the re-organisation of the Inspector's clerical duties which throws more work on their shoulders, an increase in this section may be found necessary.

The officers of both sections have responded willingly and cheerfully to the extra demands made on them by the increased pressure of work during the year. I wish to thank them for this and the ready co-operation given at all times.

To the Police Department our appreciation is again due for continued co-operation by its officers in reporting to us any machinery accidents involving injuries to persons that are brought to their notice. In a number of instances they also have been present at the scenes of mishaps during periods in which our Inspectors were investigating the occurrences, and in various ways connected with such enquiries have rendered much assistance to our Department.

In conclusion and on behalf of myself and the members of our staff I would like to express thanks for the assistance readily given to the Branch by other divisions of the Mines Department when requested.

E. J. McMANIS,
Deputy Chief Inspector of Machinery.

Return No. 9.

Revenue and Expenditure for year ended 31st December, 1961, and Comparison with Preceding Year.

*Revenue*

| | 1961 £ s. d. | 1960 £ s. d. |
|---|---|---|
| Fees from Boiler Inspections .... .... .... .... .... .... .... .... .... .... .... .... | 5,570 0 5 | 5,506 14 9 |
| Fees from Machinery Inspections .... .... .... .... .... .... .... .... .... .... .... .... | 9,468 0 0 | 9,135 13 3 |
| Fees from Engine Drivers .... .... .... .... .... .... .... .... .... .... .... .... | 753 6 0 | 728 5 0 |
| Incidentals .... .... .... .... .... .... .... .... .... .... .... .... .... | 109 18 7 | 198 5 4 |
| | £15,901 5 0 | £15,568 18 4 |
| Increase in Revenue compared with 1960 .... .... .... .... .... .... .... | £332 6 8 | |

*Expenditure*

| | 1961 £ s. d. | 1960 £ s. d. |
|---|---|---|
| Salaries .... .... .... .... .... .... .... .... .... .... .... .... .... | 33,787 15 10 | 30,613 11 11 |
| Incidentals .... .... .... .... .... .... .... .... .... .... .... .... .... | 5,041 16 5 | 7,381 17 9 |
| Engine Drivers Examinations .... .... .... .... .... .... .... .... .... .... .... .... | 140 19 7 | 257 13 3 |
| | £38,970 11 10 | £38,253 2 11 |
| Increase in Expenditure compared with 1960 .... .... .... .... .... .... | £717 8 11 | |

Return No. 10

Showing Distances Travelled, Number Inspections Made and Average Miles Travelled for Inspections for the Year ended 31st December, 1961.

| | Road Miles | Air Miles | Rail Miles | Water Miles | Collective Mileage all Transport Services | Number of Inspections | Average Miles per Inspection |
|---|---|---|---|---|---|---|---|
| Districts operated from Perth .... | 91,025 | 6,050 | *Nil* | *Nil* | 97,075 | 30,251 | 3·21 |
| Comparison with 1960 .... .... | Inc. 11,133 | Dec. 4,167 | Dec. 750 | *Nil* | Inc. 14,550 | Inc. 637 | Inc. 0·42 |
| Districts operated from Boulder .... | 15,926 | .... | .... | .... | 15,926 | 4,496 | 3·36 |
| Comparison with 1960 .... .... | Inc. 4,733 | .... | .... | .... | Inc. 4,733 | Inc. 255 | Inc. 0·72 |
| Totals .... .... .... .... | 106,951 | 6,050 | .... | *Nil* | 113,001 | 34,747 | 3·25 |
| Comparison with 1960 .... | Inc. 15,866 | Dec. 4,167 | Dec. 750 | *Nil* | Inc. 19,283 | Inc. 892 | |

Average Miles per inspection all districts, 1961 .... .... .... .... 3·25
Average Miles per inspection all districts, 1960 .... .... .... .... 2·77
Increase per inspection compared with 1960 .... .... .... .... Inc. 0·49

Note Abbreviations :—Inc. = Increase
Dec. = Decrease

# DIVISION VII

# *Government Chemical Laboratories Annual Report—1961*

*Under Secretary for Mines:*

I have the honour to present to the Honourable Minister for Mines a summarised Annual Report on the operations of the Government Chemical Laboratories for the year ending 31st December 1961.

*Administration.*

The major administrative activity during 1961 was a re-organisation of the Grades of Chemists within the Laboratories. The former system of two Grades, P.II.2/7 and P.II.8/9 was altered to provide three Grades, P.II.2/7, P.II.8/9 and P.II.10/11 and our staff was re-graded. The classification for chemists now conforms to those of other professions included in the Career Range of the Public Service.

During the year there were several discussions on the increasing tendency to appoint chemists to other Government Departments. It is considered that this is inefficient and uneconomic under present circumstances, causing duplication of effort and equipment. It is true, that as emphasised in previous annual reports these Laboratories are not able to give to other Government Departments the service they should. It is however, considered much more efficient and economical to increase these Laboratories than to establish separate small laboratories elsewhere, and our building extension plans are referred to later.

The Laboratories covered by this Annual Report consist of 6 Divisions, a Physics and Pyrometry Section, a central office and a library all under the control of the Director (Government Mineralogist, Analyst & Chemist) as follows:—

Director—L. W. Samuel, B.Sc., Ph.D., M.A.I.A.S., F.R.A.C.I., F.R.I.C.

Agriculture, Forestry & Water Supply Division—R. C. Gorman, B.Sc., A.R.A.C.I., M.A.I.A.S. Deputy Government Agricultural Chemist.

Engineering Chemistry Division—S. Uusna, Dr. Ing., A.M.I.E. (Aust). M. Inst. F., Chief Chemical Engineer.

Food, Drugs, Toxicology & Industrial Hygiene Division—N. R. Houghton, B.Sc., A.R.A.C.I., Deputy Government Analyst.

Fuel Technology Division—R. P. Donnelly, M.A., B.Sc., M.I. Gas Eng., A.M.I. Chem. Eng., M.Inst.F., Fuel Technologist.

Industrial Chemistry Division—A. Reid, M.A., B.Sc., A.R.I.C., Chief Industrial Chemist.

Mineralogy, Mineral Technology and Geochemistry Division—G. H. Payne, M.Sc., A.W.A.S.M., A.R.A.C.I., Deputy Government Mineralogist.

Physics & Pyrometry Section—N. L. Marsh, B.Sc., Physicist and Pyrometry Officer.

Librarian—Miss H. Duffield.

Office—Miss D. E. Henderson, Senior Clerk.

At 31st December 1961 the staff numbered 73, being—

| | |
|---|---|
| Professional | 44 |
| General | 15 |
| Clerical | 9 |
| Wages | 5 |
| | 73 |

It is with regret that I have to again report a difficult year for staff requirements. We have not been able to maintain a full staff of chemists and we have been forced to (a) engage Laboratory Technicians and (b) institute a system of cadetships. It is expected that the first cadets will be appointed in 1962 under the normal conditions of the Public Service.

Prospects of filling professional vacancies have not been enhanced by recent advertisements for chemists in private industry, advertisements in which the salaries appear to be based on the recent decision of the Arbitration Court on the "Engineer's case".

It has also been a very difficult year for clerical staff as we have had 4 different records clerks during the year.

The close association of these Laboratories with other Government Departments and with kindred associations was maintained during 1961 and various members of the staff are members of the following committees:

Atomic Energy Commission—Commonwealth-States Committee.

Cereal Chemistry Group of the Royal Australian Chemical Institute.

Food and Drugs Advisory Committee.

National Association of Testing Authorities, State Committee.

Oils Committee of the Government Tender Board.

Paints Advisory Committee of the Government Tender Board.

Pesticides Registration Committee.

Poison Plants Committee.

Rivers and Waters Technical Advisory Committee.

Swan River Conservation Board.

Veterinary Medicines Advisory Committee.

Water Purity Advisory Committee.

In addition the Director attended the Committee appointed to consider the supply of copper fertiliser.

Some of these Committees do not meet regularly but others do and are very active and occupy considerable time of the officers concerned, not only for the meetings but also for inspections, preparation of material and analysis of samples. This has been particularly so for the Swan River Conservation Board which requires considerable time and thought and for which a large number of analyses have been made in connection with possible pollution of the Swan River.

The Pesticides Registration Committee dealt with 98 applications for the registration of new pesticide formulations. A matter of great concern to this Committee is the poisonous nature of most of the newer pesticides, particularly as many of them can be absorbed through the skin. It is very pleasing to be able to report that the new Food and Drug Regulations under the Public Health Act have received final approval and are now being printed. This however is not the last word, the Regulations are constantly under review in the light of experience and the introduction of new substances for addition to foods.

*Equipment.*

Two major items of equipment were added to our facilities in 1961: A Perkin-Elmer infra-red spectrophotometer and a pilot plant scale magnetic separator. The infra-red spectrophotometer should be kept in an atmosphere of less than 50 per cent. relative humidity and this entailed considerable work on air conditioning equipment.

*Accommodation.*

Early in 1961 we commenced irrigating most of our extensive lawns from our own bore, situated about the middle of our eastern boundary.

As noted in previous Annual Reports the demand by other Government Departments on our facilities, especially in the analytical field, exceeds our capacity and it is essential that further buildings be provided. In my Report for 1960 I stated that the initial additions, to our Library, Office and Refectory, were expected to be made in early 1961. Unfortunately and regrettably these expectations were not realised. Long protracted negotiations with the architects leave the position of our main buildings now much as they were a year ago, except for planning.

It is pleasing to report however that we have had more success in providing a modern amenities block for the Engineering Chemistry Division at Bentley. Plans have been approved and tenders called and it is expected that construction will start early in 1962.

It is hoped that extensions to our main buildings in Adelaide Terrace will commence early in 1962 and so enable us to increase our services to Government Departments. The general complete building programme has been discussed with the architects.

The necessity for increased laboratory space can be illustrated from the "work in hand" i.e. samples received but not analysed and reported. Work in hand is listed as at the first day of each month and for 1961 the average number was 1355 with a peak of 2346 at 1st December.

*Experimental.*

In my Report for 1960 I described briefly experimental work on the effect on lawn grass of ground water contaminated with chlorophenols and 2.4.D. Irrigation of portion of our lawn with the affected water was continued in the early months of 1961 (summer) until the first rains. The last irrigation was on 24th March, 1961 and over the period of more than 4 months of summer there was no adverse effect on Kikuyu grass. Samples of each irrigation water used were analysed and the range of analyses from 15th November, 1960, to 24th March, 1961, was—

| | Range |
|---|---|
| Appearance .... .... .... | Very cloudy |
| Colour .... .... .... | Settled clear and colourless |
| Odour .... .... .... .... | Chlorophenol |
| Ferrous iron .... .... .... | Present |
| pH .... .... .... .... | 6·3—6·7 |
| | Grains per gallon |
| Total soluble salts .... .... | 102–119 |
| Sodium chloride (calculated from chloride) | 76–86 |
| | Parts per million |
| Chlorophenols (calculated as phenol) | 14–37 |
| 2 : 4 D .... .... .... | 6–31 |

A sample of this bore water was taken on 12th December, 1961 and analysed 22 p.p.m. of chlorophenols, calculated as phenol, and 13 p.p.m. of 2.4D.

*General.*

The total number of registrations during 1961 was 3,372 covering 11,921 samples, an increase of 7 per cent. in registrations but no appreciable difference in sample numbers compared with 1960, which were 3,151 registrations and 12,020 samples.

The number of registrations and of samples received each year does give some measure of our activities but does not completely describe our work. A major factor in this is the enormous variation in the amount of work associated with different samples, but also it is not possible to give a statistical account of the time and effort devoted to the various Committees previously mentioned, advice to Government Departments and the Public, attendance at Courts of Law, visits to industrial establishments and so on.

An article entitled "Production of Metallurgical Fuel from Sub-bituminous Coal (in Western Australia)" was prepared for this Sixth Plenary Meeting of the World Power Conference.

In previous Annual Reports I have referred to the number of Government Departments for which we do work, as an indication of the influence which these Laboratories exert on Government expenditure. It seems desirable to elaborate this theme a little in this Report for 1961. Table 1 lists the State Government Departments as shown in the Public Service List 1961 and shows for which of these our separate Divisions have undertaken work. This is exclusive of work from State Government Instrumentalities, such as Main Roads Department, semi Government Institutions, such as the University and the Museum, and Commonwealth Government Departments.

TABLE 1.

| Department | Division | | | | | | Laboratories |
|---|---|---|---|---|---|---|---|
| | Agriculture | Engineering Chemistry | Food and Drugs | Fuel Technology | Industrial Chemistry | Mineral | |
| Agriculture | + | .... | + | .... | + | + | + |
| Audit | .... | .... | .... | .... | .... | .... | .... |
| Chief Secretary's | .... | .... | .... | .... | .... | .... | .... |
| Child Welfare | .... | .... | .... | .... | .... | .... | .... |
| Crown Law | .... | .... | + | .... | .... | .... | + |
| Education | + | .... | .... | .... | .... | .... | + |
| Electoral | .... | .... | .... | .... | .... | .... | .... |
| Fisheries | + | .... | .... | .... | .... | .... | + |
| Forests | + | .... | + | .... | .... | + | + |
| Industrial Development | + | .... | .... | + | + | + | + |
| Labour | + | .... | + | .... | .... | + | + |
| Lands and Surveys | + | .... | .... | .... | .... | .... | + |
| Local Government | .... | .... | .... | .... | .... | .... | .... |
| Medical | .... | .... | .... | .... | .... | .... | .... |
| Mental Health Services | .... | .... | .... | .... | .... | .... | .... |
| Metropolitan Water Supply, Sewerage and Drainage | + | .... | .... | + | + | .... | + |
| Mines | + | .... | + | + | .... | + | + |
| Native Welfare | .... | .... | .... | .... | .... | .... | .... |
| Police | + | .... | + | .... | .... | .... | + |
| Premier's | + | .... | .... | .... | .... | .... | + |
| Public Health | + | .... | + | + | + | .... | + |
| Public Service Commissioner | .... | .... | .... | .... | .... | .... | .... |
| Public Works and Country Water Supplies, Sewerage and Drainage | + | + | + | + | + | + | + |
| State Government Insurance Office | .... | .... | .... | .... | .... | .... | .... |
| State Housing Commission | .... | .... | .... | + | + | .... | + |
| Town Planning | .... | .... | .... | .... | .... | .... | .... |
| Treasury | .... | .... | + | .... | + | .... | + |
| Workers' Compensation Board | .... | .... | .... | .... | .... | .... | .... |
| Total—28 | 13 | 1 | 9 | 6 | 7 | 6 | 16 |

This table shows the wide range of our activities and incidentally also shows our need for increased laboratory space since an increase in the field of any one of these Government Departments results in an increased demand for our services. It is in some ways regrettable that so much of our effort is exerted through other Government Departments and so does not receive the publicity it deserves. This year we undertook work for 16 of the 28 Government Departments listed.

This lack of publicity is perhaps responsible for the paradox that while our "analytical" divisions can not undertake all the work desired, nevertheless some Divisional Heads feel that our advisory and consultative services could be used more widely than they are.

The samples received were allocated to the various Divisions of these Laboratories according to the specialised work undertaken by each Division. In a number of cases work was done on the same sample in more than one Division and this applies particularly to the Physicist whose X-ray examination of minerals is usually on samples registered to the Mineral Division. Such samples to the Physicist are not doubly registered, but others are, so the total shown in Table 2 is greater than the total given earlier in this Report.

This co-operation between Divisions helps to foster the policy that we are one Government Chemical Laboratories, not separate Divisions as separate entities, that problems in one Division may be assisted by specialists from another Division. It is also further support for the value of one centralised chemical laboratory instead of chemical sections in various Government Departments.

Table 2 shows the source of the samples received during 1961 and their allocation to the separate Divisions.

TABLE 2.

Source and Allocation of Samples Received During 1961.

| Source | Division | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Agriculture | Engineering Chemistry | Food and Drug | Fuel Technology | Industrial Chemistry | Mineral | |
| Agriculture Department | 4,352 | .... | 522 | .... | 2 | 2 | 4,878 |
| Departmental | 3 | 4 | 27 | 39 | 9 | 88 | 170 |
| Factories Department | 1 | .... | 28 | .... | .... | .... | 29 |
| Fisheries Department | 17 | .... | .... | .... | .... | .... | 17 |
| Forests Department | 13 | .... | 1 | .... | .... | 1 | 15 |
| Geological Survey | 28 | .... | .... | 3 | .... | 170 | 201 |
| Government Tender Board | .... | .... | 98 | .... | .... | .... | 98 |
| Industrial Development Department | 3 | .... | .... | 1 | 9 | 6 | 19 |
| Lands Department | 3 | .... | .... | .... | .... | .... | 3 |
| Metropolitan Water Supply, Sewerage and Drainage Department | 177 | .... | .... | 1 | 1 | .... | 179 |
| Mines Department | 1 | .... | 16 | .... | .... | 12 | 29 |
| Police Department | 2 | .... | 758 | .... | 3 | .... | 763 |
| Public Health Department | 26 | .... | 486 | 3 | 3 | 370 | 888 |
| Public Works Department | 274 | .... | 150 | 13 | 138 | 23 | 598 |
| State Batteries | 6 | .... | .... | .... | .... | 238 | 244 |
| Swan River Conservation Board | 4 | .... | 178 | .... | 1 | .... | 183 |
| War Service Land Settlement | 5 | .... | .... | .... | .... | .... | 5 |
| Other Government Departments | 45 | .... | 5 | 1 | 1 | 8 | 60 |
| Pay— | | | | | | | |
| Commonwealth | 5 | .... | 58 | .... | 1 | .... | 64 |
| Hospitals | 5 | .... | 46 | .... | .... | .... | 51 |
| Milk Board of W.A. | .... | .... | 409 | .... | .... | .... | 409 |
| Public | 784 | 6 | 79 | 93 | 29 | 549 | 1,540 |
| Western Australian Government Railways | .... | .... | 34 | .... | .... | .... | 34 |
| Other Government Concerns | .... | .... | .... | .... | 1 | .... | 1 |
| Free— | | | | | | | |
| Public | 17 | 4 | 6 | .... | .... | 1,195 | 1,222 |
| University of W.A. | 281 | .... | .... | .... | .... | .... | 281 |
| | 6,052 | 14 | 2,901 | 154 | 198 | 2,662 | 11,981 |

Fees were charged for work undertaken for some Government Departments, for Commonwealth Government Departments, Hospitals, Milk Board and the general public but a considerable number of examinations were made free, mainly for mineral identification and assay to assist prospectors.

The summarised reports of the individual Divisions which follow show the very wide range of subjects dealt with by these Laboratories. Comparing 1961 with 1960 there were some marked alterations in the numbers of various types of samples received. These were, with the numbers received in 1960 and 1961:—

| | 1960 | 1961 |
|---|---|---|
| Marked Increase | | |
| Animal products | 145 | 238 |
| Citrus | 10 | 60 |
| Oat | 64 | 231 |
| Oil bearing seeds | 351 | 817 |
| Pasture | 96 | 247 |
| Tobacco | 231 | 1441 |
| Cheese | 84 | 140 |
| Milk | 194 | 437 |
| Pesticides | 24 | 160 |
| Beryl | 33 | 70 |
| Copper ore | 74 | 149 |
| Health hazard dusts | — | 372 |
| Mineral identification | 414 | 710 |
| Marked decrease— | | |
| Apple | 97 | 25 |
| Fertiliser Act | 63 | 8 |
| Vine | 369 | 21 |
| Wheat | 612 | 203 |
| Blood for alcohol | 358 | 215 |
| Iron ore | 1010 | 380 |

L. W. SAMUEL,
Director.

## AGRICULTURE, WATER SUPPLY AND FORESTRY DIVISION.

In 1961 the number of samples received increased by 20 per cent. on the previous year. As in the past approximately 70 per cent. of these came from the Department of Agriculture. Increase in samples from the Department of Agriculture especially from the Animal Health Laboratories has meant a considerable increase of work for this Division, not only in numbers of samples received but also in the variety of analyses required.

Accommodation shortage which has been stressed for four years, causes delays and inefficiency in operation. An extra technician has been cramped into the already limited space to handle such things as the very large increase in oil seed samples required for oil estimations. Because of this space limitation, Agriculture Department officers are repeatedly being told that we just have not got the facilities for all the work they require. A more strict culling by Agriculture Department Divisional heads of the samples sent in for analysis would ease the position until more space is available.

In August the Deputy Government Agricultural Chemist attended the Third Australian Conference in Spectroscopy organised under the auspices of the Australian Academy of Science, in Sydney. Much useful information and many contacts were made at the Conference especially with regard to Atomic-Absorption Spectroscopy. While in Sydney and on the return through Melbourne and Adelaide the opportunity was taken to visit Department of Agriculture Chemists and Water Supply Chemists in each State. The Atomic

Table 3.
Agriculture, Forestry and Water Supply Division
1961.

| | Agriculture Department | Fisheries Department | Forests Department | Geological Survey of Western Australia | University of Western Australia | Metropolitan Water Supply | Public Health Department | Public Works Department | Pay—Public | Public—Free | Other Commonwealth Government Departments | Other State Government Departments | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cereals— | | | | | | | | | | | | | |
| Barley : | | | | | | | | | | | | | |
| Grain | 1 | .... | .... | .... | 10 | .... | .... | .... | .... | .... | .... | .... | 11 |
| Plants | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 |
| Oats : | | | | | | | | | | | | | |
| Grain | 13 | .... | .... | .... | 23 | .... | .... | .... | .... | .... | .... | .... | 36 |
| Plants | 173 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 174 |
| Other | 19 | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 21 |
| Wheat : | | | | | | | | | | | | | |
| Grain | 34 | .... | .... | .... | 11 | .... | .... | .... | .... | .... | .... | .... | 45 |
| Plants | 128 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 128 |
| Roots | 12 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 12 |
| Other | 6 | .... | .... | .... | 11 | .... | .... | .... | .... | .... | 1 | .... | 18 |
| Other | 2 | .... | .... | .... | 6 | .... | .... | .... | .... | .... | .... | .... | 8 |
| Fertilisers— | | | | | | | | | | | | | |
| Act | 8 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 8 |
| Copper ore | 9 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 9 |
| Lime | 9 | .... | .... | .... | .... | .... | .... | .... | 8 | .... | .... | .... | 17 |
| Other | 16 | .... | .... | .... | .... | .... | .... | .... | 4 | .... | .... | .... | 20 |
| Horticulture— | | | | | | | | | | | | | |
| Apple | 25 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 25 |
| Citrus | 60 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 60 |
| Currants | 21 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 21 |
| Potato | 33 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 33 |
| Tobacco | 1,441 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1,441 |
| Other | 16 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 16 |
| Miscellaneous— | | | | | | | | | | | | | |
| Animal specimens | 210 | .... | .... | .... | 3 | .... | .... | .... | 2 | .... | .... | 23 | 238 |
| Deposits | .... | .... | .... | .... | .... | 9 | 1 | 10 | 2 | 4 | .... | 4 | 30 |
| Other | 11 | .... | .... | .... | 3 | .... | 1 | 5 | 16 | 1 | 1 | 14 | 52 |
| Oil Seeds— | | | | | | | | | | | | | |
| Castor bean | 5 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5 |
| Cottonseed | 16 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 16 |
| Linseed | 585 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 585 |
| Safflower | 22 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 22 |
| Sesame | 15 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 15 |
| Pastures and Fodders— | | | | | | | | | | | | | |
| Clover | 556 | .... | .... | .... | 39 | .... | .... | .... | .... | .... | .... | .... | 595 |
| Erodium | .... | .... | .... | .... | 13 | .... | .... | .... | .... | .... | .... | .... | 13 |
| Feeding Stuffs Act | 22 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 22 |
| Hay | 49 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 49 |
| Lucerne | 11 | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 12 |
| Lupin | 32 | .... | .... | .... | 121 | .... | .... | .... | .... | .... | .... | .... | 153 |
| Pasture | 247 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 247 |
| Poultry food | 12 | .... | .... | .... | 38 | .... | .... | .... | 1 | .... | .... | .... | 51 |
| Silage | 123 | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 125 |
| Sudan grass | 14 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 14 |
| Other | 14 | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | 1 | 17 |
| Soil | 350 | .... | 12 | .... | .... | .... | .... | .... | 2 | .... | .... | 2 | 366 |
| Water | 28 | 17 | 1 | 28 | 3 | 168 | 24 | 259 | 742 | 12 | 3 | 33 | 1,318 |
| | 4,352 | 17 | 13 | 28 | 281 | 177 | 26 | 274 | 784 | 17 | 5 | 78 | 6,052 |

Energy Commission's establishment at Lucas Heights, W. D. & H. O. Wills Tobacco Laboratory in Sydney, the C.S.I.R.O. Chemical Research Laboratories in Melbourne, the C.S.I.R.O. Division of Biochemistry and Nutrition in Adelaide and the Australian Mineral Development Laboratories in Adelaide were also visited. In each case contact was made with people working in associated fields to ourselves.

The professional staff of the Division were fortunate this year in being able to attend a series of eight post-graduate lectures on "Mineral Metabolism in Animals" given by Professor Underwood at the University. The Senior Research Officer also attended a series of lectures at the University on the "Application of Radioisotopes to Agriculture" given by members of the Atomic Energy Commission, but because of shortage of space and the prior claim of University staff he was unfortunately not able to participate in all the practical course.

The types, sources and numbers of samples received in 1961 are listed above in Table 3.

*Soils.*

Approximately the same number of soils were received in 1961 as in the previous year, these included:—

1. Forty-five soils from a phosphate trial on Caitup gravelly sand at Esperance Downs Research Station were analysed for hydrochloric acid soluble phosphorus. The treatments and average results of five replicates are given in Table 4 below. These results show a greater accumulation of phosphorus in the surface with rock phosphate than with superphosphate and also slight evidence of leaching of phosphorus below 12 in.

Table 4.

Phosphorus content of soils and fertiliser treatment.

| Depth | Treatment | | |
|---|---|---|---|
| | Nil | Superphosphate, 168 lb./acre, applied in 1951, 2, 3 and 8 | Rock Phosphate, 224 lb./acre, applied in 1951, 2, 3 and 8 |
| | Phosphorus, P—Parts per million | | |
| inches | | | |
| 0–3 | 13 | 29 | 60 |
| 9–12 | 11 | 19 | 19 |
| 20–24 | 19 | 23 | 21 |

2. Detailed chemical and physical analyses were carried out on the clay layer of 12 soils from near the coast east of Esperance for comparison with the clay layer from soils at Esperance Downs Research Station and the Jerramungup-Gairdner River District. This latter area has shown signs of potassium deficiency and examination of the clay indicated low potassium reserves. Six of the present series also indicated a low potassium status.

3. Six samples of soil from a Carnation Weed eradication trial at Geraldton, where sodium chlorate had been applied at 50 lbs. per acre were analysed for residual chlorate. Negligible chlorate was found indicating it had all been lost by leaching or by reduction.

4. From an investigation into phosphorus leaching in sandy soils 145 soils from Esperance Downs Research Station were analysed for total phosphorus. The Department of Agriculture experiment was conducted on Fleming gravelly sand consisting of 0-4 in. of grey sand over light grey sand from 4 in. till ironstone gravel is found between 4 and 10 in. The upper 4-6 in. of gravel is large with a sandy matrix, below which the gravel decreases in size and the clay content of the matrix steadily increases. The treatments and the average of 3-5 replicates of determinations of total phosphorus are given below in Table 5; a few exceptionally high results have been omitted from the averages. The table gives only the results of samples to a depth of 1-7 in. in gravel, further samples to a depth of 28 in. were analysed but as there was little indication of leaching to these depths these results have been omitted.

The results in Table 5 indicate that nearly all of the added phosphorus can be accounted for in the first two depths of soil except in the case of the highest rate of superphosphate addition, where there has been appreciable leaching of phosphorus. Further results not shown in the Table indicate that in this case there has been leaching below the 28 in. level.

The gravel analyses show appreciable surface absorption of the added phosphorus. However as this occurs only in the first two depth samples and the percentage of gravel in soil for these two samples is low, the amount of absorbed phosphorus is of no great significance.

Table 5.

Leaching of phosphatic fertilisers in sandy soils.

| Treatment | | *Nil* | Superphosphate, 168 lb./acre, 1951, 2, 3 & 8 | | Rock Phosphate, 224 lb./acre, 1951, 2, 3 & 8 | | Rock Phosphate, 224 lb./acre and Gypsum, 99 lb./acre, 1951, 2, 3 & 8 | | Superphosphate, 168 lb./acre, 1951, 2, 3, 4, 5, 6, 8 & 9 | | Rock Phosphate, 224 lb./acre, 1951, 2, 3, 4, 5, 6, 8 & 9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total P Applied (lb./acre) | | .... | 67 | | 141 | | 141 | | 134 | | 241 | |
| | | Phosphorus, P Parts per million | | | | | | | | | | |
| | | Fine earth fraction | | | | | | | | | | |
| | | Total | Total | T–N* | Total | T–N* | Total | T–N* | Total | T–N* | Total | T–N* |
| Depth— | | | | | | | | | | | | |
| Surface 4 in. | | 12 | 45 | 33 | 88 | 76 | 84 | 72 | 49 | 37 | 111 | 99 |
| 4 in. to gravel | | 11 | 38 | 27 | 61 | 50 | 62 | 51 | 35 | 24 | 97 | 86 |
| Top 1 in. of gravel | | 21 | 29 | 8 | 36 | 15 | 32 | 11 | 27 | 6 | 33 | 12 |
| 1 in.–7 in. of gravel | | 18 | 26 | 8 | 34 | 16 | 28 | 10 | 25 | 7 | 23 | 5 |
| | | Gravel fraction | | | | | | | | | | |
| | %G † | | | | | | | | | | | |
| Surface 4 in. | 1 | 64 | 106 | 42 | 139 | 75 | 110 | 46 | 106 | 42 | 139 | 75 |
| 4 in. to gravel | 5 | 62 | 79 | 17 | 120 | 58 | 80 | 18 | 79 | 17 | 120 | 58 |
| Top 1 in. of gravel | 55 | 44 | 54 | 10 | 49 | 5 | 62 | 18 | 54 | 10 | 49 | 5 |
| 1 in.–7 in. of gravel | 73 | 41 | 46 | 5 | 50 | 9 | 46 | 5 | 46 | 5 | 50 | 9 |

* T–N = Total phosphorus minus nil treatment total phosphorus.
† %G = Per cent. of gravel in whole sample.

*Water.*

1. For the Metropolitan Water Supply, Sewerage and Drainage Department routine analyses were made on the water from Canning Dam, Serpentine Dam, Victoria Reservoir, Wungong Brook, Churchman's Brook and the metropolitan artesian bores. One of the disturbing features of the artesian bore analyses was the increase in total dissolved solids of the Mounts Bay Road bore, an increase to 1500 parts per million.

2. For the Public Works Department, Goldfields and Country Water Supplies and Geological Surveys water from the following sources were analysed:—Albany, Broome, Bullsbrook, Bunbury, Camballin, Carnarvon, Coorow, Derby, Donnybrook, Eneabba, Geraldton, Manjimup, Marble Bar, Mt. Magnet, Mundaring Weir, Northampton, Onslow, Pt. Hedland, Roebourne, Walpole, Wellington Dam, Wicherina, Wiluna, Wittenoom and Yanchep.

3. Northampton Town Water Supply—Because of the limited supply of water from the Gwalla mine shaft the town water supply had to be supplemented with water from the Wanneranooka mine shaft. This water although previously satisfactory was found to contain up to 6.8 p.p.m. of copper and 0.31 p.p.m. of lead, the accepted safe upper limit for these in potable water is 3.0 and 0.1 p.p.m. respectively. Pumping to waste from the shaft has reduced the levels of copper and lead considerably but they both still occasionally exceed the safe upper limits. Work on the water from Wanneranooka shaft similar to the work done on the water from Gwalla shaft in 1960 for the removal of copper, showed that the controlled addition of lime would reduce the copper and lead to well below 3.0 and 0.10 p.p.m. respectively.

4. An examination of the ratio of a number of main constituents to chloride in a number of analyses of Hills Reservoirs and of deep metropolitan artesian bores showed fairly constant ratios within the two groups. Table 6 below gives these ratios and a comparison with sea-water.

These results show how closely the Hills water resembles diluted sea-water, the only major difference being in the bicarbonate figure, for which this difference is easily accounted. The main differences between the Hills water and the deep artesian bores is the lower Mg/Cl and higher Na/Cl and $HCO_3$/Cl ratios of the latter group. The shallower artesian bores at Mt. Hawthorn did not show similar constant ratios.

5. Iron in Water.—The prevalence of iron in ground waters in this State is of concern (a) because of the dark-brown staining it causes to buildings when these waters are used for garden irrigation (b) because of the blocking of discharge bores where the ground water is used for machinery cooling water purposes and is discharged back into the ground so as not to lower the water table and (c) because of its staining effect in nurseries and market gardens. In the latter case the staining is rarely harmful to plant growth, but the market price of the products is lowered because of the disfiguring stain.

Aeration with or without the addition of lime depending on the pH, and settling or sand filtration of the deposited iron is the usual method of iron removal. However because of the expense of this equipment, the space needed for it and its unsightliness, this is not always a practical solution. A series of possible alternative treatments has been tested on the bore water from the grounds of these laboratories which contains 5 p.p.m. of ferrous iron.

The use of sequestering agents was the first obvious approach. However ethylenediamine tetra acetic acid had to be eliminated because of cost, sodium hexametaphosphate and polyhydric alcohols such as glucose were not found successful possibly because of the difficulty of adding them before sufficient oxygen had been absorbed to oxidise the ferrous iron. The use of natural zeolites for iron removal is well known provided the iron remains in the ferrous state, but as the water is completely softened at the same time this limits the capacity of the zeolite and increases the cost of treatment. To minimise this cost the so called "twilight zone" of zeolite softeners where calcium and magnesium on the zeolite from the softening of the first run after regeneration, is used to replace ferrous iron in subsequent water was investigated. Theoretically the whole capacity of the softener would be available for iron removal by this method. In practice it was found that this "twilight zone" only slightly increased the capacity of the zeolite for iron exchange and did not reduce the iron to a satisfactorily low level in this region of use of the zeolite.

The use of manganese zeolite prepared from local greensands was also investigated but although the iron could be reduced to a satisfactory level by this material, the low capacity of manganese zeolite made regeneration too frequent.

Other methods of iron removal which will eliminate the necessity of double-pumping are at present under investigation, including the use of catalytic filters such as pyrolusite and organic cation exchange resins in the manganese form, with and without the addition of oxygen by a trickle air leak on the suction side of the pump.

*Fertilisers.*

1. Fertiliser Act.—Because of the pressure of other work it was fortunate that only 2 Fertiliser Act Samples were received in 1961, although there were 16 received late in 1960 which were reported in 1961. Table 7 below shows the main fertiliser constituents for which analyses were made and whether or not they comply with the Act and Regulations.

Table 7.

Fertiliser Act Samples Reported 1961.

| Constituent | Samples Analysed | Complied | Deficient |
|---|---|---|---|
| Nitrogen, N | 12 | 11 | 1 |
| Water soluble potash, $K_2O$ | 10 | 9 | 1 |
| Phosphoric Anhydride, $P_2O_5$:— | | | |
| Water soluble | 10 | 10 | 0 |
| Citrate soluble | 12 | 12 | 0 |
| Acid soluble | 12 | 12 | 0 |
| Total | 12 | 12 | 0 |
| Copper, Cu | 5 | 4 | 1 |
| Zinc, Zn | 5 | 4 | 1 |

As the few samples that did not comply were only slightly below registration, these results show that there has been no abuse of the objects of the Act.

Table 6.

Composition of water supplies—ratio to chloride, Cl

| | Hills Reservoirs | | | Deep Artesian Bores | | | Sea Water |
|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Average | Minimum | Maximum | Average | Average |
| Calcium | 0·026 | 0·062 | 0·042 | 0·027 | 0·045 | 0·038 | 0·020 |
| Magnesium | 0·057 | 0·088 | 0·074 | 0·017 | 0·021 | 0·019 | 0·066 |
| Sodium | 0·56 | 0·61 | 0·57 | 0·68 | 0·75 | 0·73 | 0·56 |
| Potassium | 0·011 | 0·021 | 0·016 | 0·022 | 0·028 | 0·024 | 0·020 |
| Bicarbonate | 0·08 | 0·30 | 0·18 | 0·29 | 0·45 | 0·36 | 0·007 |
| Sulphate | 0·042 | 0·12 | 0·087 | 0·059 | 0·081 | 0·066 | 0·15 |
| Total Dissolved Solids | 1·89 | 2·00 | 1·98 | 1·96 | 2·10 | 2·01 | 1·82 |
| Total Hardness | 0·33 | 0·50 | 0·38 | 0·14 | 0·20 | 0·16 | 0·32 |

2. Because of several abnormally high lead figures obtained in samples of pastures and lupins, the source of the lead was sought and it was thought the lead might originate in the copper ores used in the fertiliser mixtures. Analysis of seven representative samples of fertiliser grade copper ores showed 0.01—0.40 per cent. lead with an average of 0.08 per cent. This amount would not significantly contribute to the lead taken up by plants.

3. An investigation was made into obtaining the right mixture of hydrolime and superphosphate which would have a final pH7. Using lime to superphosphate ratios from 12:100 to 24:100 and measuring the pH in a 1:5 mixture with water after various times of standing, up to 10 days with intermittent stirring, it was found that (a) the results were not reproducible (b) the time of standing had appreciable effects on the final pH. Generally ratios up to 17:100 slightly increased in pH with time and ratios from 18:100 upwards decreased in pH with time.

The lack of reproducibility of results was considered to be explained by (i) high local pH values at initial mixing would revert and precipitate some of the mono and di-calcium phosphate, which would slowly redissolve again, so altering the pH (ii) high local pH values could precipitate gelatinous di-calcium phosphate over some of the undissolved superphosphate or lime, so considerably retarding the solution of these and (iii) the very slow rates of reaction of lime with the different forms of phosphate phosphorus. K. L. Elmore and T. D. Farr (I.E.C., 1940, p.580) found when investigating the $CaO$-$P_2O_5$-$H_2O$ system, that up to 10 months of continuous shaking was required to reach equilibrium.

These results of solutions of mixtures of lime and superphosphate confirmed our opinion that it is not possible to predict the final pH of a solid mixture of lime and superphosphate between pH4 and pH 10.

4. The shortage of organic fertiliser has interested the Department of Agriculture in alternative sources and the use of sewage sludge is under investigation. Analysis of samples from the three main metropolitan treatment works are given below in Table 8.

Table 8.

Composition of Sewage Sludge.

| Source | Subiaco | Swanbourne | Fremantle |
|---|---|---|---|
| pH (1 5) | 5·6 | 5·6 | 5·4 |
| | Dry basis Per cent. | Dry basis Per cent. | Dry basis Per cent. |
| Nitrogen, N | 3·89 | 3·92 | 4·29 |
| Phosphorus, P | 1·50 | 1·34 | 0·74 |
| Potassium, K | 0·20 | 0·09 | 0·10 |
| | Parts per million | Parts per million | Parts per million |
| Boron, B | 13 | 6 | 68 |
| Copper, Cu | 1,200 | 860 | 830 |
| Manganese, Mn | 160 | 130 | 94 |
| Molybdenum, Mo | less than 1 | less than 1 | less than 1 |
| Zinc, Zn | 4,800 | 4,000 | 4,100 |

These results show the main fertiliser value would be from the nitrogen content. The relatively high copper and zinc figures are difficult to explain, especially as Swanbourne receives sewage entirely from a residential area and levels are similar to the other two sources which could possibly receive some industrial effluent. These high copper and zinc figures could lead to toxicities in soils where large amounts of sewage sludge are applied. The results in Table 8 agree very well with previous anyalyses from the same sources in 1948 and therefore the samples must be regarded as representative and not just spot samples.

*Pastures, Fodders and Stock Foods.*

1. Feeding Stuffs Act.—Only eight samples were received in 1961 but a total of 27 were reported, 19 of these being received late in 1960. Table 9 below shows the number of main constituents checked and whether or not they comply with the requirements of the Act. A large majority of these samples complied with the Act and as there are no deviations from the registered values allowed in the Feeding Stuffs Act as there are in the Fertiliser Act, this indicates that there is no abuse of the objects of the Act by stock food manufacturers.

Table 9.

Feeding Stuffs Act Samples Reported, 1961.

| Constituent | Samples Analysed | Complied | Deficient | Excess |
|---|---|---|---|---|
| Crude Protein | 22 | 17 | 5 | .... |
| Crude Fat | 22 | 18 | 1 | 3 |
| Crude Fibre | 21 | 17 | .... | 4 |
| Sodium Chloride | 21 | 19 | .... | 2 |
| Phosphoric Anhydride | 23 | 20 | 3 | .... |
| Calcium | 25 | 21 | 4 | .... |

2. Silage.—125 samples were analysed for moisture and protein. These were mainly from the Silage Competition conducted by the Australian Dairy Products Board.

3. An outbreak of sheep mortality at Muchea was considered to be due to a plant toxicity. Nitrate toxicity was suspected but analysis of six suspected plant species from the property, viz., Scarlet Pimpernel, Poison sedge, Black Nightshade, Gratiola peruvianna, Lobelia tenuior and Lobelia anceps, failed to confirm this diagnosis.

4. Sixty-six plant samples were analysed for oxalates in connection with sheep mortalities at York. The weed Double Gee *(Emex australis steinh)* was suspected as being responsible, as it is botanically related to the Oxalis species (soursob). Analysis of Double Gee from various soil types and at various stages of growth showed varying and unrelated oxalate contents ranging from 2.6-11.5 per cent.

5. On a rate of copper sulphate trial on erodium at Gidgegannup the uptake of copper increased from 3.8 to 5.2 p.p.m. from the nil to the 20 lbs. of copper sulphate per acre treatment.

6. To find the effect of time of paddock closing and rate of sulphate of ammonia application on pasture quality and quantity in the southern dairying districts, 32 samples of mixed pasture were analysed as feeding stuffs. Department of Agriculture results have shown that too early closing of paddocks reduced the yield and quality of hay produced and that the application of 1 cwt. per acre of sulphate of ammonia was an economic proposition. Higher rates of sulphate of ammonia are a doubtful economic proposition and also there is the possibility of changing the botanical composition of the pasture and lowering its quality.

*Cereals.*

1. Barley.—Seventeen samples were analysed, mainly grain samples for zinc determination.

2. Maize.—Six grain samples were analysed for zinc and are mentioned further under Animal Nutrition.

3. Oats.—(a) Twenty-two samples of plants were analysed from cereal grazing trials conducted by the Department of Agriculture on Wheat and Sheep Division Research Stations.

(b) Two samples of oat feed from Katanning were found to have abnormally high lead figures of 8 and 9 p.p.m. A further seven samples taken at different stages of processing from the same mill, in an attempt to locate the source of the lead, all had less than 1 p.p.m. The original high figures must have therefore been due to accidental contamination of the samples prior to receival.

(c) Rolled Oats.—An investigation was made on behalf of the Department of Agriculture into complaints of a bitter taste in rolled oats from a local manufacturer. A valuable export market was being lost because of this bitter taste.

A close examination of the milling treatment procedure was made and samples were taken at various stages of the process. Analytical and organoleptic tests on these samples and also on other reputedly satisfactory commercial products, clearly indicated the bitter taste was associated with the lipase activity of the oats. When lipase activity as determined by the method of "The Analyst" Vol. 78, p. 726 (1953) was about one per cent. or less there was no bitter taste associated with the samples, between 1-10 per cent. lipase activity is apparently borderline, some samples having and others not having the bitter taste. All samples having a lipase activity greater than 20 per cent. had a bitter taste. This clearly indicated that the cause of the bitter taste was due to insufficient inactivation of the lipase activity in the heat treament prior to rolling.

Recommendations were made to the Company to increase the inactivation of lipase by—

(i) increasing the temperature in the heating tower as inactivation proceeds faster at higher temperatures;

(ii) increasing the moisture content of the groats prior to or during steaming since rate of inactivation increases with moisture content;

(iii) increasing the time of contact in the heating tower by slowing down the rate of passage through the tower because inactivation is directly related to time of heating.

A simple test for efficiency of lipase inactivation was found by checking for the presence of a bitter taste one week after rolling, by comparison with a known satisfactory sample. Absence of a bitter taste indicates a lipase activity of probably less than one per cent. and the product would be stable and not develop a bitter taste on storage.

The free fatty acid content of all samples taken was also determined. It was found that high free fatty acid content was also associated with bitterness in rolled oats. However it was found that high free fatty acid contents are produced through the effects of high lipase activity and time of standing after rolling and indicate only that a bitter taste has been produced. High lipase activity is not affected by time of standing after rolling and it indicates that a bitter taste has or will be produced on standing.

The results of our investigations have enabled the manufacturer to produce a satisfactory, stable product.

4. Rye.—Nineteen samples were received for protein analysis.

5. Wheat.—(a) The 1960-61 F.A.Q. wheat and flour prepared from it in a Buhler Mill are compared below with the 1959-60 samples.

| | F.A.Q. | | | |
|---|---|---|---|---|
| | Wheat | | Flour | |
| | 1960/61 | 1959/60 | 1960/61 | 1959/60 |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Moisture .... .... | 9·5 | 9·8 | 11·4 | 12·6 |
| Protein at 13·5 per cent. moisture .... .... | 9·6 | 10·0 | 8·9 | 9·4 |
| Ash at 13·5 per cent. moisture .... .... | 1·28 | 1·18 | 0·47 | 0·62 |
| Maltose figure (Kent Jones) .... .... | .... | .... | 2·84 | 2·77 |

(b) From an experiment at Mingenew nitrogen uptake in wheat tops was compared for three rates of urea and ammonium sulphate application (equivalent to 56, 112 and 224 lbs. per acre of ammonium sulphate) and two times of application (broadcast at seeding and in July).

On virgin fallow grey-yellow sand, nitrogen uptake was slightly decreased with added nitrogen fertiliser applied at seeding, but a slight increase in uptake was achieved in all rates of added nitrogen fertiliser applied in July compared with application at seeding.

On old lupin land, also on grey-yellow sand, ammonium sulphate gave slightly increased nitrogen uptake compared with urea, at all rates. On this soil there were no differences in nitrogen uptake between fertiliser application at seeding and in July.

(c) From a rate and time of application trial of ammonium sulphate at Wongan Hills Research Station on four varieties of wheat, 128 samples were analysed for nitrogen to determine differences in nitrogen uptake during the growing season. The first and second cuts were reported in 1960 and the third and fourth cuts were received in 1961. The rates were nil, 112, 224 and 448 lbs. per acre of ammonium sulphate applied at seeding or late in July. The four varieties were Gabo, Insignia, Kondut and Wongoondy.

For the third cutting, ammonium sulphate applied at seeding generally decreased the nitrogen uptake, except for the highest rate, for all varieties except Wongoondy which had decreased nitrogen uptake at all rates of application.

Added nitrogen fertiliser applied late in July increased the nitrogen uptake in the third cutting at all levels for all varieties.

Added nitrogen fertiliser had little or no effect on nitrogen uptake in the fourth cutting for all varieties and for both times of application.

(d) Thirty samples of grain were analysed for zinc. These are mentioned further under Animal Nutrition.

*Plant Nutrition.*

1. Apples.—(a) Leaves: (i) Two samples of Granny Smith leaves from Balingup from borax sprayed and unsprayed trees had similar levels of boron. Boron deficiency was suspected, but analysis confirmed the lack of response to borax spray.

(ii) Sodium analyses were made on 14 samples of leaves from Bridgetown to confirm that the scorching of leaves associated with high chloride was also associated with high sodium. The average results showed that scorched Yate leaves had 0.38 per cent sodium, healthy Cleopatra leaves had 0.09 per cent. and healthy Granny Smith leaves had 0.07 per cent. sodium.

(b) Fruit—Nine whole Granny Smith apples were analysed for nitrogen to see if there was any relationship between nitrogen and the colour of mature fruit. The results below show a definite direct relationship between green colour and nitrogen content, allowing for difficulties in the visual assessment of colour.

Apple (fruit).

| Colour | Nitrogen per cent. dry basis |
|---|---|
| Y. .... .... .... .... .... | 0·21 |
| G.Y.—G.Y.Y. .... .... .... | 0·24 |
| G.Y. .... .... .... .... | 0·28 |
| G.G.Y.—G.Y. .... .... .... | 0·36 |
| G.G.Y. .... .... .... .... | 0·40 |

G = green
Y = Yellow

2. Clover.—Five hundred and sixty-eight samples were reported, including: (a) Thirty samples analysed for phosphorus from a rate and source of phosphorus experiment on a problem soil, a gravelly loam at Manjimup, where clover had failed to grow even with 2 cwts. per acre of superphosphate. Increasing rates of superphosphate, basic superphosphate, 50/50 lime/superphosphate, Rhenania phosphate or rock phosphate did not significally increase the leaf and petiole phosphorus. Rock phosphate gave the lowest phosphorus uptake; there was little difference in plant phosphorus from the other sources.

(b) From Esperance 56 samples were analysed for zinc from an experiment designed to test the effect of different rates of zinc and zinc contaminated fertiliser on the growth of zinc deficient Bacchus Marsh clover. The results below showing the average of four replicates indicate that there is sufficient zinc in superphosphate to supply the zinc needs of the plant on this soil.

| Zinc Oxide lb./acre | Leaf and Petiole Zinc, Zn | |
|---|---|---|
| | Aerophos, 74 lb./acre Gypsum, 90 lb./acre | Superphosphate, 180 lb./acre |
| | Parts per million dry basis | |
| 0 | 26 | 44 |
| ½ | 40 | 42 |
| 1 | 39 | 38 |
| 2 | 44 | 52 |
| 4 | 40 | 58 |
| 8 | 65 | 72 |
| 16 | 80 | 75 |

(c) A further 108 samples were received from Esperance Downs Research Station to test the residual effects of zinc oxide fertiliser applied over different periods at two rates of application. The average of five replicates of zinc uptake are tabulated below for the 1959 and 1960 samplings.

| Zinc Oxide, lb./acre | Leaf and Petiole Zinc, Zn | |
|---|---|---|
| | Oct. 1959 cut | Oct. 1960 cut |
| | Parts per million dry basis | |
| 0 | 16 | 28 |
| 2 in 1953 | 22 | 31 |
| 2 in 1953 and 1959 | 29 | 35 |
| 2 in 1953, 1955 and 1958 | 29 | 36 |
| 2 in 1953, 1956 and 1959 | 28 | 42 |
| 4 in 1953 | 26 | 33 |
| 4 in 1953 and 1959 | 36 | 42 |
| 4 in 1953, 1955 and 1958 | 42 | 45 |
| 4 in 1953, 1956 and 1959 | 41 | 42 |

(d) From a similar experiment on the same soil as (c) above involving copper sulphate instead of zinc oxide, 110 samples were analysed for copper. The averages of replicates are tabulated below.

| Copper sulphate, lb./acre | Leaf and Petiole Copper, Cu | |
|---|---|---|
| | Oct. 1959 cut | Oct. 1960 cut |
| | Parts per million dry basis | |
| 0 | 5·7 | 7·9 |
| 5 in 1953 | 8·6 | 9·1 |
| 5 in 1953 and 1959 | 16 | 11 |
| 5 in 1953, 1955 and 1958 | 16 | 13 |
| 5 in 1953, 1956 and 1959 | 12 | 11 |
| 10 in 1953 | 14 | 11 |
| 10 in 1953 and 1959 | 11 | 10 |
| 10 in 1953, 1955 and 1958 | 16 | 12 |
| 10 in 1953, 1956 and 1959 | 11 | 13 |

(e) Twenty-four samples were analysed for copper from a source of copper experiment on Forest Grove gravelly sandy soil at Bramley Research Station. The four sources of copper ore applied at two rates had no significantly different effects on copper uptake compared with equivalent rates of copper sulphate.

(f) From a trial at Gidgiegannup by the University Institute of Agriculture investigating varietal differences in copper uptake from three rates of copper sulphate application, the average of replicates of leaf and petiole copper uptake for all rates of application in order of greatest to least was Yarloop, Mt. Barker and Dwalganup.

(g) Thirty eight samples were analysed for copper from a glass house experiment comparing finely ground copper ore from Marble Bar with commercial fertiliser copper ore and copper sulphate, on Waychinicup gravelly sandy loam from Woogenellup and on Bibra peaty sand. The copper uptake from less than 100 mesh Marble Bar ore was similar to that from commercial ore and copper sulphate.

(h) From another glass house trial 100 samples were analysed for copper from an experiment comparing three comparatively pure, commonly occurring copper minerals malachite, chalcocite and chalcopyrite ground and graded into three sizes -50 +100, -100 +200 and -200 mesh with copper sulphate and commercial copper ore at two equivalent rates. The samples were grown in washed sand but because of the relatively high copper found in the controls, derived from either the nutrient solution or the distilled water used for watering, no conclusive results could be obtained on the relative value of these minerals.

3. Lupins.—(a) Seventy-two samples were analysed from a rate of copper trial at Gidgiegannup, carried out by the Institute of Agriculture to find the effect of varietal differences on copper uptake at four rates of copper sulphate application. The copper uptake varied from the highest to lowest in the following varietal order for all rates of copper sulphate application: W.A. Blue, Bitter Yellow, Weiko III, N.Z. Bitter Blue, Borre and L. albus. W.A. Blue, Bitter Yellow and Weiko III all showed an increase in copper uptake with added copper, the other varieties showed little difference between the nil and added treatments.

(b) Lead in Lupins.—A series of lupin feeds from a lupinosis experiment were analysed in detail, including the determination of lead which varied from 3-8 p.p.m. in the plants and 93 p.p.m. in the seed. These are extraordinarily high figures and as analyses of further samples showed only 1-2 p.p.m. of lead, it was concluded that these high results must have been due to contamination during the collection of the samples.

(c) Because of the relationship of heavy metals to the problem of lupinosis a survey of our analyses of past and present samples of lupins was made to extract information on the composition of lupins. The results of this survey are published below in Table 10.

4. Potatoes.—A survey of a further series of potato tubers for dry matter and specific gravity showed that the varieties Delaware, Bintje, Kinebec, Pontiac and Sebago all conformed to the formula relating these two properties, derived in 1960, i.e.

$$\text{Dry matter} = \frac{250\ (\text{sp. gr.} - 1)}{\text{sp. gr.}} + 2.00$$



(11)—57785

## Table 10.

### Composition of Lupins.
### Analyses on Dry Basis.

| | Roots | | | Leaves | | | Pods | | | Stalks | | | Whole Tops | | | Seeds | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Range | Average | No. | Range | Average | No. | Range | Average | No. | Range | Average | No. | Range | Average | No. | Range | Average |
| | | Per cent. | Per cent. | | Per cent. | Per cent. | | Per cent. | Per cent. | | Per cent. | Per cent. | | Per cent. | Per cent. | | Per cent. | Per cent. |
| Protein | 8 | 8·1 –18·2 | 13·2 | 3 | 11·0 –21·5 | 17·9 | 3 | 4·0 –17·3 | 8·7 | 10 | 3·4 –11·3 | 7·0 | 20 | 4·6 –22·2 | 9·7 | 42 | 19·6 –44·1 | 35·0 |
| Fat | .... | .... | .... | 2 | 1·1 – 1·6 | 1·4 | 2 | 0·3 – 0·8 | 0·6 | 6 | 0·2 – 0·9 | 0·6 | 13 | 0·7 – 2·0 | 1·4 | 28 | 2·1 – 9·2 | 3·7 |
| Fibre | .... | .... | .... | 2 | 25·3 –29·9 | 27·6 | 2 | 40·7 –42·2 | 41·4 | 6 | 26·1 –51·7 | 45·6 | 13 | 24·3 –53·9 | 33·0 | 35 | 10·4 –23·4 | 16·1 |
| Ash | 2 | 5·1 – 6·5 | 5·8 | 2 | 10·2 –16·6* | 13·4 | 2 | 2·1 – 3·3 | 2·7 | 6 | 2·2 – 8·5 | 4·5 | 20 | 4·8 –35·2* | 9·4 | 28 | 2·1 – 4·7 | 3·3 |
| N.F.E. | .... | .... | .... | 2 | 45·4 –45·8 | 45·6 | 2 | 50·2 –51·4 | 50·8 | 6 | 37·2 –47·8 | 42·5 | 13 | 30·8 –54·2 | 44·1 | 28 | 28·2 –44·5 | 36·5 |
| Calcium | .... | .... | .... | 3 | 1·24– 1·39 | 1·28 | 3 | 0·32– 0·64 | 0·49 | 7 | 0·17– 0·59 | 0·34 | 29 | 0·40– 1·43 | 0·93 | 27 | 0·09– 0·38 | 0·19 |
| Phosphorus | 6 | 0·12– 0·43 | 0·26 | 3 | 0·09– 0·16 | 0·12 | 3 | 0·06– 0·30 | 0·19 | 7 | 0·03– 0·11 | 0·06 | 259 | 0·03– 0·58 | 0·20 | .... | .... | .... |
| Magnesium | .... | .... | .... | 1 | .... | 0·27 | 1 | .... | 0·15 | 1 | .... | 0·19 | 16 | 0·27– 0·44 | 0·36 | 1 | .... | 0·16 |
| Potassium | 6 | 0·39– 2·13 | 0·91 | 5 | 0·15– 1·02 | 0·62 | 1 | .... | 0·24 | 1 | .... | 0·78 | 50 | 0·36– 3·12 | 1·67 | 1 | .... | 0·85 |
| Sodium | .... | .... | .... | 1 | .... | 0·05 | 1 | .... | 0·05 | 1 | .... | 0·16 | .... | .... | .... | 1 | .... | 0·07 |
| Total alkaloids | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7 | 0·33– 1·50 | 0·99 | 61 | 0·12– 2·7 | 0·74 |
| | | p.p.m. | p.p.m. | | p.p.m. | p.p.m. | | p.p.m. | p.p.m. | | p.p.m. | p.p.m. | | p.p.m. | p.p.m. | | p.p.m. | p.p.m. |
| Boron | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 16 | 23 –35 | 26 | .... | .... | .... |
| Cobalt | .... | .... | .... | 2 | 0·18– 0·26 | 0·22 | 2 | 0·07– 0·29 | 0·18 | 3 | 0·01– 0·30 | 0·12 | 15 | 0·01– 0·37 | 0·10 | 12 | 0·01–0·30 | 0·04 |
| Copper | 4 | 19 –31 | 24 | 2 | 2·6 –26 | 18 | 2 | 7·0 –11 | 9·0 | 18 | 0·4 –12 | 3·9 | 46 | 2·0 –18 | 7·9 | 84 | 3·7 –14 | 7·0 |
| Iron | .... | .... | .... | 1 | .... | 3,100* | 3 | 295 –850 | 510 | 6 | 85 –300 | 205 | 8 | 240 –2,200* | 840 | .... | .... | .... |
| Lead | .... | .... | .... | 1 | .... | 1·0 | 1 | .... | 0·5 | 2 | 1·2 – 4 | 2·6 | 4 | 0·7 – 8 | 3·9 | 5 | 1 – 2 | 1 |
| Manganese | 4 | 230 –380 | 300 | 2 | 290 – 340 | 315 | 5 | 56 –330 | 194 | 7 | 10 –126 | 58 | 45 | 48 –1,300 | 283 | 10 | 21 –345 | 91 |
| Molybdenum | .... | .... | .... | 9 | 0·04– 0·59 | 0·20 | 2 | 0·05– 0·24 | 0·14 | 17 | 0·01– 3·5 | 1·0 | 23 | 0·05– 3·8 | 0·53 | 8 | 0·74– 2·3 | 1·8 |
| Zinc | 4 | 210 –2,600 | 880 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 40 | 18 –910 | 78 | .... | .... | .... |

* Soil contamination.

Table 11.

Composition of Tobacco Leaf.

| | Lugs | | Cutters | | Sub-leaf | | Leaf | |
|---|---|---|---|---|---|---|---|---|
| | 1960 | 1961 | 1960 | 1961 | 1960 | 1961 | 1960 | 1961 |
| | Per cent. on dry basis | | | | | | | |
| Starch | 3·3 | 2·7 | 3·5 | 5·0 | 1·1 | 2·8 | 2·9 | 5·9 |
| Sugars before inversion | 12·6 | 17·7 | 19·9 | 20·0 | 15·1 | 19·4 | 16·6 | 22·6 |
| Total sugars | 16·4 | 23·9 | 25·4 | 27·3 | 18·3 | 25·3 | 22·2 | 29·7 |
| Resins | 5·4 | 5·8 | 6·2 | 6·3 | 6·0 | 6·5 | 6·0 | 6·3 |
| Total nitrogen, N | 1·70 | 1·36 | 1·44 | 1·25 | 1·61 | 1·26 | 1·55 | 1·31 |
| Protein nitrogen, N | 1·07 | 0·80 | 0·97 | 0·76 | 1·06 | 0·78 | 0·99 | 0·76 |
| Total alkaloid as nicotine | 0·87 | 1·28 | 0·85 | 1·59 | 0·89 | 1·52 | 1·16 | 2·61 |
| Nicotine | 0·84 | 1·10 | 0·79 | 1·38 | 0·82 | 1·38 | 1·10 | 2·33 |
| Nor-nicotine | 0·03 | 0·16 | 0·06 | 0·19 | 0·06 | 0·13 | 0·06 | 0·26 |
| Total volatile bases | 0·19 | 0·24 | 0·15 | 0·23 | 0·18 | 0·24 | 0·22 | 0·23 |
| Ash | 13·3 | 14·4 | 11·6 | 11·3 | 12·9 | 12·7 | 9·6 | 10·5 |
| Chloride, Cl | 3·41 | 5·08 | 2·42 | 3·95 | 3·01 | 3·97 | 2·35 | 2·72 |
| Calcium, Ca | 3·87 | 3·55 | 2·61 | 2·88 | 3·48 | 2·88 | 2·76 | 2·49 |
| Potassium, K | 1·89 | 2·19 | 1·85 | 1·85 | 2·25 | 1·87 | 1·52 | 1·21 |
| Sodium, Na | 0·13 | 0·13 | 0·10 | 0·11 | 0·13 | 0·11 | 0·10 | 0·09 |
| Phosphorus, P | 0·16 | 0·16 | 0·16 | 0·15 | 0·18 | 0·17 | 0·17 | 0·15 |

5. Tobacco.—(a) Representative samples of lugs, cutters, subdivision leaf and leaf grades from the 1960 and 1961 tobacco sales were analysed in detail for comparison with each other and with previous crops. The results of these analyses are given in Table 11 above.

Compared with what is accepted as desirable these results show that for all grades for both years they are—

(i) all low in nicotine except for the leaf grade for 1961;

(ii) all low in total nitrogen;

(iii) all too high in chloride, the 1961 samples are worse in this respect than the 1960 samples;

(iv) too high in calcium in comparison to potassium.

(b) Samples of cured leaf from a glass house trial at South Perth, which were watered with varying rates of potassium sulphate solution, showed that as the nutrient solution increased from 5-30 milliequivalents per litre of potassium sulphate the leaf potassium increased from 2.85-7.60 per cent. and the leaf chloride decreased from 1.54-0.59 per cent.

(c) From a field trial at Manjimup involving three rates of ammonium sulphate, two rates of superphosphate and one rate of sulphate of potash analysis of the eighth leaf from six replicates showed that—

(i) leaf chloride, nitrogen and potassium were not affected by added nitrogen or phosphorus fertiliser;

(ii) leaf phosphorus was slightly decreased with the two highest rates of nitrogen fertiliser but was not affected by added phosphorus fertiliser.

(d) One hundred and sixty-two samples of cured leaves from a glass house experiment at South Perth involving the factorial combination of three rates of potassium, three rates of nitrogen and three rates of chloride were analysed for chloride, nitrogen and potassium. The samples were taken from three positions on the plants (leaves 2-6, 7-13 and 14-18) on two replicates. The results showed that—

(i) for all leaf positions leaf chloride increased with added chloride, decreased with added potassium and was unaffected by added nitrogen;

(ii) leaf nitrogen was unaffected by added chloride or potassium and generally slightly increased by added nitrogen for all leaf positions. The increase in nitrogen was generally greater in the 14-18 leaf position for all levels of added nitrogen;

(iii) leaf potassium increased with added potassium for all leaf positions, being highest in the oldest leaves, and was not affected by added nitrogen or chloride.

(e) From a rate and method of potash application trial at Manjimup Tobacco Research Station 107 leaf blades were received for potassium analysis. There were three rates of potash at time of planting and three rates of side dressings. No pretreatment was given but as they were planted on soil used for the same experiment in 1960, which then had three rates of pretreatment residual effects had to be considered. Leaf potassium was found to—

(i) Increase with added potash at planting.

(ii) Be not significantly affected by side dressings.

(iii) Increase with added potash in the previous years pretreatment for all levels of added potash at planting.

(f) From a continuation of a fertiliser experiment on old and new land at Manjimup, 144 samples were analysed for potassium, chloride and nitrogen. The experiment consisted of two replicates on each soil involving the factorial combination of four rates of ammonium sulphate, three rates of superphosphate and three rates of potassium sulphate. The results showed that—

(i) on both the old and new land leaf nitrogen was unaffected by added nitrogen, phosphorus or potassium;

(ii) leaf chloride was not affected by fertiliser treatment on the new land and on the old land it generally decreased with added potassium but was not affected by added nitrogen or phosphorus;

(iii) leaf potassium on both soils increased with added potassium and was not affected by added nitrogen and phosphorus.

(g) From a trial comparing the use of potassium bicarbonate with potassium sulphate at Manjimup Tobacco Research Station, 147 samples of leaf blades were analysed for potassium and chloride. The plots were given a basic dressing of superphosphate, ammonium sulphate and 200 lbs. of potassium sulphate at planting. The two sources of potassium were compared by 1 ton per acre before planting, 200 lb. per acre of each as a side dressing in December and 100 lb. per acre of each in December and at each watering. Samples were taken from seven replicates from three leaf positions and analysis showed—

(i) preplanting treatment significantly increased leaf potassium in all leaf positions, the bicarbonate giving slightly higher results than the sulphate;

(ii) Other treatment only slightly increased leaf potassium above the basic fertiliser level, sulphate giving slightly higher results than bicarbonate;

(iii) preplanting treatment increased leaf chloride in all leaf position, the sulphate and bicarbonate having equivalent effects in this respect;

(iv) the 100 lb. in December and 100 lb. at each watering treatment showed that potassium sulphate decreased chloride in all leaf positions except the youngest leaves and potassium bicarbonate increased the leaf chloride in all positions.

(h) From another trial, this time in the glass house at South Perth comparing potassium sulphate and potassium bicarbonate as potassium sources, 48 samples were analysed for potassium and chloride. The trial consisted of a control, 1 rate of potassium sulphate, 1 rate of potassium bicarbonate at 2 levels of applied chloride. Samples were taken from the tops and bottoms of the plants. The results showed—

(i) added potassium fertiliser decreased leaf chloride at both levels of applied chloride and in both leaf positions. The bicarbonate decreased the leaf chloride more than did the sulphate;

(ii) leaf potassium increased with added potassium fertiliser at both chloride levels but there was no difference in leaf potassium between bicarbonate and sulphate fertiliser, top or bottom leaf position or high and low chloride levels.

(i) Twenty samples were analysed for phosphorus, from a glass house trial consisting of 2 rates of nitrogen and 5 rates of phosphorus fertilisers. The results showed that leaf phosphorus increased with added phosphorus in the nutrient solution up to 4 milliequivalents per litre for both levels of nitrogen. Leaf phosphorus was slightly lower in the high level of nitrogen treatment than in the low level.

(j) From a further glass house trial, 144 samples were analysed for nitrogen and nicotine. The trial consisted of factorial combination of 6 rates of nitrogen treatment, two rates of potassium sulphate treatment and two rates of sodium chloride treatment. Analysis showed—

(i) increasing nitrogen fertiliser increased both leaf nitrogen and nicotine;

(ii) increasing potassium fertiliser decreased nicotine but had no appreciable effect on leaf nitrogen;

(iii) increasing chloride had no effect on leaf nitrogen or nicotine;

(iv) leaf position had little effect on leaf nitrogen or nicotine.

6. Miscellaneous Leaves.—Samples of beetroot, carrots, pumpkins and rose leaves were analysed for confirmation of visual deficiency or toxicity symptoms.

*Animal Nutrition.*

Over 200 samples of liver and kidney were analysed in 1961 for a range of trace elements. These samples have been responsible for the main increase in work in 1961 not so much in the number of samples but because the analyses involved are time consuming and exacting.

1. Lupinosis.—The problem of lupinosis in sheep in the Dandaragan and Mooliabeenie districts is being carefully investigated by the Animal Health Laboratories of the Department of Agriculture. In connection with this work this Division has received 18 liver samples for total tocopherol determination and 156 liver and kidney samples for all or most of the following elements, calcium, cobalt, copper, iron, lead and manganese.

Heavy metal metabolism has been definitely associated with the occurrence of lupinosis; one consequence of the disease is the abnormally high liver storage of iron. Sheep feeding on lupins known to cause the disease have had their mean liver irons increased 13.5 fold from 420 p.p.m. to 5,680 p.p.m. in 3-4 weeks.

2. Thirty-nine samples of pasture and 24 samples of liver were analysed for copper and cobalt for confirmation of diagnosis of marginal deficiencies of these elements in sheep and cattle.

3. White Muscle Disease.—Because of outbreaks of white muscle disease in 1960, surveys of pastures from affected properties were sampled monthly in 1961 for selenium and vitamin E analysis. Samples were also taken from properties where fresh outbreaks occurred in 1961; in all 57 samples were analysed.

(a) As levels of 0.02 p.p.m. selenium in pasture are significant in white muscle disease, it was necessary to find a method sensitive to this level. Recent published methods by J. H. Watkinson (Anal. Chem. 1960 p. 981) and F. B. Cousins (Aust. J. Exp. Biol. & Med. Science 35(1) p. 11 February, 1960) were the most promising available methods. Neither of these as published was sufficiently reliable. A modification of Cousins' method controlling the acidity of co-precipitation of selenium with arsenic and careful control of acidity during colour development with diamino-benzidine was found to give good recoveries and replications. As the method is a sensitive fluorimetric procedure and no sufficiently sensitive fluorimeter was available, a suitable instrument was made from a Unicam fluorescent attachment. Incident light from a tungsten lamp was passed through an Ilford No. 601 filter into 1 cm cells and the fluorescent light was passed through a Chance glass O.Y.2 filter on to an I.P.28 photo-multiplier. The current from the photo-multiplier was amplified by a Techtron W.M.A. amplifier unit. A physical chopper giving the necessary modulation of 50 cycles per second, was placed between the exit filter and the photo-multiplier. With the gain adjusted to give full scale deflection (100) for 1 $\mu$g. of selenium in 6 ml of toluene, the zero adjustment is used to give a blank reading of 40. Therefore as the instrument reading and method can be reproduced to the nearest scale unit a sensitivity of 1/60 $\mu$g. per gram of sample can be obtained.

The selenium figures on all pasture samples examined were from 0.01-0.08 p.p.m., except for two samples one from Dangin, the other from South Kellerberrin both of which had 0.20 p.p.m. dry basis.

(b) Vitamin E—Total Tocopherol.—The total tocopherol content of fresh pasture decreases with time after cutting and no suitable method could be found in the literature for the preservation of samples prior to analysis. Initially all samples were kept in a deep freeze, till they were ready for analysis, but this method of storage was shown to result in a loss of total tocopherol. The most satisfactory method of sample storage was found to be rapid drying at 60-70°C. Samples dried, ground and stored by this procedure gave comparable results with samples freshly cut and analysed immediately.

4. Zinc deficiency in poultry is generally considered to be of little concern as cereal grains, which form the basis of rations for these animals, are reputedly sufficiently high in zinc. Because of the low zinc status of many Australian soils, a survey of the zinc content of Australian cereal grains and of poultry feeds and supplements was made in co-operation with Professor Underwood of the University Institute of Agriculture. The results given below in Table 12 indicate that rations based entirely on cereal grains could cause zinc deficiencies.

Table 12.
Zinc Content of Poultry Feeds.

| Material | Source | No. | Zinc parts per million dry basis | |
|---|---|---|---|---|
| | | | Range | Average |
| Maize | N.S.W. | 6 | 19–33 | 25 |
| Oats | Victoria | 10 | 17–26 | 22 |
| Barley | S.A. | 5 | 17–21 | 19 |
| | Victoria | 5 | 17–34 | 20 |
| Wheat | N.S.W. | 4 | 22–29 | 26 |
| | S.A. | 5 | 14–19 | 16 |
| | Victoria | 2 | 16–20 | 18 |
| | W.A. | 8 | 15–20 | 18 |
| Whole meal | W.A. | 4 | 240–260 | 250 |
| Meatmeal | N.S.W. and W.A. | 10 | 78–96 | 89 |
| Proprietary mixed poultry foods | W.A. | 13 | 38–76 | 49 |

The average analysis of whole wheat grain and products milled from it given below, show that the zinc is concentrated in the bran and pollard fractions.

| | Zinc parts per million dry basis |
|---|---|
| Wheat, whole grain .... .... .... | 17 |
| Bran .... .... .... .... .... | 53 |
| Pollard .... .... .... .... .... | 41 |
| Flour .... .... .... .... .... | 5 |

*Miscellaneous.*

1. Spectrography.—(a) Samples of alkali-chlorides from beryl, cassiterite concentrates, dust, faeces, police exhibits, printing ink, scheelite concentrates, tinning compound and urine were analysed by semi-quantitative spectroscopy.

(b) Atomic Absorption Spectroscopy.—Equipment purchased and made for this technique has enabled us to do trace zinc determinations by this procedure, with a considerable saving in time compared with the dithizone extraction procedure. With the arrival of further equipment and reagents it is hoped to use atomic absorption spectroscopy for the determination of lead in urine and water and copper, calcium and magnesium in a variety of materials. The volume of work on hand has not permitted us to spend the time we would like on this technique.

2. Corrosion and Deposits.—(a) Samples of boiler deposits from Kalgoorlie District Hospital, Princess Margaret Hospital, Home of Peace, King Edward Memorial Hospital and Ngala were analysed and advice given on their cause and prevention.

(b) The occurrence of brown discoloured water in certain parts of the Metropolitan Water Supply reticulation is a fairly normal occurrence at the beginning of summer due to the sudden increase in water usage resulting in increased velocities in the mains, which disturbs growths or deposits which have formed over the low draw period of winter. These occurrences generally clear up, after mains in the area have been flushed. However in the early summer of 1961 there were repeated discolourations of water in the Scarborough area which could not be corrected by repeated flushing. Analysis of the discolouration indicated it was due to a growth of iron bacteria on the walls of the main. All samples taken were dark brown to black in colour, high in iron, but also unusually high in manganese. The only source of manganese would be the water and the bacteria must be very efficient at extracting it from this source as no analyses have shown greater than 0.01 p.p.m. manganese in the water. The reason for the continued dislodging of the deposit from the main walls was not discovered, but the problem rectified itself over a period of a few weeks.

Analysis of samples of deposit from the Canning Dam main walls at Queens Park and the Serpentine Dam main near the pipe-head dam, were both similar in composition to these Scarborough deposits and contained up to 20 per cent. manganese.

(c) A white corrosion product from a tank at Koorda was found to be zinc hydroxy-carbonate caused by the attack of water of high pH on the galvanising. The high pH of the water resulted from passing through several miles of new cement lined pipes.

3. Oil Seeds.—The 551 samples of linseed, safflower and cotton seed from the Avondale and Kimberley Research Stations analysed for oil content and iodine value represents a 125 per cent. increase on 1960.

4. A further 40 post-mortem blood samples were analysed for alcohol by the Kozelka and Hine method. Good agreement with results obtained by the Food and Drug Division's method was obtained.

5. Difficulty in the pinning of currant fruit was investigated to see if there was any relationship between moisture content and pinning. It was reported to the Department of Agriculture's Senior Plant Research Officer by packing shed operators, that when pinning equipment started each morning it could maintain its specified throughput but as the day progressed pinning was less satisfactory and the throughput was reduced to about one third. Investigation had shown that fruit with less than 15-16 per cent. moisture would pin satisfactorily at all times, above this moisture content temperature also becomes important. On our suggestion it was found that chilled samples could be pinned satisfactorily with moisture contents up to 25 per cent. The Department of Agriculture has since recommended that some system of cooling or chilling be introduced when pinning becomes difficult. This has the treble advantage of satisfactorily pinning the currants, maintaining plant capacity and the packer gains because of the weight of added moisture. However since deterioration on storage is likely with high moisture contents the above advantages could be out-weighed.

## ENGINEERING CHEMISTRY DIVISION.

The Division, created in 1960 by the transfer to these Laboratories, of the Research section of the Department of Industrial Development, continued as far as possible along the lines established before the transfer. The work of the Division during the year consisted, therefore, of: (a) research into the development and utilisation of natural resources of the State with emphasis on minerals as the most promising avenue for industrialisation of this State, and (b) advisory service to prospective as well as established industries.

Judging by the number and standing of overseas and interstate visitors to the Division during the year, the work of the Division, despite its very small staff, should be regarded as successful. However, it is felt that this would have been even more successful and useful for the State if there was more co-operation between the Government Departments involved in the development of the State and this Division.

The services that could be provided by the Division in the field of process and chemical engineering by scientific and technological personnel and equipment were practically not used by Government Departments or Instrumentalities during the past two years. As an example, during the year, only one unimportant enquiry was received from the Department of Industrial Development, one from the Town Planning Commissioner's Office, and none from other Departments.

Three original research projects were undertaken by the Division during the year, viz.: the upgrading of local ilmenite, the beneficiation of local low-grade manganese ore, and the recovery of sulphur from Kalgoorlie gold ore concentrates. Of these, the first has been successfully finalised in as much as a semi-commercial plant, based on the process developed is being erected by a local company for which we are acting as consultants.

All other work, listed below, was carried out for private interests:—

*Upgrading of Ilmenite.*

Investigations into upgrading of local ilmenite, which started in 1959, and later led to a patent application, were continued throughout the year with emphasis on the second stage of the process, i.e., the elimination of iron from ilmenite after reduction with subbituminous Collie coal in a rotary kiln in the first stage of the process.

The importance of the work on this subject, carried out by the Division, was emphasised by the visits from overseas to the Division (see later), and that it led to supplementary pilot plant work by Laporte Titanium Ltd. in England, and the erection of a semi-commercial plant by a local ilmenite producing company.

In connection with this latter move, the Division was engaged in consultations regarding the design, erection and operation of this plant.

In the course of the pilot plant work some time was devoted to investigation of the iron oxide produced as by-product in the process.

It was noticed that iron oxide, originally produced as a sludge, contained variable amounts of titanium oxide ($TiO_2$), sometimes up to 15 per cent.

Efforts were made to produce purer oxide by including a Wilfley table in the separation circuit. The results indicated, however, that in spite of screening out particles below 100 mesh from the reduced ilmenite fed into the aeration unit, and the use of the Wilfley table, the iron oxide produced in the process still contained 4 to 5 per cent of titanium oxide.

The assistance of the Kalgoorlie Metallurgical Laboratory was sought in this matter; they were requested to carry out ore dressing tests to investigate the possibility of reducing the titanium oxide content in the iron oxide.

The results of the work, carried out at Kalgoorlie, are the subject of their Report No. 715, September 26, 1961, and would indicate that lowering of titanium oxide content by ore dressing methods to about 2 per cent. is feasible.

There are some indications in the literature that pre-oxidation of iron oxides in ilmenite to the ferric state, may in some instances improve the degree of reduction and shorten the time required for processing. Some exploratory experiments were carried out in this direction with West Australian ilmenite.

The results of these experiments, conducted in the Birlec electric furnace (reduction for 3 hours at 1050°C, with Collie coal char as reducing medium) were not encouraging, some results being given below:

| | per cent. reduction |
|---|---|
| Ilmenite, as received .... .... .... | 97.3 |
| Ilmenite, pre-oxidised .... .... .... | 82.2 |

A number of tests of the elimination of iron by aeration under water involving batches of 50 lb. of reduced ilmenite, were carried out to establish the optimum conditions of aeration in the existing mechanically agitated unit.

At the end of the year, some time was spent in constructing and erecting a tall, narrow, Pachuca type aeration unit with air agitation, to study the oxygen take-up efficiency in such type of aerator, as compared with the mechanically agitated shallower unit.

This work was undertaken on the request of a local firm, and is still in progress.

*Beneficiation of Low-Grade Manganese Ore.*

Manganese ore is generally marketed as Battery grade (more than 50 per cent. Mn) or as Metallurgical grade (more than 40 per cent. Mn). A large proportion of manganese ore in this State falls, however, into a range of 20 per cent. to 40 per cent. Mn. For such low-grade ore there is no ready market, unless it can be beneficiated. The formulation of a beneficiation process was, therefore, long overdue.

The primary aim of investigations, commenced by the Division at the beginning of the year, was to ascertain whether West Australian manganese ores could be beneficiated by a process similar to that developed by the Division for upgrading of ilmenite, consisting of reduction to metallic iron of the iron oxide in the ore and subsequent elimination of metallic iron by aeration under water. The work was actually carried beyond these set limits.

The two best known areas in Western Australia indicating low-grade manganese ore deposits are: the Ripon Hills area in the Pilbara and the Ravensthorpe area in the South of the State.

Dry ore samples from the above areas were analysed as follows:—

| | Ripon Hills area per cent. | Ravensthorpe area per cent. |
|---|---|---|
| Total manganese (Mn) .... | 33.5 | 36.6 |
| Iron oxide ($Fe_2O_3$) .... .... | 35.3 | 6.7 |
| Silica ($SiO_2$) .... .... .... | 5.4 | 27.5 |

As the analyses show, the ores, though very similar in manganese content, have somewhat different characteristics, one being richer in iron oxide and the other in silica. This suggests that possibly different methods of beneficiation should be applied to each type of ore.

Since the main contaminant in the Ripon Hills ore is iron oxide, it would be expected to respond to the process developed for ilmenite, provided the iron oxide could be reduced selectively.

Initial efforts were, therefore, directed towards the achievement of a selective reduction of iron oxide in Ripon Hills ore by keeping the reduction temperature low so as not to reduce manganese oxides to below the $Mn_3O_4$ state, but at the same time fully reduce the iron oxides.

The reduction tests carried out in a Birlec electric furnace using Collie coal char as reductant, were unsuccessful, a temperature of at least 800°C being required for the reduction of iron oxides to metallic iron. At this temperature, however, at least a portion of the manganese oxides was also reduced, and in the aeration stage of the process the reduced portion of manganese oxidised simultaneously with iron.

The low iron content and the high figure for silica suggested that the Ravensthorpe ore might be suited to this process, where the manganese (and iron) oxides formed from the reduced ore by oxidation under water, are separated from silica, left behind.

To test this, Ravensthorpe ore, reduced at 1000°C, was aerated under water under various conditions. The best result recorded indicated beneficiation of the ore to 54.4 per cent. Mn with about 60 per cent. recovery of Mn.

Further experiments indicated that in the aeration step not all of the manganese was precipitated as hydrated oxide, but some remained in solution. In a test, where the solution was kept slightly acid throughout the operation, and the oxide with the residue was filtered off, increasing the pH of the filtrate produced a heavy deposit of manganese compound which on calcination assayed 62.2 per cent. Mn, equivalent to 86.4 per cent. $Mn_3O_4$ or 98.4 per cent. MnO.

Further work in this direction is planned.

Another line of attack on the beneficiation of Ripon Hills ores, was magnetic separation after the ore had been subjected to a magnetising roast or other treatment rendering iron oxide magnetic.

Exploratory investigations were carried out into the conversion of iron oxide to maghematite, employing low-temperature treatment as outlined in the Brit. Pat. 792, 926. However, attempts to convert $Fe_2O_3$ in the ore to magnetic$\gamma$-hematite by treatment at 200°-300° C. were unsuccessful.

Several batches of the ore from Ripon Hills area were subjected to magnetising roasting and then treated in the magnetic separator. A typical example of the results of variously bulked portions of the product (numbered 1-3) after magnetic separation, is given below:—

| | Weight, per cent. of total | Assay, per cent. | Recovery of Mn per cent. |
|---|---|---|---|
| Original ore .... .... .... .... | .... | 32·1 | .... |
| Screened ore .... .... .... | 100·0 | 35·4 | 100·0 |
| Non-magnetics (1) .... .... .... | 19·4 | 55·0 | 29·9 |
| Non-magnetics (1) + (2) .... .... | 34·1 | 51·2 | 48·9 |
| Non-magnetics (1) + (2) + (3) .... | 44·3 | 50·6 | 62·7 |
| Non-magnetics (1) + (2) + (3) + magnetics (1) .... .... .... | 52·8 | 50·0 | 73·9 |
| Non-magnetics (1) + (2) + (3) + magnetics (1) + (2) .... .... | 59·0 | 48·8 | 80·6 |
| Non-magnetics (1) + (2) + (3) + magnetics (1) + (2) + (3) .... | 84·2 | 42·5 | 100·3 |

In connection with all the above work on beneficiation of manganese ores, 50 tests were carried out and 162 samples were analysed, of which 13 samples were analysed by the Mineral Division.

At a conference held in November between the representatives of the Commonwealth Bureau of Mineral Resources, Dr. W. Coffer, Director of Australian Mineral Development Laboratories, and the State Government Officers, it was stated that the Commonwealth authorities preferred that the preliminary work, on beneficiation of West Australian manganese ores be carried out by the A.M.D.L. at Adelaide. At the request of Dr. Coffer, a list of references on beneficiation of manganese ores was prepared and forwarded to the A.M.D.L.

*Sulphur Recovery from Kalgoorlie Gold Ore Concentrate.*

During the sulphur crisis in 1950-52, an investigation was conducted by the Division (then Bureau of Research and Development, Department of Industrial Development) into the possibility of using the sulphur from the Kalgoorlie gold ore concentrates, which contain 35-40 per cent of sulphur, and which is lost as very much diluted $SO_2$ gas (2%) led into the atmosphere during treatment for gold recovery.

The only economical solution at that time appeared to be the treatment of concentrates at fertilizer works. This involves the transport of concentrates from Kalgoorlie to the individual works, roasting there for recovery of $SO_2$ for the manufacture of sulphuric acid and subsequent cyanidation of roasted concentrates for the recovery of gold.

The quantity of sulphur lost at Kalgoorlie is appreciable, estimated at some 25,000 to 30,000 tons per annum and since some new technical developments in this field have taken place since 1952, it was considered that a new investigation by the Division was warranted.

Two possible processes were formulated, viz:—

(1) Gold concentrates to be roasted in conditions controlled by admission of air and steam, so that sulphur vapour, sulphur dioxide and hydrogen sulphide are formed. Sulphur vapour is condensed to yield elemental sulphur and the sulphur dioxide and hydrogen sulphide are reacted over a catalyst to yield elemental sulphur.

The desired overall reaction is:

$$5FeS_2+3H_2+3\tfrac{1}{2}O_2 = 1\tfrac{2}{3}Fe_3O_4+3H_2S+1\tfrac{1}{2}SO_2+5\tfrac{1}{2}S$$

$$H_{25}{}^0C = -167.6 \text{ kcal.}$$

Magnetite formed is further oxidised to hematite in a separate stage and the heat evolved utilized for preheating the air supplied to the main reaction zone.

The temperature which would be required for the reaction to proceed at reasonable rates is important from the standpoint of locking up gold and the amount of excess steam necessary would determine the economic feasibility of such a process.

(2) In the second process the concentrates are to be treated in two stages. In the first stage, pyrite in the concentrates is converted to pyrrhotite by roasting in the absence of oxygen, $FeS_2+\text{heat} = FeS+S$, $H_{25}{}^0C = +16.0$ kcal. In the second stage, pyrrhotite formed is oxidised by air under water at a temperature of about 110°-115°C., and under a pressure of about 100 lb./in.$^2$

A higher yield of gold can possibly be expected when using this process.

Small scale laboratory experiments conducted with Norseman pyrites (containing no gold) indicated that—

(a) the reactions as outlined for the first process, do actually take place and the ratio of $SO_2$ to $H_2S$ can be controlled by varying the amounts of air and steam supplied. A yield of about 60 per cent. of elemental sulphur was obtained using a somewhat crude condensing train;

(b) about 80 per cent. of the remaining 55 per cent. of sulphur, originally present in pyrites, can be recovered in elemental form from pyrrhotite formed in the first stage of the second process, by using hydrometallurgical methods in the second stage, making an estimated overall recovery of about 85 per cent. Some difficulties were indicated in separation of sulphur from the iron oxide residue in this latter stage.

In the course of preliminary investigations into the first process the treatment of concentrate in the form of pellets countercurrently with gas in a shaft furnace was considered.

These attempts were, however, unsuccessful, since although comparatively strong pellets could be easily made, their strength was far from adequate at higher temperatures. Sintering of pellets prior to their treatment or use of special binders was not possible in view of the likelihood of locking up gold.

Bench scale experiments with the second, two stage, process indicate that the conversion of pyrite in the concentrate to pyrrhotite, and the recovery of the first atom of sulphur in pyrites may possibly be carried out in an entrained bed furnace without locking up the gold.

In order to establish the advisability of undertaking the above investigations into the sulphur recovery, and ensure the co-operation of the Gold Mining Industry, two senior members of the staff of the Division visited Kalgoorlie in March and May and had discussions with the managements of individual gold mines and with the Metallurgical Committee of the W.A. Chamber of Mines, at Kalgoorlie.

*Crushing and Calcination of Spodumene.*

At the request of a local firm, some spodumene from the Ravensthorpe area was crushed in the jaw-crusher to a size below 2 in., and then calcined in the rotary kiln at about 1060°C. The calcined material was discharged from the kiln through an open port into pans and bagged after cooling.

A batch of 70 lb. of unclaimed spodumene was crushed in an impact mill with a view to testing the wear of the mill parts.

The test indicated that the wear of hammers, hard-faced with the Cobalarc A1 alloy (chrome, manganese, iron alloy), was considerable and that the contamination of the product with metal was excessive.

*Roasting of Spongolite.*

A parcel of spongolite was roasted in the rotary kiln at various temperatures, at the request of a local firm. Roasted material was bulked into four grades according to the discharge temperature and colour.

*Treatment of Leucoxene.*

Twelve batches of leucoxene were treated at various temperatures in the Birlec electric furnace on the request of a local firm.

Four more samples were treated in the furnace during the third quarter of the year and later subjected to upgrading by removal of iron by aeration under water.

*Beneficiation of Calcareous Beach Sand and the Production of Lime from it.*

In continuation of the work on beneficiation of calcareous beach sand, an investigation into the influence of the preheating temperature of sand on its beneficiation by electrostatic separation was carried out.

The results indicated that there was a definite decrease in efficiency of electrostatic separation of limestone from silica if the temperature at the point of the first contact of sand with heating gas was too high (up to 800°C) even though the temperature of the beach sand was much lower when fed into the separator.

Practically no irreversible changes were found in response of lime sand to electrostatic beneficiation after heating at drying gas temperatures up to 400°-500°C. The normal temperature of sand for electrostatic beneficiation is considered to be between 100° and 150°C.

At the request of a commercial firm one smaller and one larger batch of lime were produced from the beach sand in the pilot plant entrained bed furnace. The sand was first beneficiated from 21.2% acid insolubles to 1.0% and from 8.3% to 1.25% respectively and calcined.

The analysis of the product from the larger batch was as follows:

| | Per cent. |
|---|---|
| Total CaO | 87.8 |
| Available CaO | 80.0 |
| MgO | 5.14 |
| $CO_2$ | 3.92 |
| $R_2O_3$ | 0.32 |
| Acid insolubles | 1.19 |

During the record calcination run, of 44 hours, considerable trouble was experienced with blockages in the lime recovery system, indicating that the design of this portion of the furnace requires modification.

*General.*

During the year:

(a) Chief Chemical Engineer, Dr. S. Uusna, attended "The Symposium on Fluidization" conducted by the Royal Aust. Chemical Inst. in Adelaide in February.

(b) Chief Chemical Engineer, Dr. S. Uusna, delivered a talk to the A.I.M.M., Perth Branch in February. The talk was entitled: "The Production of Sponge Iron and the Upgrading of Ilmenite." An outline of the investigational work carried out by the Engineering Chemistry Division of the Government Chemical Laboratories."

(c) Senior Engineering Chemist, R. G. Becher, delivered a paper to the R.A.C.I., Perth Branch, in April, the paper being entitled: "The Utilization of Local Raw Materials in W.A. Chemical Industry", and delivered a talk to the Perth group of the Institute of Fuel in July, describing the activities of the Division.

(d) Enquiries from local firms concerning several aspects of the utilisation of local mineral wealth were answered.

(e) There were many interstate and overseas visitors to the Division with whom fruitful discussions were held. Among these visitors were—

Mr. A. Keats, Assistant Director, A.M.D.L., Adelaide.

Mr. A. Griffin, Director and Manager, Titanium Alloy Manufacturing Co. Pty. Ltd., Tweed Heads, N.S.W.

Mr. L. H. Bates, Manager, Planning Division, E.I. du Pont de Nemours & Co., U.S.A.

Mr. R. M. Grogan, Manager, Geology Division, E.I. du Pont de Nemours & Co., U.S.A.

Dr. F. R. Williams, Manager, Minerals Division, British Titan Products Co. Ltd., U.K.

Mr. M. Takesue, Metallurgical Engineer, Nittetsu Mining Co., Japan.

Mr. S. Ichinomiya, Planning and Research Department, Kinoshita & Co., Tokyo, Japan.

Mr. Mew, Tennant Sons & Co. Ltd., London.

Mr. J. Gordon, Vice President, Swindell—Dressler Corp., Pittsburgh, U.S.A.

Dr. Fujio Kakiuchi, Director, Orissa Steel Co. Ltd., and Professor of the University of Tokyo, Japan.

Mr. Saburo Kurose, Director, Kinoshita (Aust.) Pty. Ltd., Sydney.

Mr. Y. Hanai, Kinoshita & Co., Tokyo, Japan.

Dr. I. W. Wark, Member of C.S.I.R.O. Executive, Melbourne.

Dr. S. H. Bastow, Chief Executive Officer, C.S.I.R.O., Melbourne.

Mr. L. Lewis, Officer-in-Charge, Industr. Research Liaison Section, C.S.I.R.O., Melbourne.

Mr. A. J. Gaskin, Officer-in-Charge, Cement and Ceramics Section, C.S.I.R.O., Melbourne.

Dr. W. Coffer, Director, Austr. Miner. Development Laboratories, Adelaide.

Dr. F. S. Spring, Group Director of Research and Chemical Development, Laporte Titanium Ltd., London.

## FOODS, DRUGS, TOXICOLOGY AND INDUSTRIAL HYGIENE DIVISION.

As in recent years the major proportion of the work of this Division consisted of chemical examinations for the Departments of Public Health, Police and Agriculture, as well as for the Milk Board of Western Australia and the Swan River Conservation Board, but a wide variety of miscellaneous work was also performed for other Government departments and the general public.

The personnel of the Division comprised, nominally, 11 officers, but owing to delays in filling vacancies consequent upon resignation, transfer, etc., the Division had one officer less than its nominal staff throughout the whole year, and had two officers less for half the year.

Two thousand nine hundred and one samples were received during the year, being an increase of 465, or 19.1 per cent. over the number of general, i.e., non-sewage, samples received in 1960. The main increase occurred in the number of food samples, 815, received in 1961, being more than double the number received the previous year. A broad outline of the variations in general samples over recent years is indicated in the following classification:—

Table 13.

| Class | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| Milks | 240 | 189 | 281 | 194 | 437 |
| Cheese | 40 | 54 | 113 | 84 | 140 |
| Exhibits–alcohol | 164 | 229 | 316 | 358 | 315 |
| Human toxicology | 162 | 284 | 290 | 421 | 388 |
| Industrial hygiene | 132 | 86 | 305 | 327 | 335 |
| Pesticides | 44 | 34 | 34 | 24 | 160 |
| Pollution surveys— | | | | | |
| Swan River | 237 | 205 | 128 | 204 | 178 |
| Bunbury | 72 | 48 | 48 | 48 | 50 |
| Total general samples | 2,364 | 2,604 | 2,639 | 2,436 | 2,901 |

Table 14 shows the source and description of samples received during 1961.

Table 14.

Food and Drug Division 1961.

| — | Agriculture Department | Air Department—Commonwealth | Departmental | Factories Department | Government Departments (Others) | Hospital | Milk Board | Mines Department | Police Department | Public—Free | Public—Pay | Public Health Department | Public Works Department | Tender Board | Swan River Conservation Board | Western Australian Government Railways | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Foods— | | | | | | | | | | | | | | | | | |
| Aerated waters | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 10 | .... | .... | .... | .... | 10 |
| Apples | 26 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 26 |
| Beef fat | 42 | .... | 2 | .... | .... | .... | .... | .... | .... | .... | 3 | .... | .... | .... | .... | .... | 47 |
| Cheese | 73 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 67 | .... | .... | .... | .... | 140 |
| Grapes | 16 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 16 |
| Jams | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 | .... | 12 | .... | .... | 16 |
| Meat, various | .... | 1 | .... | .... | 1 | .... | .... | .... | .... | .... | .... | 56 | .... | .... | .... | .... | 58 |
| Milk, cow | .... | .... | .... | .... | .... | .... | 409 | .... | .... | .... | .... | 28 | .... | .... | .... | .... | 437 |
| Milk, human | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 10 | .... | .... | .... | .... | 10 |
| Vinegar | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 18 | .... | .... | .... | .... | 18 |
| Various | 7 | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 3 | 21 | .... | 6 | .... | .... | 38 |
| Industrial Hygiene— | | | | | | | | | | | | | | | | | |
| Air | .... | .... | .... | 13 | .... | .... | .... | .... | .... | .... | .... | 74 | .... | .... | .... | .... | 87 |
| Urine | .... | 1 | .... | 12 | 1 | 1 | .... | .... | .... | .... | 43 | 120 | .... | .... | .... | 34 | 212 |
| Various | .... | .... | .... | 3 | 2 | .... | .... | .... | .... | .... | 2 | 29 | .... | .... | .... | .... | 36 |
| Miscellaneous— | | | | | | | | | | | | | | | | | |
| Criminal cases | .... | .... | .... | .... | .... | .... | .... | 5 | 47 | .... | .... | .... | .... | .... | .... | .... | 52 |
| Detergents | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 60 | .... | .... | 60 |
| Drugs and medicines | .... | .... | .... | .... | 3 | .... | .... | .... | 6 | .... | .... | 15 | .... | .... | .... | .... | 24 |
| Explosives and fireworks | .... | .... | .... | .... | .... | .... | .... | 11 | .... | .... | .... | .... | .... | .... | .... | .... | 11 |
| Linseed | 112 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 112 |
| Oxygen | .... | 50 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 50 |
| Pesticides | 107 | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | 3 | 49 | .... | .... | .... | 160 |
| Pipeline deposits | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 10 | .... | .... | .... | 10 |
| Polishes | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 15 | .... | .... | 15 |
| Safflower | 62 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 62 |
| Soil | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 39 | .... | .... | .... | 39 |
| Vermin Poison | 22 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 22 |
| Water | .... | .... | 24 | .... | .... | .... | .... | .... | .... | .... | 1 | 7 | .... | .... | .... | .... | 32 |
| Various | 20 | .... | .... | .... | 2 | .... | .... | .... | .... | 6 | 14 | 12 | 2 | 5 | .... | .... | 61 |
| Pollution— | | | | | | | | | | | | | | | | | |
| Effluents | 3 | .... | .... | .... | 2 | .... | .... | .... | .... | .... | 5 | .... | .... | .... | .... | .... | 10 |
| Maritime | .... | .... | .... | .... | .... | .... | .... | .... | 7 | .... | .... | .... | .... | .... | .... | .... | 7 |
| Survey : | | | | | | | | | | | | | | | | | |
| Bunbury | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 50 | .... | .... | .... | 50 |
| Swan River | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 178 | .... | 178 |
| Toxicology— | | | | | | | | | | | | | | | | | |
| Animal | 32 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 32 |
| Human : | | | | | | | | | | | | | | | | | |
| For alcohol (sobriety) | .... | .... | .... | .... | .... | .... | .... | .... | 132 | .... | 3 | .... | .... | .... | .... | .... | 135 |
| For alcohol (traffic death) | .... | .... | .... | .... | .... | .... | .... | .... | 179 | .... | .... | 1 | .... | .... | .... | .... | 180 |
| Toxicology | .... | .... | .... | .... | .... | .... | .... | .... | 387 | .... | .... | 1 | .... | .... | .... | .... | 388 |
| Specimens from patients | .... | .... | .... | .... | .... | 45 | .... | .... | .... | .... | 5 | 10 | .... | .... | .... | .... | 60 |
| | 522 | 52 | 27 | 28 | 12 | 46 | 409 | 16 | 758 | 6 | 79 | 486 | 150 | 98 | 178 | 34 | 2,901 |

*Foods:*

A total of 815 samples of foods of various kinds was received during 1961. 409 of these were samples of cows' milk submitted by the Milk Board of W.A. Of this number, 324 consisted of milks suspected of being adulterated or of failing to comply with the standards required by the Regulations under the Milk Act. 4.6 per cent. of these samples contained less than the legal minimum amount of milk fat (3.2 per cent.), and 34.5 per cent. contained less than the legal minimum of solids not fat (8.5 per cent.), while 76.8 per cent. of the samples failed to comply with the legal standard for freezing point of milk (0.540 degrees centigrade below zero). The proportion which failed to comply with the standards for fat and freezing point are much the same as in 1960, but in respect of solids not fat the figure of 34.5 per cent. shows an improvement over that for 1960, namely 57.5 per cent. failing to comply. The distribution of analytical figures is shown in the following tables:—

Milk Fat.

| Per cent. in Sample. | Per cent. of Total Samples. |
|---|---|
| Less than 3.00 | 0.3 |
| 3.00 - 3.19 | 4.3 |
| 3.20 - 3.49 | 13.5 |
| 3.50 - 3.74 | 17.3 |
| 3.75 - 3.99 | 13.0 |
| More than 3.99 | 51.6 |
| | 100.0 |

Milk Solids Not Fat.

| Per cent. in Sample | Per cent. of Total Samples |
|---|---|
| Less than 8.00 | 1.6 |
| 8.00-8.24 | 8.1 |
| 8.25-8.49 | 24.8 |
| 8.50-8.74 | 37.7 |
| 8.75-8.99 | 22.9 |
| More than 8.99 | 4.9 |
| | 100.0 |

Freezing Point.

| Degrees C. below zero | Per cent. of Total Samples |
|---|---|
| Less than 0.500 | 0.6 |
| 0.500-0.509 | 0.6 |
| 0.510-0.519 | 1.6 |
| 0.520-0.529 | 15.4 |
| 0.530-0.539 | 58.6 |
| 0.540-0.550 | 20.4 |
| More than 0.550 | 2.8 |
| | 100.0 |

In presenting the above figures it is emphasised that they were in respect of samples for which there was prima facie evidence of their not complying with legal standards.

Eighty-two samples of selected milks were analysed more fully in connection with an investigation by the Milk Board into factors affecting animal nutrition and milk quality.

Twenty-three samples of milk were examined for the Public Health Department as a result of complaints of poor milk quality at a Government Institution, and two samples were subjected to the phosphatase test in order to confirm a strong suspicion that milk labelled as pasteurised had not been so treated.

Three samples of boiled milk were also submitted by the Public Health Department in an endeavour to trace the cause of discoloration observed in several batches of boiled milk.

Seventy-three samples of cheese were analysed for the Dairying Division of the Department of Agriculture as a check on the quality of cheese produced by factories in this State. Of this number 77 per cent. contained more than 50 per cent. of fat calculated on the moisture-free basis.

Sixty-seven samples of cheese were also analysed for the Public Health Department in a survey of the different types of imported cheeses available on the local market.

Eighteen samples of food were submitted by the Government Tender Board. These consisted of chutneys, tomato sauces and jams which were examined to determine their suitability for supply to Government Institutions.

Sixteen samples of grapes were analysed for the Department of Agriculture in connection with an investigation of the seasonal variation in sugar and acid content of certain varieties of grapes.

Experimental work on the use of diphenylamine to control "scald" in apples was continued in 1961 by the Department of Agriculture, and 23 samples of apples were analysed to determine surface residues of diphenylamine and its concentration in the pulp of the fruit. The examination of three additional samples of apples which had been treated with ethoxyquin, was also carried out.

The increased interest in the possibility of insecticide residues in foods led to a considerable amount of time and work being directed to the investigation of a method of analysis and the subsequent examination of 42 samples of beef fat for the Stock Branch of the Department of Agriculture. The Horticulture Branch submitted potatoes also for examination of the suspected insecticidal dust adhering to the surface.

Ten samples of aerated waters were received from the Public Health Department. Two were examined for specific contamination following complaints regarding their flavour, and eight for the presence of artificial sweetening agent. Three samples were found to contain such a substance.

Eleven samples, in all, of fruit juices and cordials were also examined for compliance with the requirements of the Food and Drug Regulations.

Eighteen samples of vinegar were analysed for the Public Health Department. Four samples were found to be "imitation vinegar," but only one was labelled to this effect, while the label of another sample was not a correct description of the type of vinegar which it contained.

Sausages, frankfurts and minced meat, totalling 16 samples were examined for compliance with Food and Drug Regulations, particularly in regard to preservative, starch and/or total meat content.

Miscellaneous samples of food examined during the year included bran flakes and sugar for suspected contaminants, gelatine dessert and a packaged "pie filling" for compliance with Food Regulations, and canned peas which were examined for artificial colour and flavouring.

Forty samples of canned meat were received from the Public Health Department in connection with a survey of products of this type available on the local market, but owing to shortage of staff it was not possible to commence this work during 1961.

*Human Toxicology:*

Samples were received from approximately 250 cases of sudden death which were the subject of police investigation. One hundred and ten cases were as a result of "traffic accident," while 102 cases, comprising 321 exhibits, were examined for the presence of poison or other physiologically active drug.

In 24 cases no poison or drug was detected, while in 78 cases a poisonous substance or other drug was identified on analysis.

In a number of cases more than one poison or drug was detected, and in 25 of the 60 cases where a sample of blood was available, alcohol was found to be present.

Details are listed in the following table:—

| Poison or Drug | No. of Cases. |
|---|---|
| Barbiturates | 28 |
| Carbromal | 7 |
| Carbon monoxide | 28 |
| Bromvaletone | 4 |
| Chloral | 2 |
| Codeine | 2 |
| Chlorpromazine | 2 |
| Strychnine | 2 |
| Alcohol | 2 |
| A.P.C. | 2 |
| Quinine | 2 |
| Parathion | 2 |
| *Various (one each) | 6 |
| Negative | 24 |
| | 113 |

* Amylocain, barbitone, chloroform, dieldrin, malathion, unidentified "acidic."

From another 34 cases of sudden death other than "traffic accident," blood samples were examined for alcohol as a routine procedure, making a total of 94 such cases. The distribution of the blood-alcohol figures found on analysis is indicated in the following table:—

| Alcohol Per cent. | Number. |
|---|---|
| Negative | 48 |
| Less than 0.05 | 11 |
| 0.05-0.09 | 8 |
| 0.10-0.14 | 8 |
| 0.15-0.20 | 4 |
| 0.21-0.25 | 10 |
| 0.26-0.30 | 2 |
| 0.31-0.35 | 3 |
| | 94 |

*Blood-Alcohol (Traffic)—*

One hundred and eighty samples of blood and/or urine were received in connection with investigations into fatal traffic accidents. One hundred and one of these samples consisted of blood from post-mortem examinations and were analysed for alcohol content as a routine procedure. The distribution of the analytical figures for the various categories of persons involved in these accidents is shown in the following table:—

| Alcohol, per cent. | Drivers Involved | Passengers Involved | Pedestrians Involved |
|---|---|---|---|
| Negative | 31 | 5 | 16 |
| Less than 0·05 | 1 | 5 | 1 |
| 0·05—0·09 | 5 | 2 | 2 |
| 0·10—0·14 | 2 | .... | 2 |
| 0·15—0·20 | 10 | 1 | 4 |
| More than 0·20 | 8 | 2 | 4 |
| | 57 | 15 | 29 |

From the above table it will be observed that 31.6 per cent. of fatally injured drivers had a blood alcohol figure of 0.15 per cent. or more, while the corresponding figure for passengers and pedestrians was 20 per cent. and 27.8 per cent. respectively.

*Voluntary Blood-Alcohol Tests.*

132 samples of blood were submitted by the Police Department and 3 by Local Government Authorities in connection with charges of "driving while under the influence of alcohol." These samples were taken from persons who, upon being charged with such offence, had exercised the right provided by the Traffic Act to offer a sample of blood for chemical analysis.

This Act states that if the alcohol content of the blood at the time of the alleged offence is 0.15 per cent. or greater it shall be prima facie evidence that the accused was under the influence of alcohol at that time. The results of these analyses are set out in the table below, the figures being the alcohol content of the blood at the time of the alleged offence, calculated by the formula prescribed in the Blood Alcohol Test Regulations, 1958:—

| Alcohol Per cent. | No. of Cases. |
|---|---|
| Less than 0.15 | 8 |
| 0.15 - 0.20 | 44 |
| 0.21 - 0.25 | 42 |
| 0.26 - 0.30 | 25 |
| 0.31 - 0.35 | 10 |
| More than 0.35 | 6 |
| | 135 |

*Animal Toxicology.*

There was no marked alteration in the number of samples received in connection with suspected poisoning of animals, although the proportion of negative cases was high. Of 19 cases which were examined, 13 were found to be negative, while there were 2 cases of poisoning due to lead, 1 of phosphorus, 1 of arsenic, 1 of strychnine and 1 of sodium fluoroacetate ("1080").

Five samples of animal teeth were also analysed for fluorine content, further to the supplementary diet experiments conducted by the Animal Division of the Department of Agriculture.

*Industrial Hygiene.*

The considerable increase in the volume of industrial hygiene work which first occurred in 1959 was maintained in 1961 when 335 such samples were received.

201 of these were specimens of urine from persons exposed to actual or potential lead hazard, and which were submitted for chemical analysis in order to assist the clinical diagnosis. 63.2 per cent. of the specimens contained less than 0.08 part per million (milligram per litre) of lead which is considered to be the normal upper limit. The distribution of the figures obtained in these analyses is shown in the following table:—

| Lead (Pb) parts per million. | Per cent. of Total Samples. |
|---|---|
| Less than 0.08 | 63.2 |
| 0.09 - 0.15 | 25.3 |
| 0.16 - 0.20 | 5.0 |
| 0.21 - 0.40 | 4.5 |
| More than 0.40 | 2.0 |
| | 100.0 |

Of the 36.8 per cent. of samples which contained more than 0.08 part per million of lead, many were repeat analyses carried out for investigational or supervisory purposes.

Seventy samples of urine and 10 other samples of body tissues were also analysed for toxic metals, although these were not all necessarily associated with industrial hygiene. These consisted of analyses for arsenic 18, lead 16, mercury 4, thallium 30 and vanadium 1.

Nine samples of urine from workers using benzene were analysed to determine the ratio of inorganic to total sulphate, as a measure of their exposure to benzene during working operations. It is becoming evident that the determination of the phenol content of the urine should be a useful index of benzene exposure and further work on this line is intended.

Eighty-seven samples of air were analysed during the year. Thirteen of these were carried out for the Factories Inspection Branch of the Department of Labour and represented eight examinations for lead hazard in several factories, and five examinations for noxious gases in a metal-spraying process.

Seventy-four samples of air were examined for the Public Health Department. Seven were analysed for carbon monoxide as a check on the efficiency and safety of a portable air compressor, and 44 were analysed in connection with investigations into the use of "cyanogas" as a fumigant for stored wheat.

The use of aluminium phosphide "tablets" as a source of phosphine for the control of weevil infestation in bulk wheat led to a considerable volume of work in collaboration with the Public Health Department and the commercial authorities concerned. Apart from the metropolitan area, bulk wheat installations were inspected at Belka, Erikin, Geraldton, Tammin and Yarding and 23 samples of air were analysed for phosphine gas in order to assess the safety or otherwise of working conditions.

Miscellaneous samples included adhesives which were examined for toxic solvents, childrens' paints for the presence of lead, plastic spectacle frames for inflammability, and a child's toy for possible hazard arising from the use of "fluorescent" plastic material.

*Pollution Surveys.*

1. Swan River.—Regular investigations as a check on the pollution of the Swan River were continued in 1961 for the Swan River Conservation Board, and 178 samples were analysed. One hundred and seven of these represented samples of river water from selected points of potential pollution collected on the regular quarterly surveys, while 54 similar samples were examined in the course of a systematic survey to determine the extent of pollution in a particular locality.

Sixteen samples of trade effluents were also analysed for the Board in order to check their suitability or otherwise for discharge into the River, while five such effluents were similarly analysed for the general public.

2. Leschenault Inlet Bunbury.—The normal summer and winter pollution surveys were carried out in January and June, when 50 samples were collected and analysed. The degree of pollution indicated in the summer survey appeared to be similar to that of previous years, but there was a noticeable decrease in the amount of winter pollution following the diversion to sea of much of the effluent which had formerly discharged into the Inlet.

3. Maritime.—Seven samples of oily fluids alleged to have been discharged from ships on to the waters of Fremantle Harbour were analysed for the purpose of providing supporting evidence as to the nature of the fluid.

*Miscellaneous.*

One hundred and twelve samples of linseed were received and examined for oil content in connection with seed trials conducted by the Department of Agriculture, but the analysis of 62 samples of safflower seed for oil and iodine value of the oil had to be deferred on account of shortage of staff.

Twenty-two samples of vermin poison were analysed for the Agriculture Protection Board. These consisted of sodium fluoroacetate ("1080"), oats impregnated with "1080", and arsenical powders.

Sixty samples of detergents were the subject of extensive consideration in order to advise the Government Tender Board as to those which were most suitable for use in Government institutions.

Investigations which commenced in 1960 concerning the source, extent and effects of an unusual chemical contamination of water, were continued in 1961 when 24 such samples were examined departmentally.

The analysis of "high altitude" oxygen for the Department of Air was again carried out when 50 samples were received and examined. Because of the exacting specifications to which this oxygen is prepared, laboratory checks were performed on each batch, in addition to the normal factory inspection tests.

An unusually large number of pesticides was received during the year, 160 compared with 24 in 1960. The increase was largely due to check analyses for the Weeds and Seeds Branch, Department of Agriculture, of weedicides of the 2:4D type, and for the Architectural Division, Public Works Department of insecticides used in white ant preventive treatments. The number and variety of pesticides examined is shown in the following table:—

| Pesticide | Number |
|---|---|
| Aldrin concentrate | 26 |
| Aldrin (diluted) | 23 |
| Dieldrin concentrate | 18 |
| Dieldrin (solid) | 1 |
| Chlordane concentrate | 5 |
| Dipterex concentrate | 1 |
| Malathion concentrate | 1 |
| Malathion fruit-fly bait | 5 |
| Fly-spray | 1 |
| Weedicides (2:4D type) | 77 |
| Various | 2 |
| | 160 |

In attempts to assess the efficiency of application of insecticidal sprays, 39 samples of treated soil were submitted by the Architectural Division, Public Works Department. Twenty-four of these were analysed for aldrin content and 15 for dieldrin.

Twenty-four samples of drugs and medicines were received from various departments. These included pethidine, morphine, physeptone, pentobarbitone, so-called fluorine tablets and tincture of opium which were submitted for assay or identification.

A variety of exhibits totalling 60 in all were submitted in connection with criminal investigations or other police enquiries. Of ten suspected poison baits, three were found to contain strychnine. Ten exhibits were examined in connection with hit-run cases, five with alleged breaking and entering, eight from cases of fire causing damage to life or property, and five in connection with an unexplained explosion.

Samples examined for the Explosives Branch of the Mines Department included gelignite, dynamite, semigel, imported fireworks and "home-made" explosive powders.

Samples of building material were again examined for fire resistance to assist the Public Health Department in determining their suitability for use in public buildings.

Fifteen samples of floor polishes and stains were received from the Government Tender Board and examined to determine their relative suitability for the purposes required by the Board.

Five samples of soap were also received from the Tender Board, two for analysis as a check on their compliance with specifications, while three were examined in connection with complaints of skin irritation.

Seven samples of tallow were received from the general public and analysed to determine their quality in terms of normal trade requirements.

Four samples of material which had been found on beaches were submitted for identification, but in no instance was the sample found to be ambergris.

A sample of stained sand with obvious oily characteristics proved on examination to contain an oil strongly resembling "used engine oil."

Miscellaneous samples received and examined during the year included cattle "dipping" fluids for arsenic content, binder twine for identification of colouring, a leather dressing alleged to have therapeutic value, overalls for testing to "flameproofness" specifications, liquid fuel for checking of "flash-point," and samples of leather for examination against Commonwealth Government specifications.

The usual enquiries for information were received during the year, generally by telephone, and endeavours were always made to assist with the required advice or information.

Expert evidence at Criminal, Coroners' and other Courts was tendered as required by Messrs. Houghton, Wood, Sedgman, Tulloch, Uren, Katnic and Jago in connection with their official duties.

The acquisition by the Laboratories of a new infra-red spectrometer of modern design has added considerably to the instrumental facilities available for the identification of unknown substances. The potentialities of this spectrometer have yet to be fully explored, and in common with other problems requiring investigation have had to give way to the pressure of "routine" type activities presented in this report. The provision of extra staff and accommodation will be necessary if the Division is to be able to meet the demands being made upon it both in regard to the expansion of existing work and the undertaking of new activities.

## FUEL TECHNOLOGY DIVISION.

*General.*

Coking Coal in Western Australia.—Samples of coking coal were received during the year from an oil test bore at Eneabba, a location about 150 miles north of Perth. The coking properties shown were sufficiently well developed to suggest that a strong, formed coke could be made from the coal in accordance with the most recent developments in the production of blast furnace fuel. The discovery is therefore one of significance in a State where, heretofore, deposits of coking coal were thought to be non-existent.

Though the coal was struck at 6,000 feet, the seam penetrated was reported as being at least 100 feet thick. If it could be proved in further drilling at a more workable depth both the quality and quantity of the coal would solve problems presented to coal based industrial developments in the State by the limitations of both the quality and quantity of easily worked coal at Collie. An analysis and assessment of the coal is presented in this report.

Oil and Wood Fired Boilers.—Applied fuel technology work on wood fired and oil fired boilers has shown that a prevailing trend to change from wood firing to oil firing can result in a marked increase in steam costs so long as the relatively low price and high quality of wood fuel available hold. There seems to be no grounds to fear any change in the wood fuel supply position and it would seem that industry and institutions should have regard to our findings to keep down the basic costs of steam which are fundamental to domestic and manufacturing economy.

In the endeavour to keep down oil firing costs the oil fired boilers tested used residual fuel oil of high sulphur content (2.5%). In consequence their stack gases contained sulphur oxides in quantity sufficient to cause local pollution problems which appears to be unavoidable except at high treatment costs.

Sawdust Fired Boilers.—In continuation of our long term work on utilisation of sawdust as a boiler fuel a test was made on a boiler specifically installed to use sawdust in accordance with recommendations made by us several years ago. The test gave most gratifying performance and efficiency figures, a feature of which was the ability and flexibility of the boiler in carrying overloads which were up to 100 per cent. of its rated capacity. The maximum heat release was 27,500 B.t.u. per cubic foot of combustion space per hour, a high value. A clearly suggested conclusion from this performance is that sawdust and hogged wood waste could become a preferred industrial fuel in factories where overloads and wide fluctuations in demand are features of the process.

The main attraction of sawdust is, of course, the major reduction in fuel costs which results from its use. The boiler tested, by its installation in substitution of boilers fired by log wood, has effected fuel economies in the neighbourhood of £20,000 per annum, enough to pay the installation costs of the boiler in two or three years.

A limitation on further expansion of sawdust firing in the metropolitan area is that practically all near-metropolitan sources of sawdust are now booked up by the number of factories which have adopted sawdust firing during the period of our activities in the field. Additional supplies of sawdust must now be transported from greater distances or hogging of industrial and forest waste wood must be undertaken. The maximum price which such sources could carry and maintain competition with oil or coal as alternative fuels would be about £4 per ton. Hogging costs about 30/- per ton and transport about 6d. per ton mile so that the scope for development of sawdust and wood waste burning is considerable and should be seriously considered by industry in this State in the interests of fuel economy.

An ancillary problem of sawdust firing is that of prevention of emission of charred sawdust fliers and dust. It is a problem to which we have not the necessary full access for its solution but work on it is done as and when opportunity offers.

Coal Survey.—Coal has been sampled at Collie and analysed in continuation of our fuel survey work. The quality of the succession of the seams overlying the 40 feet Hebe seam, as they are being progressively uncovered, is of interest. They appear to be maintaining the low ash characteristics which were found in earlier analyses during the Geological Survey drilling of the Muja series.

Oversight of the quality of Collie coal reaching industrial users is maintained through paid analyses done for some of these. There is a tendency for the ash content of such delivered coal to be higher than seam analyses would suggest. The digging of some shale with the coal is the probable explanation of this trend.

Miscellaneous.—In addition to the foregoing work in the proper sphere of fuel technology, work has been done on dust size analysis, gas chromatography and a certain amount on our normal refractory work, notably in the measurement of thermal conductivity of insulating materials. Work on expanded aggregates for concrete has been commenced as attempts to produce this material locally have not yet succeeded in making a true foamed, semi-vitrified material of high strength and porosity.

A conference on fluidisation was attended at Adelaide in the early part of the year and the visit was extended to Melbourne to maintain contact with the Forest Products Division of C.S.I.R.O. on sawdust utilisation and with Aeronautical Research Laboratories on oil fired burners as a high intensity burner is required for development of our work in flash drying.

A trend of the division to indulge in miscellaneous work, disconnected in character and often only remotely related to fuel technology has continued over the past year. This is regrettable as on the few occasions where the true function of a Fuel Technology organisation in the exercise of Fuel Technology applied to industrial economy has been undertaken, valuable work of economic significance has been invariably performed. The services of fuel technologists are extensively used elsewhere. In the United Kingdom there is a National Fuel Economy Service whose function it is to save on and reduce industrial fuel costs. In the industrial development of this State the availability and use of such a service is vital to development competitively with industry elsewhere. If our work in this is allowed to fall into desuetude and a group of chemists is not trained and maintained in the necessary practice of fuel technology the loss will be great in the future as indeed it is in the present.

Table 15 shows the type and source of samples received in 1961.

TABLE 15

| | Departmental | Public Pay | Public Works Department | Other Government Departments | Total |
|---|---|---|---|---|---|
| Boiler trials | 29 | .... | 11 | .... | 40 |
| Fuel— | | | | | |
| Coal | 7 | 62 | .... | 3 | 72 |
| Various | .... | 5 | 2 | 4 | 11 |
| Miscellaneous | 3 | 11 | .... | 2 | 16 |
| | 39 | 78 | 13 | 9 | 139 |

*Coal Sampling and Analysis.*

Particular attention has been given to new seams uncovered in the development of the Muja Open Cut above the 40 foot Hebe seam. In addition to Galatea which has been worked for some years the Flora and Eos seams are now exposed. Diana, Ceres, Bellona and Aete remain to be exposed as the cut is stripped back towards the new Muja Power Station site. The analyses of the coal maintain the same quality and characteristics shown in drilling exploration and common to all coals found in the South-Eastern corner of the field. Analyses are shown in Table 16.

TABLE 16
Fuel Laboratory Survey Samples

| Origin of Sample— Seam | Eos | Flora | Galatea | *Hebe |
|---|---|---|---|---|
| Locality | Muja open cut | Muja open cut | Muja open cut | Hebe deep mine |
| Laboratory No. : 1961 | 7924 | 9051 | 7925 | 9049, 9050 |
| Proximate Analysis— | Per cent. | Per cent. | Per cent. | Per cent. |
| Moisture | 28·6 | 26·4 | 28·1 | 29·9 |
| Ash | 3·2 | 4·5 | 1·6 | 2·6 |
| Volatile matter | 28·3 | 23·5 | 27·4 | 25·7 |
| Fixed carbon | 39·9 | 45·6 | 42·9 | 41·8 |
| | 100·0 | 100·0 | 100·0 | 100·0 |
| | B.t.u. per lb. | B.t.u. per lb. | B.t.u. per lb. | B.t.u. per lb. |
| Calorific Value | 8840 | 8810 | 8930 | 8720 |
| Ash Fusion Point— | degrees C. | degrees C. | degrees C. | degrees C. |
| Softening | above 1400 | above 1400 | above 1400 | 1340 |
| Blobbing | .... | .... | .... | 1360 |
| Fluid | .... | .... | .... | 1380 |

* Mean of two samples.

Average analysis of Collie coal samples submitted by private industries:—

| | Per cent. |
|---|---|
| Moisture | 25.9 |
| Ash | 5.8 |
| | B.t.u. per lb. |
| Calorific value | 8740 |

Coal from Eneabba No. 1 oil exploration drill hole struck in a 100 foot seam at 6,000 feet proved of great interest as the first coking coal found in Western Australia. It has a good gas and tar yield and the English National Coal Board classification would be 702—weakly coking or 622 under the International Classification system. Its gas and tar yield show that it would be a good gas making coal. It would also, probably, be suitable for Lurgi gasification as it is similar to weakly coking coals which are used for this purpose in Scotland.

To us its main interest is its probable suitability for the manufacture of formed coke by hot briquetting techniques. There is a present day trend to this way of making metallurgical coke and away from the accepted coke oven technique. For the production of formed coke, definite, but otherwise weak coking properties are desirable. Collie coal with no revealed coking property is unsuitable; many accepted Eastern States coals have too pronounced a coking behaviour. The intermediate behaviour of this Eneabba coal seems however to be favourable. If it were proved at workable depth a concentration of research on the production of formed coke from it would call for immediate research and plant development work requiring the full resources of the research capacity formerly used on the production of coked briquettes from Collie coal.

A drawback of the samples of Eneabba coal received is high ash content but washing analyses show that a coal of 10 per cent. ash content can be produced in 60 per cent. yield of the raw coal and the residue will average less than 30 per cent. ash content and could be used in power stations.

Analysis of Eneabba coal samples is given in Table 17.

Table 17.

Analysis of Eneabba Coal.

| | As received | Dry ash-free |
|---|---|---|
| Proximate analysis— | Per cent. | Per cent. |
| Moisture | 3·7 | .... |
| Ash | 14·6 | .... |
| Volatile matter | 34·9 | 42·7 |
| Fixed carbon | 46·8 | .... |
| | 100·0 | |
| Ultimate analysis— | | |
| Carbon | 65·1 | 79·7 |
| Hydrogen | 4·8 | 5·9 |
| Sulphur | 1·1 | .... |
| | B.t.u. per lb. | B.t.u. per lb. |
| Calorific value | 12,010 | 14,700 |
| Crucible swelling test | Coke button | size 3½–4 |
| Gray-King carbonisation assay— | | |
| Assay temperature | 600°C. | 900°C. |
| | per 100 gm. | per 100 gm. |
| Coke | 69·0 gm. | 69·8 gm. |
| Tar | 15·4 gm. | 3·9 gm. |
| Liquor, below 105°C. | 3·7 gm. | 3·7 gm. |
| Liquor, above 105°C. | 5·2 gm. | 5·7 gm. |
| Gas | 7,350 ml. | 25,810 ml. |
| Gas analysis— | Per cent. | Per cent. |
| Carbon dioxide, $CO_2$ | 7·4 | 4·0 |
| Unsaturated hydrocarbon, CnHm | 4·9 | 6·4 |
| Hydrogen, $H_2$ | 19·7 | 44·3 |
| Carbon monoxide, CO | 10·6 | 8·5 |
| Ethane, $C_2H_6$ | 15·7 | 1·5 |
| Methane, $CH_4$ | 39·6 | 28·7 |
| Nitrogen, $N_2$ | 2·1 | 6·6 |

Typical Washing Analysis

| Specific gravity of fraction | Weight of fraction | Moisture in fraction | Ash content of fraction |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Below 1·3 | 16·7 | 5·1 | 6·5 |
| 1·3 —1·35 | 45·2 | 4·5 | 11·3 |
| 1·35—1·40 | 31·3 | 4·0 | 16·5 |
| 1·40—1·45 | 5·5 | 3·4 | 22·5 |
| 1·45—1·50 | 1·3 | 2·6 | 32·6 |
| | 100·0 | 4·4 | 13·0 |

It is concluded that beneficiation could be effected at 1.35 sp. gr. to give (a) a 60 per cent. yield of coal of about 10 per cent. ash and (b) a higher ash fraction suitable for power generation.

*Wood and Oil Fired Boilers.*

Hosko Boilers—Colonial Type.—Two wood fired Hosko Colonial type boilers have been tested at separate institutions. The boiler is an under fired shell type boiler with return tubes. The performance and efficiencies are given in Table 18. The interesting fact which appears from the tests is that the flue gases leave the boiler at the high temperatures of 360° C. and 292° C. Looking back on earlier results on similar type boilers similar high exit temperatures were found. The boilers run on natural draft and the figures therefore suggest that a change to induced draught and the fitting of economisers to gain an additional 5 per cent. or more in efficiency should be considered. The boiler is a compact one which can be produced at competitive cost; it is claimed by the manufacturers at less than the cost of Cornish boilers. Consideration should be given to it as a work horse type of boiler which, at the low wood fuel costs which we can hold in the State, could become confirmed as a standard small factory and institution boiler. It has held this position in the past though it has latterly been displaced by oil fired boilers. At a later point in this section the claims of oil firing are somewhat discounted and no doubt could be reduced still more if consideration were given to the use of hogged chips fed by underfired stokers.

Table 18.

Boiler Tests.

| Boiler | Evaporation | Efficiency | Exit Temp. |
|---|---|---|---|
| | lb./hr. f&a. | Per cent. | °C. |
| Mt. Henry | 4,000—5,000 | 56·0 | 360 |
| Sunset | 2,400—3,300 | 59·6 | 292 |

Cornish Boiler.—A somewhat unexpected result was the comparatively high efficiency of an old Cornish boiler tested. The working figure returned was close to 65 per cent. The evaporation averaged 4,300 lbs. per hour from and at 212° F. and on peak loads exceeded 5,000 lbs. per hour f & a. The flue gas temperatures were comparatively low at 240° C. The high efficiency was attributed to the fact that the single furnace tube of a Cornish boiler can be packed full of wood to give good combustion conditions. The firetube was further crossed by no less than five Galloway tubes which gave improved heat transfer.

Oil Fired Boiler.—The Cornish boiler was to be shut down and its load taken by two automatic oil fired boilers which we tested as running at 80.2 per cent. efficiency. Comparative steam raising costs based on cost records kept at the institution show that the change to oil firing had increased steam raising costs. Compared with log wood firing the cost of oil firing was about £5,000 greater per annum, an increase of more than 30 per cent.

Associated with the use of oil was an air pollution problem occasioned by the high sulphur content of flue gases and the low discharge height of the boiler stacks. Limitations are placed on the discharge of these boilers' stacks by the sulphur content. If the stack is carried to any useful height, cooling of gases could cause condensation of sulphuric acid in the stack and anticipated rapid corrosion.

The results of our brief survey of these institution boilers suggest strongly that further substitution of oil fired for wood fired boilers is inadvisable and that capital which can be expended in this direction should be used to modernise existing wood fired boilers and to improve the efficiency of such existing boilers.

Relative Costs of Wood and of Oil Firing.—Figures are available for the cost of operating the oil fired boilers without any auxiliary use of the wood fired boiler over the period 1/7/60-31/3/61. From these figures and the records of oil and steam consumptions over the period, annual costs of using all oil fuel or all wood fuel may be derived which show that the oil fired boilers have increased the cost of steam raising by £4,400-£5,600 per annum on the basis of wood purchased at 50s. to 40s. per ton and by nearly £10,000 per annum on the basis of the former supply of sawdust obtained at cost of cartage only. The present cost of steam raising from the oil fired boilers is taken as £19,046 per annum for an annual steam consumption of 23,918,000 lb. or 15s. 11d. per 1,000 lb.

| *Fuel used*— | *Oil* | *Wood* | |
|---|---|---|---|
| Weight per annum—tons | 732 | 2,390 | |
| Cost per ton | 264·5/- | 40/- | 50/- |
| | £ | £ | £ |
| Total fuel cost | 9,677 | 4,780 | 5,974 |
| Labour and overhead | 8,755 | 8,257 | 8,257 |
| Electric power and gas | 614 | negligible * | |
| Steam for steam pump | *Nil* | 339 | 370 |
| Total operating cost † | 19,046 | 13,376 | 14,601 |
| Operating cost per 10,000 lb. of steam | 0·797 | 0·559 | 0·611 |
| | Per cent. | Per cent. | Per cent. |
| Boiler efficiency | 80 | 65 | 65 |

Total operating costs 1958–1959 when using sawdust at a cartage charge of £600 per annum was £9,060.

* Electricity used for lighting only.

† Includes costs of water treatment.

Sawdust Fired Boilers.—The following is a report of an efficiency test on an International Combustion, spreader stoker fired boiler, using sawdust as fuel. The installation of this boiler followed work done by us in 1954 on steam survey and fuel

consumption. The new boiler saves an estimated £20,000 per annum and provides a greater and steadier steam supply than the wood fired boilers it replaced.

Summary.—A test was conducted on 7/12/61 and the steam raising efficiency of the boiler was estimated as 64.5 per cent. The boiler generated steam at an average rate of 16,650 lb. per hour and peak demands exceeded a rate of 20,000 lb. per hour (the chart maximum), at an average pressure of 133 p.s.i.g. The boiler was designed for a normal rating of 10,000 lb. per hour and a maximum calculated rating of 12,000 lb. per hour, both at 160 p.s.i.g. Obviously the boiler is operating well beyond its designed capacity and therefore the efficiency is probably acceptable although it is less than the designed 69 per cent.

General Details.—The boiler is an International Combustion Ltd. design with water tube walls and fitted with automatic controls for firing sawdust and auxiliary oil firing if required. The heat transfer surface is 3,420 sq. ft. and the grate area is 63 sq. ft. The combusion space is 1,208 c. ft. The fuel is fired by spreader stokers. The flue gas is exhausted through a multiclone dust collector and the smuts are returned to the combustion chamber. Feed water is pumped to the boiler by steam pumps.

Boiler Capacity.—The normal capacity of 10,000 lb. at 160 p.s.i.g. is equivalent to a steam production of 3.5 lb. of steam f & a 212°F per sq. ft. of heat transfer surface per hour. This is not a high rate and theoretically and practically the boiler is capable of a rate of 5 lb. of steam f & a 212°F per sq. ft. per hour, equivalent to over 15,000 lb. of steam per hour at the operating conditions of the boiler. This would require a fuel consumption rate of about 66 lb. of sawdust (30% moisture content) per sq. ft. of grate area per hour; 20,000 lb. of steam per hour would require a fuel combustion rate of 88 lb. of sawdust per sq. ft. per hour. These are possible combustion rates for boilers firing sawdust with forced draught.

During the trial the boiler carried the whole load and produced steam at an average rate of 16,650 lb. of steam per hour at 133 p.s.i.g. from feed water at 164°F. This is an evaporation rate of 5.3 lb. of f & a steam per sq. ft. of heating surface per hour. Peak demands exceeded a rate of 20,000 lb. per hour (7.0 lb. per sq. ft. per hour) and the boiler was able to meet these demands comfortably. The fuel at 18 per cent. moisture was drier than the normal figure of 30-40 per cent. for green sawdust and this may have materially improved the performance of the boiler. At maximum rates of firing the heat release was 27,000 B.t.u. per c. ft. of combustion space per hour.

Fuel.—A batch of sawdust was specially weighed and stored for the test. 13,910 lb. of sawdust was burned in 3 hours 40 min. equivalent to a combustion rate of 60 lb. of sawdust per square foot of grate area per hour. This is not a high rate for a forced draught boiler. The moisture content of the fuel was 18 per cent.

Flue Gas.—The flue gas passes through a multiclone dust collector before going to the stack. The temperature of the flue gas was measured after the multiclone and the volume of the flue gas was calculated from its average carbon dioxide content (13.6 per cent.) and the weight of fuel. When the boiler was meeting peak demands the stack was emitting medium black smoke and analysis of flue gas showed the presence of carbon monoxide. This is a source of heat loss probably occasioned by operating the boiler beyond its designed capacity. The carbon dioxide content in the flue gas varied between 10 per cent. and 17.3 per cent. with a mean of 13.6 per cent. and this indicates that generally combustion is satisfactory.

The flue gas temperature was fairly steady during the test and the mean value was 318°C. The pyrometer installed in the duct was indicating an estimated 15°C low and probably required recalibration.

There would seem to be good reason for investigating the possibility of recovering some of the heat at present being discharged via the flue gas. The installation of an economiser could reduce the flue gas temperature by 100°C and the heat so saved would amount to about $1.5 \times 10^6$ B.t.u. per hour. This is equivalent to about 4 cwt. per hour of sawdust containing 25 per cent. moisture being burned at an efficiency of 65 per cent. and would add about 5 per cent. to the efficiency of the boiler. Such an economy would seem to be worthwhile (especially when the new boiler is installed) but must be weighed against the cost of an economiser with a heat transfer surface of about 1,800 sq. ft.

An alternative suggestion is to preheat the combustion air to improve fire conditions.

Details of Test—7/12/61.—The heat balance detailed in Table 19 shows a gross steam raising efficiency of 64.5 per cent. The total loss of heat in the flue gas was estimated as almost 25 per cent. and for wetter sawdust this figure would increase and the efficiency of the boiler may decrease. The radiation loss has been calculated as a nominal five per cent. of the heat in the fuel and this may be a low estimate because the flue gas temperature was obtained beyond the multiclone and there must be some unmeasured radiation loss associated with that unit. The total of the inaccuracies associated with the trial is measured in the "unaccounted" item in the heat balance, amounting to 5.6 per cent. of the heat in the fuel. This amount includes the errors referred to above, e.g.—

(i) loss of heat as carbon monoxide in the flue gas;

(ii) unmeasured radiation loss;

(iii) errors in estimation of quantity of fuel burned.

In view of the results of the test it is not considered that the "unaccounted" item represents any serious inaccuracies in the boiler efficiency trial.

Table 19.

| | B.t.u. | Per cent. |
|---|---|---|
| Heat In— | | |
| Fuel | 100,373,000 | 100·0 |
| Heat Out— | | |
| Steam | 64,760,000 | 64·5 |
| Flue Gas : | | |
| Sensible heat | 16,375,000 | 16·3 |
| Latent heat | 8,670,000 | 8·6 |
| Radiation | 5,019,000 | 5·0 |
| Unaccounted | 5,549,000 | 5·6 |
| | 100,373,000 | 100·0 |

*Sub-Sieve Particle Size Analysis.*

Size analysis of dusts and finely ground materials in the size range 50 to 5 microns is on occasions called for especially in our work on cyclones and and other dust catching devices. It is not generally known that our work in this latter connection seems in advance of anything similar reported from elsewhere in Australia and, especially, for cyclones, we have made available to consultants and industry exact cyclone designs to give maximum performance for minimum size and back pressure loss. Unfortunately our connection in this regard with the sawmilling industry which has a standard dust arrestment problem is not as close as it could be. We have it on schedule to install cyclones and other dust catchers in conjunction with the Engineering Chemistry Division to exemplify to industry what can be achieved in this matter. Unfortunately the development is held up for lack of time and manpower in both our Divisions but progress should be achieved during 1962.

In the actual matter of sub-sieve analysis we have attained by two methods commercially satisfactory analyses although the results achieved have not reached full research accuracy. In one application we were able to reassure a chocolate manufacturer that his raw materials were being ground sufficiently finely for his purposes. Such analytical applications are perhaps far removed from fuel technology work but exemplify how widely spread our work has to be to meet the demands of industry.

*Atmospheric Pollution.*

Dust size analysis as well as smoke prevention brings us in contact with moves to control atmospheric pollution in the State. It is felt, however, that because of the dispersal of industry in the State, because of the generally free ventilation of a capital, which meteorologically has the highest Australian wind movement, and because of the relatively low incidence of atmospheric inversions that atmospheric pollution is unlikely to be a general problem although local occurrences may have to be policed and solved. A further point is that the fuels we use, wood, low volatile coal and oil do not cause much smoke nuisance although high sulphur content residual fuel oil may cause local sulphur oxide nuisance of a not easily resolvable nature.

*Gas Chromatography.*

A vapour gas chromatograph of relatively simple nature is in use and is being developed by addition of new thermostatted columns. Thermistor detectors have been substituted for the original katharometers and the change has made the apparatus more satisfactory. At the present time there is no great call for this method of analysis and only one commercial sample was analysed on it during the year. Purchase of a more modern, package apparatus or additional components of the same nature is not at the present time justified. It is felt too that commercial apparatus is still in the stages of development to simpler and lower priced units which, if regular routine work is called for, could be purchased for use in specific applications as a routine, bench analytical tool.

*Refractories, Insulating Materials and Expanded Aggregates.*

Our normal intermittent work in the refractory field has been extended to cover the development of expanded aggregate. This has been developed by C.S.I.R.O. for Eastern States users. Work in this State on our own clays is therefore desirable. An expanded aggregate is essentially a clay or shale which is bloated by internal gas evolution during a particular stage of its vitrification by heat. The resultant product is a pumice like material, full of small closed pores of sufficient strength for use as an aggregate in concrete but of low density. Densities one third that of stone aggregates are attainable so that it is possible to produce concrete beams and members comparable in weight with that of dense timber. The development is therefore important in modern structural and architectural engineering and one which should increase with the improvement in quality and quantity of manufacture of the material.

So far the only material produced commercially locally is a rather weak clinker, a chance sample of which has been examined. Application of our ordinary refractory methods of examination suggest strongly that manufacture is on the wrong lines at present and that mixtures used have too high a vitrification temperature to be suitable. In fact one raw material examined appeared to be a silliceous clay of the highest refractory quality, better in this regard than any other refractory raw material previously examined in the many years in which we have been engaged on examination of refractories.

Our work is to be developed to find a suitable low temperature vitrifying clay or developing one as an artifact into which we can introduce bloating agents if these do not exist already in the clay. The work should not be difficult and could be productive of immediate results.

In the past we developed a simple method of measuring thermal conductivity of insulating refractories. The measurement is one normally calling for considerable elaboration of apparatus such as would not be justified in our establishment for the limited call for this particular measurement. Requests for thermal conductivity measurements on concretes made with expanded and with ordinary aggregates were met with this apparatus. The resultant figures agreed with figures quoted for such materials in the literature and, as well, showed that claims put out in an advertising pamphlet for some concretes were not completely accurate.

Thermal Conductivity of Concretes.

| Temperature °C. | Conductivity B.t.u./ft.,/sq. ft./°F./hr. Light Aggregate | (Heavy Aggregate) |
|---|---|---|
| 300 | 0.245 | 0.365 |
| 400 | 0.265 | 0.385 |
| 500 | 0.290 | 0.410 |
| 600 | 0.320 | 0.440 |
| 700 | 0.345 | 0.465 |
| 800 | 0.385 | 0.495 |
| 900 | 0.415 | 0.510 |

*Papers Read to Learned Societies.*

Only one paper was read during the year, to the West Australian Branch of the Institute of Fuel, in conjunction with the Deputy Government Agricultural Chemist, on Boiler Water Treatment. The paper discussed internal and external treatment and corrosion inhibitors in steam and condensates. Its purpose was to set out for the benefit of boiler engineers and others the various methods of treatment now available. Attention was called to the low relative cost of base exchange treatment of water supplies in Perth and the probable greater satisfaction of treatment by this method.

*Consultations, Etc.*

A normal number of visits and requests for advice were received ranging from gas analysis of fruit storage atmospheres to use of wood spirit for boiler firing. Enquiries about oil analyses and solar heaters are amongst the commonest received. The most elementary, what is a B.t.u.

## INDUSTRIAL CHEMISTRY DIVISION.

The work done in the Division has followed the lines of previous years, i.e. consultative service for Government Departments, industry, and the public, short term investigations into the feasibility of new processes and the manufacture of new products, and the testing of a wide variety of materials, but mainly related to the construction industries.

The consultation service continues to be used, particularly by smaller industries. The wide scope of the enquiries requires a correspondingly wide knowledge of general and applied chemistry.

An investigation was conducted into a new process, the treatment by solvent extraction of abattoir's offal and trash fish, and into the various aspects of solvent recovery, filtration, and removal of residual solvent from the solid product. Investigations continued on the shrinkage of concrete and the use of cement additives.

Testing of materials such as floor tiles, paints, and protective coatings, continued. This aspect of the work of the Division is assuming increasing importance owing to the tendency to specify materials more rigidly, either by a performance or an ingredient specification. Attention has been given to the acquisition of specialised equipment for this purpose. The facility, scope, and accuracy of the analytical work of the Division has been increased by the Laboratories' purchase of a double beam infrared spectrometer, which has been of inestimable value in the positive identification and estimation of materials, particularly in the paint and plastic fields.

The use of plastics in W.A. continues to increase both in quantity and scope, reflecting worldwide trends. The tendency to relegate plastic articles to copies or cheap imitations is fast diminishing as it is recognised that these materials can not only out-perform conventional materials in many fields, but can also be used in applications where other materials are unsuitable. The quality of many plastic articles is increasing as manufacturers become aware of the necessity of choosing the correct raw material for each article, depending on its use. New plastic raw materials—polypropylene, polycarbonate, and polyoxymethylene will further increase the utility and use of plastics.

TABLE 20.

Industrial Chemistry Division 1961.

| | Departmental | Department Industrial Development | Main Roads Department | Public Works Department | Public Pay | Other Government Departments | Total |
|---|---|---|---|---|---|---|---|
| Assistance to Industry | .... | 5 | .... | .... | 21 | .... | 26 |
| Building Materials— | | | | | | | |
| Cement and Concrete | .... | .... | .... | 6 | .... | .... | 6 |
| Fibrolite | .... | .... | .... | 12 | .... | .... | 12 |
| Floor Covering | .... | .... | .... | 7 | 3 | .... | 10 |
| Paint | .... | 3 | 12 | 18 | 2 | .... | 35 |
| Various | 7 | .... | 1 | 51 | 2 | .... | 61 |
| Goldfields Water Supply Pipeline | .... | .... | .... | 23 | .... | .... | 23 |
| Miscellaneous | 2 | 1 | 4 | 4 | 1 | 13 | 25 |
| Total | 9 | 9 | 17 | 121 | 29 | 13 | 198 |

The rapid development in plastic technology has necessitated constant literature reviews to keep abreast of these advances. Technical literature from the main supply houses has been of great value in this regard. The quantity of work on plastics as indicated by the number of samples examined, is small. A high percentage of the technical enquiries received, however, relate to the use (or abuse) of plastics.

Plastic industries in W.A. are still of the processing type, i.e. manufacture of articles from imported raw materials. Manufacture of raw materials in W.A. may not be long delayed because of the large industrial expansion which is occurring, and the increasing use of plastics. In this regard plastics will probably find more structural use in buildings e.g. polyurethane, phenolic, or polystyrene foam filled sandwich panels, as well as their present use as "trim".

The number of samples received during the year totalled 198 which is more than double the number received in 1960. The samples are itemised in Table 20.

*Plastics.*

At the request of the Government Printer, an investigation was made into the use of polyurethane printers' rollers. After a small roller made in laboratory scale equipment performed satisfactorily, larger batches were successfully made using a glass lined kettle in the Unit Process Pilot Plant. Some of these rollers had blemishes such as air bubbles, and poor adhesion to the stock, but were sufficiently encouraging to warrant manufacture. The work was transferred to the Printing Works, and after some initial difficulties high quality rollers have been made. Most of the machines at the Printing Works are now equipped with polyurethane rollers. Their use has allowed a higher production rate than was possible with composition rollers, and they are unaffected by temperature or humidity. The cost of the new rollers compares favourably with composition rollers, but their manufacture is more critical.

Polyurethane foam is being made by some manufacturers in W.A., mainly for insulation and buoyancy. One producer using a "home made" machine was assisted in the early stages of his production, but the machine was not entirely successful.

A plastic for use in hardware incorporated in additions to Parliament House was identified by infra red spectroscopy as an ABS copolymer (copolymer of acrylonitrite, butadiene, and styrene). Further samples of tiles were examined for a Government Department. As discussed later, the question of abrasion resistance of flooring materials received attention.

*Paints.*

The large number of enquiries received concerning the most effective coating system for metals subject to a variety of conditions, suggests that the formulation of a system for choosing a protective coating, is becoming essential. An evaluation of the effectiveness of many new materials becoming available compared to conventional materials, is overdue.

The use of a vinyl paint to an American specification for coating of stop logs in the Camballin Rice Project involved considerable work in testing of ingredients and manufactured paints for compliance with specification. A similar type of vinyl paint to be used for painting radial gates of the Ord River Dam has also been tested, and some work was done with airless spray equipment in a specially made spray booth simulating hot weather conditions, using solvents with a low evaporation rate. It was concluded that special thinners were not essential, although their use allowed a greater film thickness per coat.

Red lead paints to be used on machinery for the Ord River Dam were also tested. Some were found to have a viscosity outside the specified limit and were rejected on this account. The structural steelwork of the Causeway was repainted during the year, and paints and ingredients from the paint manufacturer and "from the job" were examined for compliance with the specifications.

The use of lead pigments in pole signs was found to be the cause of a darkening in the colour of the sign after a short term exposure.

Several types of zinc-rich paints are at present undergoing exposure tests. Paints of this type contain 90 to 95 per cent. zinc dust in the dried film, but their sphere of use is determined by the binder used. Zinc rich paints are becoming increasingly popular because of the positive protection afforded against corrosion, and their less stringent surface preparation requirements.

A paint manufacturer was assisted in a thinner formulation by the use of infra red spectroscopy and a gas chromatograph in the Fuel Technology Division.

The painting system on a wooden handrail of a bridge built in a country area was found not to comply with the painting system specified. As a result the contractor was required to remove the applied paint, and paint the handrail according to specification.

At the request of the Department of Industrial Development, three samples of paint based on coal tar were examined for suitability for use in W.A., and the prospects of manufacture in W.A. were outlined.

An exposure test on painted quarter sawn karri timber continued. After two years exposure, painting systems with a primer containing aluminium and micaceous iron oxide pigments in a linseed oil vehicle have shown excellent performance. Under certain conditions, therefore, karri can now be painted successfully. Work on other aspects of the problem, e.g., the use of backsawn timber, remains outstanding.

A "Dustbin" weatherometer, for testing the performance of materials when subjected to ultraviolet light, was put into service during the year.

Because of the increasing interest in assessing the performance of paints, plastics, and building materials generally, consideration has been given to the purchase of specialised equipment, and in particular physical testing equipment. The selection of suitable equipment is made difficult by the non-uniformity of testing equipment for testing the same property on different types of materials. The American Society for Testing Materials, for



(12)—57785

instance, specifies the use of thirteen different machines for testing resistance to abrasion, a property of vital interest in testing competitive materials, particularly flooring materials.

A member of the Division went to Onslow during the year to inspect cyclone damage to the buildings at a Native Mission. The buildings were sheathed in galvanised iron, and showed "white rust," and the surface was sandblasted. Recommendations were made on a suitable cleaning treatment and protective coating. The severity of the conditions in such areas suggests that only first quality materials should be used.

*Solvent Extraction of Meat, Fish and Offal.*

At the request of the Department of Industrial Development, this division undertook a programme of research on behalf of Cavanagh's Solvent Processes Pty. Ltd. This firm is a private company formed to develop a process invented and patented by Mr. J. C. Cavanagh. The process applies to the treatment of animal offals and trash fish, or any material containing oils or fats and water by countercurrent solvent extraction with acetone. The fat (or oil) and water are removed from a raw material high in fat and moisture to yield (a) a solid product relatively free from fat and moisture and (b) an acetone-water-fat mixture from which the fat and water soluble materials are recovered after removal and recovery of the acetone.

The original field of work, comprising the clarification of the extraction unit liquors, the fractional distillation of the same, and the removal of residual solvent from the solid products was later extended to cover the preparation of concentrated solubles and the issue of Certificates of Supervision with regard to the yields obtained from the process.

Because of the high (10%) solids content and the high vapour pressure of the liquor at operating temperatures, batchwise pressure filtration and continuous vacuum filtration are impracticable. The most suitable clarification method applied was a combination of decantation and centrifugal filtering of the settled solids. A perforated steel centrifuge basket one foot in diameter running at 2,000 rev/min. had a capacity of 0.75 gallons per minute per square foot.

Study of the distillation and solvent recovery section has shown that to produce a 99% acetone distillate from a feed containing 65% by weight of acetone (a typical figure for extraction unit liquor) a packed fractionating column of height equivalent to 8 theoretical plates operated batchwise with an initial reflux ratio of 0.95, and increased to 2.0 as the still liquid becomes stripped of its more volatile component, will give 97.2% recovery at 99% purity and leave 2.8% of the total acetone in the still residue. This 2.8% may be distilled out without fractionation to give a small quantity of liquid of approximately 62% acetone which may be included in the feed of a subsequent batch. The heat required to recover the acetone is slightly less than the heat required to remove by evaporation the water from a corresponding amount of raw material. A fractionating column designed from the above data is operating satisfactorily on a pilot plant scale.

Experimental work on the removal of residual solvent from the solid material showed that the extraction unit left 0.15 gallons of acetone in each pound (on a solvent free basis) of solid product, and that the application of heat quickly removed this residual solvent. It is essential that the acetone vapour be swept from the void spaces, because acetone vapour, having a density twice that of air tends to remain in the void spaces and be re-absorbed by the material as it cools.

The aqueous layer which separates below the fat after the acetone has been removed contains water soluble extractives, which if the process has been applied to wholesome, hygienic raw materials, are of value in the meat extract field. Concentrated extracts prepared by vacuum evaporation of the liquors from the processing of beef, fish and whales, were found to be both palatable and appetising in flavour and aroma.

Certificates of Supervision certifying as to the yields of the process when applied to beef bones and trash fish were issued. Calculations based on the registered analysis of commercial meatmeals and of the products from solvent extraction indicate that solvent extraction yields some 50% more tallow than the digestion process.

Feeding tests on the solid material conducted by the Poultry Branch, Department of Agriculture showed that cockerels fed on solvent extracted beef bone protein meal gained 7 per cent. more weight than a control group, and that a group fed on solvent extracted fish meal gained 30 per cent. more weight than control.

*Cement.*

Shrinkage.—An investigation into the shrinkage of cement blocks showed that shrinkage is associated with water loss, and that test strips with a low water:cement ratio shrink less than those with a high water:cement ratio. Flow table tests on cements mixed with and without additives showed that the use of additives permitted the reduction of the water:cement ratio without loss of plasticity. Tests at present in progress are expected to confirm that the use of additives reduces the shrinkage by permitting a lower water:cement ratio to be used without loss of workability.

Additives.—Six samples of cement additives for use in the Ord River Dam Diversion Project were examined for lignosulphonic acid, and total and fermentable sugars.

A comparison of analytical methods for the determination of lignosulphonic acid was made, but few conclusions concerning the methods could be reached due to the lack of a reasonably pure salt of lignosulphonic acid. Efforts to prepare a pure salt are in progress.

Goldfields Water Supply Pipeline.—Some work was done for the Goldfields Water Supply in determining the composition of deposits on the internal surface of concrete lined pipe. The effect of various treatments, injected into the water supply, on the composition of the deposits was determined by periodic sampling. The object of the work was to modify the surface of the pipeline to reduce friction loss.

*Miscellaneous.*

Investigations were made into stains on plasterboard ceilings and walls. In one case the stain was identified as a sulphide stain caused by insufficient ventilation over a stove.

A sample of bentonite was examined for physical properties, comparison being made with a Wyoming bentonite.

A liquid effluent from a factory was examined and recommendations made to render it innocuous.

A literature survey was made to compare the efficiency of various types of zinc coatings on sheet steel.

The "blowing up" of a sealed plastic bag containing fertiliser was traced to the evolution of carbon dioxide produced by a reaction between the fertiliser and, presumably, a carbonate-containing filler.

Xanthates used in mineral dressing were identified and assayed.

An attempt was made to prepare a small quantity of benzyl adenine, which is an experimental material used for preserving fresh fruit. Some progress was made, but work ceased when the material became available commercially.

Concretions in sand, which were of a dark brown tubular material, were tentatively identified as termite deposits.

Investigations into the use of non slip floor additives of the silicon carbide type to cement floors, and the manufacture of a foamed inorganic material, were begun.

## MINERALOGY, MINERAL TECHNOLOGY AND GEO-CHEMISTRY DIVISION.

*General.*

The number of samples examined during the year (2653) was much the same as in 1960 (2563) but the distribution was different. The completion of the preliminary surveys of the Koolyanobbing and Mt. Goldsworthy iron deposits led to a pronounced reduction in the number of iron samples submitted (from 1010 in 1960 to 380 in 1961), and there was also a drop from 221 to 176 in the number of battery tailings submitted by the State Batteries for check gold assays.

Against these, there was an increase of almost 300 in the number of mineral identifications carried out, and also significant increases in tantalite, beryl and copper ores examined.

A dust sampling project initiated by Public Health Department resulted in the microscopic examination of 370 dust samples.

The main sources of samples were:—

| | |
|---|---|
| General public (free) | 1195 |
| General public (pay) | 546 |
| Public Health Department | 370 |
| State Batteries Branch | 238 |
| Geological Survey Branch | 170 |

Table 21 details the nature and source of all samples allotted to the Division.

During the year the Deputy Government Mineralogist visited the Dalgaranga field where intense prospecting activity had opened up new beryl, tantalite and columbite deposits, and where occurrences had been found of a number of interesting minerals including cassiterite, ilmenorutile, metamict columbite, topaz, microlite and simpsonite.

In October, Messrs. D. Burns and R. Morris flew to Marble Bar to examine mineral deposits, with particular reference to the occurrence of the new mineral hendersonite.

In both these field trips information and specimens of interest were obtained. It is hoped that the prospecting and mining communities visited also reaped some benefit.

In December, the Deputy Government Mineralogist acted as an assessor on behalf of the National Association of Testing Authorities in connection with an application by a Perth steel foundry for registration as an approved chemical testing laboratory.

No changes in staff occurred during the year. Preliminary enquiries have been received from overseas from well qualified men regarding opportunities within the Division and much useful additional work could be carried out if space were available and an establishment existed to allow the employment of a selection of such applicants.

*Mineral Collections.*

During 1961, 584 specimens were added to the Mineral Division Collection. Most of these (450) were selected from the Geological Survey of Western Australia collection by arrangement with the Government Geologist and in accordance with the policy of combining the two collections into one comprehensive collection housed under one roof.

In March agreement was reached with the Trustees of the W.A. Museum for the formal transfer of the Simpson Collection to these Laboratories and as a result much time has been spent in reorganising this collection. The collection had been classified according to what is now an obsolete Dana system and work is in hand reclassifying the specimens by the Hey system which will modernise the collection and bring its classification system into line with that of the Mineral Division Collection. Its housing, indexing and the accessibility of individual specimens have also been improved.

As the Museum possesses the largest collection of meteorites and tektites in the State it was agreed to transfer these items from the Simpson collection to the Museum. As a result, 94 australites, 24 meteorite fragments and five miscellaneous tektites were transferred.

Requests received from universities, schools, students and prospectors for collections of W.A. minerals have been met by the supply during the year of twelve sets each containing 10 to 30 specimens, in addition to a number of individual minerals required for research purposes.

These requests originated from overseas (U.S.A., Canada and Sweden) as well as from interstate and local organisations.

Four sets of W.A. minerals were prepared for display by the Tourist Development Authority in their Perth, Adelaide, Melbourne and Sydney branches.

*Building Materials.*

1. Cement and Concrete.—(a) Aggregates—Expansion measurements of mortar bars prepared from Ord River and Fitzroy River aggregates during 1960 were continued at monthly intervals until the test had run 12 months. A report was issued in August covering all the work carried out on these aggregates.

The expansion recorded for a range of mixes tested did not exceed 14 parts per 100,000 on Ord aggregate, or 7 parts per 100,000 on Fitzroy aggregate.

In the case of the Ord aggregate, the most reactive mix gave an expansion of 12 parts per 100,000 after six months, falling to 10 after 12 months, with the maximum of 14 at 8½ months.

Table 21.
MINERAL DIVISION 1961.

| | Public | | Government Geologist | State Batteries | Departmental | Public Health | Other State Government Departments | Total |
|---|---|---|---|---|---|---|---|---|
| | Pay | Free | | | | | | |
| Aggregates | 13 | .... | .... | .... | .... | .... | 18 | 31 |
| Burnt lime | 28 | .... | .... | 10 | .... | .... | 1 | 39 |
| Clays | 20 | 10 | 5 | .... | .... | .... | .... | 35 |
| Dusts | .... | .... | .... | .... | 2 | 370 | .... | 372 |
| Mineral Identifications | 52 | 593 | 24 | 3 | 28 | .... | 10 | 710 |
| Minerals and Ores— | | | | | | | | |
| Bauxite | 8 | 6 | 3 | .... | .... | .... | 3 | 20 |
| Beryl | 49 | 14 | .... | .... | 7 | .... | .... | 70 |
| Copper | 46 | 103 | .... | .... | .... | .... | .... | 149 |
| Gold, ores | 38 | 175 | 6 | .... | .... | .... | 7 | 226 |
| Gold, tailings | .... | .... | .... | 176 | .... | .... | .... | 176 |
| Gold, umpires | .... | .... | .... | 34 | .... | .... | .... | 34 |
| Heavy Sands | 7 | 19 | .... | .... | .... | .... | .... | 26 |
| Iron | 99 | 162 | 119 | .... | .... | .... | .... | 380 |
| Limestone | 4 | 11 | 8 | .... | 4 | .... | .... | 27 |
| Lithium | 11 | 8 | .... | .... | .... | .... | .... | 19 |
| Manganese | 4 | 8 | .... | .... | 15 | .... | 2 | 29 |
| Tantalite | 67 | 22 | 1 | .... | 3 | .... | .... | 93 |
| Tin | 24 | 17 | .... | .... | .... | .... | .... | 41 |
| Titanium | 12 | 15 | .... | .... | 23 | .... | .... | 50 |
| Vanadium | 9 | 18 | .... | .... | .... | .... | .... | 27 |
| Miscellaneous | 58 | 14 | 4 | 15 | 6 | .... | 11 | 108 |
| | 549 | 1,195 | 170 | 238 | 88 | 370 | 52 | 2,662 |

Fitzroy aggregate behaved somewhat similarly in that at 6 months the expansion was 4 parts per 100,000, being virtually the same after 12 months with a maximum of 7 at 8½ months.

It seems generally accepted in the published literature that concrete expansion is not harmful below a figure of 50 parts per 100,000 after 6 months or 100 parts per 100,000 after 12 months.

The cement used in the tests contained 0.35 per cent. $Na_2O$ and 0.47 per cent. $K_2O$ and therefore had a total alkalinity equivalent to 0.66 per cent. expressed as sodium oxide. It is apparent then that the aggregates tested would not react with cement of this alkalinity to produce complexes causing concrete expansion of dangerous magnitude.

Detailed examinations were made on a number of aggregates at the request of both Public Works Department and private contractors.

Four samples from the Hall's Creek area were examined for Public Works Department. They consisted of three coarse sands and one fine and all met specification requirements except one of the coarse samples. This sand was composed of quartz fragments, weathered feldspar and hornblende together with many coarse concretions of limonite containing fine siliceous material. The potential reactivity of such aggregate would be due mainly to this last ingredient.

A sample of crushed stone from Broome was also reactive due to a proportion of chalcedony that was cementing the main quartz grains.

Two non-reactive aggregates came from Carnarvon and Kalgoorlie. The Carnarvon sample was mainly calcite and quartz with a little limonite, while the Kalgoorlie sample consisted of chips from rock composed of ankerite, albite, quartz, sericite, chlorite and biotite, with small amounts of ilmenite, leucoxene and a non-reactive pyrite.

(b) Hardened Cement Products.—Only seven samples of this nature were examined, one for Forests Department and six for a building firm. All were of cement-lime mortar and an indication of the original cement-lime-sand ratios was required. None of the original raw materials was available and results obtained were therefore subject to the usual reservations which apply in these circumstances.

2.—Pozzolans.—Examinations were carried out at the request of Public Works Department on five potential pozzolans from East Kimberley and the Darling Ranges.

The samples from the Darling Ranges were commonly used ceramic clays, the main clay minerals present being kaolinite and illite with one of the samples containing in addition about 10 per cent. montmorillonite.

Analyses of the three clays showed them to meet the chemical requirements laid down in A.S.T.M. Tentative Specifications for natural pozzolans for use as admixtures in portland cement concrete. These requirements are for at least 70 per cent. ($SiO_2 + Al_2O_3 + Fe_2O_3$) with magnesia not greater than 5 per cent., sulphur trioxide not greater than 3 per cent. and loss on ignition not in excess of 10 per cent.

Two East Kimberley samples were examined, one a black soil, the other a red soil. Of the black soil, over 80 per cent. was made up of the clay minerals kaolinite, illite and montmorillonite with the latter predominating (it represented about 40 per cent. of the clay fraction); the red soil contained about 40 per cent. of clay which was predominantly clay mica with some kaolinite. These soils also met the analytical requirements quoted above.

Chemical composition alone is not sufficient to assess the pozzolanic activity of a sample and many investigators have attempted to relate this activity to the amount of material soluble in some medium. The U.S. Bureau of Reclamation adopted such a test in assessing the suitability of calcined shales for use in the Davis Dam, the test involving the measurement of the reduction in alkalinity of a normal solution of sodium hydroxide due to reaction with the finely ground potential pozzolan. The test claims to be indicative of the ability of the material to counteract expansion resulting from alkali-aggregate reaction rather than a measure of general pozzolanic activity.

Of the five materials from the Public Works Department subjected to the above test, the Kimberley black soil and one of the Darling Range clays met requirements of the U.S. Specification, one clay was borderline, and the remaining two samples gave figures considerably below the minimum required.

The pozzolanic properties of some materials are enhanced by calcination and fine grinding. All samples were therefore calcined at 700°C., ground to about 97 per cent. minus 200 mesh and re-tested. With the exception of the red Kimberley soil, they all now gave reduction in alkalinity figures in excess of the minimum laid down.

Calcined and ground samples were prepared for further testing by the Public Works Department.

3.—Lime.—Twenty-one samples of burnt lime were submitted by the public for determination of free lime content. The samples were from both producers and buyers, submitted mainly because of discrepancies in the respective works assays. It appears that the help given both parties by officers of this Division regarding sampling and assaying techniques has not borne fruit.

Two commercial hydrated limes were examined as regards sizing by the relevant British Standard Specification, while a third was tested for the presence of unslaked lime as reported under Health Hazards, Miscellaneous.

Four commercial lime products were examined for the presence of calcium silicate. Microscopic, X-ray and chemical techniques were used and conclusions drawn linking the presence of the silicates pseudowollastonite and possibly larnite with burning temperatures during manufacture.

A sample of carbide residues from acetylene manufacture was assayed for free lime and sulphur contents.

Lime samples examined for purposes other than building, consisted of ten samples assayed on behalf of the State Batteries Branch. Of these, four fell short of specification requirements, two showing excessive ignition loss and two being deficient in CaO content on ignited samples.

4. Miscellaneous.—Porosity and density of spongolite samples from the Porongorups area were determined but these particular samples appeared too friable for use as general purpose bricks. Much better material from the Ravensthorpe area was also examined.

Stains on clay brick samples that proved resistant to all solvents were found to be caused by local reducing conditions within the kiln during firing.

Stains on cement masonry blocks were due mainly to calcium carbonate and slight modifications in method of manufacture were suggested as a remedy. Stains or efflorescences from the Narrows Bridge were also predominantly calcium carbonate, originating from lime set free during hydration of the cement. Efflorescence on clay ware was shown to be due to soluble salts, present either in the raw clay or the water used.

A sample of used asbestos-cement water pipe (8 in. diameter, 1 5/16 in. wall thickness) from the metropolitan area was examined for deterioration. Determination of lime, sulphate and fibre contents of turnings taken at 1/16 in. intervals from the inner surface indicate that considerable leaching of lime had taken place through almost one third of the wall thickness, but no dangerous sulphate build-up was revealed. The extent of the lime leaching varied from about 66 per cent. of the original content in the first sixteenth of an inch, to 40 per cent. at 5/16 in. and 20 per cent. at ⅜ in.

*Health Hazards.*

1.—Foundry Dust Survey.—The Public Health Department requested the Laboratories to undertake a survey of air-borne dust in W.A. industry to follow on the chest X-ray survey of W.A. industry by that Department.

A midget impinger apparatus was purchased for the Mineral Division. With new accessories, a microscope was modified for the specialised counting of dust samples and a number of glass cells 1 mm. deep were made.

The foundry industry, with the emphasis on silicosis hazard, was selected as the first industry to be surveyed and the foundry at the Western Australian Government Railways Workshops, Midland, the first foundry.

From plans kindly supplied by the Workshops' drafting division in March a number of small scale base plans were prepared by the Mines Department Drafting Branch for sampling records, one plan for each sampling day.

On 6th April the survey was commenced, with the assistance of Factories Inspectors, by the sampling for chemical analysis of settled dust on horizontal surfaces of the foundry building.

During the period from 1st June to 8th November with added assistance from the Public Health Department, 347 samples of air-borne dust were taken with the impinger apparatus.

The samples were collected using ethyl alcohol as the collecting medium and counted in the Mineral Division. The approximate composition of the dust was noted, particularly the free silica content and the concentration of particles per cubic centimetre of air calculated and recorded.

Samples were taken initially of the general air of the foundry away from any particular dust-generating process. Samples were also taken of the dust concentration encountered in the air near the foundry processes of moulding, shaking-out, sand conditioning, abrasive blasting, rumbling, brushing, grinding and chipping.

From this early sampling, fifteen foundry jobs were selected for detailed study to determine the mean hourly exposure to dust of a man employed in each job.

The fifteen jobs are considered to expose the workers carrying out the duties which make up each job to the highest total daily dust concentrations of any workers in the foundry.

The results of the survey are to be correlated and a report made to the Public Health Department which will be used as a basis for future investigation of W.A. foundries.

This report is expected to be ready during the first quarter of 1962.

2.—Miscellaneous.—Most of the work under this heading consisted of identification of inorganic constituents in dusts, with emphasis on those likely to cause silicosis or asbestosis.

Practically all dust samples were taken at the request of the Public Health Department.

Nine samples from inside a building adjacent to a factory manufacturing fibre board were found to contain no significant concentrations of asbestos fibres.

All three specimens submitted in connection with a dust complaint were found to contain siliceous material, both as free silica (quartz) and combined as silicate (cement.)

The possibility of residual free lime in slaked lime causing dermatitis led to a request to examine a commercial product for any unslaked material. The chemical determination of calcium oxide in the presence of a large excess of calcium hydroxide presents problems which appear insoluble, but a physical method was devised relating the temperature rise of a slurry with the amount of unslaked lime originally present. No measurable amount of calcium oxide was detected.

*Minerals and Ores.*

1.—Beryl.—The big increase in the number of beryl samples examined resulted largely from the opening up of beryl deposits in the Dalgaranga area north-east of Yalgoo.

Almost two-thirds of the samples dealt with were for chemical analysis. Most of these were from shipment parcels, eight of which assayed below the minimum commercial grade of 10 per cent. beryllium oxide. The average figure for these parcels was about 11 per cent.

Samples for identification were submitted from widely scattered localities. An interesting specimen from 6 m. SE of Roebourne contained beryl associated with albite, phlogopite and powellite pseudomorphous after molybdenite. Another, from the Cue District, consisted of clear green beryl occurring as crystals in quartz. Similar crystals, occurring in say biotite schist, could possibly have yielded some gem quality emerald but in a quartz matrix recovery of undamaged crystals would be difficult.

Information was received during the year of a single beryl crystal at Yinnietharra from which 23 tons of beryl had been won. Dimensions reported were a length of 25 feet and a thickness up to 6 feet. As far as our records show, this would be the largest crystal worked in Australia, though it falls far short of giant crystals reported in United States and the Argentine, weighing upwards of 200 tons.

2.—Clays.—Increasing use was made of X-ray diffraction examination in identifying the actual mineral constituents of clays.

Identification of clays from a large number of localities was undertaken and, where justified, was followed by firing tests. A number of clays particularly from inland localities such as Binneringa, Widgiemooltha, Corrigin and the Kalgoorlie district showed salt contents too high for firing without washing. A Binneringa clay contained over .5 per cent. of sodium chloride.

A Corrigin clay showed some vanadium staining after burning.

A sample from Byford exhibited anomalous shrinkage properties. Briquettes (dried at 105° C) showed 0.3 per cent. expansion when fired at 950° C, then shrinkages of 1.2 per cent. at 1050° C, 6.7 per cent. at 1150° C and back to 2.4 per cent. at 1250° C. Percentage water-absorption of briquettes fired at the four temperatures were 20.8, 18.8 and 8.2 and 14.8 respectively.

A carbonaceous shale from the Kimberleys, thought to have possibilities as a light-weight expanded aggregate, showed no tendency to "bloat" on firing.

Reference was made in the annual report for 1960 to the discovery by the Geological Survey of Western Australia of an halloysite deposit 24m. N. of Borrabbin. A washed and screened sample from that deposit has now been analysed with the following results:—

| | Per Cent. |
|---|---|
| Silica, $SiO_2$ | 35.58 |
| Alumina, $Al_2O_3$ | 38.99 |
| Ferric oxide, $Fe_2O_3$ | 0.19 |
| Ferrous oxide, FeO | Nil |
| Magnesia, MgO | 0.33 |
| Lime, CaO | 0.15 |
| Soda, $Na_2O$ | 1.29 |
| Potash, $K_2O$ | 0.20 |
| Combined water $H_2O+$ | 19.81 |
| Moisture, $H_2O-$ | 2.02 |
| Titania, $TiO_2$ | 0.03 |
| Phosphorus pentoxide, $P_2O_5$ | 0.01 |
| Sulphur trioxide, $SO_3$ | 0.01 |
| Chloride, Cl | 1.66 |
| Chromic oxide, $Cr_2O_3$ | Nil |
| Manganese oxide, MnO | trace |
| | 100.27 |
| Less O = 2Cl | 0.37 |
| | 99.90 |

Analyst J. R. Gamble.

This material dries and grinds to an exceptionally good white and has found commercial application as a paint filler as well as in drilling mud.

Other complete analyses were made of clay minerals from Gingin in connection with a University research project, and a number of partial clay analyses were made at the request of brick manufacturers.

3.—Copper.—Twice as many copper samples were received as in the previous year, reflecting the added interest in the search for new sources of agricultural copper.

Most samples contained the oxidised minerals suitable for incorporation in superphosphate fertilizer, but a number of analyses were also carried out on sulphide flotation concentrates from a mine operating in the Coolgardie District. These concentrates were assayed for arsenic, gold and silver as well as for copper.

A number of assays were made for a producer in the Pilbara Goldfield as a check against his own figures. A miner from the Meekatharra area was given detailed instructions on the short iodide method for determining copper and check assays suggest that he has now mastered the technique sufficiently to make his own field analyses.

The minerals most common in the oxidised copper ores received have been malachite, azurite, chrysocolla and cuprite but some samples received contained the much less common atacamite (from the Wiluna area) and brochantite and olivenite (from Ashburton Downs). The atacamite was of unusual interest in that it occurred in a rock made up of gypsum, biotite and some limonite, with portion of the hand specimen assaying 19.5 per cent. copper.

The basic sulphate mineral brochantite and the basic arsenate olivenite occurred in a number of specimens from a complex deposit of argentiferous lead and copper minerals on Ashburton Downs Station.

4.—Gold and Silver.—The number of gold ores assayed for the public was much the same as last year but there was a decrease in the number of tailings assayed for State Batteries both as regards check and umpire samples.

Prospecting samples were submitted from all parts of the State, with the largest numbers coming from the Yilgarn and Yalgoo Goldfields. Some arsenical ores from the Warriedar area carried high values as did a quartz ore from Warda Warra.

Gold and silver assays were made on commercial flotation concentrates and on a number of lead and copper ores from Ashburton Downs.

Work for the Government Geologist was limited to five diamond drill cores from Mountain View North Prospect, Murchison Goldfield. Six ores from the Frances Firness Gold Mine, Marvel Loch were assayed for the State Mining Engineer.

5.—Heavy Sands.—As in 1960, the majority of heavy-sand samples were received from inland centres rather than the coastal areas so popular in the past.

Sands were received from Turkey Creek and Mt. Amy in the Kimberley area; from 20 m. S.W. of Roebourne in the North West; Mangaroon Station in the Upper Gascoyne; Yalgoo and Meeline in the Murchison; Kirup, Bendering and Corrigin in the South West.

The predominant heavy mineral was usually either ilmenite or magnetite with zircon not uncommon and monazite appearing in the samples from Yalgoo and Meeline Station.

Samples of beach sands from twenty coastal localities were made available to a British firm for further tests on the availability of suitable minerals for production of titanium pigments.

6.—Iron.—The interest in iron ore continued throughout the year and resulted in a large number of prospector samples being submitted for identification and assay as well as samples from large development companies for partial and complete analyses.

Composite samples were prepared from both bore core and surface samples and analyses made for iron, sulphur, phosphorus, titanium, manganese, silica, lime and alumina. At the request of a mining company copper assays were run on two iron ores, giving figures of 0.02 and 0.01 per cent. while the tin content of a third ore sample was found to be less than 0.01 per cent.

The big majority of the iron samples received from the Government Geologist were diamond drill bore cores from the Weld Range (or Wilgie Mia) deposits. After mineral identification, these cores were first assayed for acid-soluble iron, followed by virtually complete analyses of composite samples.

Cores from one drill-hole showed a complex association of minerals. In addition to limonite, hematite, magnetite and pyrite, other minerals present included minnesotaite, chalybite, stilpnomelane, chlorite and an unidentified iron manganese phosphate. This represents the first recorded occurrence of minnesotaite in W.A. It was present in veins varying in colour from greenish-brown to black and with a hardness of about 5. Though these properties differ slightly from those of the mineral as originally described from Minnesota, X-ray powder diffraction patterns leave little doubt as to its true identity.

The phosphate mineral in these cores, occurring as black veinlets, has the properties of rockbridgeite except refractive index, and similar but not identical X-ray diffraction patterns. It is possibly a new member of the frondelite-rockbridgeite group of iron manganese phosphates.

Hand specimens from prospectors included a striking specimen of fibrous goethite from 14 m. N.E. of Hall's Creek and two lodestone specimens, one from the Glenburgh Station in the Upper Gascoyne, the other from 20 m. S.W. of Roebourne. Another specimen of interest contained martite pseudomorphous after a magnetite-ilmenite intergrowth in a rock which assayed 52.9 per cent. iron, 10.6 per cent. titanium and 0.92 per cent. vanadium.

7.—Lithium.—Continued attempts by private interests to exploit spodumene deposits at Ravensthorpe led to a number of lithium determinations being carried out in the Division on both the raw material and treatment products. As a low iron content is specified, analyses were made to determine the degree of iron contamination resulting from fine grinding.

Lepidolite was reported for the first time from 4 m. S. of Roebourne. From Warda Warra, a medium-grained lepidolite assayed 3.8 per cent. lithia but carried too much iron to meet the stringent specifications of overseas markets. For use in the production of television tubes, this specification requires an iron figure not greater than 0.07 per cent.

A sample of zinnwaldite assaying 2.67 per cent. $Li_2O$ was found to contain traces of gallium. A second sample of the same mineral from Dalgaranga assayed 1.6 per cent. $Li_2O$ and was the first record of the mineral from that area. A fine specimen of zinnwaldite associated with columbite originated from a Ravensthorpe pegmatite.

Other interesting lithium minerals included a petalite-quartz-albite intergrowth assaying 2.44 per cent. lithia from the Coolgardie Goldfield, and a petalite carrying 4.17 per cent. lithia from the Dundas Goldfield. As the only previously recorded occurrence of petalite in W.A. was at Londonderry, these two specimens, both from new localities, were of particular interest.

Minerals of the amblygonite-montebrasite series have previously been reported only from Ravensthorpe and Ubini. A specimen of montebrasite from Nanutarra Station was therefore the first occurrence in the North West Division of this high-lithium mineral.

8.—Manganese.—Most work on manganese consisted of analyses in connection with a manganese ore up-grading programme being carried out by Engineering Chemistry Division. Analyses were made on head samples

and various treatment products, the latter containing manganese and iron in various stages of oxidation. The problem of the separate determination of $MnO_2$ MnO, metallic Mn, ferrous iron, ferric iron and metallic iron when all could occur together remains unsolved.

A manganese ore from a new locality on Lake Way Station was found to be composed of cryptomelane and pyrolusite and one from Glenburgh Station was a high-grade psilomelane ore. A sample from Balfour Downs Station consisted mainly of psilomelane with a little pyrolusite and carried 11.7 per cent. of barium oxide. A pyrolusite-cryptomelane sample from Hall's Creek assayed 55.4 per cent. manganese.

9.—Tantalo-Columbate Minerals.—as in the case of beryl, the big increase in the number of tantalite-columbite samples received (93 in 1961, 47 in 1960) was in a large degree due to the increased activity in prospecting for this mineral in the Dalgaranga area. This was stimulated by the sharp rise in the market value of good grade tantalite towards the end of the year.

A large proportion of the work on tantalite minerals consisted of identification and the grading of samples representing commercial parcels. Where possible this grading is made by determining the specific gravity of the tantalite fraction. Figures obtained by this means show reasonable agreement with those obtained by the much more expensive and time-consuming chemical analysis. Samples containing tantalum-niobium minerals other than tantalite and columbite (such as microlite, simpsonite, fergusonite and tanteuxenite) had of necessity to be analysed chemically as no quantitative relationship between gravity and mixed oxide content exists for those minerals.

Samples containing a variety of tantalo-columbate minerals were received from Strelley and Tabba Tabba in the North West and from Dalgaranga in the Murchison. One from Strelley contained 73 per cent. of high-grade tantalite and 18 per cent. microlite with the remainder mainly cassiterite, while a sample from Dalgaranga, assaying 71 per cent. $Ta_2O_5$, was made up of tapiolite, microlite and simpsonite.

The presence of tin in the tantalite from Tabba Tabba was further confirmed by examination of two parcels of mixed tin-tantalum concentrates from that area. Careful separation of the mineral components of the first sample showed the presence of approximately 71 per cent. cassiterite, 23 per cent. tantalite, and 5 per cent. microlite. Chemical assay of the tantalite fraction showed it to contain a further 10.9 per cent. tin. Similarly a second sample showed 7.9 per cent. tin present as cassiterite and 4.7 per cent. in solid solution with tantalite.

A sample from the Marble Bar area was found to consist of tantalite and cassiterite, with 23 per cent. fergusonite. A sample from Shaw River was comprised chiefly of fergusonite with a little monazite. Though the W.A. mineral originally described as fergusonite was later identified as yttrotantalite, X-ray examination of the fergusonite in the current samples places it indisputably in the fergusonite-formanite series of rare-earth columbotantalate minerals.

An alluvial concentrate consisting of 50 per cent. of the rare-earth titano-tantalate mineral tanteuxenite, together with columbite and cassiterite was received from the North-West. Specimens of a metamict mineral received from Dalgaranga were examined by X-ray after recrystallisation by heat and shown to be altered columbite. Similar mineral in the past had been referred to as manganomossite.

Another interesting specimen was apparently an inter-growth of columbite and rutile, having a specific gravity of 4.70 which suggests a preponderence of rutile. It is one of the many columbotantalate minerals set aside for detailed chemical study when time and staff become available.

A specimen from the vicinity of Gascoyne Junction was identified as a member of the annerodite-samarskite series of uranium-bearing rare-earth tantalo-columbates. It occurred as a brown mineral with a resinous lustre on fresh surfaces and with a specific gravity of 5.17. Partial analysis showed—

| | Per cent. |
|---|---|
| Uranium dioxide, $UO_2$ .... .... | 5.69 |
| Uranyl oxide, $UO_3$ .... .... | 10.38 |
| Thorium dioxide, $ThO_2$ .... .... | 1.03 |
| Rare-earth oxides .... .... | 9.57 |
| Tantalic oxide, $Ta_2O_5$ .... .... | 3.17 |
| Niobic oxide, $Nb_2O_5$ .... .... | 47.28 |
| Calcium oxide, CaO .... .... | 2.23 |

Seven ore samples from the Northern Territory were assayed for niobium at the request of a N.S.W. mining company, while one of wolframite from Tasmania was analysed for mixed oxides for tantalum and niobium.

10.—Tin.—About half the tin samples handled were for chemical analysis, the remainder being for mineral identification.

Analyses were mainly of cassiterite concentrates from producing and exporting companies. As required by one overseas specification, a cassiterite parcel was analysed for sulphur, lead, bismuth, copper, antimony, zinc, arsenic, tungsten and iron. The iron content was 1.66 per cent., copper 0.11 and lead 0.10 with the remainder each considerably less than 0.1 per cent.

Most cassiterite identification work was carried out on a semi-quantitative basis on tantalite-cassiterite concentrates from the North-West and, to a lesser degree, Greenbushes. Separate cassiterite specimens, either as alluvium or in lode formation, were received from about 15 m N.E. of Mt. Dalgaranga and from Poona in the Murchison; Strelley, 5 m S. of Roebourne, Mt. Francisco and Yinnietharra in the North-West and from Mt. Dockrell in the Kimberley Division.

A particularly interesting specimen was recorded from Bremer Range. It consisted of cassiterite with an external zonal growth of tantalum-bearing cassiterite (or ainalite). Ainalite, which can carry up to 10 per cent. of iron tantalate, presents problems in identification in that it does not readily react to the standard zinc dish test for cassiterite.

11.—Titanium.—Most titanium analyses were carried out on products from the experiments on the up-grading of ilmenite and leucoxene being undertaken at Engineering Chemistry Division, though some analytical work was also done on titaniferous hematites and tantalite concentrates.

Odd specimens of massive ilmenite were received, with one or two of rutile but probably the most interesting titanium occurrence was the rutile-columbite intergrowth described under tantalum minerals.

12.—Vanadium.—Increased world demand for vanadium led to a marked increase in the interest shown in vanadium prospecting.

Samples for assay were received from the Ord River area in the Kimberley, from Meekatharra and Youno Downs, Ravensthorpe, Roebourne, Holyoake, Mogumber and particularly the Wundowie area. Assays varied from less than 0.1 per cent. up to 1.5 per cent. vanadium.

Except for some mottramite from Ashburton Downs Station no particular vanadium mineral was recognised, nearly all samples carrying their vanadium in intimate association with iron minerals.

The sample from Youno Downs was predominantly martite, pseudomorphous after a coarsely crystallised magnetite-ilmenite intergrowth (see also under iron).

Most of the samples assayed showed appreciable percentages of titanium, ranging up to 15 per cent. A sample of interest, originated from the Roebourne area, assayed 48.0 per cent. iron, 9.16 per cent. chromium, 3.97 per cent. titanium and 0.58 per cent. vanadium.

*Mineral Identifications.*

1.—General.—Many mineral identifications are referred to in the appropriate sections under Minerals and Ores. A selection of other specimens received is described hereunder.

Bismuth carbonate minerals associated with beryl and feldspar were identified in a sample from 10 m S.E. of Yalgoo, and, associated with quartz, in a sample from 16 m S.E. Croydon Station homestead. Both these were new localities. Moolyella was the only other source of bismuth specimens during the year.

Wolframite from the Onslow area, and from 5 m N.E. of Ora Banda were the only tungsten minerals received for identification. The latter belonged at the hubnerite end of the hubernite-ferberite series and showed some surface alteration to scheelite.

Specimens of molybdenite were received from the vicinity of Mt. Dugel in the Gascoyne and from Mulgine.

An unusual specimen of baryte, pseudomorphous after a fibrous mineral probably asbestiform anthophyllite, originated from Eudamulla.

Talc from the Northam area though tough, ground to soft, only slightly off white powder, as did a sample from Sherlock Station.

An unusual number of prehnite samples was received, due in part to the mineral having been identified in commercial beryl consignments from the Roebourne area. It occurred in a grey form which could be mistaken in the field for Beryl. A pale green specimen from Meeline Station, occurring with epidote and feldspar was the first reported from that area.

Chabazite was identified lining vesicles in an amphibole-pyroxene-feldspar basaltic rock.

An aluminium iron phosphate, occurring as a variety of variscite, was identified from 6 m. S.E. of Mt. Magnet while from 6 m. S.E. of Roebourne a specimen was received consisting of the calcium molybdate mineral powellite pseudomorphous after molybdenite and associated with albite, beryl and phlogopite.

Arsenic minerals received were specimens of arsenopyrite from Dalgaranga, Warriedar and Field's Find, and a quartz-feldspar rock from Jerramungup containing the iron arsenide lollingite and its alteration products scorodite and symplesite.

From the Stockyard Creek area on Ashburton Downs Station a series of rock samples carrying complex secondary and tertiary minerals, mainly of lead and copper, was examined. One specimen containing abundant brochantite, some azurite and traces of atacamite assayed over 11 ozs. of silver per ton. A second specimen, mainly cerussite, contained also brochantite, anglesite, olivenite and possibly mottramite. The uncommon copper-bearing sulphate-carbonate of lead, caledonite, occurred with cerussite, anglesite, brochantite and cuprite in another specimen while the suite also contained specimens of the hydrated copper uranium arsenate, metazeunerite, and the suspected presence of the basic copper phosphate, libethenite. A number of minerals still remained unidentified and work on them will continue as opportunity arises.

Two soils were examined to determine why discs used in plowing one of the soils had a very much shorter life than similar discs used on the second type of soil. Examination showed the abrasive (Brookton) soil to contain much the higher percentage of large sharp quartz fragments.

Some interesting limonite pseudomorphs were received from Ashburton Downs Station.

Other minerals identified, with approximate localities, included corundum (Koojan), fibrous actinolite (Yalgoo), rutile (Yinnietharra), topaz (Mt. Francisco and Dalgaranga), stibnite and its alteration products (vicinity Yampi Sound), aragonite (Big Bell and Lake Austin), oncosine (Ravensthorpe), apatite (Roebourne), graphite (Kunanalling), miloschite (Kunanalling and L. Yundarlgooda), vermiculite (Ravensthorpe), pyrrhotite and chalcopyrite (Southern Cross), garnet and hypersthene (Jennacubbine) and pyrite from wells at Boallia and Bunbury.

2.—New Mineral Species.—In June a sample was received from Mr. J. Henderson of Port Hedland consisting of a light green mineral associated with quartz, baryte, iron and manganese oxides and clay. The green mineral was subsequently found to be a new species for which the name edgarite is proposed.

The mineral is a basic lead aluminium copper sulphate of the alunite group with the generalised formula of Pb (Cu Al Fe)$_3$(SO$_4$)$_2$(OH)$_6$ and is the aluminium analogue of beaverite, Pb (Cu Fe Al)$_3$ (SO$_4$)$_2$(OH)$_6$.

In colour edgarite is very close to Ridgway's "Veronese Green" and occurs as friable aggregates of minute crystals, often showing hexagonal outline and rarely the development of the rhombohedron. The mineral exhibits both uniaxial and biaxial positive character with mean refractive index of 1.72. The specific gravity is 4.037 (observed) and 4.167 (calculated).

X-ray powder diffraction data show that edgarite has a rhombohedral lattice, and cell dimensions have been determined.

The strongest lines of the powder diffraction pattern are in descending order of intensity, 3.00, 5.75, 3.52, 2.874, 2.284, 1.917, 1.502 Angstrom units.

Chemical analysis gave the following results:—

| | Per Cent. | Molecular Ratios |
|---|---|---|
| PbO | 33.15 | |
| CuO | 11.83 | 0.913 |
| $Al_2O_3$ | 17.51 | 0.915 |
| $Fe_2O_3$ | 0.77 | 1.056 } 2.0 |
| $SO_3$ | 26.02 | 0.030 |
| $H_2O+$ | 10.42 | 1.999 |
| $H_2O-$ | 0.09 | 3.557 |
| Insol | 0.19 | |

Analyst: M. B. Costello.

The analysis leads to a formula of Pb (Cu Al Fe)$_3$ (SO$_4$) $_2$(OH)$_6$ $\frac{1}{2}$H$_2$O which, apart from the $\frac{1}{2}$H$_2$O, conforms to the general formula of the alunite group A′B″$_3$′(SO$_4$)$_2$(OH)$_6$ in which the monvalent A′ position is almost filled by Pb″, and Cu″ substitutes for Al‴ in the B‴ position to give valence compensation. The excess water is believed to be due to a hydrated phase present in the mineral, a suggestion based on the biaxial nature of some of the sample and the broadening of the moderate to high angle lines on X-ray powder diffraction photographs.

In October a short visit was paid to the Marble Bar area and the field occurrence of the new mineral was examined. The mineral was found some 35 m. E.S.E. of Marble Bar, on Mt. Edgar Station, and occurs as two small "pipe-like" bodies in a copper-bearing quartz baryte vein.

A few yards from these "pipes" a small deposit of a complex mixture of quartz, baryte, iron oxides, manganese oxides and clay minerals was found to contain an uncommon lead copper sulphate mineral, linarite, with the copper sulphate, brochantite, and a pale green-blue copper-bearing clay-like mineral which has so far not been identified and is possibly a second new mineral.

A paper on edgarite has been prepared and will be submitted for publication overseas by Mr. R. C. Morris of this Division.

3.—Minerals from New Localities.—Minerals were received from a number of localities from which they had not previously been recorded at these Laboratories. As most of these have been discussed under headings appropriate to their composition, a list only is given here.

| Mineral | New Locality |
|---|---|
| | (a) Kimberley Division. |
| Stibnite .... | .... 80 m. N. of Derby, 3 miles from coast. |
| Malachite | .... 20 m. S.W. of Halls' Creek. |

| Mineral | New Locality |
|---|---|
| | (b) North West Division. |
| Annerodite | Arthur River in vicinity of Gascoyne Junction. |
| Malachite | 6 m. N.E. of Wanna Homestead. |
| Malachite | 20 m. N.E. of Mooloo Homestead. |
| Chrysocolla | 20 m. N.E. of Mooloo Homestead. |
| Chrysocolla | 15 m. N. of Mooloo Homestead. |
| Powellite | 6 m. S.E. of Roebourne. |
| Beryl | 5 m. S. of Roebourne. |
| Beryl | 30 m. S.E. of Maroonah Homestead. |
| Cassiterite | 5 m. S. of Roebourne. |
| Bismutite | 16 m. S.E. of Croydon. |
| Talc | Sherlock Station. |
| Montebrasite | 1 m. E. of Nanutarra Homestead. |
| Olivenite | Stockyard Creek, Ashburton Downs. |
| Mottramite | Stockyard Creek, Ashburton Downs. |
| Caledonite | Stockyard Creek, Ashburton Downs. |
| Metazeunerite | Stockyard Creek, Ashburton Downs. |
| Atacamite | Stockyard Creek, Ashburton Downs. |
| Formanite | 10 m. S.W. of Shaw River. |
| Topaz | 18 m. W.S.W. of Roebourne. |
| | (c) Murchison Division. |
| Cassiterite | 12 m. N.E. of Mt. Dalgaranga. |
| Cassiterite | 20 m. N.N.E. of Mt. Dalgaranga. |
| Tapiolite | 20 m. N.N.E. of Mt. Dalgaranga. |
| Microlite | 20 m. N.N.E. of Mt. Dalgaranga. |
| Columbite | 20 m. N.N.E. of Mt. Dalgaranga. |
| Simpsonite | 12 m. N.E. of Dalgaranga Homestead. |
| Ilmenorutile | ½ m. N.N.E. of Dalgaranga Homestead. |
| Monazite | 8 m. N. of Dalgaranga. |
| Lodestone | 7 m. S. of Glenburgh Homestead. |
| Psilomelane | 7 m. S. of Glenburgh Homestead. |
| Prehnite | Meeline Station. |
| Variscite | 6 m. S.W. of Mt. Magnet. |
| Beryl | 58 m. N. of Yalgoo. |
| Beryl | 35 m. E. of Yalgoo. |
| Molybdenite | 5 m. S.W. of Mt. Dugel. |
| Atacamite | Wiluna. |
| Minnesotaite | Weld Range. |
| | (d) Central Division. |
| Arsenopyrite | Evanston. |
| Petalite | Spargoville. |
| Petalite | Bremer Range. |
| | (e) South-West Division. |
| Corundum | 7 m. E. of Koojan. |
| Talc | 7½ m. N. E. of Northam. |
| Ilmenorutile | 6 m. N. of Mukinbudin. |
| Lollingite | 2 m. E. of Jerramungup. |
| Scorodite | 2 m. E. of Jerramungup |
| Symplesite | 2 m. E. of Jerramungup. |

Many of the above localities are by no means as exact as could be wished but allowance must be made for the combination of featureless country and limited surveying means at the disposal of the average prospector.

4.—Complete Analyses.—Only a limited number of complete mineral analyses can be undertaken and during the year only six were reported. A considerable increase in staff would be necessary to meet the ideal requirement of a full analysis of all minerals reported for the first time from any new locality.

Four of the analyses undertaken during the year were of clays and have been referred to under that heading while the analysis of the new mineral hendersonite is also reported elsewhere.

A sample of good quality topaz was received from 18 m. W.S.W. of Roebourne, the nearest occurrence previously recorded by us being at Wodgina, 120 miles distant. The topaz was not gem quality but the mineral may have some potential as a glass opacifier in place of imported cryolite.

Analysis of the sample is given below.

| | Per Cent. |
|---|---|
| Silica, $SiO_2$ | 32.81 |
| Fluorine, F | 15.84 |
| Alumina, $Al_2O_3$ | 55.47 |
| Ferric oxide, $Fe_2O_3$ | 0.09 |
| Manganese oxide, MnO | 0.01 |
| Titania, $TiO_2$ | 0.01 |
| Magnesia, MgO | 0.03 |
| Lime, CaO | Nil |
| Soda, $Na_2O$ | 0.08 |
| Potash, $K_2O$ | 0.43 |
| Combined water, $H_2O+$ | 1.67 |
| Moisture, $H_2O-$ | 0.05 |
| | 106.49 |
| Less O = 2F | 6.67 |
| | 99.82 |

Analyst R. S. Pepper.

*Miscellaneous Analyses.*

1.—Minerals.—Three sales parcels of bismuth concentrates were assayed. One assayed well below the minimum commercial grade of 65 per cent. Bi, but the other two carried in the vicinity of 75 per cent. of the metal.

Scheelite concentrate from Davyhurst, representing an export parcel, was assayed for tin, arsenic, sulphur, phosphorus, bismuth, copper, iron, silica, lime, antimony and molybdenum as well as tungsten. Figures for these impurities were required by overseas buyers.

Two nickel-bearing rocks from the Coolgardie area assayed 0.2 per cent. nickel oxide; one from Big Bell less than 0.08 per cent. A sulphide concentrate obtained from a silicified dolomite from the Roebourne area contained pyrite, chalcopyrite and the nickel sulphide mineral millerite. The concentrate assayed 17 per cent. nickel suggesting that about a quarter of the sample was millerite.

Baryte samples were assayed for iron to determine their suitability for use in the paper or pigment industries. The specific gravity of other samples was determined in connection with the use of the ground mineral as drilling mud.

Considering the publicity given to the search for bauxite it was surprising that only twenty samples were submitted throughout the year. These were assayed for soda-soluble alumina and reactive silica, but only four samples gave alumina figures in excess of 40 per cent.

Fifteen samples of saline clays were analysed at the request of an exploration company. Determinations were made for potassium, soda, boron, chloride and sulphate.

2.—Non-Minerals.—A fire-retardant composition was examined and found to be made up of ammonium phosphate, sodium ammonium phosphate, sodium fluoride, ammonium dichromate and ammonium sulphate. A dust sample from inside an oxygen cylinder was submitted for examination by the Commonwealth Directorate of Quality Control. It was found to be comprised mainly of metallic fragments with about 0.5 per cent. quartz and silicate particles and traces of a isotropic amorphous material not positively identified.

Nothing abnormal was found in the corrosion products from a fire extinguisher which had been exposed to humid conditions for a prolonged period in the North-West.

Another corrosion product examined was material submitted by the Post Master General's Department from a damaged electrical switch.

A sample of aluminium submitted by Public Works Department was analysed for copper, lead, iron, nickel, zinc and tin and found to comply with the relevant specification. A stainless steel was analysed for chromium, nickel, carbon and silicon, also at the request of Public Works Department and two lead dross samples were examined for a metal buying firm.

### PHYSICS AND PYROMETRY SECTION.

*Pyrometry.*

Thirteen mercury in glass thermometers were received for calibration against laboratory standards, the total temperature range being from -40° C to +400° C.

Preparations for registration with N.A.T.A. were completed during the years and these Laboratories are now registered as Lab. No. 350 in the field of heat and temperature measurement.

*X-ray Diffraction.*

A total of 82 samples was processed by the section, involving 450 exposures. Of these samples, 18 were clays and 15 were rare earth minerals. These figures show a substantial increase over those for 1961. This increase is due in part to the use of the X-ray equipment by two members of the staff of the Mineral Division, whose proficiency has now progressed beyond the level of routine mineral identification by this method to the indexing of powder patterns and determining the unit cell dimensions of new minerals.

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## CONTENTS


Page

Administration—

Accommodation .... 129
Committees .... 130
Staff .... 129

General—

Government Departments from which samples were received .... 130
Samples and Operations in 1961 .... 131

Summarised Reports of Divisions—

Agriculture, Forestry and Water Supplies .... 132
Engineering Chemistry .... 141
Food, Drugs Toxicology and Industrial Hygiene .... 144
Fuel Technology .... 148
Industrial Chemistry .... 152
Mineralogy, Mineral Technology and Geo-Chemistry .... 155
Physics .... 162

Tables showing Sources and Nature of Samples received in 1961—

General, Table 2 .... 131
Agriculture, Forestry and Water Supplies Division, Table 3 .... 132
Food, Drugs Toxicology and Industrial Hygiene Division, Table 14 .... 145
Fuel Technology Division, Table 15 .... 149
Industrial Chemistry Division, Table 20 .... 153
Mineralogy, Mineral Technology and Geo-Chemistry Division, Table 21 .... 155

# DIVISION VIII

# *Annual Report of the Chief Inspector of Explosives for the Year 1961*

*Under Secretary for Mines:*

For information of the Hon. Minister for Mines, I am honoured to report on the scope and operations of the Explosives Branch in 1961.

*Importation of Explosives.*

Except for blasting agents prepared as and when required from non-explosive components, substantially all the State's explosives were manufactured products of the Nobel Division of I.C.I.A.N.Z. Ltd., Melbourne. Conveyance was about equally divided between shipments to the coastal reserve at Woodman's Point and direct transcontinental railage to Kalgoorlie. Former supplies to Cockatoo Island by iron ore vessels returning from New South Wales were supplemented and later replaced by loaded portable magazines placed aboard north-bound ships after discharge of steel billets at A.I.S. jetty, Kwinana. Minor explosives movements from South Australia to a ballasting job just west of the border were also recorded.

Though much of the same frequency, smaller ships on the run carried between one-half and two-thirds of the 16,000 case loads once commonplace. These reduced increments, together with diversion attributable to railage, have eased pressure on the magazines, whose capacity was apt to be heavily taxed on past occasions where the larger shipments were closely spaced. The railage to the major gold-mining district worked so smoothly that little need be added to or said in modification of last year's account. It is true that some of the Commonwealth vans when inspected at Parkeston were found below W.A. Government Railways standards for explosive-bearing rolling stock, but these shortcomings proved readily rectifiable. Recent advice from Nobel's commercial manager indicated that railage would continue, despite economies in time and handling expected by loading ships from road vehicles ex the factory at the Point Wilson jetty, Victoria, when completed in 1962.

*Types of Explosives.*

The general pattern underwent no significant change. As for years past, the demand was met essentially by compositions consisting of partly or wholly gelatinized nitrated glycol-glycerol, oxidising agents and various additives. This class included well-known lines like Gelignite, Gelatin Dynamite, Semigel, Geophex, Plastergel, Monobel, etc., but not blasting powder, which nowadays is used to small extent in timber-splitting guns and where a mild non-shattering dislodgment is required, as in quarrying dimensional stone. Blasting agents, on the other hand, gained wider acceptance. These mixtures, not to be confused with blasting powder, may be described as fuels such as carbon black, molasses, oil and certain metallic powders intended for admixture with ammonium nitrate just before use. Although fuel oil dominates, inquiries as to its substitution by powdered aluminium were received. A non-carbonaceous composition of this type should produce no carbon monoxide on explosion, but it is expensive and may form nitrogen oxides in lethal concentration. Indeed the fume problem generally, though of no consequence in geoseismology and open-cut work, must be accorded close attention because of mounting interest in the use of blasting agents underground.

*Use of Explosives.*

Though less detail than formerly was available the table below shows proportionate consumption of explosives and blasting agents. Where both types were employed, the weights were added and expressed in the right-hand column as percentages of total.

| Industry | Explosives | Blasting Agents | Explosives plus Blasting Agents |
|---|---|---|---|
| Gold Mining .... .... | 61·7 | 2·4 | 57·3 |
| Coal Mining .... .... | 8·6 | 0·4 | 8·1 |
| Geoseismic .... .... | 2·1 | 93·1 | 8·9 |
| Metals and Minerals (other than gold) .... | 16·0 | 1·2 | 14·7 |
| Public and Local Authority Works .... .... | 1·4 | .... | 1·4 |
| Construction .... .... | 7·7 | 2·8 | 7·3 |
| Miscellaneous .... .... | 2·1 | .... | 2·1 |

Certain difficulties in presenting a precise picture revolve about the varying effectiveness of different explosives. Ammonium nitrate, for example, breaks less rock than the same weight of gelignite, and yet all must be considered together in deriving the final results.

*Quality of Explosives.*

Of less than one per cent. of the State's importations withheld from distribution because of suspected deterioration, most was ultimately pronounced fit for use. Exceptions were where wetting had occurred in transit. No explanation could be advanced concerning 73 cases of 1" gelignite, sound on arrival in July, but showing a 45 per cent incidence of spoilage when subjected to individual plug examination after four months' storage known to be satisfactory. Exudation, or seepage of nitroglycerin, was detected in a 600-case railage of gelignite to Kalgoorlie. Incipient liquefaction at the inner edge of the wrapper extended no further than two inches along the paper in the worst specimens, and not a sign of permeation on the exterior surface was noticed. Such localised occurrence of exudate, too small on any one plug for response to percussion testing, was deemed so devoid of hazard that the whole consignment was released. Lest the defect became progressive, prospective users were asked to report any irregularity in appearance or performance. Neither during the fortnight in which the gelignite was consumed nor later was any adverse comment received.

Further minor outbreaks of exudation reported to the Branch by Eastern States inspectors were either negligible or not detectable in the remainder of the year's importations. As a whole, and with reservations already indicated, the quality of explosives in 1961 could well be described as satisfactory. This assertion is based not merely on physical condition and stability, as established by some 2,500 heat tests, but takes account also of detonation velocity, sensitivity and chemical analysis.

*Packaging of Explosives.*

Their suitability for railage and road conveyance being well established, fibreboard encased explosives were shipped at first experimentally and then as regular practice over the year under review. The load was usually superposed on a stable level platform of wooden cases which also served to minimise possible contact with bilgewater. Inspection in the hold dispelled earlier apprehension of crushing and deformation, provided dry conditions prevailed. Where heavily wetted, however, the fibreboard lost rigidity, became prone to tearing and tended to assume grotesque shape. Even in such extreme instances the cases remained handleable and, assisted by the liners, lost none of their contents.

Despite maintenance and precautions, occasional ingress of seawater has occurred ever since the first shallow-draft vessels brought explosives to Woodman's Point. The future of fibreboard packaging therefore appears linked with enhanced moisture resistance and wet strength, and at least one Australian Explosives Department is seeking regulation accordingly.

Other packaging changes came about by acceptance of fibreboard for small arms ammunition, and even the traditional black japanned detonator "tin" is under experimental replacement by a stiffened cardboard box. These containers, more distinctively labelled than formerly, may be furnished with perforated inserts to ensure safety in repacking small orders.

*Waxless-ended Explosives Cartridges.*

Explosives wrapped as usual in pre-waxed paper but devoid of additional end sealing have been preferred for underground use on the Eastern Goldfields because of the lower carbon monoxide expected from less organic matter. During the introductory stages, periodic gas analyses indicated small variable benefits. This aspect was exploited by the industry on the grounds that any suppression of lethal fumes was worthwhile, no matter how thorough the ventilation. The outcome has been a unanimous demand for continued adequate supplies of waxless-ended explosives. Notwithstanding indifference or even aversion in other States, the manufacturers agreed to meet West Australian requirements, but an obstacle arose from a section of the Victorian Explosives Act and Regulations requiring thorough waterproofing of explosives in the class under discussion. We feel—and the Chamber of Mines Underground Managers' Committee also presses the point—that elimination of surplus wax has not appreciably lowered moisture resistance of explosives used soon after manufacture in the low atmospheric humidity general on the goldfields. The Chief Inspector in Victoria has been sympathetic to our views and most helpful in issuing special packing authority to maintain supplies. As this concession may not hold indefinitely, negotiations will continue to ensure that the local mining requirements are amply fulfilled.

*Explosives for Destruction.*

About 1½ tons of explosives representing all varieties were destroyed by controlled burning in small quantities. The bulk was made up of residual material from analysis and heat testing and sodden plugs from leaking holds or unsatisfactory land storage. The remainder consisted of unwanted or deteriorated explosives submitted by the police and public.

*Criminal Misuse of Explosives.*

On 17th April an explosion heard a mile away left a crater in front of a Dalkeith house, dislodged limestone foundations, broke windows and cracked concrete. Police and officers from the Explosives Branch could find neither fuse remnants nor indeed anything to indicate the type of explosive or by whom placed and fired. Analyses of soil and other specimens similarly failed to give a lead.

*Magazine and Store Inspections.*

The year's activities extended to most of the goldfields and lower portion of the State. Except on Koolan Island, no new major magazines were constructed, and a drive was therefore made toward better security and distancing of the older establishments. Sometimes where conditions had altered since previous inspection, mere relocation of small magazines or licensed vendors' explosives receptacles served to restore the requisite isolation. Suggestions for rebuilding, renovating or enlarging magazines if warranted were well received and implemented. Small quarries, however, continued to present problems which proved more acute with explosives storage below minimum licensing quantity. Whatever the amount, reasonable security and protection should be exercised with all explosives, detonators and fuse. Some local authorities regulate quarrying; it is believed that control should be extended to illegalise any such operations without proper facilities for safeguarding explosives.

*Inspection of Explosives Importations.*

Visual examination of cases in the supply vessel's holds prior to detailed inspection and testing continued unchanged. The Branch's staff could not regularly exercise the same vigilance over bulk at Kalgoorlie, from which centre, however, unopened cases railed each week to Woodman's Point were subjected to treatment identical with that for shipments. The only known instance of unchecked explosives entering consumption was at Cockatoo Island, formerly served by the northerly shipping route from Newcastle, but on each occasion acceptance was contingent upon receipt of the N.S.W. Explosives Department's certificate of compliance with heat test and physical soundness.

*Inspection of Ordnance Movements in Harbours.*

Regulation No. 218 framed under the Fremantle Harbour Trust Act, 1902-1954, invests supervisory powers on the Inspector, charges him to enforce relevant regulations and to pursue whatever action or safety measures considered necessary during the presence and handling of explosives in waters under the Trust's control. The year's inspectional work to this end was quite comprehensive, for apart from the usual munitioning and demunitioning operations in the Inner Harbour, two movements over the Naval Jetty south of Woodman's Point took place and another from a freighter also carrying commercial explosives to the Reserve. The first dealt with about 160 tons of aerial bombs roaded by the R.A.A.F. at Pearce for lighterage to a ship in Cockburn Anchorage. Next, in a large disposal job extending over three weeks, quantities of unserviceable and over-age ordnance from the R.A.N.R. Depot, Byford, were dumped in deep water beyond Rottnest by H.M.A.S. Diamantina. In the third undertaking, M.V. Blythe Star discharged a mixed cargo of commercial and military explosives before loading up with other services material for return.

Though beset with various problems, the above work was carried through to completion under stringent and faithfully-observed safety precautions. The Fremantle Harbour Trust and Explosives Branch were both gratified at the diversion of large-scale explosives handling from the Inner Harbour, and it is hoped that a pattern has been set for the future.

*Explosives Reserves.*

*Kalgoorlie.*—A survey of the area and environs, completed last September, clarified many points previously in doubt or unknown. With boundaries, fencing and building locations defined, positions were chosen for additional magazines which the direct railage scheme may bring into being. The road and rail layout was examined in the light of modernisation expected in due course consequent upon westward extension of the 4 ft. 8½ in. gauge line.

*Woodman's Point.*—There were no major developments during the year. The beach sand-drift problem, a recurrent nuisance in fouling crossover points and depositing by the south fence, was discussed with engineers and others without arriving at any practical solution.

*General.*

Periodic requests that certain gazetted explosives reserves be released for industrial or recreational purposes were considered primarily in relation to a district's present and possible future explosives requirements. In general, land was relinquished only if an alternative site was available. This principle of exchange has sometimes reacted advantageously, as at Geraldton where a block under offer was found more suitable and accessible than the old one.

*Fireworks—Shopgoods Class.*

Despite assurance that controls beyond those provided by regulation were not intended for the season ending in November, the clamour for modification or even banning of all fireworks was reflected to some extent in the sizes and types on sale. Importations from England, Hong Kong, N.S.W. and Victoria comprised mainly well-known lines complying with State requirements and rarely found objectionably noisy or violent. As usual, odd instances arose where adjustments were recommended, particularly in ensuring extinction of falling stars before ground level. A few composite fireworks of fearsome size and powder content were included in one manufacturer's advance sample box probably as a "try-out"—which failed. Rockets capped with sharp plastic cones came under notice following investigation in Victoria, where the Chief Inspector found dangerous penetrative characteristics by firing horizontally at lead sheet. One such rocket was responsible for severe throat injury to a boy struck at close range. The hard tips, which contributed nothing to performance and spectacle, were consequently disallowed under existing provision for paper and cardboard only as constructional materials.

*Fireworks—Display.*

The products of two local licensed firework manufacturers were in demand for displays at several public functions. A problem loomed up from two importations of semi-display lines, one accompanied by adequate directions and safety pointers whilst the other left much to skill and judgment. These goods, well made and acceptable under Class 7 Division 2 category, were more suited to small communal celebrations than home use. The Branch instituted a permit-to-purchase scheme so that prospective owners might become known and instructed where necessary, but actually very few sales occurred.

*Firework Composition—Accident.*

Premature ignition of a smoke bomb mixture caused painful burns to a schoolboy at Palmyra. His collection of apparatus and reagents, examined at police request, contained a couple of potent chemicals and of course the usual lengths of metal pipe intended as casing. No charge was laid, but the illegality and danger of such pursuits was emphasised before the lad and his parents.

*Explosives and Dangerous Goods Act.*

Passage of the legislation late last session through both Houses without amendment was recorded with satisfaction. As assent is not expected till 1962 and regulations have still to be gazetted, a description of the whole structure seems better deferred until experience in administration, interpretation and public reaction has accumulated. Preparation involved some years' intermittent labours. The text embodies both original provisions and those which after analysis, inquiry and conference discussion were deemed the most desirable features of the English and Australasian Acts.

*Acknowledgments.*

To the Hon. Minister and colleagues, Crown Law officers and others connected with the drafting and introduction of the new Act gratitude is expressed. Contingent matters at Head Office heaped on regular duties meant heavier work, with admirable response. Praise is also due to the management and staff of the coastal and goldfields explosives reserves. Finally, at the risk of repeating what has been recorded or inferred before, the Branch places high value on the attitude toward it of the many departments, businesses and individuals concerned with importation, conveyance, storage, sale and use of explosives.

F. F. ALLSOP,
Chief Inspector of Explosives.

# DIVISION IX

## *Report of Chairman, Miner's Phthisis Board and Superintendent Mine Workers' Relief Act-1961*

*Under Secretary for Mines:*

1. I have the honour to submit for the information of the Honourable Minister for Mines, my report on this Branch of the Mines Department for the year 1961.

*General.*

2. The State Public Health Department, under arrangements made with this Department, continued the periodical examination of mine workers, the work being carried on throughout the year at the Kalgoorlie Laboratory, and a mobile x-ray unit visited the Dundas, Coolgardie, Murchison, Mt. Margaret, North Coolgardie, Phillips River, West Pilbara and Yilgarn Goldfields, the South-West Mineral Field and Esperance, while the mobile unit staff examined miners at Yampi with equipment provided by Australian Iron and Steel Limited.

*Mine Workers' Relief Act.*

3. The examinations under the Mine Workers' Relief Act during the year totalled 5,753 as compared with 5,759 for the previous year, a decrease of six. The results of the examinations are as follows:—

| | |
|---|---|
| Normal | 5,188 |
| Silicosis early, previously normal | 54 |
| Silicosis early, previously silicosis early | 479 |
| Silicosis advanced, previously silicosis early | 13 |
| Silicosis plus tuberculosis, previously normal | 2 |
| Silicosis plus tuberculosis, previously silicosis early | 3 |
| Tuberculosis | 3 |
| Asbestosis early, previously normal | 3 |
| Asbestosis early, previously asbestosis early | 4 |
| Asbestosis advanced, previously asbestosis early | 1 |
| Asbestosis plus silicosis, previously normal | 1 |
| Asbestosis plus silicosis, previously silicosis early | 1 |
| Asbestosis plus silicosis, previously asbestosis plus silicosis | 1 |
| Total | 5,753 |

These 1961 figures; but not in such detailed analysis, together with the figures for the previous years, are shown in the Table annexed hereto. Graphs are also attached illustrating the trend of examinations since 1940.

3.1.—Analyses of Examinations: In explanation of the examination figures I desire to make the following comments:—

3.1.1.—Normal, etc.: These numbered 5,188 or 90.18 per cent. of the men examined and include men having first class lives or suffering from fibrosis only; the figures for the previous year being 5,214 or 90.54 per cent.

3.1.2.—Early Silicosis: These numbered 533 of which 54 were new cases and 479 had been previously reported, the figures for 1960 being 50 and 473 respectively. Early silicotics represent 9.26 per cent. of the men examined, the percentage for the previous year being 9.08.

3.1.3.—Advanced Silicosis: There were 13 cases reported and all were men who advanced from early silicosis during the year. Advanced silicotics represent 0.23 per cent. of the men examined, the percentage for the previous year being 0.09.

3.1.4.—Silicosis Plus Tuberculosis: Five cases were reported compared with 11 in 1960.

3.1.5.—Tuberculosis Only: Three cases were reported, which is the same number as in 1960.

3.1.6.—Asbestosis: One case of advanced asbestosis and 10 cases of early asbestosis were reported. Of the early cases four were new and six had been previously reported. Cases of asbestosis represented 0.19 per cent. of the total examinations.

*Mines Regulation Act.*

4. Examinations under the Mines Regulation Act totalled 2,133. These were in addition to the 5,753 examinations under the Mine Workers' Relief Act. There was an increase of 507 examinations under this Act in 1961 as compared with those in 1960. Of the total of 2,133 men examined, 1,753 were new applicants and 380 were re-examinees.

4.1.—Analyses of Examinations: Particulars of the examinations are as follows:—

4.1.1.—New Applicants:

| | |
|---|---|
| Normal | 1,732 |
| Pneumoconiosis or increased fibrosis | 7 |
| Silicosis early | Nil |
| Silicosis advanced | Nil |
| Silicosis plus tuberculosis | Nil |
| Silicosis early plus query tuberculosis | Nil |
| Tuberculosis | Nil |
| Query tuberculosis | 5 |
| Other cases | 9 |
| Total | 1,753 |

Of the above applicants for admission into the industry, 1,732 received the Initial Certificate (Form 2), six received the Temporary Rejection Certificate (Form 3), 14 received the Rejection Certificate (Form 4) and in one case no certificate was issued. Thus of the 1,753 applicants, 1,732, or 98.80 per cent., were eligible for employment anywhere on a mine.

4.1.2.—Re-examinees:

| | |
|---|---|
| Normal | 335 |
| Pneumoconiosis | 24 |
| Pneumoconiosis plus query tuberculosis | Nil |
| Silicosis early | 11 |
| Silicosis advanced | Nil |
| Silicosis early plus tuberculosis | Nil |
| Silicosis early plus query tuberculosis | Nil |
| Tuberculosis | 1 |
| Query tuberculosis | 4 |
| Other conditions | 5 |
| Total | 380 |

These men had been previously examined and some were in the industry prior to this examination. 327 received the Initial Certificate (Form 2), two received the Temporary Rejection Certificate (Form 3), three received the Rejection Certificate (Form 4), 16 received the Re-admission Certificate (Form 5), 27 received the Special Certificate (Form 9) and in five cases no certificate was issued. Thus of the 380 men examined 343 were eligible for employment anywhere on a mine, 27 were eligible for surface work only and 10 were not eligible for work on a mine.

4.1.3.—Grouping of Examinations—New Applicants and Re-examinees: Grouping the two sets of figures discloses that the following certificates were issued under the Mines Regulation Act:—

| | |
|---|---|
| Initial Certificates (Form 2) | 2,059 |
| Temporary Rejection Certificates (Form 3) | 8 |
| Rejection Certificates (Form 4) | 17 |
| Re-admission Certificates (Form 5) | 16 |
| Special Certificates (Form 9) | 27 |
| No certificates | 6 |
| Total | 2,133 |

The percentage of men of normal health (Initial Certificates) to the number examined was 96.53 per cent. compared with 93.73 per cent. in 1960.

*Miner's Phthisis Act.*

5. The amount of compensation paid during the year totalled £11,683 1s. 3d. compared with £12,734 1s. 10d. for the previous year.

The number of beneficiaries under the Act on the 31st December, 1961, was 106, being eight exminers and 98 widows.

*Administrative.*

6. During the year extensive amendments were made to the Mine Workers' Relief Act, and while a number of these were minor in nature the following changes are of particular interest:—

(i) The period during which a person is deemed to be a mine worker after having ceased work in the mining industry was extended from one year to three years for persons found in that period to be suffering from silicosis, asbestosis, or tuberculosis with silicosis or asbestosis, and to two years for persons found to be suffering from tuberculosis in the second year of his leaving the industry providing a Medical Board shall certify that the tuberculous condition is a result of that person's employment as a mine worker. As before, a person found to have tuberculosis at any time during the first twelve months of his leaving the industry is deemed a mine worker without reference to any Board.

(ii) Provision was made for the establishment of an Appeal Board to which any examinee under the Act may appeal against the medical diagnosis of the Laboratory.

(iii) The provision for the initial benefit of £750 which tuberculous men used to draw at a maximum rate of £3 10s. per week was deleted, and these beneficiaries now may immediately receive the higher maximum benefit of £4 10s. per week as provided by Scale 1 of the Second Schedule under the Act.

(iv) Provision was made for the termination of benefits payable for tuberculosis upon the Laboratory's certificate that the beneficiary's tuberculous condition has been arrested and that he is fit for full-time gainful employment. If, however, the person suffers a recurrence of the condition, the Fund benefits shall be reinstated.

(v) The scope of benefits was increased to include under certain conditions, registered early silicotics who are invalid or old age pensioners or who are unable to work on account of some other malady or disease which is not compensable under the Worker's Compensation Act.

(vi) To meet the added liability caused by increased benefits, contributions to the Fund were increased by regulation from 1s. to 1s. 9d. per week.

(vii) The amendments mentioned also refer to prospectors who are placed in much the same position as the mine workers except that prospectors do not qualify for compensation under the Worker's Compensation Act on account of there being no employer-employee relationship in their case.

W. Y. R. GANNON,
Superintendent Mine Workers' Relief Act,
and Chairman Miner's Phthisis Board.

(13)—57785



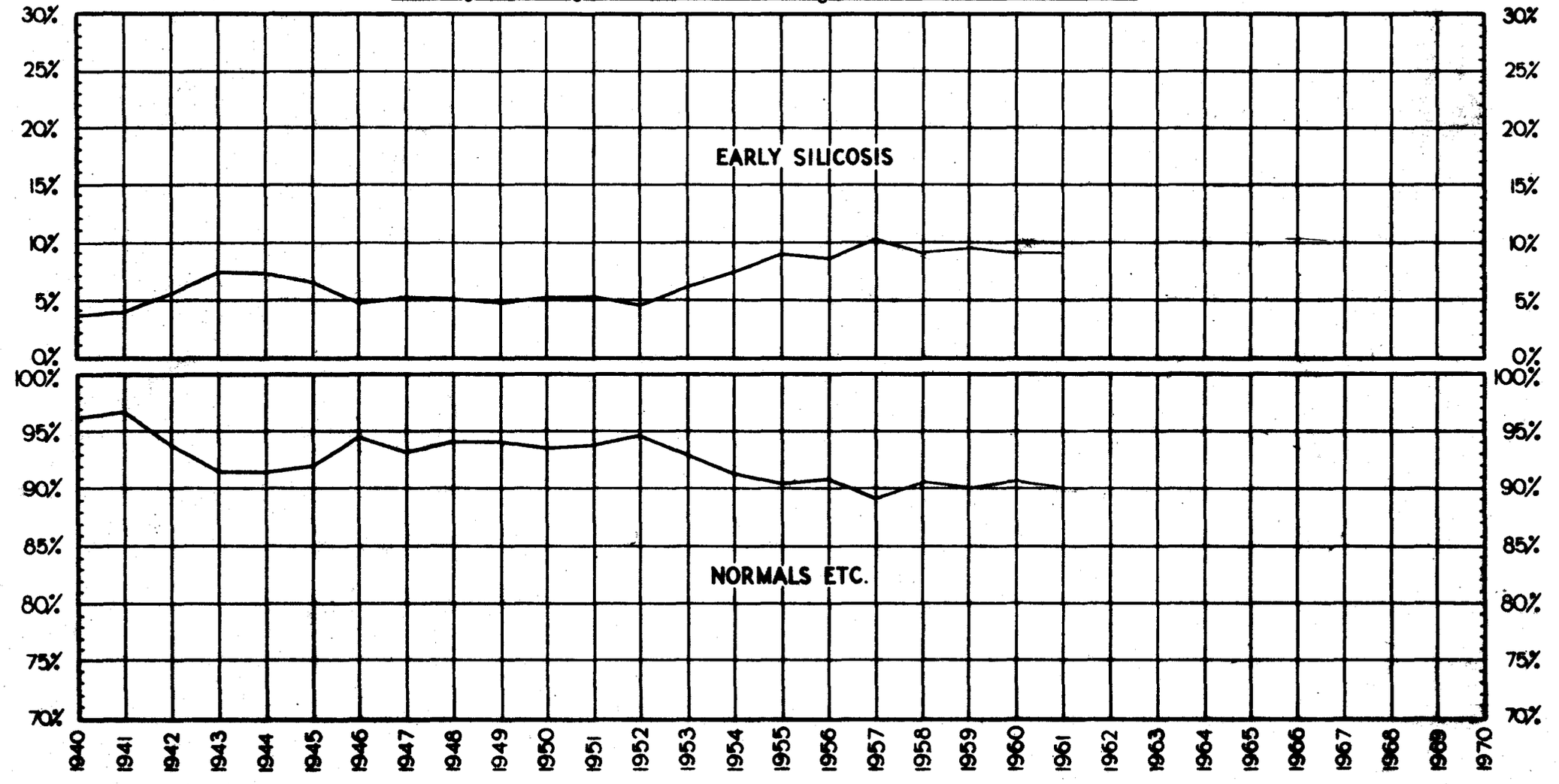
## Table showing Results of Periodical Examination of Mine Workers from Inception of Examinations (1925).

| Year | Normal | | Silicosis Early | | | | Silicosis Advanced | | | | | Silicosis plus Tuberculosis | | | | | Tuberculosis Only | | Asbestosis (Segregation of Asbestosis diagnoses commenced in 1959.) | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Per Cent. | Previously reported as Normal etc. | Previously reported as Silicosis Early | Total | Per Cent. | Previously reported as Normal etc. | Previously reported as Silicosis Early | Previously reported as Silicosis Advanced | Total | Per Cent. | Previously reported as Normal etc. | Previously reported as Silicosis Early | Previously reported as Silicosis Advanced | Total | Per Cent. | Total | Per Cent. | Asbestosis early previously normal | Asbestosis early previously asbestosis early | Asbestosis advanced previously normal | Asbestosis advanced previously asbestosis early | Asbestosis advanced previously asbestosis advanced | Asbestosis plus tuberculosis previously normal | Asbestosis plus tuberculosis previously asbestosis | Total | Per Cent. | |
| 1925<br>1926 | 3,239 | 80·5 | .... | .... | 459 | 11·4 | .... | .... | .... | 183 | 4·5 | .... | .... | .... | 131 | 3·3 | 11 | 0·3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,023 |
| 1927 | 3,116 | 83·6 | 33 | 348 | 381 | 10·2 | 8 | .... | 85 | 93 | 2·5 | 39 | 27 | 62 | 128 | 3·4 | 10 | 0·3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,728 |
| 1928 | 2,977 | 85·5 | 59 | 303 | 362 | 10·4 | 3 | 16 | 79 | 98 | 2·8 | 18 | 14 | 10 | 42 | 1·2 | 4 | 0·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,483 |
| 1929 | 2,120 | 81·9 | 102 | 224 | 326 | 12·6 | .... | 34 | 60 | 94 | 3·6 | 8 | 14 | 19 | 41 | 1·6 | 7 | 0·3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2,588 |
| 1930 | 2,785 | 81·9 | 136 | 247 | 383 | 11·3 | 2 | 22 | 43 | 67 | 2·0 | 8 | 60 | 46 | 114 | 3·3 | 50 | 1·5 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,399 |
| 1931 | 2,530 | 84·0 | 94 | 252 | 346 | 11·5 | .... | 18 | 35 | 53 | 1·8 | 4 | 35 | 19 | 58 | 1·9 | 25 | ·8 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,012 |
| 1932 | 3,835 | 89·5 | 35 | 338 | 373 | 8·7 | .... | 6 | 47 | 53 | 1·2 | 3 | 9 | 4 | 16 | ·4 | 8 | ·2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,285 |
| 1933 | 2,920 | 86·5 | 57 | 322 | 379 | 11·2 | 1 | 15 | 44 | 60 | 1·8 | 2 | 9 | 4 | 15 | ·4 | 3 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,377 |
| 1934 | 5,140 | 92·4 | 54 | 315 | 369 | 6·6 | 1 | 24 | 12 | 37 | ·7 | 6 | 6 | .... | 12 | ·2 | 5 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,563 |
| 1935 | 4,437 | 92·3 | 35 | 303 | 338 | 7·0 | .... | 24 | 2 | 26 | ·6 | .... | 5 | .... | 5 | ·1 | 2 | ·0 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,808 |
| 1936 | 6,972 | 94·7 | 29 | 323 | 352 | 4·8 | 1 | 15 | 4 | 20 | ·3 | 3 | 8 | .... | 11 | ·1 | 8 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7,363 |
| 1937 | 7,487 | 95·4 | 15 | 319 | 334 | 4·3 | .... | 14 | 4 | 18 | ·2 | 1 | 10 | .... | 11 | ·1 | 2 | ·0 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7,852 |
| 1938 | 6,833 | 95·7 | 13 | 266 | 279 | 3·9 | .... | 15 | 2 | 17 | ·2 | 1 | 8 | .... | 9 | ·1 | 3 | ·0 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7,141 |
| 1939 | 6,670 | 95·6 | 18 | 264 | 282 | 4·0 | .... | 7 | 3 | 10 | ·1 | 1 | 9 | 1 | 11 | ·2 | 2 | ·0 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6,975 |
| 1940 | 7,023 | 96·2 | 12 | 245 | 257 | 3·5 | .... | 10 | 1 | 11 | ·2 | .... | 4 | .... | 4 | ·0 | 4 | ·0 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7,299 |
| 1941 | 6,840 | 95·8 | 32 | 248 | 280 | 3·9 | .... | 11 | 3 | 14 | ·2 | .... | .... | .... | .... | .... | 7 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7,141 |
| 1942 | 5,469 | 93·9 | 61 | 264 | 325 | 5·6 | .... | 20 | 5 | 25 | ·4 | .... | 2 | .... | 2 | ·0 | 3 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,824 |
| 1943 | 3,932 | 91·5 | 63 | 262 | 325 | 7·6 | .... | 25 | 7 | 32 | ·7 | .... | 5 | .... | 5 | ·1 | 4 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,298 |
| 1944 | 4,079 | 91·5 | 70 | 270 | 340 | 7·5 | .... | 21 | 14 | 35 | ·8 | 1 | 7 | .... | 8 | ·2 | 6 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,468 |
| 1945 | 3,071 | 92·1 | 54 | 166 | 220 | 6·6 | .... | 26 | 10 | 36 | 1·1 | 3 | 2 | .... | 5 | ·2 | 2 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,334 |
| 1946 | 5,294 | 94·4 | 89 | 172 | 261 | 4·7 | 1 | 36 | 2 | 39 | ·7 | 3 | 1 | 2 | 6 | ·1 | 6 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,606 |
| 1947 | 6,021 | 93·3 | 101 | 237 | 338 | 5·2 | .... | 49 | 9 | 58 | 1·0 | 13 | 11 | 1 | 25 | ·3 | 8 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6,450 |
| 1948 | 4,827 | 94·0 | 24 | 239 | 263 | 5·1 | .... | 18 | 17 | 35 | ·7 | 1 | 3 | .... | 4 | ·1 | 5 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,134 |
| 1949 | 5,162 | 94·0 | 24 | 239 | 263 | 4·8 | .... | 20 | 31 | 51 | 1·0 | 3 | 2 | 1 | 6 | ·1 | 7 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,489 |
| 1950 | 5,077 | 93·6 | 14 | 269 | 283 | 5·2 | .... | 14 | 41 | 55 | 1·0 | .... | 1 | 2 | 3 | ·1 | 8 | ·2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,426 |
| 1951 | 4,642 | 93·9 | 13 | 248 | 261 | 5·3 | .... | 9 | 20 | 29 | ·6 | .... | 4 | 2 | 6 | ·1 | 4 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,942 |
| 1952 | 5,073 | 94·6 | 8 | 234 | 242 | 4·5 | .... | 4 | 31 | 35 | ·6 | .... | 2 | .... | 2 | ·1 | 7 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,359 |
| 1953 | 4,474 | 93·03 | 74 | 225 | 299 | 6·22 | .... | 8 | 24 | 32 | ·6 | .... | 2 | .... | 2 | ·1 | 2 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,809 |
| 1954 | 5,142 | 91·33 | 154 | 275 | 429 | 7·62 | .... | 22 | 21 | 43 | ·76 | 1 | 6 | 2 | 9 | ·1 | 7 | ·1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,630 |
| 1955 | 4,559 | 90·40 | 63 | 386 | 449 | 8·90 | .... | 9 | 22 | 31 | ·62 | 1 | 1 | 1 | 3 | ·06 | 1 | ·02 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,043 |
| 1956 | 4,600 | 90·78 | 25 | 401 | 426 | 8·41 | .... | 8 | 25 | 33 | ·65 | 1 | 3 | .... | 4 | ·08 | 4 | ·08 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,067 |
| 1957 | 3,925 | 89·08 | 30 | 424 | 454 | 10·30 | .... | 8 | 10 | 18 | ·41 | 1 | 4 | .... | 5 | ·12 | 4 | ·09 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,406 |
| 1958 | 5,154 | 90·20 | 46 | 483 | 529 | 9·26 | .... | 15 | 9 | 24 | ·42 | .... | 6 | .... | 6 | ·10 | 1 | ·02 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5,714 |
| 1959 | 5,242 | 90·10 | 66 | 485 | 551 | 9·47 | .... | 9 | .... | .... | ·15 | 1 | 5 | 1 | 7 | ·12 | 3 | ·05 | 6 | .... | .... | .... | .... | .... | .... | 6 | .... | 5,818 |
| 1960 | 5,214 | 90·54 | 50 | 473 | 523 | 9·08 | .... | 5 | .... | 5 | ·09 | 2 | 9 | .... | 11 | ·19 | 3 | ·05 | 2 | .... | .... | .... | .... | .... | 1 | .... | 3 | 5,759 |
| 1961 | 5,188 | 90·18 | 54 | 479 | 533 | 9·26 | .... | 13 | .... | 13 | ·23 | 2 | 3 | .... | 5 | ·09 | 3 | ·05 | 5 | 5 | .... | 1 | .... | .... | .... | 11 | ·19 | 5,755 |

# PERIODICAL EXAMINATION OF MINE WORKERS

## GRAPH No. 1

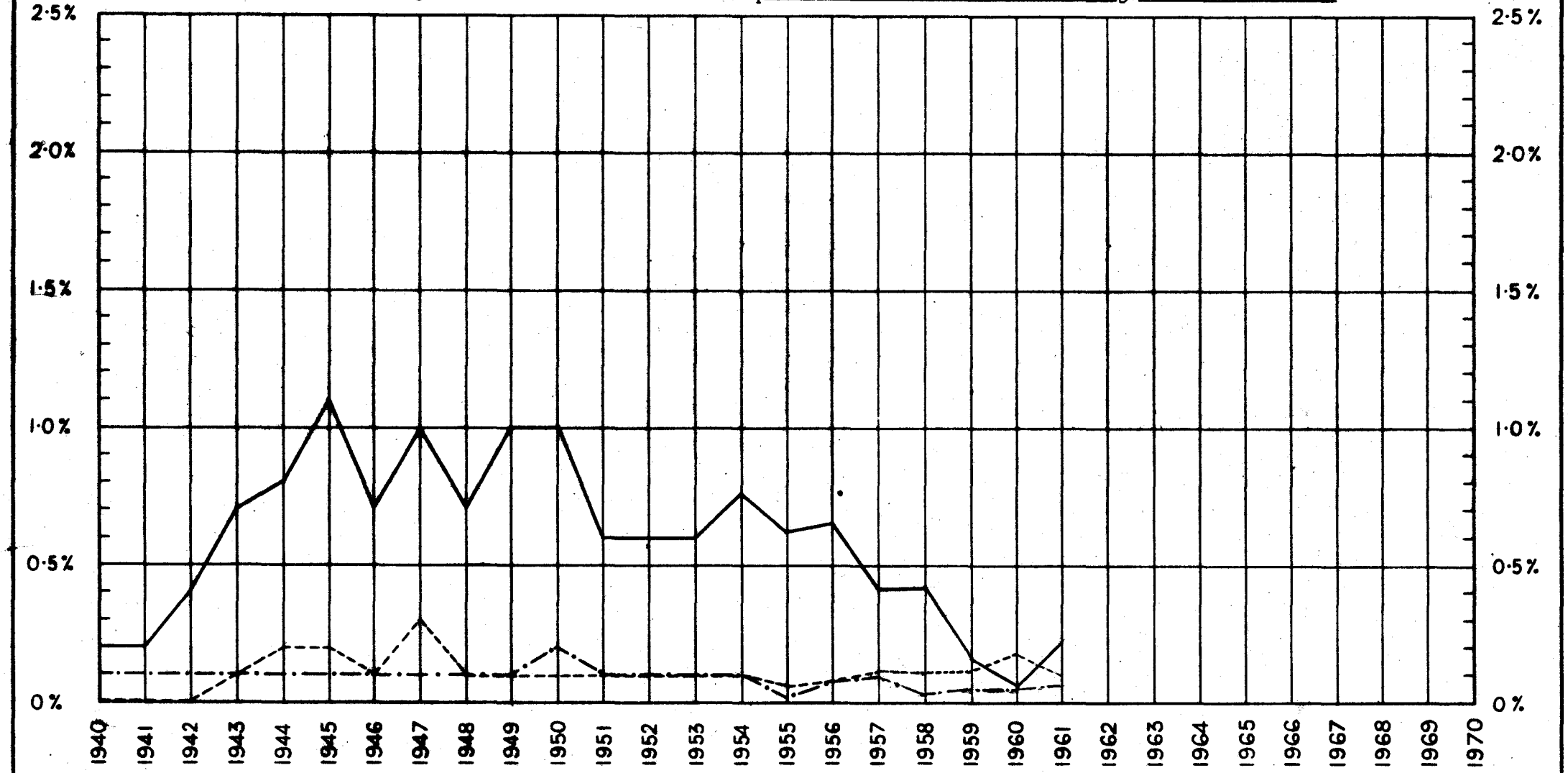
Showing Percentages of Normals and Early Silicotics from 1940 onwards



# PERIODICAL EXAMINATION OF MINE WORKERS

## GRAPH No. 2

Showing Percentages of Silicosis Advanced, Silicosis plus Tuberculosis and Tuberculosis only, from 1940 onwards




*Silicosis Advanced* ———— *Silicosis Plus Tuberculosis* – – – – – *Tuberculosis Only* —·—·—·—

# DIVISION X

# *Report of the Chief Draftsman for the Year 1961*

*Under Secretary for Mines:*

I have the honour to submit, for the information of the Honourable the Minister for Mines, my report on the operations of the Survey and Mapping Branch for the year ended 31st December, 1961.

*Staff.*

The staff of the Branch consists of 25 males and 4 females. Due to the increased interest in iron ore and other minerals the amount of work in all sections increased considerably and the officers co-operated excellently to cope with the added demand. Two cadet draftsmen, D. Maxwell and I. Edwards, were successful in passing the final examinations at the end of their four-year course of instruction at the Perth Technical College. They are now entitled to receive the Diploma of Cartography from that institution.

During the year some of the cadets gained valuable knowledge and practical experience from field excursions with licensed surveyors and departmental geologists.

The gazettal, on 10th November, 1961, of the South-West Mineral Field, necessitated by the great increase in mineral activity in the area, has created a large number of problems in regard to alienation of land, and liaison with other departments and local government authorities.

Reports, in summarised form, of the sections of the Branch are as follows:—

*Surveys.*

Contract surveys in conformance with Mines Department regulations to the value of £4,453 6s. 3d. were carried out by survey parties as follows:—

| | | | | | |
|---|---|---|---|---|---|
| L. M. Norman .... | 13 | Field | Books, | 65 | Surveys. |
| E. Brook .... .... | 4 | „ | „ | 19 | „ |
| F. G. Medcalf .... | 1 | „ | „ | 9 | „ |
| P. M. Crowe .... | 1 | „ | „ | 1 | „ |
| R. K. Morland .... | 1 | „ | „ | 1 | „ |
| Total .... .... | 20 | „ | „ | 95 | „ |

In addition to normal survey of tenements, a series of cadastral connections were made to the State geodetic triangulation system by Surveyor K. A. Pownall of the Surveyor General's Division, Lands Department. These connections were made at the request of this Branch, with the co-operation of the Lands Department, and are in line with the policy of this department to carry accurate geodetic control into mining groups throughout the State.

Surveys were carried out at the following localities during the year:—

Outside Proclaimed Goldfield and South-West Mining District—
- Wanneroo
- Lake Gnangara
- Dwellingup
- Jarrahdale
- Gosnells
- Glen Forrest
- Capel
- Hines Hill
- Mt. Kokeby
- Namban.

Collie Mineral Field—
- Shotts
- Collie Cardiff.

Murchison Goldfield—
- Big Bell
- Mt. Magnet
- Chesterfield
- Cashmans.

East Murchison Goldfield—
- Wiluna
- Kathleen Valley.

Yalgoo Goldfield—
- Dalgaranga.

Yilgarn Goldfield—
- Lake Brown
- Westonia.

Coolgardie Goldfield—
- Kambalda.

East Coolgardie Goldfield—
- Kalgoorlie.

Kimberley Goldfield—
- Palm Springs.

West Pilbara Goldfield—
- Whim Creek.

Pilbara Goldfield—
- Eleys
- Cooglegong
- Middle Creek
- Blue Spec
- Bill Jim
- Nullagine
- Five Mile
- Moolyella
- Wymans Well
- Lionel.

*Survey Examination.*

Diagrams of the surveys were drawn and examined. Duplicate and original plans were prepared for 21 lease instruments and two special leases. Diagrams of surrender and resumption were prepared as required.

*Geodetic.*

With the future progress of State development in mind, particularly in the north, the principal geodetic programme was resumed, and computations for the laying down and cadastral plotting control for plans on the Transverse Mercator Projection were made where necessary.

*Mapping*

The main mapping programme carried out was as follows:—

(1) Two maps of areas in the Pilbara Goldfield, 1 mile series, prepared one map 80 % completed.

(2) 1 : 50,000 series. Two maps 80% completed, six commenced.

(3) 20 chain lithographs, Transverse Mercator Projection, 12 drawn.

(4) Standard plans, 13 drawn.

(5) For Geological Surveys, 44 plans were prepared, plus 1,928 prints and copy-rapid duplicates. Nullagine 4 mile map was completed together with a structure map and also a general information map of the Pilbara region.

(6) A State general information map was published, of which 190 copies were supplied to the Commissioner of Police for distribution to the various police stations throughout the State.

(7) Numerous surveys, from field notes, plotted on compilations.

(8) Copy-rapid reproductions for Chemical Laboratories, Explosives and Inspection of Machinery Branch, with miscellaneous plans for State Mining Engineer and Kalgoorlie School of Mines.

(9) Interpretation from air-photos as required and preparation of diagrams and drawings for Annual Report.

*Public Plans.*

| | |
|---|---|
| Number of applications dealt with .... | 977 |
| Number of Public Plans in use or maintained .... .... .... .... .... | 714 |
| Number of existing mining tenements on Public Plans .... .... .... .... | 3848 |
| Number of maps, underground plans, sketches, etc., supplied to public and outstations .... .... .... .... | 684 |
| Number of temporary reserves applied for | 601 |
| Number in force at 31st December, 1961 | 417 |

Number of permits to explore and licenses to prospect for oil were 33 and 42 respectively.

Field inspections were carried out during the year and general liaison was maintained with the Government Printer, various other Government departments, private companies and the public.

L. A. JONES,
Chief Draftsman.

# MINING STATISTICS

## to 31st December, 1961

•

## *Table of Contents*

•


Page

Table I.—Tonnage of Ore Treated and Yield of Gold and Silver, in fine ounces, reported to the Mines Department, from existing Leases during 1961, and Total Production recorded to 31st December, 1961, from all holdings .... 174

Table II.—Total Alluvial, Dollied and Specimen Gold, Tonnage of Ore Treated, Yield of Gold and Silver therefrom, reported to the Mines Department from each respective Goldfield and District .... 208

Table III.—Total Production of Alluvial, Dollied and Specimen Gold, Tonnage of Ore Treated, Yield of Gold and Silver therefrom, since inception to 31st December, 1961 .... 209

Table IV.—Output of Gold Bullion, Concentrates, etc., entered for Export, and received at the Perth Branch of the Royal Mint from 1st January, 1886, to 31st December, 1961, showing Proportion derived from each Goldfield .... 210

MINERALS OTHER THAN GOLD

Table V.—General Return of Ore and Minerals, other than Gold, showing the Quantity Produced and the Value thereof, as reported to the Mines Department from the respective Goldfields and Mineral Fields, during 1961 and previous Years .... 211

Table VI.—Return of Minerals, other than Gold and Silver, showing the Quantity Produced and the Value thereof, as reported to the Mines Department from the respective Goldfields and Mineral Fields, during 1961 216

Table VII.—Showing average number of Men Employed above and underground in the larger Goldmining Companies operating in Western Australia during the Years from 1952 to 1961 inclusive .... 218

# TABLE 1.

PRODUCTION OF GOLD AND SILVER FROM ALL SOURCES, SHOWING IN FINE OUNCES THE OUTPUT AS REPORTED TO THE MINES DEPARTMENT DURING 1961, AND THE TOTAL PRODUCTION TO DATE.

(*Note.*—Lease numbers in brackets indicate that the holding was *voided* during the year.)

(*Note.*—* Denotes mainly derived from treatment of tailings. † Denotes mainly derived from Silver Lead Ore and Concentrates. ‡ Denotes mainly derived from Copper Ore. § Concentrates. || Tantalum.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **Kimberley Goldfield.** | | | | | | | | | | | | |
| Brockman .... | .... | Voided leases .... | .... | .... | .... | .... | .... | .... | .... | 1,545·75 | 1,455·34 | .... |
| | | Sundry claims .... | .... | .... | .... | .... | .... | 7·62 | 7·62 | 2,484·00 | 1,871·92 | .... |
| Halls Creek .... | .... | Voided leases .... | .... | .... | .... | .... | .... | .... | .... | 423·00 | 477·76 | .... |
| | | Sundry claims .... | .... | .... | .... | .... | .... | 27·73 | .... | 217·05 | 179·57 | 12·64 |
| Mary .... .... | .... | Voided leases .... | .... | .... | .... | .... | .... | 82·66 | 951·52 | 399·00 | 210·03 | .... |
| | | Sundry claims .... | .... | .... | .... | .... | .... | .... | 14·36 | 46·85 | 53·66 | .... |
| Mt. Dockrell .... | .... | Voided leases .... | .... | .... | .... | .... | .... | 9·17 | 13·66 | 1,173·70 | 1,206·09 | 93·00 |
| | | Sundry claims .... | .... | .... | .... | .... | .... | 18·89 | 31·31 | 160·00 | 89·64 | .... |
| Panton .... .... | .... | Voided leases .... | .... | .... | .... | .... | .... | .... | .... | 42·95 | 140·47 | .... |
| | | Sundry claims .... | .... | .... | .... | .... | .... | .... | 6·28 | 6·15 | 18·01 | .... |
| Ruby Creek .... | G.M.L. 97 .... | Ruby Queen .... | .... | .... | .... | .... | .... | .... | .... | 3,069·25 | 1,726·56 | 2·14 |
| | | Voided leases .... | .... | .... | .... | .... | .... | .... | 16·05 | 12,902·20 | 9,619·82 | .... |
| | | Sundry claims .... | .... | .... | .... | .... | .... | 12·71 | .... | 281·25 | 183·30 | .... |
| | *From District generally :* | | | | | | | | | | | |
| | | Sundry claims .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | †20·98 |
| | | Reported by Banks and Gold Dealers .... | .... | 15·92 | .... | .... | .... | 8,837·69 | 1,894·04 | ·75 | 8·15 | .... |
| | | **Totals** .... | .... | **15·92** | .... | .... | .... | **8,996·47** | **2,934·84** | **22,751·90** | **17,240·32** | **128·76** |
| **West Kimberley Goldfield.** | | | | | | | | | | | | |
| Napier Range .... | M.C. 29 .... | Devonian Silver Lead Mine .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | †13,575·29 |
| | *From District generally :* | | | | | | | | | | | |
| | | Sundry claims .... | .... | .... | .... | .... | .... | 1·30 | 24·68 | 1·00 | 2·49 | .... |
| | | **Totals** .... | .... | .... | .... | .... | .... | **1·30** | **24·68** | **1·00** | **2·49** | **13,575·29** |

# Pilbara Goldfield.

## MARBLE BAR DISTRICT.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bamboo Creek .... | G.M.L. 1120 .... | Bamboo Queen .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 88·50 | 30·99 | [illegible] | ·34 |
| | 1107 .... .... | Bulletin .... .... .... .... .... | .... | .... | 104·00 | 20·48 | .... | .... | .... | 995·25 | 446·03 | [illegible] | 2·02 |
| | (850) .... .... | Federation .... .... .... .... .... | .... | .... | .... | .... | .... | .... | 8·22 | 3,026·00 | 2,203·86 | | 6·35 |
| | 1118 .... .... | Kitchener .... .... .... .... .... | .... | .... | 161·00 | 21·41 | 2·48 | .... | .... | 261·00 | 61·44 | | 3·53 |
| | 1097, 1096, 1095 | Mt. Prophecy Leases .... .... .... | .... | .... | 185·00 | 40·52 | .... | .... | 24·50 | 3,053·00 | 1,096·72 | | 49·63 |
| | 817 .... .... | Prince Charlie .... .... .... .... | .... | .... | 923·00 | 675·76 | 189·74 | .... | 3·68 | 8,376·00 | 6,003·23 | | 269·16 |
| | 1072 .... .... | Princess May .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 92·50 | 24·27 | | .... |
| | 924 .... .... | True Blue .... .... .... .... .... | .... | .... | 267·00 | 7·25 | ·21 | .... | .... | 3,122·75 | 111·91 | | ·21 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 13·54 | 560·19 | 46,237·85 | 53,505·43 | | 2·62 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 8·97 | 307·83 | 5,208·85 | 3,034·45 | | 7·21 |
| Boodalyerrie .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 292·07 | 120·25 | 587·86 | | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | 7·16 | .... | .... | | .... |
| Braeside .... .... | .... .... .... | Sundry claims and producers .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | | †21,960·80 |
| | | Braeside Lead Claims .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | | †3,892·95 |
| Lalla Rookh .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 4·78 | 3,612·00 | 4,696·33 | | 574·01 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 7,943·00 | 7,675·09 | | .... |
| Marble Bar .... | 930 (956) .... | Alexander Leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 354·50 | 120·94 | | ·81 |
| | 930 .... .... | Alexander .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 640·00 | 114·59 | | .... |
| | 1094 .... .... | Blue Bar .... .... .... .... .... | .... | .... | 50·50 | 5·11 | ·48 | .... | .... | 1,187·50 | 167·19 | | ·48 |
| | 927, etc. .... | Halley's Comet .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 6,360·00 | 6,390·33 | | 680·36 |
| | 1121 .... .... | Little Portree .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 103·00 | 66·88 | | 6·93 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 45·98 | 199·09 | 165,957·49 | 151,729·10 | | 595·61 |
| | | Sundry claims .... .... .... .... | .... | .... | 311·00 | 21·80 | .... | 67·08 | 255·30 | 21,488·54 | 12,846·92 | | 9·43 |
| North Pole .... | 1122 (1123) (1124) | Normay Leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,685·00 | 1,435·98 | | 1,755·28 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 4,339·00 | 1,930·51 | | 260·08 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 669·75 | 298·62 | | 15·82 |
| North Shaw .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 7·53 | .... | 1,072·45 | 996·29 | | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 2·84 | 579·91 | 179·75 | 121·72 | | .... |
| Pilgangoora .... | M.C. 291 .... | Northern Territory Prospecting and Development Co. Ltd. .... .... .... | .... | .... | .... | .... | .... | .... | 2·12 | .... | 39·54 | | .... |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 16·65 | .... | 2,255·00 | 403·60 | | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 161·08 | 45·64 | 483·60 | 150·15 | | .... |
| Sharks .... .... | G.M.L. 1082-1085 | Table Top Leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,082·75 | 594·97 | | 17·28 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 1·43 | .... | 1,739·50 | 1,969·65 | | 1·16 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 163·14 | 47·93 | 1,159·50 | 1,675·34 | | ·97 |
| Talga Talga .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 93·15 | 1,799·00 | 1,760·68 | | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 76·17 | 85·18 | 2,013·65 | 1,509·26 | | ·70 |
| Tambourah .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 73·90 | 1,603·50 | 1,886·22 | | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 89·52 | 294·75 | 3,742·25 | 2,689·78 | | .... |
| Warrawoona .... | 1193 .... .... | Trump .... .... .... .... .... | .... | .... | 83·50 | 7·99 | ·96 | .... | .... | 228·50 | 16·70 | | ·96 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 16·99 | 17,749·30 | 19,645·44 | | 23·70 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 70·98 | 623·67 | 6,632·79 | 4,247·38 | | ·08 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **PILBARA GOLDFIELD—continued.** | | | | | | | | | | | | |
| MARBLE BAR DISTRICT—*continued.* | | | | | | | | | | | | |
| Western Shaw | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 1,222·50 | 957·80 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 22·34 | 67·47 | 71·50 | 81·49 | .... |
| Wodgina | | Sundry claims | .... | .... | .... | .... | .... | .... | 43·37 | ·50 | .... | 3·25 |
| Wymen's Well | 1084 | New Copenhagen | .... | .... | .... | 1·48 | 2·99 | .... | .... | 770·55 | 165·52 | 4·34 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 42·86 | 2,977·29 | 1,258·44 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 4·47 | 51·52 | 2,732·71 | 1,324·64 | 1·47 |
| Yandicoogina | | Voided leases | .... | .... | .... | .... | .... | .... | 140·76 | 3,159·20 | 6,218·83 | .... |
| | | Sundry claims | .... | .... | 18·25 | 18·28 | 5·00 | 4·32 | 239·89 | 622·25 | 682·47 | 45·96 |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | H. B. and C. L. Dorrington (L.T.T. 1451H) | .... | .... | 94·00 | 3·47 | ·42 | .... | .... | 94·00 | *3·47 | ·42 |
| | | H. N. Flegg (L.T.T. 1439H) | .... | .... | .... | .... | .... | .... | .... | .... | *1·04 | .... |
| | | State Battery, Bamboo Creek | .... | .... | .... | 174·35 | 34·26 | .... | .... | 40·00 | *11,686·00 | 296·95 |
| | | State Battery, Marble Bar | .... | .... | .... | 199·68 | 10·25 | .... | .... | 12·00 | *12,083·07 | 63·36 |
| | | Various Works | .... | .... | .... | .... | .... | .... | .... | 286·95 | 1,919·97 | 5·54 |
| | | Reported by Banks and Gold Dealers | 7·28 | ·34 | .... | .... | ·55 | 14,508·50 | 457·01 | .... | 15·41 | †2,224·53 |
| | | **Totals** | **7·28** | **·34** | **2,197·25** | **1,197·58** | **247·34** | **15,264·54** | **4,568·94** | **338,652·72** | **328,683·54** | **32,784·30** |
| **NULLAGINE DISTRICT.** | | | | | | | | | | | | |
| Eastern Creek | | Voided leases | .... | .... | .... | .... | .... | 8·96 | 8·19 | 5,594·00 | 9,854·21 | 14·76 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 12·74 | 1,409·10 | 1,600·71 | 16·90 |
| Elsie | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 586·25 | 1,675·91 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 8·28 | 58·00 | 188·08 | .... |
| McPhee's Creek | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 113·00 | 137·92 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 134·00 | 197·09 | .... |
| Middle Creek | 337L | All Nations | .... | .... | .... | .... | .... | .... | .... | 353·50 | 27·12 | .... |
| | 229L | Barton | .... | .... | 203·00 | 120·80 | .... | 1·22 | .... | 8,489·75 | 4,473·08 | 35·28 |
| | 231L, 264L, 265L, 266L | North West Mining N.L. | .... | .... | 4,842·88 | 3,234·07 | .... | .... | .... | 8,243·57 | 5,223·68 | .... |
| | 231L, etc. | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 53,391·41 | 32,009·01 | 10·99 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 1·02 | 18,459·65 | 11,718·61 | 8·37 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 18·69 | 6,117·60 | 2,437·40 | .... |
| Mosquito Creek | 331L | Ard Patrick | .... | .... | .... | 9·54 | .... | 10·80 | .... | 78·00 | 19·75 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 1·07 | 30·12 | 8,392·30 | 12,839·13 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 181·64 | 3,707·44 | 3,789·21 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nullagine .... .... | 292L .... .... | Alice .... .... .... .... .... | .... | .... | .... | .... | .... | 3·85 | 1,159·85 | 138·85 | 331·29 | 63·45 |
| | 336L .... .... | Happy Wanderer .... .... .... | .... | .... | 102·00 | 39·94 | 4·15 | .... | .... | 201·00 | 80·54 | 4·15 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 599·59 | 9,192·75 | 13,376·46 | 36·92 |
| | | Sundry claims .... .... .... | 5·83 | .... | 13·50 | 18·48 | 2·09 | 321·36 | 684·67 | 6,629·45 | 10,552·87 | 17·31 |
| Spinaway Well .... | 314L .... .... | Copper Hills Copper Mine .... | .... | .... | .... | .... | .... | .... | .... | .... | ‡15·44 | ‡483·78 |
| Twenty Mile Sandy | M.C. 112L .... | J. C. & G. M. Baker .... .... | .... | .... | .... | .... | .... | .... | .... | .... | ·93 | ‡51·20 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 16·97 | 7,243·70 | 9,007·72 | 320·50 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 33·10 | 30·50 | 7,793·85 | 6,283·29 | 2·76 |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | Barton's Battery .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *45·19 | .... |
| | McKinnon's Sluicing Plant (D.C. 10L, 14L, 15L) | .... | .... | .... | .... | .... | 3·89 | 2·23 | .... | 7·20 | .... |
| | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 124·50 | *8,110·35 | 1·37 |
| | Reported by Banks and Gold Dealers .... .... | 5·51 | .... | .... | .... | .... | 10,043·59 | 147·52 | .... | 29·81 | 5·80 |
| | **Totals** .... .... .... .... | **11·34** | .... | **5,161·38** | **3,422·83** | **6·24** | **10,427·84** | **2,902·01** | **146,451·67** | **134,032·00** | **1,073·54** |

## West Pilbara Goldfield.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Croydon .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 8·00 | 5·44 | .... |
| Hong Kong .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 331·00 | 442·45 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 21·40 | ·02 | 9·00 | 3·15 | .... |
| Lower Nicol .... | G.M.L. 177 .... | Swelpme .... .... .... .... | .... | .... | 24·00 | 4·32 | ·43 | .... | .... | 24·00 | 4·32 | ·43 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1·10 | 653·20 | 402·22 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 10·44 | 2·71 | 99·00 | 35·16 | ·40 |
| Mallina .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 141·60 | 128·44 | .... |
| Nicol .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 30·00 | 11·47 | .... |
| Pilbara .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 9·90 | 48·12 | 267·00 | 432·84 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 1·11 | 86·24 | 163·00 | 255·42 | .... |
| Roebourne .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,396·86 | 1,424·04 | 385·15 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 15·47 | 3·29 | 1,934·85 | 811·86 | 130·21 |
| Station Peak .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 177·74 | 41·37 | 11,016·00 | 11,388·18 | ·08 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·69 | .... | 86·50 | 77·23 | .... |
| Towranna .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 2·62 | 3,965·80 | 5,187·51 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 22·00 | 12·35 | .... |
| Upper Nicol .... | .... .... .... | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 6·50 | 2·57 | .... |
| Weerianna .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 3,200·15 | 3,214·45 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 336·00 | 135·26 | 1·29 |
| Whim Creek .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | ‡883·80 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **WEST PILBARA GOLDFIELD—continued.** | | | | | | | | | | | | |
| | | *From Goldfield generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | Various Works | .... | .... | .... | .... | .... | .... | .... | .... | *102·39 | 4·90 |
| | | Sundry claims and leases | .... | .... | .... | .... | .... | .... | 11·77 | .... | .... | †503·36 |
| | | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 6,102·62 | 177·50 | 103·50 | 231·54 | ·87 |
| | | **Totals** | .... | .... | **24·00** | **4·32** | **·43** | **6,339·37** | **374·74** | **24,793·96** | **24,308·29** | **1,910·49** |
| **Ashburton Goldfield.** | | | | | | | | | | | | |
| Belvedere | | Voided leases | .... | .... | .... | .... | .... | .... | 9·88 | 1,560·00 | 435·86 | 176·48 |
| Dead Finish | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 1,699·00 | 874·60 | ·03 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 11·89 | 104·25 | 245·08 | .... |
| Linden Station | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 128·35 | 203·51 | .... |
| Melrose | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 2,704·00 | 840·26 | 213·11 |
| | | Sundry claims | .... | .... | .... | .... | .... | 12·41 | 21·88 | 562·00 | 262·78 | 6·40 |
| Mt. Edith | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 5·00 | 3·97 | .... |
| Mt. Mortimer | | Sundry claims | .... | .... | .... | .... | .... | 364·63 | 315·64 | 44·50 | 40·25 | 74·47 |
| Uroao | | Voided leases | .... | .... | .... | .... | .... | .... | .... | .... | .... | †7,713·22 |
| | | *From Goldfield generally :* | | | | | | | | | | |
| | | Sundry claims (Silver-Lead) | .... | .... | .... | .... | .... | .... | .... | .... | .... | †33,787·67 |
| | | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 8,890·33 | 123·17 | .... | 7·12 | .... |
| | | **Totals** | .... | .... | .... | .... | .... | **9,267·37** | **482·46** | **6,807·10** | **2,913·43** | **41,971·38** |
| **Gascoyne Goldfield.** | | | | | | | | | | | | |
| Bangemall | | Voided leases | .... | .... | .... | .... | .... | .... | 6·22 | 350·70 | 313·82 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 88·97 | 33·55 | 36·30 | 203·47 | .... |
| Carnarvon | M.C. 4 | Allen McDonald | .... | .... | .... | .... | .... | .... | 49·09 | .... | .... | 26·92 |
| | G.M.L. 46C | Star Mangaroon | .... | .... | 77·00 | 205·89 | .... | .... | .... | 77·00 | 205·89 | .... |
| | | Sundry claims | .... | .... | 60·00 | 238·64 | .... | .... | .... | 97·00 | 376·12 | .... |
| | | *From Goldfield generally :* | | | | | | | | | | |
| | | Reported by Banks and Gold Dealers | 3·26 | 4·28 | .... | .... | .... | 607·90 | 28·97 | .... | 2·56 | .... |
| | | **Totals** | **3·26** | **4·28** | **137·00** | **444·53** | .... | **696·87** | **117·83** | **561·00** | **1,101·86** | **26·92** |

# Peak Hill Goldfield.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulloo Downs .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | †50·09 |
| Egerton .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 62·31 | 224·68 | 7,292·25 | 6,604·91 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 235·35 | 23·51 | 1,501·77 | 791·34 | .... | |
| Horseshoe .... | G.M.L. 568P .... | Horseshoe Lights .... .... .... | .... | .... | 1,536·00 | 168·27 | ·34 | .... | .... | 9,549·00 | 1,255·34 | ·34 | |
| | 568P, etc. .... | Anglo-Westralian Mining Pty. Ltd. .... | .... | .... | .... | .... | .... | .... | .... | 135,872·00 | 22,870·80 | 1,407·05 | |
| | 568P .... .... | Horseshoe Lights (Prior to transfer) | .... | .... | .... | .... | .... | .... | .... | 3,914·00 | 894·44 | .... | |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 15·57 | 1,975·37 | 5,654·38 | 2,818·56 | 2·00 | |
| | | Sundry claims .... .... .... | .... | .... | 10·00 | 1·32 | ·05 | 20·12 | 829·58 | 2,201·35 | 792·31 | ·05 | |
| Jimblebar .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 172·75 | 7,526·25 | 2,561·95 | ·58 | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 13·79 | 65·95 | 1,048·05 | 574·16 | .... | |
| Mt. Fraser .... | 602P .... .... | Duffer .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 9·50 | 15·32 | .... | |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 389·50 | 320·96 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 88·28 | 40·61 | 480·75 | 460·12 | .... | |
| Mt. Seabrook .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 5·05 | 620·25 | 428·26 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,089·35 | 803·12 | .... | |
| Peak Hill .... | 512P .... .... | Atlantic .... .... .... .... | .... | .... | 696·00 | 39·27 | 1·52 | 1·69 | 2·87 | 5,399·75 | 628·42 | 1·52 | |
| | (599P) .... | Bobby Dazzler .... .... .... | .... | .... | .... | .... | .... | .... | .... | 517·00 | 52·27 | .... | |
| | 511P .... .... | Commercial .... .... .... .... | .... | .... | 220·00 | 22·29 | ·86 | .... | .... | 3,965·25 | 613·34 | ·86 | |
| | 584P .... .... | Dazzle Star .... .... .... .... | .... | .... | 11·00 | 11·49 | ·50 | .... | .... | 329·00 | 99·97 | ·50 | |
| | 567P .... .... | Miner Bird .... .... .... .... | .... | .... | 13·00 | 5·59 | ·27 | .... | .... | 2,056·00 | 937·79 | ·27 | |
| | 553P .... .... | Morning Star .... .... .... | .... | .... | .... | .... | .... | .... | 4·43 | 3,191·75 | 437·29 | .... | |
| | 604P .... .... | Mt. Pleasant .... .... .... | .... | .... | 98·00 | 2·24 | ·10 | .... | .... | 98·00 | 2·24 | ·10 | |
| | (601P) .... | Mt. Pleasant .... .... .... | .... | .... | .... | .... | .... | .... | .... | 771·00 | 46·87 | .... | |
| | 587P .... .... | Murray Heath .... .... .... | .... | .... | .... | .... | .... | .... | .... | 41·00 | 6·17 | .... | |
| | 506P .... .... | No. 1 North .... .... .... | .... | .... | 280·00 | 37·50 | 1·64 | .... | 86·47 | 8,384·70 | 1,752·05 | 1·64 | |
| | 492P .... .... | North Star .... .... .... .... | .... | .... | 185·00 | 12·68 | .... | 23·20 | 69·63 | 13,371·50 | 2,091·89 | .... | |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 7·39 | 920·21 | 521,841·33 | 247,054·04 | 2,285·63 | |
| | | Sundry claims .... .... .... | .... | .... | 373·00 | 26·57 | 1·20 | 61·51 | 306·63 | 34,779·35 | 8,982·11 | 1·20 | |
| Ravelstone .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 101·64 | 4,219·85 | 3,117·68 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 553·60 | 283·17 | .... | |
| Wilgeena .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 23·54 | 230·50 | 156·25 | .... | |
| W [redacted] | | | | | | | | | | | | | |
| ilthorpe .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 47·00 | 20·93 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 89·00 | 25·71 | .... | |
| Yowereena .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 19·50 | 36·46 | .... | |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 117·25 | 203·16 | .... | |
| | | *From Goldfield generally :* | | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | | |
| | | Australian Machinery & Investment Co. Plant | .... | .... | .... | .... | .... | .... | .... | .... | *1,686·20 | .... | |
| | | State Battery, Peak Hill .... .... .... | .... | .... | .... | .... | .... | .... | 3·05 | 15·00 | *7,171·41 | .... | |
| | | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,332·00 | *5,723·81 | 23·12 | |
| | | Reported by Banks and Gold Dealers .... .... | .... | ·55 | .... | 1·56 | .... | 2,855·14 | 444·91 | .... | 15·88 | .... | |
| | | **Totals** .... .... .... .... | .... | ·55 | 3,422·00 | 328·78 | 6·48 | 3,384·35 | 5,300·88 | 778,517·73 | 322,336·70 | 3,774·95 | |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **East Murchison Goldfield.** | | | | | | | | | | | | |
| **LAWLERS DISTRICT.** | | | | | | | | | | | | |
| Kathleen Valley .... | G.M.L. 1369 .... | Kathleen Development Syndicate .... | .... | .... | 305·00 | 18·09 | ·94 | .... | .... | 305·00 | 18·09 | ·94 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 144·85 | 80,563·66 | 49,028·87 | .... |
| | | Sundry claims .... .... .... | .... | .... | 78·00 | 4·01 | .... | 14·37 | 526·03 | 5,836·75 | 2,662·74 | 893·45 |
| Lawlers .... .... | 1363 .... .... | Kim Prospecting & Development Syndicate .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 290·00 | 25·64 | .... |
| | 1236 .... .... | Waroonga .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 99·40 | ·50 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 25·51 | 692·45 | 1,622,917·40 | 575,150·65 | 14,803·08 |
| | | Sundry claims .... .... .... | .... | .... | 39·00 | 45·46 | 3·01 | 401·71 | 451·61 | 17,637·98 | 9,735·13 | 271·35 |
| Sir Samuel .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 359·03 | 275,417·55 | 141,829·52 | 10,234·80 |
| | | Sundry claims .... .... .... | .... | .... | 16·00 | 2·77 | .... | 57·64 | 64·96 | 7,851·00 | 4,585·10 | ·02 |
| Wildara Station .... | 1367 .... .... | Tahmoo .... .... .... .... | .... | .... | 533·00 | 212·44 | .... | .... | .... | 533·00 | 212·44 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 143·23 | .... | .... | .... | .... |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | State Battery, Sir Samuel .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 53·50 | *2,356·81 | .... |
| | Vanguard Cyanide Plant .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 4·00 | *1,014·04 | 3·18 |
| | Western Machinery Co. Pty. Ltd. .... .... | | .... | .... | .... | .... | .... | .... | .... | 5·00 | *4,291·25 | 29·00 |
| | Prior to transfer to present holders .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | *1,371·33 | 15·64 |
| | Various Works .... .... .... .... .... | | .... | .... | .... | .... | .... | 2·12 | 2·35 | 1,711·53 | *30,788·76 | 936·21 |
| | Reported by Banks and Gold Dealers .... .... | | 27·35 | .... | .... | .... | .... | 6,451·88 | 101·91 | ·05 | 10·00 | .... |
| | | **Totals** .... .... .... .... | **27·35** | .... | **971·00** | **282·77** | **3·95** | **7,096·46** | **2,343·19** | **2,013,126·42** | **823,179·77** | **27,188·17** |
| **WILUNA DISTRICT.** | | | | | | | | | | | | |
| Coles .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,765·50 | 1,240·40 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 21·03 | 3,844·50 | 1,507·23 | .... |
| Corboys .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 5·24 | 1·25 | 14,946·29 | 11,036·71 | 5·00 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 21·58 | .... | 9,082·35 | 5,210·79 | .... |
| Gum Creek .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 20·75 | .... | 1,380·00 | 595·73 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 1·36 | 407·25 | 131·08 | .... |
| Mt. Eureka .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 142·25 | 96·36 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 783·75 | 548·56 | .... |
| Mt. Keith .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 44·54 | 20,259·50 | 13,551·08 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 4·81 | 227·29 | 3,862·50 | 2,480·03 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New England .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 5·74 | 95·70 | 5,364·25 | 3,490·87 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 9·31 | 5·78 | 4,534·75 | 3,111·97 | .... |
| Wiluna .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 574·76 | 8,777,986·65 | 1,789,127·12 | 10,049·13 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 105·39 | 225·82 | 27,442·65 | 10,897·38 | ·33 |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | T. J. Jones (L.T.T. 1J/1961) .... .... .... | .... | .... | .... | 2·87 | ·06 | .... | .... | .... | *2·87 | ·06 |
| | State Battery, Wiluna .... .... .... | .... | .... | .... | .... | .... | .... | .... | 637·00 | *23,679·00 | 219·70 |
| | Various Works .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 139·00 | 5,322·12 | 12·72 |
| | Reported by Banks and Gold Dealers .... .... | 2·10 | .... | .... | .... | ·27 | 61·91 | 56·58 | .... | 158·54 | 12·02 |
| | **Totals** .... .... .... .... | **2·10** | .... | .... | **2·87** | **·33** | **234·73** | **1,254·11** | **8,873,578·19** | **1,872,187·84** | **10,298·96** |

## BLACK RANGE DISTRICT.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barambie .... .... | G.M.L. 1116B.... | Dingo .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1·00 | 201·93 | .... |
| | 1117B .... .... | Scheelite leases .... .... .... | .... | .... | 92·50 | 57·91 | 2·22 | .... | .... | 746·25 | 417·88 | 2·22 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 22·49 | 18,554·67 | 17,363·81 | 125·60 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 5·07 | 170·20 | 978·55 | 1,062·22 | 216·73 |
| Bellchambers .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 111·80 | 4,349·27 | 3,130·56 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,182·80 | 557·95 | .... |
| Birrigrin .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 820·68 | 12,042·93 | 15,086·09 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 179·92 | 2,487·55 | 1,238·22 | .... |
| Currans .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 18·24 | 222·89 | 7,252·25 | 3,116·68 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 29·38 | 2,158·75 | 827·18 | .... |
| Errolls .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 14·17 | 152·29 | 14,170·50 | 9,328·92 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 6·53 | 399·11 | 964·75 | 595·45 | .... |
| Hancocks .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 6,968·16 | 33,726·00 | 36,664·76 | 55·72 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 4·21 | 142·89 | 8,608·10 | 3,228·18 | .... |
| Maningamarley .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 195·20 | 60,833·48 | 48,494·40 | 22·55 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 158·16 | 3,079·65 | 1,768·16 | .... |
| Montague .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 100·17 | 79,550·60 | 23,444·82 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 71·09 | 5,041·35 | 3,171·19 | .... |
| Nunngarra .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 25·94 | 952·34 | 9,509·00 | 3,655·49 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 50·27 | 1,458·98 | 7,682·40 | 2,960·27 | .... |
| Sandstone .... | (G.M.L. 1114B) | Black Range Gold Mine .... .... | .... | .... | .... | .... | .... | .... | 86·04 | 170·00 | 730·37 | .... |
| | (1118B) .... | Lady Jennifer .... .... .... | .... | .... | .... | .... | .... | .... | .... | 23·50 | 5·45 | .... |
| | 958B .... .... | Lady Mary .... .... .... | .... | .... | .... | .... | .... | .... | 383·35 | 7,165·75 | 7,119·35 | 2·35 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 4·75 | 4,363·69 | 696,431·82 | 447,563·94 | 11,754·22 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 44·95 | 1,421·07 | 15,998·95 | 6,928·81 | .... |
| Youanmi .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | ·36 | 126·92 | 731,497·55 | 273,884·97 | 10,474·10 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 1·07 | 18·79 | 6,258·55 | 1,814·66 | .... |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **EAST MURCHISON GOLDFIELD—continued.** | | | | | | | | | | | | |
| **BLACK RANGE DISTRICT—continued.** | | | | | | | | | | | | |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | State Battery, Sandstone .... .... .... | .... | .... | .... | .... | .... | .... | .... | 290·50 | *23,575·34 | 61·02 |
| | | State Battery, Youanmi .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 40·00 | *5,504·08 | .... |
| | | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 104·50 | *11,496·73 | .... |
| | | Reported by Banks and Gold Dealers .... .... | .... | .... | .... | .... | .... | 1,494·98 | 52·23 | .... | 20·38 | .... |
| | | **Totals** .... .... .... .... | .... | .... | **92·50** | **57·91** | **2·22** | **1,670·54** | **18,607·84** | **1,730,900·97** | **954,958·24** | **22,714·51** |
| **Murchison Goldfield.** | | | | | | | | | | | | |
| **CUE DISTRICT.** | | | | | | | | | | | | |
| Big Bell .... .... | G.M.L. 2282 .... | Orange Bell .... .... .... | .... | .... | 71·00 | 3·85 | .... | .... | .... | 712·00 | 95·84 | 2·34 |
| | 2274 .... .... | Silver City .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 273·25 | 61·35 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 4·49 | 5,539,857·75 | 730,970·13 | 251,813·67 |
| | | Sundry claims .... .... .... | .... | .... | 14·25 | 1·26 | .... | ·39 | 6·32 | 577·50 | 482·19 | 6·61 |
| Cuddingwarra .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 10·59 | 132·46 | 102,115·91 | 56,152·11 | 100·71 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 18·46 | 384·38 | 10,335·89 | 5,743·75 | 16·85 |
| Cue .... .... | (2279) .... .... | New Light .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 63·25 | 11·88 | .... |
| | 2247 .... .... | Victory .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 226·75 | 125·38 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 202·71 | 911·60 | 292,134·49 | 222,197·86 | 73·03 |
| | | Sundry claims .... .... .... | .... | .... | 322·25 | 23·94 | ·40 | 252·92 | 894·70 | 47,411·74 | 20,545·18 | 4·64 |
| Eelya .... .... | (2241) .... .... | Eagle Hawk .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,408·75 | 417·30 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 8·78 | 1,069·00 | 1,811·26 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 6·20 | 143·81 | 2,309·90 | 1,099·24 | 1·31 |
| Mindoulah .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 3·07 | 2·54 | 9,380·28 | 5,672·31 | 42·97 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 29·30 | 3,309·85 | 2,347·36 | .... |
| Reedy .... .... | (2253) .... .... | Rand No. 3 .... .... .... | .... | .... | .... | .... | .... | .... | .... | 4,152·25 | 1,356·56 | .... |
| | (2261) .... .... | West Rand .... .... .... .... | .... | .... | .... | .... | .... | 1·36 | 2·98 | 53·75 | 67·95 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 1·46 | 216·72 | 725,487·43 | 238,924·59 | 20,467·28 |
| | | Sundry claims .... .... .... | .... | .... | 66·00 | 10·04 | ·62 | 170·71 | 137·16 | 7,295·00 | 2,690·88 | 1·24 |
| Tuckabianna .... | 2237 .... .... | Gidgie .... .... .... .... | .... | .... | .... | .... | .... | .... | 297·73 | 2,789·90 | 2,108·79 | 33·57 |
| | 2244 .... .... | Winston .... .... .... .... | .... | .... | .... | .... | .... | .... | 671·45 | 816·00 | 368·20 | 4·05 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 649·70 | 324·77 | 13,152·23 | 7,465·12 | |
| | | Sundry claims .... .... .... | .... | .... | 190·75 | 11·90 | ·15 | 154·26 | 489·40 | 5,567·85 | 2,790·63 | ·35 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tuckanarra .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 85·37 | 3,511·10 | 19,490·00 | 22,828·99 | 172·77 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 115·23 | 797·89 | 10,190·82 | 10,308·25 | .... |
| Weld Range .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 23·64 | 2,169·75 | 1,137·11 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 3·90 | 1,438·50 | 1,136·41 | .... |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | A. E. Hannan (L.T.T. 1450H) .... | .... .... | .... | .... | .... | *54·48 | 2·60 | .... | .... | .... | *78·01 | 2·60 |
| | A. L. Armstrong (L.T.T. 1425H) .... | .... .... | .... | .... | .... | .... | .... | .... | .... | .... | *109·35 | .... |
| | A. L. Armstrong (L.T.T. 1427H) .... | .... .... | .... | .... | .... | .... | .... | .... | .... | .... | *107·79 | 23·02 |
| | State Battery, Cue .... .... | .... .... | .... | .... | .... | .... | .... | .... | .... | 76·25 | *26,792·60 | 123·99 |
| | State Battery, Tuckanarra .... | .... .... | .... | .... | .... | .... | .... | .... | .... | 518·50 | *5,535·57 | .... |
| | Various Works .... .... .... | .... .... | .... | .... | .... | .... | .... | .... | .... | 8,097·02 | 30,177·79 | 1,206·50 |
| | Reported by Banks and Gold Dealers .... | .... | ·34 | .... | .... | .... | .... | 3,429·07 | 109·87 | .... | 22·62 | ·07 |
| | **Totals** .... .... .... .... | | **·34** | .... | **664·25** | **105·47** | **3·77** | **5,101·50** | **9,104·99** | **6,812,481·56** | **1,401,740·35** | **274,097·57** |

## MEEKATHARRA DISTRICT.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abbotts .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 26·45 | 36,841·35 | 38,775·28 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 5·29 | 3,951·57 | 2,357·54 | .... |
| Burnakura .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 3,247·59 | 39,387·45 | 30,920·76 | 26·90 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 17·03 | 129·24 | 2,486·55 | 1,310·84 | 1·54 |
| Chesterfield .... | G.M.L. 1942N, 1946N | Margueritta Leases .... .... | .... | .... | .... | .... | .... | .... | .... | 2,960·00 | 708·22 | 6·65 |
| | 1946N .... | Margueritta East .... .... | .... | .... | .... | .... | .... | .... | .... | 1,420·00 | 250·09 | 10·65 |
| | 1942N .... | Margueritta .... .... .... | .... | .... | .... | .... | .... | .... | .... | 732·00 | 197·73 | 7·74 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 29·02 | 420·32 | 6,875·26 | 7,500·57 | ·80 |
| | | Sundry claims .... .... .... | .... | .... | 70·50 | 14·62 | .... | .... | 42·19 | 1,069·05 | 776·69 | .... |
| Gabanintha .... | 1990N .... | Tumbulgum .... .... .... | .... | .... | .... | .... | .... | .... | .... | 188·25 | 49·09 | 4·72 |
| | 1986N .... | Tumbulgum North .... .... | .... | .... | .... | .... | .... | .... | .... | 52·50 | 46·35 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 11·79 | 38·14 | 32,995·35 | 22,204·79 | 815·57 |
| | | Sundry claims .... .... .... | .... | .... | 36·50 | 25·19 | ·98 | 16·78 | 159·05 | 5,221·00 | 2,979·59 | ·98 |
| Garden Gully .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 26·36 | 74·91 | 30,272·07 | 21,864·74 | 1,102·59 |
| | | Sundry claims .... .... .... | .... | .... | 48·25 | 1·15 | ·02 | .... | 18·74 | 2,980·19 | 1,721·62 | ·02 |
| Gum Creek .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 25·27 | 91·96 | 3,893·08 | 3,819·91 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 4·37 | 84·86 | 735·05 | 656·05 | .... |
| Holdens .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 18·99 | 18,061·00 | 7,320·42 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 164·95 | 49·07 | 425·15 | 279·25 | .... |
| Jillawarra .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,263·53 | 1,999·80 | 3,565·40 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 173·02 | 150·04 | 443·75 | 404·77 | .... |
| Meeka Pool .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 111·58 | 82·27 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 2·84 | 233·57 | 205·38 | .... |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **MURCHISON GOLDFIELD—continued.** | | | | | | | | | | | | |
| **MEEKATHARRA DISTRICT—*continued.*** | | | | | | | | | | | | |
| Meekatharra | 1991N | Commodore | .... | .... | .... | .... | .... | .... | .... | 20·00 | 40·11 | .... |
| | (1975N) | Fortune Teller | .... | .... | .... | .... | .... | .... | .... | 97·00 | 13·83 | .... |
| | 1977N | Haveluck | .... | .... | 1,307·00 | 110·52 | 2·93 | .... | .... | 2,903·70 | 289·92 | 2·93 |
| | 1559N | Ingliston | .... | .... | .... | .... | .... | .... | 498·32 | 3,167·85 | 1,885·91 | .... |
| | 1985N | Lady Central | .... | .... | .... | .... | .... | .... | .... | 327·75 | 39·19 | .... |
| | 1529N | Prohibition | .... | .... | 793·00 | 66·23 | 1·24 | .... | .... | 6,425·25 | 2,159·54 | 5·49 |
| | 1529N | Prohibition Gold Mining Co. N.L. | .... | .... | .... | .... | .... | .... | .... | 24,844·25 | 4,978·31 | 11·83 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 29,422·00 | 4,971·30 | .... |
| | R.C. 75N | C. J. S. White & W. E. Fisher | .... | .... | .... | .... | .... | 173·82 | 43·80 | 372·50 | 131·88 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 7·57 | 1,664·22 | 1,713,919·62 | 928,825·27 | 2,469·64 |
| | | Sundry claims | .... | .... | 460·00 | 112·64 | 3·03 | 279·84 | 1,009·74 | 31,346·95 | 11,595·43 | 3·03 |
| Mistletoe | | Voided leases | .... | .... | .... | .... | .... | 4·15 | 1,000·24 | 417·00 | 486·21 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 119·14 | 71·85 | 19·75 | 2·03 | .... |
| Mt. Maitland | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 88·00 | 80·11 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 420·75 | 240·86 | .... |
| Munara Gully | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 13,283·50 | 6,559·93 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 34·23 | 1,009·75 | 373·74 | .... |
| Nannine | | Voided leases | .... | .... | .... | .... | .... | 47·31 | 844·02 | 129,492·88 | 76,482·78 | 167·45 |
| | | Sundry claims | .... | .... | 4·00 | 2·25 | ·12 | 138·95 | 1,301·28 | 6,752·68 | 4,728·61 | ·12 |
| Quinns | | Voided leases | .... | .... | .... | .... | .... | 7·30 | 1,186·50 | 33,356·91 | 13,464·37 | 90·70 |
| | | Sundry claims | .... | .... | .... | .... | .... | 15·07 | 1,289·65 | 3,841·67 | 2,718·33 | .... |
| Ruby Well | | Voided leases | .... | .... | .... | .... | .... | .... | 43·46 | 7,461·00 | 4,046·70 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 1,015·87 | 409·39 | 520·25 | 629·60 | .... |
| Stakewell | | Voided leases | .... | .... | .... | .... | .... | .... | 200·12 | 21,362·00 | 9,566·18 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 31·91 | 34·73 | 1,003·60 | 584·54 | .... |
| Star of East | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 27,244·00 | 20,305·40 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 127·62 | 94·97 | .... |
| Yaloginda | 1853N | Bluebird | .... | .... | 364·00 | 33·96 | 1·09 | .... | .... | 10,077·50 | 3,000·71 | 1·09 |
| | | Voided leases | .... | .... | .... | .... | .... | 19·03 | 1,972·23 | 28,175·54 | 14,609·36 | 8·68 |
| | | Sundry claims | .... | .... | .... | .... | .... | 61·89 | 647·51 | 11,440·42 | 5,059·93 | .... |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | Hanley & Christie Plant .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 234·00 | 9·69 | .... |
| | | P. Polletti Plant .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 13·50 | 4·82 | .... |
| | | State Battery, Meekatharra .... .... .... | .... | .... | .... | *139·08 | .... | .... | .... | 130·00 | *27,938·13 | 24·34 |
| | | Various Works .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 3,699·80 | *13,948·46 | 391·20 |
| | | Reported by Banks and Gold Dealers .... .... | 2·01 | 5·48 | .... | .... | ·18 | 12,241·13 | 185·53 | 451·50 | 97·71 | ·78 |
| | | **Totals .... .... .... ....** | **2·01** | **5·48** | **3,083·25** | **505·64** | **9·59** | **14,631·57** | **18,260·03** | **2,306,806·06** | **1,307,961·21** | **5,155·44** |
| | | **DAY DAWN DISTRICT.** | | | | | | | | | | |
| Day Dawn .... | 573D, etc. .... | Mountain View Gold N.L. .... .... | .... | .... | .... | .... | .... | .... | .... | 13,612·10 | 17,376·85 | 217·60 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 94·05 | 10,060·78 | 32,623·97 | .... |
| | (576D) .... | New Fingall .... .... .... | .... | .... | .... | .... | .... | 6·12 | 6·84 | 3,230·00 | 1,226·01 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 160·64 | 826·65 | 1,922,088·36 | 1,225,599·75 | 169,210·44 |
| | | Sundry claims .... .... .... | .... | .... | 14·25 | 16·80 | 1·34 | 96·42 | 523·56 | 13,660·51 | 6,773·85 | 2·89 |
| Lake Austin .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 613·00 | 3,079·62 | 36,872·20 | 51,050·49 | .... |
| | | Sundry claims .... .... .... | .... | .... | 6·00 | 1·39 | .... | 59·07 | 965·49 | 3,545·19 | 1,341·15 | 4·60 |
| Mainland .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | ·41 | 3,296·77 | 7,575·62 | 25,026·07 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 17·85 | 771·56 | 1,337·95 | 701·31 | .... |
| Pinnacles .... .... | 664D .... .... | Eclipse .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 282·75 | 29·73 | .... |
| | 676D .... .... | Eclipse Amalgamated North .... | .... | .... | .... | .... | .... | .... | .... | 187·50 | 17·68 | .... |
| | 670D .... .... | Eclipse North .... .... .... | .... | .... | .... | .... | .... | .... | .... | 840·00 | 47·62 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 4·90 | 1,213·68 | 18,280·00 | 9,915·71 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 62·93 | 509·50 | 4,678·17 | 1,801·29 | .... |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | V. Hronsky (L.T.T. 1441H) .... .... .... | .... | .... | .... | 1·51 | ·59 | .... | .... | .... | *1·51 | ·59 |
| | | F. W. Turner (L.T.T. 1418H) .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | *7·13 | .... |
| | | Various Works .... .... .... .... | .... | .... | .... | .... | .... | .... | 16·61 | 988·00 | *1,988·33 | .... |
| | | Reported by Banks and Gold Dealers .... .... | 3·41 | .... | .... | .... | .... | 2,223·83 | 37·30 | .... | 12·57 | ·01 |
| | | **Totals .... .... .... ....** | **3·41** | .... | **20·25** | **19·70** | **1·93** | **3,245·17** | **11,341·63** | **2,037,239·13** | **1,375,541·02** | **169,436·13** |
| | | **MOUNT MAGNET DISTRICT.** | | | | | | | | | | |
| Jumbulyer .... | G.M.L. 1410M.... | Gold Bug .... .... .... .... | .... | .... | .... | .... | .... | .... | 2·20 | 927·35 | 277·15 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 13·37 | 680·10 | 361·74 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 20·32 | 116·27 | 1,216·70 | 886·47 | .... |
| Lennonville .... | 1566M .... | Empress .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 9·51 | .... |
| | 1637M .... | Long Reef South .... .... .... | .... | .... | 113·75 | 128·65 | 9·69 | .... | .... | 224·75 | 230·27 | 9·69 |
| | 1596M .... | Wheel of Fortune South .... .... | .... | .... | .... | .... | .... | .... | .... | 18·00 | 51·37 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 3,226·91 | 151,502·55 | 128,568·28 | 459·62 |
| | | Sundry claims .... .... .... | .... | .... | 191·65 | 172·51 | 6·52 | 25·86 | 108·82 | 15,137·02 | 5,945·92 | 6·52 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **MURCHISON GOLDFIELD—continued.** | | | | | | | | | | | | |
| **MOUNT MAGNET DISTRICT—*continued*.** | | | | | | | | | | | | |
| Mt. Magnet | 1563M | Corona East | .... | .... | .... | .... | .... | .... | .... | 8·75 | 2·56 | .... |
| | 1527M | Eclipse Gold Mine N.L. | .... | .... | 8,550·00 | 7,859·90 | 1,688·73 | .... | .... | 25,873·00 | 30,539·76 | 2,908·42 |
| | 1527M | Eclipse | .... | .... | .... | .... | .... | .... | .... | 272·10 | 141·41 | 1·34 |
| | 1255M, 1415M | Edward Carson Leases | .... | .... | .... | .... | .... | 1·82 | .... | 18,042·75 | 12,899·55 | 7·76 |
| | 1455M | Evening Star | .... | .... | .... | .... | .... | .... | .... | 1,083·25 | 124·35 | .... |
| | 1581M | Exchange | .... | .... | .... | .... | .... | .... | .... | 22·00 | 29·36 | .... |
| | 1287M | Havelock | .... | .... | .... | .... | .... | .... | 11·05 | 4,332·50 | 840·14 | .... |
| | 1282M, etc. | Hill 50 Gold Mine N.L. | .... | .... | 157,196·00 | 82,952·57 | 5,760·99 | .... | .... | 1,691,825·40 | 856,851·56 | 31,545·26 |
| | 1246M | (Neptune) | .... | .... | .... | .... | .... | .... | 829·41 | 8,787·65 | 4,122·61 | ·21 |
| | 1361M | Jupiter | .... | .... | .... | .... | .... | .... | ·83 | 658·05 | 261·71 | .... |
| | 1444M | Late Comer | .... | .... | .... | .... | .... | .... | 2·53 | 511·00 | 391·31 | .... |
| | 1597M | Mayflower | .... | .... | .... | .... | .... | .... | .... | 37·00 | 6·43 | .... |
| | 1447M | Morning Star | .... | .... | 42·75 | 24·93 | 1·53 | .... | .... | 2,135·40 | 483·54 | 1·53 |
| | 1475M | Morning Star North | .... | .... | .... | .... | .... | .... | .... | 11·75 | 8·13 | .... |
| | 1536M | Pat Omeara | .... | .... | .... | .... | .... | .... | .... | 34·00 | ·68 | .... |
| | 1505M | Perseverance | .... | .... | .... | .... | .... | .... | .... | 107·25 | 11·40 | .... |
| | 1588M | Three Boys | .... | .... | .... | .... | .... | .... | .... | 48·00 | 2·47 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 29·26 | 9,811·54 | 834,392·06 | 312,777·27 | 851·39 |
| | | Sundry claims | 31·49 | .... | 57·50 | 32·85 | 9·10 | 157·95 | 2,626·24 | 61,069·67 | 29,986·08 | 13·59 |
| Mt. Magnet East | | Voided leases | .... | .... | .... | .... | .... | 63·29 | 764·53 | 5,522·28 | 2,811·75 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 37·22 | 418·25 | 428·29 | .... |
| Moyagee | 1538M | Moyagee | .... | .... | .... | .... | .... | .... | .... | 33·75 | 34·88 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 23·59 | 12,439·10 | 18,299·16 | 757·77 |
| | | Sundry claims | .... | .... | .... | .... | .... | 14·44 | 176·21 | 1,550·75 | 1,752·39 | .... |
| Paynesville | | Voided leases | .... | .... | .... | .... | .... | .... | 1,613·34 | 449·77 | 1,116·15 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 3·36 | 540·21 | 882·57 | 1,372·00 | .... |
| Winjangoo | | Voided leases | .... | .... | .... | .... | .... | ·99 | 191·88 | 72·00 | 69·98 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 223·32 | 237·53 | 71·58 | .... |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | R. F. Johns & D. Budge (L.T.T. 1M/61) | .... | .... | 37·25 | 27·41 | 2·28 | .... | .... | 37·25 | 27·41 | 2·28 |
| | | State Battery, Boogardie | .... | .... | .... | .... | .... | .... | .... | 348·26 | *35,102·45 | 15·62 |
| | | Various Works | .... | .... | .... | .... | .... | .... | .... | 56·06 | *18,949·24 | 10·04 |
| | | Reported by Banks and Gold Dealers | 4·27 | .... | .... | .... | .... | 2,316·12 | 114·69 | 8·00 | 113·15 | ·22 |
| | | **Totals** | **35·76** | .... | **166,188·90** | **91,198·82** | **7,478·84** | **2,633·41** | **20,434·16** | **2,841,013·62** | **1,465,959·46** | **36,591·26** |

# Yalgoo Goldfield.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bilberatha .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 1·27 | 90·94 | 3,384·50 | 1,845·05 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | 6·64 | 3,075·05 | 1,401·56 | .... |
| Carlaminda .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 1·28 | 3·39 | 2,056·57 | 862·42 | 3·30 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,368·50 | 600·68 | .... |
| Fields Find .... | G M.L. 1207 .... | Rose Marie .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 418·67 | 254·46 | 1·59 |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 226·72 | 50,316·71 | 33,692·51 | 58·08 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 5·77 | 188·67 | 5,458·85 | 1,777·91 | .... |
| Goodingnow .... | 1063 .... .... | Ark .... .... .... .... .... | .... | .... | .... | .... | .... | .... | 12·49 | 2,270·50 | 1,927·29 | .... |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 146·70 | 299·28 | 81,692·71 | 66,350·01 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 152·96 | 169·70 | 10,370·05 | 5,125·26 | .... |
| Gullewa .... .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 19·05 | 39,913·60 | 20.966·51 | 113·70 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | 170·45 | 4,391·25 | 1,918·24 | .... |
| Kirkalucka .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 61·25 | 45·10 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | 17·79 | 257·30 | 126·29 | .... |
| Messengers Patch.... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 8·64 | 349·71 | 39,836·51 | 28,564·95 | 1,083·01 |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 463·12 | 333·98 | 1,595·10 | 588·36 | ·07 |
| Mt. Farmer .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 64·00 | 40·19 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 462·90 | 145·06 | .... |
| Mt. Gibson .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 6·44 | 526·50 | 888·70 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | 3·95 | 44·72 | 1,152·60 | 502·15 | 1·00 |
| Ninghan .... .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 10·00 | 1·41 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 324·75 | 123·28 | .... |
| Noongal .... .... | 1201 .... .... | Hard to Find .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 114·00 | 111·83 | .... |
| | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | 7·88 | 31·96 | 11,149·75 | 5,659·83 | 4·04 |
| | | Sundry claims .... .... .... .... | .... | .... | 7·50 | 29·10 | 1·16 | 39·32 | 310·31 | 8,506·55 | 3,590·35 | 1·16 |
| Nyounda .... .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 217·63 | 416·00 | 183·91 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | 80·00 | 5·04 | .... | .... | 30·88 | 1,035·00 | 228·94 | .... |
| Pinyalling .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 313·79 | 2,318·90 | 1,146·19 | .... |
| | | Sundry claims .... .... .... ·14 | .... | .... | .... | .... | 3·27 | 134·09 | 1,500·00 | 959·31 | .... |
| Retaliation .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 5,089·25 | 1,872·98 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 913·25 | 321·52 | .... |
| Rothsay .... .... .... .... .... | | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | 24·06 | 40,680·75 | 10,777·98 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | ·73 | 6,469·50 | 2,562·03 | .... |
| Wadgingarra .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 691·11 | 650·63 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,131·30 | 559·83 | .... |
| Wardawarra .... | .... .... .... | Voided leases .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 10,760·50 | 5,862·04 | .... |
| | | Sundry claims .... .... .... .... | .... | .... | 7·00 | 51·13 | 2·31 | .... | .... | 940·75 | 421·00 | 2·31 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **YALGOO GOLDFIELD—*continued.*** | | | | | | | | | | | | |
| Warriedar .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 13,661·50 | 4,607·88 | 7·30 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 2·84 | 8,782·85 | 1,892·46 | .... |
| Yalgoo .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 3·23 | 6,314·50 | 9,965·18 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 23·56 | 2,622·75 | 1,010·02 | .... |
| Yuin .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 127·12 | 68,139·50 | 27,908·57 | 130·13 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 4·70 | 335·50 | 67·53 | .... |
| | *From Goldfield generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | State Battery, Paynes Find .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 156·50 | *4,548·42 | .... |
| | State Battery, Warriedar .... .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | *6,545·96 | ·90 |
| | State Battery, Yalgoo .... .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | *1,200·51 | .... |
| | Various Works .... .... .... | | .... | .... | .... | .... | .... | 9·42 | .... | 865·00 | *3,337·19 | 99·84 |
| | Reported by Banks and Gold Dealers .... .... | | .... | .... | .... | .... | .... | 958·32 | 58·32 | .... | 48·90 | ·20 |
| | | **Totals** .... .... .... .... | **·14** | .... | **94·50** | **85·27** | **3·47** | **1,801·90** | **3,223·19** | **442,602·58** | **263,788·38** | **1,506·63** |
| **Mt. Margaret Goldfield.** | | | | | | | | | | | | |
| **MOUNT MORGANS DISTRICT.** | | | | | | | | | | | | |
| Australia United.... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,911·63 | 15,913·69 | 23,305·76 | 1·76 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 580·98 | 1,307·50 | 2,227·65 | .... |
| Eucalyptus .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 2,878·56 | 1,603·85 | 3,251·01 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 591·62 | 2,160·30 | 2,011·78 | .... |
| Linden .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 7·53 | 566·97 | 72,919·81 | 66,208·35 | ·68 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 132·11 | 244·96 | 19,575·35 | 13,822·37 | .... |
| Mt. Margaret .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 12·13 | 1·89 | 8,900·39 | 5,291·51 | 12·55 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 25·22 | 111·18 | 1,790·10 | 661·42 | .... |
| Mt. Morgans .... | 399F, etc. .... | Morgans Gold Mines Ltd. .... .... | .... | .... | .... | .... | .... | .... | .... | 5,070·05 | 13,981·69 | .... |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 16·66 | 779,578·43 | 354,225·86 | 5,552·63 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 17·95 | 148·79 | 61,354·50 | 34,786·53 | 77·86 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 36·41 | 398·78 | 5,104·07 | 3,396·77 | .... |
| Murrin Murrin .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 10·43 | 231·35 | 136,940·22 | 104,029·97 | 29·60 |
| | | Sundry claims .... .... .... | .... | .... | 81·00 | 98·69 | 8·04 | 51·15 | 557·24 | 6,642·68 | 4,661·32 | 8·04 |
| Redcastle .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 4·49 | 491·33 | 4,284·95 | 4,111·85 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 113·84 | 1,183·57 | 642·45 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yundamindera .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 110·93 | 84,523·85 | 52,042·94 | 36·50 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 3·01 | 271·93 | 6,674·35 | 4,789·46 | .... |
| | *From District generally :* | | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | | |
| | Crocker's Anniversary Battery .... .... .... | .... | .... | .... | .... | .... | .... | .... | 10·00 | *26·96 | .... |
| | United Aborigines Mission .... .... .... | .... | .... | .... | .... | .... | 113·08 | 18·87 | 403·00 | 135·50 | ·09 |
| | State Battery, Linden .... .... .... | .... | .... | .... | .... | .... | .... | 9·16 | 299·54 | *15,502·97 | .... |
| | Various Works .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,257·81 | *8,561·39 | 99·97 |
| | Reported by Banks and Gold Dealers .... .... | 8·02 | .... | .... | .... | .... | 3,130·76 | 141·84 | 10·30 | 95·75 | ·68 |
| | **Totals** .... .... .... .... | **8·02** | .... | **81·00** | **98·69** | **8·04** | **3,544·27** | **9,398·51** | **1,217,508·31** | **717,771·26** | **5,820·36** |

## MOUNT MALCOLM DISTRICT.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cardinia .... .... | G.M.L. 1795C.... | Rangoon .... .... .... .... | .... | .... | .... | .... | .... | .... | 6·49 | 330·00 | 188·66 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 13·87 | 1,591·66 | 5,201·74 | 4,049·91 | .... |
| | | Sundry claims .... .... .... | .... | .... | 7·00 | 15·38 | .... | 4·25 | 121·91 | 1,896·25 | 620·92 | ·66 |
| Diorite .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 945·65 | 38,879·03 | 35,144·28 | 33·18 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 11·21 | 332·13 | 4,655·85 | 4,514·02 | .... |
| Dodgers Well .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 57·90 | 1,373·30 | 1,936·52 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·95 | 28·32 | 1,440·25 | 904·23 | .... |
| Lake Darlot .... | 1845C .... .... | Monte Christo .... .... .... | .... | .... | 1,429·50 | 117·34 | 1·31 | .... | .... | 3,310·50 | 281·25 | 1·31 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 4,482·18 | 74,717·46 | 52,293·77 | 7·56 |
| | | Sundry claims .... .... .... | .... | .... | 55·50 | 46·85 | ·43 | 129·92 | 906·52 | 11,492·12 | 6,171·10 | 3·03 |
| Leonora .... .... | 1829C .... .... | Jessie Alma .... .... .... | .... | .... | .... | .... | .... | .... | 582·87 | 727·25 | 1,920·53 | .... |
| | 1579C, etc. .... | Sons of Gwalia Ltd. .... .... .... | .... | .... | 135,995·00 | 32,947·37 | 3,046·73 | .... | .... | 6,749,316·53 | 2,523,117·14 | 183,424·61 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 109,081·00 | 55,989·21 | 8·66 |
| | 1848C .... .... | Tower Hill .... .... .... .... | .... | .... | 312·75 | 40·66 | 1·47 | .... | .... | 312·75 | 40·66 | 1·47 |
| | 1847C .... .... | Victor .... .... .... .... | .... | .... | 16·50 | 33·73 | ·05 | .... | .... | 16·50 | 33·73 | ·05 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,866·86 | 176,575·00 | 91,197·84 | 94·57 |
| | | Sundry claims .... .... .... | .... | .... | 454·50 | 64·54 | 4·46 | 37·73 | 377·26 | 20,901·95 | 12,334·88 | 4·67 |
| Malcolm .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 11·65 | 47·07 | 62,656·53 | 47,563·43 | .... |
| | | Sundry claims .... .... .... | .... | 2·21 | 372·00 | 17·64 | 1·47 | 5·75 | 35·60 | 4,948·47 | 2,728·98 | 1·59 |
| Mertondale .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 89,024·75 | 60,935·32 | 1,497·58 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 5·42 | 85·74 | 3,216·41 | 2,295·52 | .... |
| Mt. Clifford .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,786·51 | 9,588·96 | 16,640·81 | .... |
| | | Sundry claims .... .... .... | .... | .... | 8·00 | 2·82 | ·24 | 53·98 | 1,860·00 | 5,602·70 | 3,494·04 | ·24 |
| Pigwell .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 13,587·32 | 14,676·58 | 63·68 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 34·61 | 2,896·65 | 1,225·46 | .... |
| Randwick .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 246·76 | 10,912·65 | 9,736·57 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 66·57 | 164·02 | 2,551·64 | 1,320·66 | .... |
| Webster's Find .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 30·30 | .... | 22,167·50 | 14,377·65 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 36·84 | 695·68 | 2,356·15 | 1,530·56 | .... |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **MOUNT MARGARET GOLDFIELD**—continued. | | | | | | | | | | | | |
| **MT. MALCOLM DISTRICT**—*continued.* | | | | | | | | | | | | |
| Wilson's Creek .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 333·50 | 168·27 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·70 | 4·24 | 316·00 | 261·12 | .... |
| Wilson's Patch .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 99·38 | 28,863·35 | 13,050·19 | 1·05 |
| | | Sundry claims .... .... .... | .... | .... | 13·00 | 4·42 | ·03 | 4·68 | 54·46 | 1,645·16 | 1,426·90 | ·03 |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | State Battery, Darlot .... .... .... .... | .... | .... | .... | *531·06 | 2·91 | .... | .... | 18·00 | *2,046·96 | 2·91 |
| | | Reefer Cyanide Plant .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 20·00 | *3,125·37 | 22·38 |
| | | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 789·50 | *22,175·93 | 135·97 |
| | | Reported by Banks and Gold Dealers .... .... | 35·72 | .... | .... | .... | .... | 3,643·47 | 252·83 | 46·50 | 57·80 | .... |
| | | **Totals** .... .... .... .... | **35·72** | **2·21** | **138,663·75** | **33,821·81** | **3,059·10** | **4,057·29** | **16,666·65** | **7,461,769·22** | **3,009,576·77** | **185,305·20** |
| **MOUNT MARGARET DISTRICT.** | | | | | | | | | | | | |
| Burtville .... .... | G.M.L. 2567 .... | Boomerang .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 578·00 | 34·08 | 3·67 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 4·89 | 419·10 | 74,268·45 | 122,454·22 | 948·27 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 2·65 | 208·27 | 8,677·66 | 5,673·60 | .... |
| Duketon .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 5·35 | 3,216·10 | 31,889·42 | 22,542·63 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 85·07 | 528·26 | 2,442·65 | 2,196·49 | 29·76 |
| Eagles Nest .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 145·34 | 534·50 | 1,238·22 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 24·07 | 487·05 | 1,046·35 | 360·11 | .... |
| Erlistoun .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 10·07 | 393·41 | 156,731·00 | 101,641·56 | 4,327·81 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 1,181·65 | 165·05 | 5,716·59 | 3,888·89 | .... |
| Euro .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 65·14 | 91,821·50 | 37,678·25 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 4·87 | 73·04 | 1,507·00 | 835·30 | .... |
| Laverton .... .... | 2445T, etc. .... | Lancefield Leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 49,350·75 | 5,137·53 | 22·62 |
| | 2245T .... .... | Lancefield Extended West .... | .... | .... | .... | .... | .... | .... | .... | 881·25 | 846·77 | .... |
| | 2489T .... .... | Wedge .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 222·00 | 21·19 | .... |
| | 2478T .... .... | Lancefield North .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,235·25 | 438·99 | .... |
| | 2541T .... .... | Mary Mack .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 119·00 | 13·71 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 28·59 | 2,028·85 | 2,078,312·87 | 813,661·87 | 56,923·16 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 215·58 | 1,492·90 | 17,552·50 | 9,256·80 | .... |
| Mt. Barnicoat .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 23·08 | 2,370·00 | 2,251·99 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | ·68 | 1,309·75 | 1,087·77 | .... |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mt. Shenton .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 15·00 | 26·65 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 279·25 | 209·67 | .... |
| | | *From District generally :* | | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | | |
| | | United Gold Recoveries Pty. Ltd. .... .... | .... | .... | .... | .... | .... | .... | .... | .... | ·25 | *3,786·44 | 3,374·06 |
| | | State Battery, Laverton .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 97·50 | *19,327·97 | 561·11 |
| | | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 214·75 | *19,403·68 | ·24 |
| | | Reported by Banks and Gold Dealers .... .... | 10·16 | .... | .... | .... | .... | 2,580·75 | 108·08 | .... | | 29·18 | .... |
| | | **Totals** .... .... .... .... | **10·16** | .... | .... | .... | .... | **4,143·54** | **9,354·35** | **2,528,173·24** | | **1,174,043·56** | **66,190·70** |

# North Coolgardie Goldfield.

## MENZIES DISTRICT.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Comet Vale .... | G.M.L. 5766Z.... | Coonega Extended .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 100·25 | 35·55 | .... |
| | (5778Z) .... | Meteor .... .... .... .... | .... | .... | 51·00 | 6·07 | .... | .... | .... | .... | 283·25 | 29·20 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 419·74 | 267,385·72 | 193,243·62 | | 5,355·33 |
| | | Sundry claims .... .... .... | .... | .... | 5·25 | 24·22 | .... | .... | 40·19 | 2,175·21 | 1,163·23 | | .... |
| Goongarrie .... | 5740Z .... .... | Gull's Blow .... .... .... .... | .... | .... | .... | .... | .... | .... | 164·75 | 357·50 | 257·47 | | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | ·94 | 1,385·26 | 29,897·79 | 18,124·83 | | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 46·46 | 2,140·81 | 2,853·85 | 3,362·73 | | .... |
| Menzies .... .... | 5543Z .... .... | Black Swan .... .... .... .... | .... | .... | 120·00 | 23·73 | .... | .... | .... | 1,255·63 | 1,682·22 | | 9·08 |
| | 5736Z .... .... | Bodington .... .... .... .... | .... | .... | .... | .... | .... | .... | 134·83 | 150·50 | 181·15 | | .... |
| | 5511Z .... .... | First Hit .... .... .... .... | .... | .... | 288·75 | 94·11 | 1·12 | .... | .... | 5,964·50 | 7,486·43 | | 22·37 |
| | 5511Z, etc. .... | First Hit Gold Mines (1934) Ltd. .... | .... | .... | .... | .... | .... | .... | .... | 68,473·70 | 49,060·96 | | 6,676·23 |
| | 5542Z .... .... | Good Block Lease .... .... .... | .... | .... | 477·75 | 49·45 | .... | .... | 7·32 | 3,361·65 | 3,043·43 | | .... |
| | 5780Z .... .... | Good Enough .... .... .... .... | .... | .... | 274·00 | 146·45 | .... | .... | .... | 1,523·70 | 484·64 | | .... |
| | 5520Z .... .... | Mignonette .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 808·50 | 404·43 | | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 45·42 | 1,125·41 | 937,698·50 | 727,099·60 | | 13,586·39 |
| | | Sundry claims .... .... .... | .... | .... | 1,720·75 | 237·66 | .... | 56·87 | 624·33 | 38,144·84 | 26,050·61 | | 812·86 |
| Mt. Ida .... .... | 5701Z, etc. .... | Moonlight Wiluna Gold Mines Ltd. .... | .... | .... | 23,871·00 | 12,495·98 | 124·68 | .... | 40·77 | 316,064·86 | 163,989·96 | | 912·22 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 31,833·25 | 16,021·98 | | 891·37 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 92·21 | 68,748·92 | 72,681·44 | | 106·63 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 48·14 | 436·08 | 16,117·41 | 8,280·58 | | ·12 |
| Twin Hills .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 582·30 | 574·93 | | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 97·80 | 86·69 | | .... |
| | | *From District generally :* | | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | | |
| | | R. McPherson (L.T.T. 3Z/59) .... .... | .... | .... | .... | .... | .... | .... | .... | .... | *15·20 | | .... |
| | | R. H. Bennetts (L.T.T. 1423H) .... .... | .... | .... | .... | .... | .... | .... | .... | 79·50 | *31·83 | | .... |
| | | State Battery, Mt. Ida .... .... .... .... | .... | .... | .... | 2·54 | .... | .... | .... | 1,866·25 | *7,556·16 | | 2·04 |
| | | State Battery, Menzies .... .... .... .... | .... | .... | .... | *370·71 | 100·23 | .... | .... | .... | *3,033·93 | | 648·57 |
| | | Various Works .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 3,136·55 | 58,757·09 | | 3,062·11 |
| | | Reported by Banks and Gold Dealers .... .... | 2·70 | .... | .... | .... | .... | 1,489·87 | 403·22 | 100·00 | 48·49 | | .... |
| | | **Totals** .... .... .... .... | **2·70** | .... | **26,808·50** | **13,450·92** | **226·03** | **1,687·70** | **7,014·92** | **1,799,061·93** | **1,362,788·38** | | **32,085·32** |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **NORTH COOLGARDIE GOLDFIELD—continued.** | | | | | | | | | | | | |
| **ULARRING DISTRICT.** | | | | | | | | | | | | |
| Davyhurst .... | G.M.L. 1016U, etc. | New Coolgardie Gold Mines N.L. .... | .... | .... | .... | .... | .... | .... | .... | 132,278·00 | 67,738·19 | 15,808·01 |
| | 1016U, 1085U | (New Callion) .... .... .... | .... | .... | .... | .... | .... | .... | .... | 5,293·30 | 2,002·37 | 119·67 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 2·93 | 152·64 | 166,783·32 | 126,011·36 | 5,408·47 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 208·48 | 14,160·19 | 5,787·29 | .... |
| Morleys .... .... | 1094U .... .... | First Hit .... .... .... .... | .... | .... | 216·25 | 18·92 | ·13 | .... | .... | 4,782·25 | 6,804·46 | ·13 |
| | 1168U .... .... | Hazel Dawn .... .... .... | .... | .... | .... | .... | .... | .... | .... | 51·25 | 104·97 | .... |
| | 1081U .... .... | Mabel Gertrude .... .... .... | .... | .... | .... | .... | .... | .... | 17·19 | 1,692·75 | 1,998·06 | .... |
| | 1089U .... .... | Paramount .... .... .... .... | .... | .... | .... | .... | .... | .... | 1·49 | 4,547·50 | 3,812·36 | .... |
| | 1163U .... .... | Two Chinamen .... .... .... | .... | .... | .... | .... | .... | .... | .... | 9·25 | 15·28 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 3,881·18 | 7,349·00 | 8,409·85 | 10·54 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 2·16 | 932·23 | 1,983·75 | 2,648·51 | .... |
| Mulline .... .... | 1107U .... .... | Ajax West .... .... .... .... | .... | .... | .... | .... | .... | .... | 1·37 | 8,355·50 | 6,653·34 | .... |
| | 1170U .... .... | Golden Wonder .... .... .... | .... | .... | 83·00 | 96·37 | .... | .... | .... | 540·75 | 2,071·46 | .... |
| | 1173U .... .... | Riverina .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 29·50 | 23·51 | .... |
| | (1070U) .... | (Riverina) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 283·00 | 75·30 | .... |
| | 1068U, etc. .... | Riverina Gold Mines Pty. Ltd. .... | .... | .... | .... | .... | .... | .... | .... | 32,085·50 | 11,669·45 | ·07 |
| | (1175U) .... | Problem .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 37·60 | 72·15 | .... |
| | 1176U .... .... | Wild Cat .... .... .... .... | .... | .... | 62·00 | 67·11 | .... | .... | .... | 133·50 | 132·99 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 274·09 | 102,683·22 | 103,366·11 | 530·75 |
| | | Sundry claims .... .... .... | .... | .... | 19·25 | 46·93 | .... | 10·82 | 296·42 | 11,148·64 | 9,753·94 | 1·10 |
| Mulwarrie .... | 1153U .... .... | Fourmile .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 89·00 | 498·92 | .... |
| | 1113U .... .... | Oakley .... .... .... .... | .... | .... | 152·00 | 195·82 | 10·70 | .... | .... | 4,246·00 | 5,954·46 | 10·70 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 165·29 | 19,480·68 | 26,369·21 | 38·47 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·80 | 282·29 | 3,106·33 | 2,722·13 | .... |
| Ularring .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 563·34 | 9,771·60 | 13,907·76 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 671·50 | 309·48 | .... |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | State Battery, Mulline .... .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 639·99 | *16,459·89 | .... |
| | State Battery, Mulwarrie .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 613·18 | *6,564·16 | .... |
| | Linnett & Hawkins (L.T.T. 1252H) .... | | .... | .... | .... | *67·33 | 1·53 | .... | .... | .... | *229·52 | 1·53 |
| | Riverina South Battery .... .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | *900·46 | .... |
| | Various Works .... .... .... .... | | .... | .... | .... | .... | .... | .... | 15·82 | 268·15 | *9,639·15 | 11·15 |
| | Reported by Banks and Gold Dealers .... .... | | .... | .... | .... | .... | .... | 112·81 | 411·29 | 100·00 | 106·34 | .... |
| | **Totals** .... .... .... | | .... | .... | **532·50** | **492·48** | **12·36** | **129·52** | **7,203·12** | **533,214·20** | **442,812·43** | **21,940·59** |

## NIAGARA DISTRICT.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Desdemona | | Voided leases | | | | | | | | 7·12 | 9,809·00 | 7,555·81 | 12·04 |
| | | Sundry claims | | | | | | | | 10·35 | 2,225·45 | 892·48 | |
| Kookynie | G.M.L. 928G | Altona | | | 665·50 | 212·82 | 6·85 | | | | 11,550·75 | 7,038·65 | 7·29 |
| | (933G) | New Gladstone | | | | | | | | | 898·25 | 323·72 | |
| | 937G | Victory | | | 56·00 | 17·56 | ·90 | | | | 137·25 | 63·03 | ·90 |
| | | Voided leases | | | | | | 3·35 | 347·30 | | 747,567·21 | 395,967·19 | 5,375·97 |
| | | Sundry claims | | | 16·25 | 19·25 | ·88 | 60·92 | 106·60 | | 9,419·55 | 6,937·30 | 3·90 |
| Niagara | | Voided leases | | | | | | | 104·54 | | 85,876·50 | 52,365·05 | |
| | | Sundry claims | | | | | | 28·10 | 97·22 | | 14,687·91 | 8,265·87 | |
| Tampa | | Voided leases | | | | | | | 41·58 | | 50,477·57 | 23,287·71 | 174·24 |
| | | Sundry claims | | | | | | 32·60 | 283·40 | | 8,041·33 | 4,113·02 | |
| | *From District generally :* | | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | | |
| | Various Works | | | | | | | | | | 1,220·50 | *20,884·22 | 120·98 |
| | Reported by Banks and Gold Dealers | | | | | | | 1,593·39 | 823·66 | | | 63·53 | |
| | **Totals** | | | | **737·75** | **249·63** | **8·63** | **1,718·36** | **1,821·77** | | **941,911·27** | **527,757·58** | **5,695·32** |

## YERILLA DISTRICT.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Edjudina | | Voided leases | | | | | | | | 18·44 | 35,523·70 | 43,374·79 | 37·79 |
| | | Sundry claims | | | | | | | | 28·52 | 6,967·58 | 4,829·77 | ·69 |
| Patricia | | Voided leases | | | | | | | | | 4,158·50 | 5,396·40 | 25·40 |
| | | Sundry claims | | | | | | | | | 47·00 | 20·78 | |
| Pingin | | Voided leases | | | | | | | | 48·34 | 17,463·30 | 10,742·77 | |
| | | Sundry claims | | | | | | | | 154·86 | 5,642·59 | 3,475·75 | |
| Yarri | G.M.L. 1320R | Margaret | | | 152·00 | 29·69 | ·32 | | | | 4,036·00 | 1,253·32 | ·32 |
| | 1126R, etc. | Porphyry (1939) Gold Mines N.L. | | | | | | | | | 66,939·00 | 9,893·51 | 261·95 |
| | 1126R, etc. | (Edjudina Gold Mining Co. N.L.) | | | | | | | | | 30,220·00 | 5,409·93 | 507·51 |
| | | Prior to transfer to present holders | | | | | | | | | 124·50 | 38·89 | |
| | 1339R | Yilgangie | | | | | | | | | 463·00 | 207·93 | |
| | | Voided leases | | | | | | 6·30 | 87·08 | | 45,427·75 | 21,392·94 | 2·00 |
| | | Sundry claims | | | 181·00 | 53·97 | ·29 | ·87 | 5·93 | | 17,965·05 | 6,301·79 | 1·27 |
| Yerilla | | Voided leases | | | | | | | 3,107·25 | | 16,481·43 | 12,925·74 | 13·93 |
| | | Sundry claims | | | | | | 19·30 | 97·63 | | 2,752·83 | 1,590·03 | |
| Yilgangie | 1176R, etc. | Western Mining Corporation | | | 1,610·00 | 1,558·49 | 215·10 | | | | 27,886·75 | 26,186·10 | 3,899·27 |
| | | Prior to transfer to present holders | | | | | | | ·85 | | 1,244·75 | 1,830·28 | |
| | | Voided leases | | | | | | | 9·94 | | 2,432·75 | 1,500·80 | |
| | | Sundry claims | | | 31·00 | 10·64 | | 121·67 | 98·20 | | 3,367·30 | 2,067·50 | ·63 |
| | *From District generally :* | | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | | |
| | State Battery, Yarri | | | | | | | | | | 276·50 | *9,060·18 | 11·65 |
| | State Battery, Yerilla | | | | | | | | | | | *43·52 | |
| | Various Works | | | | | | | 2·17 | | | 642·25 | 6,049·24 | |
| | Reported by Banks and Gold Dealers | | | | | | | 1,161·60 | 160·08 | | | 27·36 | |
| | **Totals** | | | | **1,974·00** | **1,652·79** | **215·71** | **1,311·91** | **3,817·12** | | **290,062·53** | **173,619·32** | **4,762·41** |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **Broad Arrow Goldfield.** | | | | | | | | | | | | |
| Bardoc | | Voided leases | .... | .... | .... | .... | .... | .... | 2,335·41 | 85,370·59 | 55,699·50 | 203·60 |
| | | Sundry claims | .... | .... | 29·75 | 2·87 | .... | 54·95 | 1,218·09 | 17,777·78 | 8,332·87 | .... |
| Black Flag | G.M.L. 2229W | Bellevue | .... | .... | 360·25 | 75·52 | 7·01 | .... | 212·68 | 3,984·73 | 3,191·77 | 7·18 |
| | | Voided leases | .... | .... | .... | .... | .... | 27·81 | 405·90 | 48,277·79 | 28,175·08 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 712·92 | 251·59 | 8,337·01 | 5,020·54 | .... |
| Broad Arrow | | Voided leases | .... | .... | .... | .... | .... | 70·32 | 10,453·81 | 155,895·94 | 120,088·05 | 20·23 |
| | | Sundry claims | .... | .... | 224·51 | 56·70 | ·37 | 1,007·72 | 3,046·26 | 35,166·90 | 17,095·77 | ·48 |
| Canegrass | | Voided leases | .... | .... | .... | .... | .... | .... | 27·77 | 669·82 | 460·72 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 227·55 | 717·45 | 505·06 | .... |
| Carnage | | Voided leases | .... | .... | .... | .... | .... | 176·04 | 659·31 | 2,402·00 | 2,170·67 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 6·61 | 2,340·33 | 921·90 | .... |
| Cashmans | | Voided leases | .... | .... | .... | .... | .... | 67·51 | 813·76 | 8,172·15 | 7,090·91 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 40·31 | 1,205·12 | 361·74 | ·05 |
| Christmas Reef | 2279W | New Mexico | .... | .... | 233·00 | 215·80 | 6·99 | .... | .... | 603·50 | 467·35 | 6·99 |
| | 2253W | New Mexico South | .... | .... | 41·50 | 12·91 | ·22 | .... | .... | 3,167·50 | 3,452·25 | ·22 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 55·49 | 1,865·12 | 3,606·65 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 441·85 | 3,312·14 | 3,245·56 | .... |
| Fenbark | | Voided leases | .... | .... | .... | .... | .... | .... | 4·42 | 6,771·00 | 2,711·68 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 51·96 | 3,031·52 | 1,000·47 | .... |
| Grants Patch | 2277W | Coronation | .... | .... | 9·75 | 8·03 | 1·39 | .... | .... | 516·25 | 428·40 | 1·39 |
| | 2299W | Jeanie May | .... | .... | 23·00 | 6·37 | .... | .... | .... | 362·85 | 91·03 | .... |
| | 2278W | Prince of Wales Syndicate | .... | .... | 133·25 | 208·28 | 40·88 | .... | .... | 702·75 | 1,246·34 | 40·88 |
| | 2277W, 2278W | (Ora Banda Amalgamated Mines N.L.) | .... | .... | .... | .... | .... | .... | .... | 961·00 | 1,148·58 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 274·13 | 203,675·74 | 80,047·31 | 175·00 |
| | | Sundry claims | .... | .... | 143·25 | 22·87 | .... | .... | 356·66 | 7,168·84 | 3,205·88 | .... |
| Ora Banda | 2270W, 2290W | Gimlet South Leases | .... | .... | 921·00 | 119·58 | ·06 | .... | .... | 10,374·75 | 2,006·13 | ·06 |
| | 2303W | Old Victoria | .... | .... | 66·50 | 12·45 | .... | .... | .... | 66·50 | 12·45 | .... |
| | 2300W | Sleeping Beauty | .... | .... | 1,045·25 | 423·10 | 1·14 | .... | .... | 1,691·00 | 690·49 | 1·14 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 846·13 | 423,464·77 | 151,188·55 | 1,685·77 |
| | | Sundry claims | .... | .... | 72·00 | 17·61 | .... | .... | 467·18 | 15,272·55 | 4,865·76 | .... |
| Paddington | 2298W | Rona Lucille | .... | .... | .... | .... | .... | .... | .... | 227·50 | 40·46 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 5,566·30 | 463·31 | 196,486·56 | 86,485·99 | 32·15 |
| | | Sundry claims | .... | .... | 106·35 | 18·48 | .... | 1,714·16 | 291·43 | 17,442·18 | 9,306·29 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riche's Find .... | 2306W.... .... | Cave Hill .... .... .... .... | .... | 238·15 | 32·00 | 96·87 | .... | .... | 238·15 | 32·00 | 96·87 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 21·64 | 7,643·09 | 6,095·69 | 71·36 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 549·09 | 1,963·50 | 2,486·06 | ·13 |
| Siberia .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 1·07 | 2,649·28 | 28,995·47 | 31,776·06 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 289·06 | 1,261·72 | 21,308·29 | 12,887·07 | .... |
| Smithfield .... | 2296W.... .... | Timewell .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 24·50 | 20·66 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 19·19 | 11,717·71 | 2,068·58 | .... |
| | | Sundry claims .... .... .... | .... | .... | 53·50 | 22·75 | ·11 | .... | 124·29 | 3,916·09 | 1,397·67 | ·11 |
| | *From Goldfield generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | W. J. Ferguson (L.T.T. 1455H) .... .... | .... | .... | .... | ·50 | ·52 | .... | .... | .... | ·50 | ·52 | .... |
| | H. J. Kingdon (M.A. 4W) .... .... | .... | .... | .... | ·05 | 2·24 | ·18 | .... | 1·53 | 12·55 | 6·49 | ·18 |
| | State Battery, Ora Banda .... .... | .... | .... | .... | .... | 878·64 | 43·64 | .... | .... | 128·05 | *26,524·15 | 73·53 |
| | Golden Arrow Battery .... .... | .... | .... | .... | .... | .... | .... | .... | .... | 80·75 | *4,333·07 | 2·30 |
| | Various Works .... .... .... | .... | .... | .... | .... | .... | .... | 2,275·66 | 1·24 | 16,967·02 | 49,504·77 | 3,103·45 |
| | Reported by Banks and Gold Dealers .... .... | .... | 15·54 | .... | .... | ·15 | 10,018·30 | 165·70 | 61·68 | 95·83 | ·15 |
| | **Totals** .... .... .... .... | .... | **253·69** | **3,495·41** | **2,201·59** | **102·14** | **21,981·82** | **27,983·44** | **1,360,332·83** | **741,655·69** | **5,426·35** |

# North-East Coolgardie Goldfield.

## KANOWNA DISTRICT.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gindalbie .... .... | G.M.L. 1583X.... | S.H.E. .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 243·00 | 163·25 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,151·99 | 46,180·53 | 41,748·13 | 38·31 |
| | | Sundry claims .... .... .... | .... | .... | 80·50 | 30·78 | ·01 | .... | 716·52 | 5,846·77 | 3,305·91 | ·01 |
| Gordon .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 682·54 | 53,900·58 | 20,072·51 | 517·61 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 177·38 | 2,265·95 | 1,229·87 | .... |
| Kalpini .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 38·73 | 13,543·50 | 6,753·78 | ·07 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 24·70 | 269·72 | 1,492·50 | 1,026·37 | .... |
| Kanowna .... .... | 1572X .... | Kanowna Red Hill .... .... | .... | .... | 260·00 | 68·62 | 2·77 | .... | 2·38 | 3,338·75 | 1,076·34 | 2·77 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 24·94 | 4,516·76 | 685,625·60 | 380,504·87 | 2,482·24 |
| | | Sundry claims .... .... .... | .... | .... | 268·50 | 42·81 | ·21 | 125·32 | 2,169·07 | 27,895·77 | 12,049·95 | 1·71 |
| Mulgarrie .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,216·63 | 6,902·26 | 4,197·98 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 16·78 | 1,290·00 | 646·60 | .... |
| Six Mile .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,603·72 | 559·00 | 767·72 | .... |
| | | Sundry claims .... .... .... | .... | .... | 7·25 | 1·53 | .... | .... | 56·51 | 771·75 | 232·66 | .... |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | Various Works .... .... .... .... | .... | .... | .... | .... | .... | 330·42 | 867·52 | 158,935·05 | 153,209·41 | .... |
| | Reported by Banks and Gold Dealers .... .... | 5·10 | .... | .... | .... | .... | 106,030·39 | 40·42 | ·50 | 109·73 | .... |
| | **Totals** .... .... .... .... | **5·10** | .... | **616·25** | **143·74** | **2·99** | **106,535·77** | **13,526·67** | **1,008,791·51** | **627,095·08** | **3,042·72** |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1960 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **NORTH COOLGARDIE GOLDFIELD**—continued. | | | | | | | | | | | | |
| KURNALPI DISTRICT. | | | | | | | | | | | | |
| Jubilee | | Voided leases | .... | .... | .... | .... | .... | .... | 145·13 | 2,122·50 | 1,465·16 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 25·57 | 13·52 | 1,246·25 | 522·21 | .... |
| Kurnalpi | | Voided leases | .... | .... | .... | .... | .... | 371·18 | 3,166·80 | 4,130·76 | 4,022·13 | 6·27 |
| | | Sundry claims | .... | .... | 27·00 | 12·02 | .... | 324·12 | 727·39 | 4,539·11 | 2,353·20 | .... |
| Mulgabbie | | Voided leases | .... | .... | .... | .... | .... | .... | 1,402·66 | 226·75 | 7,845·87 | 4·95 |
| | | Sundry claims | .... | .... | .... | .... | .... | 8·06 | 2,772·71 | 1,327·45 | 2,241·18 | .... |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | Various Works | .... | .... | .... | .... | .... | .... | .... | 101·50 | 388·63 | .... |
| | | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 12,106·56 | 70·70 | .... | 2·35 | 1·49 |
| | | **Totals** | .... | .... | **27·00** | **12·02** | .... | **12,835·49** | **8,298·91** | **13,694·32** | **18,840·73** | **12·71** |
| **East Coolgardie Goldfield.** | | | | | | | | | | | | |
| EAST COOLGARDIE DISTRICT. | | | | | | | | | | | | |
| Binduli | G.M.L. 6582E | Royal Standard | .... | .... | 61·25 | 2·62 | .... | .... | .... | 264·25 | 19·55 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 1,640·35 | 475·81 | .... |
| | | Sundry claims | .... | .... | 73·85 | 4·50 | ·06 | .... | 13·01 | 5,603·87 | 1,718·02 | ·06 |
| Boorara | | Voided leases | .... | .... | .... | .... | .... | .... | 459·07 | 309,467·82 | 172,861·95 | 411·37 |
| | | Sundry claims | .... | .... | 57·25 | 7·01 | .... | ·49 | 145·56 | 4,243·59 | 1,569·63 | ·05 |
| Boulder | 6145E | Boomerang | .... | .... | .... | .... | .... | .... | .... | 77·00 | 8·00 | .... |
| | 5531E | Cassidy's Hill | .... | .... | 189·00 | 12·02 | .... | .... | .... | 1,313·25 | 105·32 | .... |
| | 5964E | Croesus Extended | .... | .... | .... | .... | .... | .... | .... | 192·75 | 16·57 | .... |
| | 6537E | Golden Key | .... | .... | 71·00 | 56·37 | .... | .... | 58·22 | 767·10 | 828·68 | .... |
| | 5692E, etc. | Gold Mines of Kalgoorlie (Aust.) Ltd. | .... | .... | 500,293·00 | 142,992·18 | 31,806·83 | .... | .... | 2,513,495·00 | 667,947·02 | 131,722·88 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 791·73 | 15916155·97 | 6,415,881·49 | 819,123·27 |
| | 5696E, etc. | Great Boulder Gold Mines Ltd. | .... | .... | 452,145·00 | 129,387·61 | 44,031·36 | .... | 1·53 | 14126422·97 | 6,400,022·22 | 1,568,140·23 |
| | 5478E, etc. | Lake View and Star Ltd. | .... | .... | 681,108·00 | 174,369·99 | 20,811·78 | .... | .... | 16498926·30 | 4,825,714·77 | 531,150·10 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 8·49 | 15792500·38 | 9,149,223·80 | 1,348,055·28 |
| | 5431E, etc. | North Kalgurli (1912) Ltd. | .... | .... | 373,795·00 | 90,219·92 | 28,136·05 | .... | 127·55 | 6,091,743·24 | 1,651,785·26 | 367,253·93 |
| | 5405E, etc. | North Kalgurli (1912) Ltd. (Croesus Pty. Group) | .... | .... | .... | .... | .... | .... | 51·20 | 90,159·00 | 19,261·22 | .... |
| | 5891E | New Croesus | .... | .... | .... | .... | .... | .... | .... | 193·00 | 48·74 | .... |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | 43·99 | .... | 4,018,436·01 | 2,815,911·21 | 97,625·03 |
| | | Voided leases | .... | .... | .... | .... | .... | 129·24 | 12,023·37 | 1,822,556·06 | 761,933·46 | 24,046·96 |
| | | Sundry claims | .... | .... | .... | .... | .... | 24·58 | 212·32 | 11,649·99 | 4,300·62 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cutters Luck .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 45·87 | 133·58 | 74·50 | 239·19 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 8·11 | 501·65 | 922·90 | 384·71 | .... |
| Feysville .... .... | 6591E .... .... | Kalgoorlie Star .... .... .... | .... | .... | 24·75 | 12·01 | ·57 | .... | .... | 24·75 | 12·01 | ·57 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 110·93 | 863·30 | 425·16 | .... |
| | | Sundry claims .... .... .... | .... | .... | 8·40 | 5·81 | .... | .... | 199·00 | 1,264·75 | 655·20 | .... |
| Hampton Plains .... | P.P. 1 .... | Hampton Boulder .... .... .... | .... | .... | 89·25 | 14·19 | ·08 | .... | .... | 165·75 | 18·70 | ·08 |
| | P.P. 1, etc. .... | Consolidated Gold Areas N.L. .... | .... | .... | .... | .... | .... | .... | .... | 142,565·73 | 37,249·15 | 5,835·85 |
| | P.P. 10 .... | F. C. Schoppe .... .... .... | .... | .... | .... | .... | .... | .... | .... | 891·50 | 42·05 | .... |
| | P.P. 12 .... | Junction Extended .... .... | .... | .... | 20·50 | 3·31 | .... | .... | .... | 3,660·50 | 538·86 | .... |
| | P.P. 86 .... | Golden Hope N.L. .... .... | .... | .... | .... | .... | .... | .... | .... | 5,964·00 | 2,006·14 | .... |
| | P.P. 50 .... | A. McKay .... .... .... | .... | .... | .... | .... | .... | .... | .... | 80·25 | 5·46 | .... |
| | P.P. 23 .... | Mutoroo (Scherini & Rowe) .... | .... | .... | .... | .... | .... | .... | .... | 1,747·50 | 134·82 | .... |
| | P.P. 48 .... | E. Doherty .... .... .... .... | .... | .... | .... | 34·65 | .... | .... | .... | .... | 34·65 | .... |
| | P.P. 175 .... | S. Shackleton .... .... .... | .... | .... | .... | .... | .... | .... | .... | 121·25 | 7·40 | .... |
| | P.P. 175 .... | Jubilee (F. C. Schoppe) .... | .... | .... | .... | .... | .... | .... | .... | 6,708·00 | 906·81 | .... |
| | P.P. 192 .... | Golden Hope North .... .... | .... | .... | .... | .... | .... | .... | .... | 353·00 | 201·02 | .... |
| | P.P. 222 .... | Hampton Jubilee .... .... .... | .... | .... | 35·50 | 8·73 | ·34 | .... | .... | 157·75 | 18·56 | ·34 |
| | P.P. 252 .... | Hampton Properties Ltd.—Mount Martin | .... | .... | .... | .... | .... | .... | .... | 14,953·75 | 5,574·11 | .... |
| | P.P. 277 .... | M. Africh .... .... .... .... | .... | .... | 2,709·75 | 264·37 | .... | .... | .... | 3,981·00 | 397·48 | .... |
| | P.P. 277 .... | Pernatty .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 7,247·75 | 866·88 | ·01 |
| | P.P. 277 .... | New Hope .... .... .... .... | .... | .... | .... | .... | .... | .... | 17·23 | 61,468·55 | 11,175·94 | .... |
| | P.P. 460 .... | Hampton Xmas Gift .... .... | .... | .... | .... | .... | .... | 6·72 | 37·57 | 107·00 | 89·44 | .... |
| | P.P. 471 .... | D. Cullen & R. Renton .... .... | .... | .... | .... | .... | .... | .... | .... | 7·05 | 126·78 | .... |
| | P.P. 474 .... | L. Rowell .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 20·75 | 3·96 | .... |
| | P.P. 476 .... | Ivy Rose .... .... .... .... | .... | .... | 10·75 | 65·20 | ·72 | .... | 7·75 | 92·05 | 179·96 | ·72 |
| | P.P. 478 .... | L. Bracegirdle .... .... .... | .... | .... | 2·75 | 5·25 | .... | .... | .... | 2·75 | 5·25 | .... |
| | P.P. 480 .... | A. Brokenshire .... .... .... | .... | .... | 13·00 | 4·08 | .... | .... | .... | 13·00 | 4·08 | .... |
| | | Cancelled leases .... .... .... | .... | .... | .... | .... | .... | 4,578·52 | 203·94 | 126,877·34 | 39,711·84 | 69·83 |
| | | Sundry claims and leases .... | .... | .... | 24·25 | 3·76 | ·13 | 2·68 | 70·85 | 46,491·16 | 8,523·04 | ·13 |
| Kalgoorlie .... | G.M.L. 6562E .... | Bretvic .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 326·50 | 26·09 | .... |
| | 6563E, 6564E | Champagne Syndicate N.L. .... .... | .... | .... | .... | .... | .... | .... | .... | 12,287·75 | 1,348·10 | 61·41 |
| | 4547E, etc. .... | Mount Charlotte (Kalgoorlie) Gold Mines N.L. | .... | .... | .... | .... | .... | .... | .... | 25,143·25 | 2,888·32 | 110·15 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 5·72 | 48,292·60 | 13,930·79 | .... |
| | 6503E .... .... | Coronation .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 20·50 | 2·52 | .... |
| | 5510E .... .... | Golden Dream .... .... .... | .... | .... | .... | .... | .... | .... | .... | 207·75 | 19·29 | .... |
| | 5774E .... .... | Golden Goose .... .... .... | .... | .... | .... | .... | .... | .... | .... | 374·50 | 76·47 | .... |
| | 6589E .... .... | Grays Central .... .... .... | .... | .... | 210·75 | 88·35 | .... | .... | .... | 741·75 | 105·33 | .... |
| | 6502E .... .... | Gold Mines of Kalgoorlie (Aust.) Ltd. (Hannans North) | .... | .... | 1,314·50 | 322·80 | 1·89 | .... | .... | 1,314·50 | 322·80 | 1·89 |
| | 6502E .... .... | Western Mining Corporation (Hannans North) | .... | .... | .... | .... | .... | .... | .... | 256·00 | 65·07 | 4·28 |
| | 6091E .... .... | Lesanben .... .... .... .... | .... | .... | 82·75 | 101·71 | 1·93 | .... | 193·96 | 1,039·80 | 635·83 | 1·93 |
| | 6485E .... .... | Maritana Hill .... .... .... | .... | .... | .... | .... | .... | .... | .... | 3,138·50 | 394·23 | .... |
| | 6535E .... .... | Mary A. .... .... .... .... | .... | .... | 602·00 | 56·52 | ·14 | .... | .... | 5,110·00 | 479·76 | ·14 |
| | 6321E .... .... | North End Extended .... .... | .... | .... | .... | .... | .... | .... | 69·28 | 2,125·00 | 514·29 | .... |
| | 5852E (6024E) | Pedestal Leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,828·50 | 490·37 | .... |
| | 5852E .... .... | Pedestal .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,608·75 | 444·93 | .... |
| | (6024E) .... | Trident .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 58·75 | 36·67 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 242·48 | 10,733·00 | 1,472,624·51 | 582,111·90 | 45,975·97 |
| | | Sundry claims .... .... .... | .... | .... | 426·25 | 54·75 | ·18 | 232·41 | 1,124·61 | 62,215·78 | 23,290·09 | ·18 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **EAST COOLGARDIE GOLDFIELD**—continued. | | | | | | | | | | | | |
| **EAST COOLGARDIE DISTRICT**—*continued.* | | | | | | | | | | | | |
| Wombola .... .... | (6051E) .... | Bigbull .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 669·75 | 481·76 | .... |
| | 5688E (5967E) | Caledonian Leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 970·00 | 659·67 | .... |
| | 5688E .... .... | Caledonia .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 4,275·00 | 3,632·98 | .... |
| | (5967E) .... | North Caledonian .... .... .... | .... | .... | .... | .... | .... | .... | 1·27 | 22·25 | 8·15 | .... |
| | 5497E, 5500E | Daisy Leases .... .... .... | .... | .... | 1,014·25 | 595·10 | 25·23 | .... | .... | 17,062·20 | 12,323·13 | 109·76 |
| | 5497E .... .... | Daisy .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 6,282·25 | 5,031·93 | .... |
| | 5500E .... .... | Happy-Go-Lucky .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,075·25 | 1,675·85 | .... |
| | 6325E .... .... | Great Hope .... .... .... | .... | .... | .... | .... | .... | .... | 26·66 | 621·50 | 252·04 | .... |
| | 5689E, etc. .... | Mt. Monger Mining Syndicate .... | .... | .... | 458·50 | 191·20 | 15·54 | .... | .... | 4,916·75 | 3,215·62 | 41·72 |
| | 5689E .... .... | (Haoma Gold Mines N.L.) .... .... | .... | .... | .... | .... | .... | .... | .... | 9,233·00 | 7,239·42 | 269·03 |
| | 5689E .... .... | (Haoma Leases) .... .... .... | .... | .... | .... | .... | .... | .... | .... | 27,396·50 | 25,445·40 | 79·15 |
| | 5689E .... .... | (Haoma) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,168·00 | 1,948·36 | ·54 |
| | 5525E .... .... | (Xmas Flat) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 330·25 | 264·74 | .... |
| | 5798E .... .... | (Maranoa) .... .... .... .... | .... | .... | .... | .... | .... | .... | 32·17 | 3,183·50 | 1,633·27 | .... |
| | 5493E .... .... | (New Milano N.L.) .... .... .... | .... | .... | .... | .... | .... | .... | ·25 | 17,390·75 | 11,622·24 | 479·00 |
| | 5493E .... .... | (Milano) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 4,012·75 | 11,676·72 | .... |
| | 5616E .... .... | (Leslie) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 602·00 | 939·10 | .... |
| | 6312E .... .... | Inverness .... .... .... .... | .... | .... | 90·75 | 16·40 | .... | .... | .... | 3,062·50 | 547·82 | .... |
| | 6540E .... .... | Launa Doone .... .... .... | .... | .... | 25·50 | 7·35 | ·58 | .... | .... | 653·25 | 160·16 | ·58 |
| | 6487E .... .... | Leslie .... .... .... .... | .... | .... | 27·00 | 15·45 | ·49 | .... | .... | 343·75 | 343·85 | ·49 |
| | (6213E) .... | Pauline .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 282·50 | 229·08 | .... |
| | 6570E .... .... | Rock and Roll .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,475·75 | 239·51 | .... |
| | 6533E .... .... | Rosemary .... .... .... .... | .... | .... | 985·15 | 740·26 | 56·74 | .... | .... | 5,144·10 | 7,789·00 | 56·74 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 3·80 | 2,464·78 | 30,666·09 | 42,246·83 | ·60 |
| | | Sundry claims .... .... .... | .... | .... | 57·50 | 22·18 | ·20 | .... | 711·10 | 25,413·18 | 14,416·56 | ·20 |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | Golden Horseshoe (New) Ltd. .... .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | *350,028·15 | 354,192·20 |
| | State Battery, Kalgoorlie .... .... .... | | .... | .... | .... | *743·08 | 42·54 | .... | .... | 390·70 | *35,719·52 | 174·06 |
| | Sundry Claims .... .... .... .... | | .... | .... | .... | .... | .... | 11,014·57 | 465·61 | 5,440·46 | 2,541·10 | .... |
| | Bagworth & Parker (L.T.T. 1415H) .... .... | | .... | .... | .... | .... | .... | .... | .... | .... | 3·57 | .... |
| | Northern Mineral Sands .... .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 532·25 | *216·88 | .... |
| | Various Works .... .... .... .... | | .... | .... | .... | .... | .... | 384·36 | 64·70 | 41,135·02 | *270,756·33 | 14,114·46 |
| | Reported by Banks and Gold Dealers .... .... | | 27·76 | .... | .... | .... | .... | 16,990·14 | 10,070·47 | 392·43 | 7,498·53 | .... |
| | | **Totals** .... .... .... .... | **27·76** | .... | **2,016,027·15** | **540,429·33** | **124,933·38** | **33,707·96** | **41,138·13** | **79487493·85** | **34447142·11** | **5,309,111·17** |

## BULONG DISTRICT.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balagundi .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 2,408·98 | 1,115·93 | 1,488·91 | 12·92 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 3·51 | 293·52 | 806·01 | 505·93 | .... |
| Bulong .... .... | G.M.L. 1311Y.... | Blue Quartz .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,031·25 | 701·61 | .... |
| | 1337Y .... .... | Rainbow .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 288·50 | 39·37 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 107·54 | 8,526·12 | 108,515·05 | 85,819·62 | .... |
| | | Sundry claims .... .... .... | .... | .... | 181·75 | 16·15 | .... | 1,655·86 | 1,611·58 | 18,053·73 | 17,970·72 | .... |
| Majestic .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 19·45 | 63·91 | 1,317·94 | 647·62 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 42·88 | 154·58 | 1,926·55 | 948·06 | .... |
| Morelands .... | .... .... .... | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | ·13 | 308·75 | 81·84 | .... |
| Mount Monger .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 2,771·39 | 1,437·85 | 1,256·10 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 215·60 | .... | 379·05 | 308·48 | .... |
| Randalls .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 60·04 | 33,180·35 | 11,100·46 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 20·70 | 9·79 | 4,842·56 | 1,216·07 | .... |
| Taurus .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 2·06 | 3·70 | 1,765·10 | 909·84 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 112·69 | 51·88 | 2,656·60 | 1,049·81 | .... |
| Hampton Plains (Trans Find) | P.P.L. 308A .... | Dawn of Hope .... .... .... | .... | .... | .... | .... | .... | .... | 2·87 | 1,145·75 | 330·33 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,098·42 | 876·22 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 5·93 | 808·25 | 335·33 | .... |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | Various Works .... .... .... | .... .... | .... | .... | .... | .... | .... | .... | .... | 6,102·15 | 6,675·38 | .... |
| | Reported by Banks and Gold Dealers .... | .... | .... | .... | .... | .... | .... | 25,224·93 | 70·15 | ·01 | 28·44 | .... |
| | **Totals** .... .... .... .... | .... | .... | 181·75 | 16·15 | .... | 27,405·22 | 16,034·57 | 187,779·80 | 132,290·14 | 12·92 |

# Coolgardie Goldfield.

## COOLGARDIE DISTRICT.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bonnievale .... | G.M.L. 5986 .... | Jenny Wren .... .... .... | .... | .... | 27·50 | 19·47 | .... | .... | .... | 180·25 | 78·79 | .... |
| | 5622 .... .... | Lucky Hit .... .... .... | .... | .... | 24·00 | 31·25 | .... | .... | 3·28 | 1,108·10 | 598·93 | .... |
| | 5890 .... .... | Rayjax .... .... .... | .... | .... | 44·25 | 58·07 | 1·80 | .... | .... | 508·25 | 910·32 | 1·80 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 212·48 | 362,696·87 | 196,412·90 | 19·86 |
| | | Sundry claims .... .... .... | .... | .... | 150·25 | 43·69 | ·38 | .... | 163·19 | 8,341·88 | 5,436·67 | ·42 |
| Bulla Bulling .... | 6003 .... .... | Worked Out .... .... .... | .... | .... | 24·75 | 27·86 | .... | .... | .... | 54·50 | 54·90 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,410·56 | 968·52 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 5·21 | 15·98 | 2,068·76 | 819·66 | .... |
| Burbanks .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 14·90 | 376·98 | 420,591·86 | 306,446·31 | 521·06 |
| | | Sundry claims .... .... .... | .... | .... | 316·25 | 60·40 | ·06 | 55·05 | 497·55 | 16,971·60 | 9,153·53 | ·06 |
| Cave Rocks .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 8,223·16 | 1,941·42 | .... |
| | | Sundry claims .... .... .... | .... | .... | 28·00 | 2·00 | .... | .... | 50·00 | 4,501·65 | 1,084·79 | .... |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **COOLGARDIE GOLDFIELD—continued.** | | | | | | | | | | | | |
| **COOLGARDIE DISTRICT—*continued.*** | | | | | | | | | | | | |
| Coolgardie | 5935, etc. | Gold Mines of Kalgoorlie (Aust.) Ltd. | .... | .... | 17,219·00 | 9,699·68 | .... | .... | .... | 126,733·00 | 65,517·78 | 907·43 |
| | 5876 | (Bayleys West) | .... | .... | .... | .... | .... | .... | .... | 6·25 | 2·22 | .... |
| | 6000 | Dendon | .... | .... | 534·75 | 62·05 | .... | .... | .... | 636·00 | 87·52 | .... |
| | 5868 | El Dorado | .... | .... | .... | .... | .... | .... | 498·20 | 175·45 | 1,034·94 | .... |
| | (5997) | Ellen Jean | .... | .... | 133·25 | 14·55 | ·61 | .... | 20·01 | 676·25 | 242·64 | ·61 |
| | 6010 | Emperor of Coolgardie | .... | 5·11 | .... | .... | .... | .... | 5·11 | .... | .... | .... |
| | 5844 | Jackpot | .... | .... | 776·75 | 339·62 | .... | .... | .... | 9,778·00 | 4,076·81 | .... |
| | 5884 | Lone Hand | .... | .... | .... | .... | .... | .... | 19·85 | 499·00 | 84·85 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 1,301·71 | 4,764·07 | 1,111,004·74 | 449,495·29 | 4,819·59 |
| | | Sundry claims | ·39 | 30·90 | 664·00 | 149·77 | ·17 | 219·47 | 2,794·41 | 79,430·94 | 28,579·33 | ·17 |
| Eundynie | .... | Voided leases | .... | .... | .... | .... | .... | 3·70 | 16·09 | 31,772·98 | 16,531·34 | 1·75 |
| | | Sundry claims | 8·85 | .... | .... | .... | .... | 8·85 | 229·66 | 698·12 | 521·20 | .... |
| Gibraltar | 5723 | Lloyd George | .... | .... | .... | .... | .... | .... | .... | 763·00 | 176·78 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 33·97 | 38,762·63 | 20,114·27 | .... |
| | | Sundry claims | .... | .... | 15·00 | 4·47 | .... | 1·39 | 50·76 | 3,305·60 | 1,400·22 | .... |
| Gnarlbine | .... | Voided leases | .... | .... | .... | .... | .... | .... | 13·95 | 2,731·75 | 1,341·60 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 4·90 | 1,186·10 | 504·18 | .... |
| Hampton Plains | P.P.L. 462 | Bobby Dazzler | .... | .... | .... | .... | .... | .... | 28·55 | 31·37 | 301·45 | .... |
| | P.P.L. 419 | Chatanooka | .... | .... | .... | .... | .... | .... | .... | 1,267·75 | 295·73 | 1·10 |
| | P.P.L. 335 | D. & C. P. Clews | .... | .... | .... | .... | .... | .... | .... | 149·75 | 119·66 | .... |
| | P.P.L. 338 | Dry Hill | .... | .... | .... | .... | .... | .... | .... | 43·00 | 58·42 | .... |
| | P.P.L. 465 | G. Dugan & Party | .... | .... | .... | .... | .... | .... | .... | 53·75 | 17·54 | .... |
| | P.P.L. 454 | Golden Dollar | .... | .... | .... | .... | .... | .... | .... | 105·50 | 13·66 | .... |
| | P.P.L. 319 | Lady May | .... | .... | .... | .... | .... | .... | .... | 248·25 | 146·21 | .... |
| | P.P.L. (319) | (Lady May) | .... | .... | .... | .... | .... | .... | .... | 1,742·25 | 981·39 | .... |
| | P.P.L. 334 | Gold Mines of Kalgoorlie (Aust.) Ltd. | .... | .... | 731·75 | 271·70 | .... | .... | .... | 1,569·25 | 636·05 | .... |
| | P.P.L. 468 | Nichols & Hacket | .... | .... | .... | .... | .... | .... | .... | 24·25 | 5·30 | .... |
| | P.P.L. 469 | Cullen & Frank | .... | .... | .... | .... | .... | .... | 6·46 | 3·75 | 2·34 | .... |
| | P.P.L. 316–330 | Gold Mines of Kalgoorlie (Aust.) Ltd. | .... | .... | .... | .... | .... | .... | .... | 261,552·50 | 134,026·06 | 29,871·18 |
| | P.P.L. 316 | (Surprise Gold Mine) | .... | .... | .... | .... | .... | .... | .... | 7,189·00 | 3,425·59 | .... |
| | P.P.L. 330 | (Barbara) | .... | .... | .... | .... | .... | .... | .... | 2,157·75 | 1,655·63 | .... |
| | P.P.L. 471 | A. J. Wells | .... | .... | .... | .... | .... | .... | .... | 45·00 | 1·40 | .... |
| | P.P.L. 472 | F. Clarke | .... | .... | .... | .... | .... | .... | .... | 30·75 | 4·02 | .... |
| | P.P.L. 473 | Austin & Hadlow | .... | .... | .... | .... | .... | 2·56 | .... | 30·00 | 28·38 | .... |
| | P.P.L. 475 | F. J. Wallace | .... | .... | .... | .... | .... | .... | .... | 16·00 | 5·22 | .... |
| | P.P.L. 478 | A. E. Smith | .... | .... | .... | .... | .... | .... | .... | 22·25 | 57·73 | .... |
| | P.P.L. 481 | C. W. Avard | .... | .... | 60·50 | 53·22 | .... | .... | .... | 106·75 | 73·49 | .... |
| | P.P.L. 482 | T. R. Baker | .... | .... | 304·00 | 47·18 | ·08 | .... | .... | 455·25 | 89·88 | ·08 |
| | | Cancelled leases | .... | .... | .... | .... | .... | .... | 451·32 | 13,950·84 | 11,118·69 | .... |
| | | Sundry claims and leases | .... | .... | .... | .... | .... | 1·63 | 132·06 | 1,948·00 | 856·51 | .... |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Higginsville** .... | G.M.L. 5647 .... | Fair Play Gold Mine .... .... .... | .... | 62·70 | 103·50 | 7·92 | .... | .... | 62·70 | 28,495·50 | 3,160·74 | ·02 |
| | 6002 .... .... | Two Boys .... .... .... .... | .... | .... | 101·25 | 43·75 | ·08 | .... | .... | 201·25 | 106·64 | ·08 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 482·47 | 45,601·85 | 22,058·79 | 160·72 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 187·25 | 3,664·76 | 1,957·50 | .... |
| **Larkinville** .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 22·77 | 54·44 | 2,335·16 | 3,256·49 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 147·20 | 490·53 | 1,033·19 | .... |
| **Logans** .... .... | (5324, etc.) .... | Spargo's Reward Gold Mine (1935) N.L. | .... | .... | .... | .... | .... | .... | 11·09 | 105,397·50 | 26,324·42 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,263·31 | 607·26 | .... |
| | | Sundry claims .... .... .... | .... | .... | 36·50 | 6·92 | .... | 6·88 | 128·95 | 2,072·35 | 932·20 | .... |
| **Londonderry** .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 95·04 | 34,155·35 | 22,238·37 | ·35 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 16·68 | 78·66 | 4,191·67 | 2,680·35 | 22·42 |
| **Mungari** .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 17·71 | 1,872·50 | 458·43 | .... |
| | | Sundry claims .... .... .... | .... | .... | 71·25 | 3·54 | .... | 1·77 | 153·24 | 2,900·19 | 756·14 | .... |
| **Paris** .... .... | 5953, etc. .... | Northern Minerals Syndicate .... .... | .... | .... | 5,540·00 | 1,548·44 | 1,011·61 | .... | .... | 10,507·00 | 3,321·67 | 1,376·32 |
| | 5873 .... .... | (Paris West) .... .... .... | .... | .... | .... | .... | .... | .... | .... | 19·00 | 11·03 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | ·88 | 4·30 | 15,497·00 | 8,625·37 | 79·19 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,104·25 | 518·98 | .... |
| **Red Hill** .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 14·87 | 1,551·81 | 40,797·40 | 31,070·65 | .... |
| | | Sundry claims .... .... .... | .... | .... | 32·00 | 28·79 | .... | 15·29 | 95·72 | 1,464·64 | 1,110·41 | .... |
| **Ryans Find** .... | 5999 .... .... | Little Nipper .... .... .... | .... | 454·55 | .... | .... | .... | .... | 796·29 | 15·50 | 109·33 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 54·16 | 151·69 | .... |
| | | Sundry claims .... .... .... | .... | 1·26 | 17·75 | 9·60 | .... | .... | 479·26 | 177·19 | 399·29 | .... |
| **St. Ives** .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 63·34 | 146·87 | 39,318·46 | 16,208·86 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 211·25 | 950·23 | 4,177·56 | 1,459·39 | .... |
| **Wannaway** .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 28·61 | 1,831·95 | 1,465·70 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 193·79 | 1,336·12 | 1,310·57 | .... |
| Widgiemooltha .... | 5663 .... .... | Bobs .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 16·00 | 4·94 | .... |
| | 5834 .... .... | Harpers .... .... .... .... | .... | .... | .... | .... | .... | .... | 9·54 | 40·00 | 93·06 | .... |
| | 5451 .... .... | Host Group .... .... .... .... | .... | .... | .... | .... | .... | .... | 12·75 | 1,604·15 | 565·02 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 17·95 | 1,252·70 | 22,727·81 | 11,965·35 | ·17 |
| | | Sundry claims .... .... .... | .... | .... | 11·00 | 4·12 | .... | 46·49 | 470·06 | 16,230·66 | 6,895·15 | ·07 |
| | *From District generally :* | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | |
| | State Battery, Coolgardie .... .... .... | | .... | .... | .... | *334·87 | ·13 | .... | .... | 771·01 | *40,180·67 | 17·13 |
| | Australian Machinery & Investment Co. Ltd. | | .... | .... | .... | .... | .... | .... | .... | .... | *3,044·44 | 86·31 |
| | T. A. James (T.A. 201) .... .... .... .... | | .... | .... | .... | .... | .... | .... | .... | 361·00 | *373·02 | .... |
| | Various Works .... .... .... .... .... | | .... | .... | .... | .... | .... | 7·75 | .... | 4,014·61 | *29,780·07 | 223·06 |
| | Reported by Banks and Gold Dealers .... .... | | 2·56 | 9·60 | .... | .... | ·40 | 14,989·77 | 737·84 | 48·25 | 139·56 | 1·05 |
| | **Totals** .... .... .... .... | | **11·80** | **564·12** | **26,967·25** | **12,872·93** | **1,015·32** | **17,030·16** | **18,537·35** | **2,923,315·85** | **1,511,912·80** | **38,112·00** |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **COOLGARDIE GOLDFIELD—continued.** | | | | | | | | | | | | |
| **KUNANALLING DISTRICT.** | | | | | | | | | | | | |
| Carbine | G.M.L. 1048S.... | Carbine | .... | .... | .... | .... | .... | .... | .... | 13,853·50 | 7,065·75 | .... |
| | (33S), etc. .... | Carbine Leases | .... | .... | .... | .... | .... | .... | 687·98 | 51,991·86 | 39,862·25 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | .... | 20,116·00 | 5,470·81 | .... |
| | | Sundry claims | .... | .... | 71·25 | 49·29 | .... | 136·27 | 96·96 | 6,517·63 | 2,323·91 | .... |
| Chadwin | .... | Voided leases | .... | .... | .... | .... | .... | .... | .... | 4,837·80 | 5,298·69 | 2·50 |
| | | Sundry claims | .... | .... | .... | .... | .... | 14·28 | 82·36 | 5,987·55 | 2,953·07 | ·25 |
| Dunnsville | .... | Voided leases | .... | .... | .... | .... | .... | .... | 828·58 | 17,548·85 | 8,657·45 | .... |
| | | Sundry claims | .... | .... | 8·75 | 9·71 | .... | 21·00 | 1,034·08 | 3,017·71 | 2,103·06 | .... |
| Jourdie Hills | .... | Voided leases | .... | .... | .... | .... | .... | .... | 18·00 | 28,009·74 | 19,401·09 | 28·45 |
| | | Sundry claims | .... | .... | .... | .... | .... | 1·86 | 49·81 | 2,037·00 | 917·52 | 1·05 |
| Kintore | .... | Voided leases | .... | .... | .... | .... | .... | 18·70 | 169·33 | 56,822·89 | 40,044·61 | 677·88 |
| | | Sundry claims | .... | .... | 71·75 | 10·41 | .... | 111·91 | 102·70 | 4,800·28 | 2,567·76 | .... |
| Kunanalling | .... | Voided leases | .... | .... | .... | .... | .... | 86·13 | 1,734·92 | 130,303·61 | 100,812·73 | 40·77 |
| | | Sundry claims | .... | 145·01 | 154·75 | 170·79 | 3·84 | 216·53 | 960·73 | 15,844·77 | 10,012·28 | 8·14 |
| Kundana | .... | Voided leases | .... | .... | .... | .... | .... | .... | .... | 465·00 | 68·12 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 475·25 | 60·38 | .... |
| | | *From District generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | Goldfields Australian Development Plant | .... | .... | .... | .... | .... | .... | .... | .... | *548·07 | .... |
| | | Various Works | .... | .... | .... | .... | .... | 42·23 | .... | 1,782·26 | 5,063·55 | .... |
| | | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 871·79 | 17·93 | .... | 5·85 | ·49 |
| | | **Totals** | .... | **145·01** | **306·50** | **240·20** | **3·84** | **1,520·70** | **5,783·38** | **364,411·70** | **253,236·95** | **759·53** |
| **Yilgarn Goldfield.** | | | | | | | | | | | | |
| Blackbornes | .... | Voided leases | .... | .... | .... | .... | .... | .... | .... | 1,282·50 | 341·37 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 392·50 | 81·15 | .... |
| Bullfinch | .... | Great Western Consolidated N.L. (Copperhead) | .... | .... | 162,073·00 | 19,912·25 | 3,237·04 | .... | .... | 3,031,887·00 | 417,246·68 | 119,555·52 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 64·80 | 78,404·34 | 24,644·88 | .... |
| | (4447) .... | Mistletoe | .... | .... | 95·00 | 44·35 | 4·75 | .... | .... | 95·00 | 44·35 | 4·75 |
| | 4287 .... | Volcano | .... | .... | .... | .... | .... | .... | .... | 187·00 | 168·43 | ·41 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 10·14 | 490,361·07 | 185,489·03 | 27,958·41 |
| | | Sundry claims | .... | .... | .... | .... | .... | 8·47 | 45·49 | 7,564·39 | 4,114·27 | 8·50 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corinthian .... | 3398, etc. .... | Great Western Consolidated N.L. (Corinthian) | .... | .... | 13,486·00 | 1,659·75 | 241·12 | .... | .... | 131,106·00 | 18,802·01 | 4,136·81 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 14,416·58 | 6,248·03 | .... |
| | 4180 .... .... | Deliverance .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 480·00 | 167·55 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 23·46 | 138,241·40 | 33,293·21 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 2·68 | 1,088·35 | 640·61 | .... |
| Eenuin .... .... | G.M.L. 4491 .... | Sweet William .... .... .... | .... | .... | 451·75 | 122·41 | 13·75 | .... | .... | 451·75 | 122·41 | 13·75 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 196·74 | 10,208·06 | 10,660·65 | ·01 |
| | | Sundry claims .... .... .... | .... | .... | 12·60 | 6·50 | ·82 | 2·50 | 90·95 | 2,786·95 | 1,993·29 | ·82 |
| Evanston .... .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 79·27 | 64,533·06 | 33,191·88 | 10·14 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 4·98 | .... | 638·35 | 159·55 | .... |
| Forrestonia .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,185·00 | 298·15 | .... |
| | | Sundry claims .... .... .... | .... | .... | 8·00 | 16·07 | .... | .... | .... | 386·00 | 160·08 | .... |
| Golden Valley .... | (4484) .... .... | Great Western Consolidated N.L. .... | .... | .... | 614·00 | 26·10 | 4·16 | .... | .... | 2,804·00 | 126·55 | 18·55 |
| | 4247 .... .... | Lily of the Valley .... .... | .... | .... | .... | .... | .... | .... | .... | 709·00 | 177·73 | .... |
| | 4220 .... .... | Manxman South .... .... .... | .... | .... | .... | .... | .... | .... | .... | 19·00 | 4·42 | .... |
| | 3266, etc. .... | Radio Leases .... .... .... | .... | .... | 4,600·00 | 2,396·06 | 299·61 | .... | 2·70 | 42,064·80 | 62,883·26 | 1,307·85 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 36·34 | 36,835·92 | 28,969·41 | 10·99 |
| | | Sundry claims .... .... .... | .... | .... | 5·80 | 4·75 | ·60 | 4·58 | 241·60 | 6,679·07 | 4,950·53 | 2·34 |
| Greenmount .... | (4433) .... .... | Sydney .... .... .... .... | .... | .... | 385·00 | 19·05 | 3·20 | .... | .... | 778·00 | 81·63 | 16·69 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 45·99 | 21·62 | 125,127·64 | 31,585·45 | 944·50 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·46 | 4·27 | 3,152·58 | 832·58 | 5·28 |
| Holleton .... .... | 4450 (37P.P.) | Brittania .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 2,200·00 | 1,726·15 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 9·33 | 45,003·25 | 13,147·88 | 36·69 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 3·75 | 3,464·05 | 923·78 | ·20 |
| Hopes Hill .... | 3414 .... .... | Great Western Consolidated N.L. (Pilot G–P) | .... | .... | 45,554·00 | 5,626·30 | 893·38 | .... | .... | 152,540·00 | 22,384·70 | 4,156·08 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 19,446·12 | 2,948·68 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 74·78 | 132,660·55 | 36,462·02 | 1·00 |
| | | Sundry claims .... .... .... | .... | 3·69 | .... | .... | .... | 21·12 | 95·75 | 4,607·27 | 1,432·52 | .... |
| Kennyville .... | 3875 .... .... | Victoria .... .... .... .... | .... | .... | 70·00 | 10·76 | ·55 | .... | .... | 5,430·00 | 1,195·50 | 1·18 |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 18·76 | 55,876·63 | 21,625·66 | ·59 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 5·06 | 8,700·50 | 2,337·49 | .... |
| Koolyanobbing .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | ·99 | 1,768·05 | 972·77 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | ·26 | 17·33 | 724·85 | 339·23 | .... |
| Marvel Loch .... | 4499 .... .... | Bohemia .... .... .... .... | .... | .... | 44·00 | 18·31 | ·98 | .... | .... | 44·00 | 18·31 | ·98 |
| | (4243) .... .... | Christmas Gift .... .... .... | .... | .... | .... | .... | .... | .... | 32·56 | 137·60 | 66·99 | .... |
| | 4434 .... .... | Cornwall .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 17,708·00 | 2,455·96 | 527·34 |
| | 4449 (13P.P.) .... | Cricket .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 1,671·00 | 932·04 | .... |
| | 4039 .... .... | Cromwell .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 995·50 | 159·91 | .... |
| | 3942, etc. .... | Edwards Reward Leases .... .... | .... | .... | 3,078·00 | 1,414·01 | 218·65 | .... | .... | 71,200·50 | 31,294·75 | 281·28 |
| | 3942 .... .... | (Edwards Reward) .... .... | .... | .... | .... | .... | .... | .... | .... | 2,080·00 | 2,016·32 | .... |
| | 3943 .... .... | (Sunshine) .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 3,866·00 | 2,384·79 | .... |
| | 4034 .... .... | Firelight .... .... .... .... | .... | .... | .... | .... | .... | .... | 2·68 | 6,653·75 | 940·03 | .... |
| | 3724 .... .... | Frances Furness .... .... .... | .... | 9·87 | 1,739·75 | 560·33 | 28·71 | .... | 9·87 | 16,624·25 | 7,772·89 | 28·71 |
| | 4428 .... .... | Great Victoria .... .... .... | .... | .... | 444·00 | 56·85 | 9·54 | .... | .... | 12,662·00 | 1,349·73 | 252·14 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **YILGARN GOLDFIELD—continued.** | | | | | | | | | | | | |
| **Marvel Loch**—*contd.* | 4375 .... .... | Great Western Consolidated N.L. (Nevoria) | .... | .... | 73,445·00 | 14,131·20 | 2,289·19 | .... | .... | 256,604·00 | 52,227·74 | 10,841·13 |
| | (4446) .... .... | Great Western Consolidated N.L. .... | .... | .... | .... | .... | .... | .... | .... | 252·00 | 37·67 | 7·69 |
| | 4435 .... .... | I.X.L. .... .... .... .... | .... | .... | 56·00 | 7·36 | ·16 | .... | .... | 183·25 | 27·46 | ·16 |
| | 3718 .... .... | Kurrajong .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 9,293·00 | 3,281·99 | .... |
| | 3914 .... .... | May .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 145·00 | 45·86 | .... |
| | 4230 .... .... | May Queen .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 286·00 | 43·42 | .... |
| | 3970 .... .... | Mountain Queen .... .... .... | .... | .... | 31·00 | 12·85 | 1·63 | .... | .... | 1,262·00 | 468·50 | 1·63 |
| | 4384 .... .... | Newry .... .... .... .... | .... | .... | 5,201·00 | 557·50 | 88·26 | .... | .... | 6,061·75 | 714·72 | 97·34 |
| | (4362) .... .... | North Star .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 104·00 | 18·60 | .... |
| | 4478 (107P.P.) | Patalena .... .... .... .... | .... | .... | .... | .... | .... | .... | 9·22 | 59·25 | 100·32 | .... |
| | 4419 .... .... | Prince Charlie .... .... .... | .... | .... | 1,323·00 | 154·79 | 21·37 | .... | .... | 5,463·00 | 591·19 | 102·72 |
| | 4035 .... .... | Undaunted .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 865·00 | 113·59 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 1,504·26 | 861,190·48 | 206,986·63 | 2,501·60 |
| | | Sundry claims .... .... .... | .... | .... | 359·73 | 102·44 | 8·87 | 11·35 | 809·31 | 38,224·84 | 13,823·19 | 82·68 |
| **Mount Jackson** .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | 180·85 | 55,166·78 | 39,927·52 | 2,313·77 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 6·44 | 52·87 | 10,935·95 | 4,879·54 | 70·74 |
| **Mt. Palmer** .... | G.M.L. 4250 .... | Palmerston .... .... .... .... | .... | .... | .... | .... | .... | 2·03 | .... | 583·00 | 97·60 | .... |
| | 4345 .... .... | Speedie .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 123·25 | 40·30 | .... |
| | M.L. 4 .... | Yellowdine Gold Development Pty. Ltd. (In Liquidation) | .... | .... | .... | .... | .... | .... | .... | 93·00 | 136·46 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 306,408·40 | 158,486·81 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 1,643·48 | 18·19 | 450·25 | 387·14 | .... |
| **Mt. Rankin** .... | G.M.L. 4462 (81P.P.) | Golden View .... .... .... | .... | 16·44 | 49·00 | 16·90 | 2·38 | .... | 316·90 | 142·00 | 284·87 | 2·38 |
| | 4469 (88P.P.) .... | Lynette .... .... .... .... | .... | .... | 36·00 | 21·28 | 1·80 | .... | .... | 835·50 | 298·94 | 18·65 |
| | 4461 (76P.P.) .... | Marjorie Glenn .... .... .... | .... | .... | 55·00 | 37·47 | 1·24 | .... | 191·46 | 3,076·55 | 3,954·94 | 1·24 |
| | 3555 .... .... | No Trumps .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 5,562·37 | 853·06 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | 3·84 | 5·20 | 496·00 | 122·17 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 1·85 | 771·00 | 956·57 | .... |
| **Parkers Range** .... | 4485 .... .... | Constance Una .... .... .... | .... | .... | 82·50 | 24·46 | ·86 | .... | .... | 124·75 | 51·71 | ·86 |
| | 4423 .... .... | Spring Hill .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 223·50 | 43·92 | .... |
| | | Voided leases .... .... .... | .... | .... | .... | .... | .... | ·42 | 270·76 | 63,642·10 | 32,711·48 | 26·46 |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 6·59 | 303·93 | 13,169·80 | 5,583·20 | ·98 |
| **Southern Cross** .... | 4424 .... .... | Excelsior .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 115·50 | 10·85 | ·81 |
| | 4002, etc. .... | Great Western Consolidated N.L. (Fraser's) | .... | .... | 95,528·00 | 16,917·20 | 2,626·67 | .... | .... | 255,842·00 | 70,282·20 | 15,639·33 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 13,720·50 | 1,876·00 | 1·26 |
| | 3444 .... .... | (Three Boys) .... .... .... | .... | .... | .... | .... | .... | .... | .... | 4,180·00 | 727·75 | .... |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3934 | (Three Boys North) | .... | .... | .... | .... | .... | .... | .... | .... | 106·00 | 14·66 | .... |
| | 3981 | (Three Kings) | .... | .... | .... | .... | .... | .... | .... | .... | 104·00 | 10·01 | .... |
| | 3444 | (Yellowdine Options N.L.) | .... | .... | .... | .... | .... | .... | .... | .... | 8,074·25 | 2,000·29 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 4·89 | 261·35 | 454,906·68 | 215,351·50 | 364·41 |
| | | Sundry claims | .... | .... | ·50 | 11·50 | 1·80 | ·61 | 95·90 | 648·99 | 8,376·66 | 2,643·85 | ·61 |
| **Westonia** .... .... | .... | Voided leases | .... | .... | .... | .... | .... | .... | .... | 4·06 | 597,118·14 | 381,435·37 | 5,104·07 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 9·51 | 64·96 | 4,310·76 | 2,823·33 | ·72 |
| | *From Goldfield generally :* | | | | | | | | | | | | |
| | Sundry Parcels treated at : | | | | | | | | | | | | |
| | W. B. Ridge Evanston Plant | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *4,210·25 | 964·42 |
| | Great Western Consolidated N.L. Plant (Nevoria) | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *276·58 | .... |
| | Great Western Consolidated N.L. Plant (Frasers) | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *1,357·18 | 85·92 |
| | Great Western Consolidated N.L. Plant (Copperhead) | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *5,770·90 | 458·63 |
| | Kurrajong Battery | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *409·57 | .... |
| | Pilot Cyanide Plant | .... | .... | .... | .... | .... | .... | .... | .... | .... | 30·00 | *3,753·59 | .... |
| | R. R. Robinson's Plant | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *1,408·40 | .... |
| | Three Boys Cyanide Plant | .... | .... | .... | .... | .... | .... | .... | .... | .... | 7·00 | *4,001·02 | 19·78 |
| | Harper's Battery | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | *479·51 | 96·24 |
| | Great Western Consolidated N.L. Plant (L.T.T. 2/61) | .... | .... | 30·00 | ·30 | ·03 | .... | .... | 30·00 | ·30 | ·03 | | |
| | Great Western Consolidated N.L. Plant (L.T.T. 1/61) | .... | .... | .... | *204·38 | 39·42 | .... | .... | .... | *204·38 | 39·42 | | |
| | State Battery, Marvel Loch | .... | .... | .... | *186·51 | .... | .... | .... | 29·00 | *1,650·91 | .... | | |
| | Various Works | .... | .... | .... | .... | .... | .... | .... | 364·98 | *99,250·35 | 120·01 | | |
| | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 325·11 | 81·41 | ·60 | 170·54 | .... | | |
| | **Totals** | .... | .... | **30·50** | **408,868·63** | **64,270·29** | **10,039·35** | **2,197·92** | **5,816·49** | **7,749,043·02** | **2,349,783·64** | **198,247·20** | |

## Dundas Goldfield.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Beete** .... .... | G.M.L. 1908 | Beete | .... | .... | 177·00 | 132·86 | ·89 | .... | .... | 244·00 | 198·78 | ·89 |
| | 1907 | Eldridge's Find | .... | .... | 358·50 | 286·42 | 13·58 | .... | .... | 487·75 | 395·26 | 13·58 |
| | | Sundry claims | .... | .... | 32·00 | 1·34 | .... | .... | .... | 386·50 | 376·41 | .... |
| **Buldania** .... .... | .... | Voided leases | .... | .... | .... | .... | .... | .... | 3·02 | 846·05 | 708·99 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | 39·25 | 1,324·27 | 861·36 | ·72 |
| **Dundas** .... .... | .... | Voided leases | .... | .... | .... | .... | .... | 1·88 | 28·02 | 6,241·98 | 2,560·53 | 155·02 |
| | | Sundry claims | .... | .... | 12·25 | 6·54 | ·39 | ·76 | 413·85 | 2,239·00 | 1,162·42 | 20·03 |
| **Norseman** .... | 1191 | Abbots Hall | .... | .... | 260·50 | 27·78 | ·48 | .... | .... | 260·50 | 27·78 | ·48 |
| | 1288, etc. | Central Norseman Gold Corporation N.L. | .... | .... | 175,124·00 | 98,305·46 | 55,558·05 | .... | .... | 3,225,253·20 | 1,445,399·82 | 975,074·25 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | 1,663·32 | 69,819·83 | 47,892·08 | 16,508·85 |
| | 1315, etc. | Norseman Gold Mines N.L. | .... | .... | .... | .... | .... | .... | .... | 964,099·00 | 241,009·50 | 353,206·54 |
| | | Prior to transfer to present holders | .... | .... | .... | .... | .... | .... | .... | 20,657·00 | 3,909·60 | 4,981·00 |
| | 1910 | Old Miller | .... | .... | 356·00 | 22·46 | .... | .... | .... | 493·00 | 29·44 | .... |
| | | Voided leases | .... | .... | .... | .... | .... | 14·27 | 10,601·15 | 915,789·67 | 601,766·42 | 39,001·23 |
| | | Sundry claims | .... | 39·91 | 478·25 | 54·68 | 8·15 | 1,052·09 | 3,491·46 | 48,991·45 | 22,542·62 | 217·82 |
| **Peninsula** .... .... | .... | Voided leases | .... | .... | .... | .... | .... | .... | 24·29 | 9,603·39 | 6,102·61 | 12·20 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 217·25 | 119·32 | ·97 |

Table I.—*Production of Gold and Silver from all sources, etc.*—continued.

| Mining Centre | Number of Lease | Registered Name of Company or Lease | Total for 1961 | | | | | Total Production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver | Alluvial | Dollied and Specimens | Ore treated | Gold therefrom | Silver |
| | | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. |
| **DUNDAS GOLDFIELD—continued.** | | | | | | | | | | | | |
| | | *From Goldfield generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | M. E. Hourigan (L.T.T. 1447H) | .... | .... | 87·00 | 5·36 | .... | .... | .... | 87·00 | 5·36 | .... |
| | | State Battery, Norseman | .... | .... | 10·00 | 7·48 | ·40 | .... | .... | 427·89 | *25,358·99 | 1,051·53 |
| | | Various Works | .... | .... | .... | .... | .... | .... | 54·52 | 780·89 | *15,110·71 | 2,588·35 |
| | | Reported by Banks and Gold Dealers | .... | .... | .... | .... | .... | 1,181·77 | 49·59 | 47·50 | 21·37 | ·70 |
| | | **Totals** | .... | **39·91** | **176,895·50** | **98,850·38** | **55,581·94** | **2,250·77** | **16,368·47** | **5,268,297·12** | **2,415,559·87** | **1,392,834·16** |
| **Phillips River Goldfield.** | | | | | | | | | | | | |
| **Hatters Hill** | | Voided leases | .... | .... | .... | .... | .... | .... | 4·38 | 1,599·55 | 1,222·72 | .... |
| | | Sundry claims | .... | .... | .... | .... | .... | 74·91 | 24·26 | 5,386·60 | 2,755·81 | 26·09 |
| **Kundip** | G.M.L. 263 | Hillsborough | .... | .... | .... | .... | .... | .... | .... | 258·00 | 65·75 | 19·33 |
| | | Voided leases | .... | .... | .... | .... | .... | 113·28 | 556·17 | 84,866·58 | 60,584·54 | 4,008·81 |
| | | Sundry claims | .... | .... | .... | .... | .... | 90·27 | 73·02 | 6,434·68 | 1,951·87 | 54·65 |
| **Mt. Desmond** | | Voided leases | .... | .... | .... | .... | .... | .... | 1·40 | 9·00 | 3,905·46 | 6,891·59 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | 80·00 | 41·96 | 51·01 |
| **Ravensthorpe** | M.L. 411 | Wehr Bros. | .... | .... | .... | .... | .... | .... | .... | .... | 1·99 | .... |
| | M.C. 35, 419 | Ravensthorpe Copper Mines N.L. | .... | .... | .... | ‡2,717·67 | 6,459·30 | .... | .... | .... | ‡6,543·20 | 23,790·77 |
| | M.L. 421 | Big Surprise | .... | .... | .... | .... | .... | .... | .... | 6·46 | ‡3·03 | 116·48 |
| | | Voided leases | .... | .... | .... | .... | .... | .... | 141·80 | 24,723·55 | 26,070·94 | 4,384·07 |
| | | Sundry claims | .... | .... | .... | .... | .... | 163·96 | 7·68 | 7,267·82 | 3,197·97 | 41·12 |
| **West River** | | Voided leases | .... | .... | .... | .... | .... | .... | .... | .... | 10·34 | 31·06 |
| | | Sundry claims | .... | .... | .... | .... | .... | .... | .... | .... | 6·60 | 3·44 |
| | | *From Goldfield generally :* | | | | | | | | | | |
| | | Sundry Parcels treated at : | | | | | | | | | | |
| | | F. C. Daw (T.A. 11) | .... | .... | .... | .... | .... | .... | .... | .... | *128·45 | .... |
| | | Various Works | .... | .... | .... | .... | .... | .... | .... | 27·00 | *4,118·73 | 515·43 |
| | | Reported by Banks and Gold Dealers | .... | 2·30 | .... | .... | .... | 164·69 | 14·61 | .... | 8·47 | .... |
| | | **Totals** | .... | **2·30** | .... | **2,717·67** | **6,459·30** | **607·11** | **823·32** | **130,659·24** | **110,617·83** | **39,933·85** |

## Outside Proclaimed Goldfield.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Burracoppin .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | .... | .... | 710·85 | 706·38 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | ·98 | 372·75 | 213·97 | .... |
| Donnybrook .... | .... .... .... | Voided leases .... .... .... | .... | .... | .... | .... | .... | 23·24 | .... | 1,613·30 | 816·23 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | 44·01 | 43·03 | 119·50 | 15·71 | 15·18 |
| Lake Grace .... | G.M.L. 106H.... | Griffin's Find .... .... .... | .... | .... | 218·50 | 113·66 | .... | .... | .... | 218·50 | 113·66 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | .... | 27·75 | 17·91 | .... |
| Northampton .... | .... .... .... | Sundry leases and claims .... | .... | .... | .... | .... | †213·95 | .... | .... | .... | .... | †4,898·41 |
| Ongerup .... .... | 103H .... .... | Hornblende .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 24·50 | 2·85 | .... |
| | | Sundry claims .... .... .... | .... | .... | .... | .... | .... | .... | 1·58 | ·33 | 1·74 | .... |
| | *From State generally :* | | | | | | | | | | | |
| | Sundry Specimens .... .... .... .... .... | .... | .... | .... | .... | .... | 4·24 | 56·85 | .... | .... | .... |
| | Various Works .... .... .... .... .... | .... | .... | .... | .... | .... | .... | .... | 27·00 | *9,009·75 | 31,521·73 |
| | Miscellaneous Voided Leases and Sundry Claims | .... | .... | .... | .... | .... | 245·83 | 3·07 | 1,472·10 | 353·19 | .... |
| | Reported by Banks and Gold Dealers .... .... | 4·28 | 8·91 | .... | 95·38 | .... | 1,181·83 | 1,048·24 | .... | 917·68 | 1,140·93 |
| | **Totals** .... .... .... .... | **4·28** | **8·91** | **218·50** | **209·04** | **213·95** | **1,499·15** | **1,153·75** | **4,586·58** | **12,169·07** | **37,576·25** |

# TABLE II

**Production of Gold and Silver from all Sources, showing in fine ounces the output, as reported to the Mines Department during the year 1961.**

| Goldfield | District | District | | | | | | Goldfield | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alluvial | Dollied and Specimens | Ore Treated | Gold Therefrom | Total Gold | Silver | Alluvial | Dollied and Specimens | Ore Treated | Gold Therefrom | Total Gold | Silver |
| | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. |
| Kimberley | .... | .... | .... | .... | .... | .... | .... | .... | 15·92 | .... | .... | 15·92 | .... |
| West Kimberley | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| West Pilbara | .... | .... | .... | .... | .... | .... | .... | .... | .... | 24·00 | 4·32 | 4·32 | ·43 |
| Pilbara | Marble Bar | 7·28 | ·34 | 2,197·25 | 1,197·58 | 1,205·20 | 247·34 | 18·62 | ·34 | 7,358·63 | 4,620·41 | 4,639·37 | 253·58 |
| | Nullagine | 11·34 | .... | 5,161·38 | 3,422·83 | 3,434·17 | 6·24 | | | | | | |
| Ashburton | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Gascoyne | .... | .... | .... | .... | .... | .... | .... | 3·26 | 4·28 | 137·00 | 444·53 | 452·07 | .... |
| Peak Hill | .... | .... | .... | .... | .... | .... | .... | .... | ·55 | 3,422·00 | 328·78 | 329·33 | 6·48 |
| East Murchison | Lawlers | 27·35 | .... | 971·00 | 282·77 | 310·12 | 3·95 | | | | | | |
| | Wiluna | 2·10 | .... | .... | 2·87 | 4·97 | ·33 | 29·45 | .... | 1,063·50 | 343·55 | 373·00 | 6·50 |
| | Black Range | .... | .... | 92·50 | 57·91 | 57·91 | 2·22 | | | | | | |
| Murchison | Cue | ·34 | .... | 664·25 | 105·47 | 105·81 | 3·77 | | | | | | |
| | Meekatharra | 2·01 | 5·48 | 3,083·25 | 505·64 | 513·13 | 9·59 | 41·52 | 5·48 | 169,956·65 | 91,829·63 | 91,876·63 | 7,494·13 |
| | Day Dawn | 3·41 | .... | 20·25 | 19·70 | 23·11 | 1·93 | | | | | | |
| | Mt. Magnet | 35·76 | .... | 166,188·90 | 91,198·82 | 91,234·58 | 7,478·84 | | | | | | |
| Yalgoo | .... | .... | .... | .... | .... | .... | .... | ·14 | .... | 94·50 | 85·27 | 85·41 | 3·47 |
| Mt. Margaret | Mt. Morgans | 8·02 | .... | 81·00 | 98·69 | 106·71 | 8·04 | | | | | | |
| | Mt. Malcolm | 35·72 | 2·21 | 138,663·75 | 33,821·81 | 33,859·74 | 3,059·10 | 53·90 | 2·21 | 138,744·75 | 33,920·50 | 33,976·61 | 3,067·14 |
| | Mt. Margaret | 10·16 | .... | .... | .... | 10·16 | .... | | | | | | |
| North Coolgardie | Menzies | 2·70 | .... | 26,808·50 | 13,450·92 | 13,453·62 | 226·03 | | | | | | |
| | Ularring | .... | .... | 532·50 | 492·48 | 492·48 | 12·36 | 2·70 | .... | 30,052·75 | 15,845·82 | 15,848·52 | 462·73 |
| | Niagara | .... | .... | 737·75 | 249·63 | 249·63 | 8·63 | | | | | | |
| | Yerilla | .... | .... | 1,974·00 | 1,652·79 | 1,652·79 | 215·71 | | | | | | |
| Broad Arrow | .... | .... | .... | .... | .... | .... | .... | .... | 253·69 | 3,495·41 | 2,201·59 | 2,455·28 | 102·14 |
| North-East Coolgardie | Kanowna | 5·10 | .... | 616·25 | 143·74 | 148·84 | 2·99 | 5·10 | .... | 643·25 | 155·76 | 160·86 | 2·99 |
| | Kurnalpi | .... | .... | 27·00 | 12·02 | 12·02 | .... | | | | | | |
| East Coolgardie | East Coolgardie | 27·76 | .... | 2,016,027·15 | 540,429·33 | 540,457·09 | 124,933·38 | 27·76 | .... | 2,016,208·90 | 540,445·48 | 540,473·24 | 124,933·38 |
| | Bulong | .... | .... | 181·75 | 16·15 | 16·15 | .... | | | | | | |
| Coolgardie | Coolgardie | 11·80 | 564·12 | 26,967·25 | 12,872·93 | 13,448·85 | 1,015·32 | 11·80 | 709·13 | 27,273·75 | 13,113·13 | 13,834·06 | 1,019·16 |
| | Kunanalling | .... | 145·01 | 306·50 | 240·20 | 385·21 | 3·84 | | | | | | |
| Yilgarn | .... | .... | .... | .... | .... | .... | .... | .... | 30·50 | 408,868·63 | 64,270·29 | 64,300·79 | 10,039·35 |
| Dundas | .... | .... | .... | .... | .... | .... | .... | .... | 39·91 | 176,895·50 | 98,850·38 | 98,890·29 | 55,581·94 |
| Phillips River | .... | .... | .... | .... | .... | .... | .... | .... | 2·30 | .... | 2,717·67 | 2,719·97 | 6,459·30 |
| Outside Proclaimed Goldfield | .... | .... | .... | .... | .... | .... | .... | 4·28 | 8·91 | 218·50 | 209·04 | 222·23 | 213·95 |
| **Totals** | .... | .... | .... | .... | .... | .... | .... | **198·53** | **1,073·22** | **2,984,457·72** | **869,386·15** | **870,657·90** | **209,646·67** |

# TABLE III

Return showing total production reported to the Mines Department, and respective Districts and Goldfields from whence derived, to 31st December, 1961.

| Goldfield | District | District | | | | | | Goldfield | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alluvial | Dollied and Specimens | Ore Treated | Gold Therefrom | Total Gold | Silver | Alluvial | Dollied and Specimens | Ore Treated | Gold Therefrom | Total Gold | Silver |
| | | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Fine ozs. | Tons (2,240 lb.) | Fine ozs. | Fine ozs. | Fine ozs. |
| Kimberley | .... | .... | .... | .... | .... | .... | .... | 8,996·47 | 2,934·84 | 22,751·90 | 17,240·32 | 29,171·63 | 128·76 |
| West Kimberley | .... | .... | .... | .... | .... | .... | .... | 1·30 | 24·68 | 1·00 | 2·49 | 28·47 | 13,575·29 |
| West Pilbara | .... | .... | .... | .... | .... | .... | .... | 6,339·37 | 374·74 | 24,793·96 | 24,308·29 | 31,022·40 | 1,910·49 |
| Pilbara | Marble Bar | 15,264·54 | 4,568·94 | 338,652·72 | 328,683·54 | 348,517·02 | 32,784·30 | 25,692·38 | 7,470·95 | 485,104·39 | 462,715·54 | 495,878·87 | 33,857·84 |
| | Nullagine | 10,427·84 | 2,902·01 | 146,451·67 | 134,032·00 | 147,361·85 | 1,073·54 | | | | | | |
| Ashburton | .... | .... | .... | .... | .... | .... | .... | 9,267·37 | 482·46 | 6,807·10 | 2,913·43 | 12,663·26 | 41,971·38 |
| Gascoyne | .... | .... | .... | .... | .... | .... | .... | 696·87 | 117·83 | 561·00 | 1,101·86 | 1,916·56 | 26·92 |
| Peak Hill | .... | .... | .... | .... | .... | .... | .... | 3,384·35 | 5,300·88 | 778,517·73 | 322,336·70 | 331,021·93 | 3,774·95 |
| East Murchison | Lawlers | 7,096·46 | 2,343·19 | 2,013,126·42 | 823,179·77 | 832,619·42 | 27,188·17 | 9,001·73 | 22,205·14 | 12,617,605·58 | 3,650,325·85 | 3,681,532·72 | 60,201·64 |
| | Wiluna | 234·73 | 1,254·11 | 8,873,578·19 | 1,872,187·84 | 1,873,676·68 | 10,298·96 | | | | | | |
| | Black Range | 1,670·54 | 18,607·84 | 1,730,900·97 | 954,958·24 | 975,236·62 | 22,714·51 | | | | | | |
| Murchison | Cue | 5,101·50 | 9,104·99 | 6,812,481·56 | 1,401,740·35 | 1,415,946·84 | 274,097·57 | 25,611·65 | 59,140·81 | 13,997,540·37 | 5,551,202·04 | 5,635,954·50 | 485,280·40 |
| | Meekatharra | 14,631·57 | 18,260·03 | 2,306,806·06 | 1,307,961·21 | 1,340,852·81 | 5,155·44 | | | | | | |
| | Day Dawn | 3,245·17 | 11,341·63 | 2,037,239·13 | 1,375,541·02 | 1,390,127·82 | 169,436·13 | | | | | | |
| | Mt. Magnet | 2,633·41 | 20,434·16 | 2,841,013·62 | 1,465,959·46 | 1,489,027·03 | 36,591·26 | | | | | | |
| Yalgoo | .... | .... | .... | .... | .... | .... | .... | 1,801·90 | 3,223·19 | 442,602·58 | 263,788·38 | 268,813·47 | 1,506·63 |
| Mt. Margaret | Mt. Morgans | 3,544·27 | 9,398·51 | 1,217,508·31 | 717,771·26 | 730,714·04 | 5,820·36 | 11,745·10 | 35,419·51 | 11,207,450·77 | 4,901,391·59 | 4,948,556·20 | 257,316·26 |
| | Mt. Malcolm | 4,057·29 | 16,666·65 | 7,461,769·22 | 3,009,576·77 | 3,030,300·71 | 185,305·20 | | | | | | |
| | Mt. Margaret | 4,143·54 | 9,354·35 | 2,528,173·24 | 1,174,043·56 | 1,187,541·45 | 66,190·70 | | | | | | |
| North Coolgardie | Menzies | 1,687·70 | 7,014·92 | 1,799,061·93 | 1,362,788·38 | 1,371,491·00 | 32,085·32 | 4,847·49 | 19,856·93 | 3,564,249·93 | 2,506,977·71 | 2,531,682·13 | 64,483·64 |
| | Ularring | 129·52 | 7,203·12 | 533,214·20 | 442,812·43 | 450,145·04 | 21,940·59 | | | | | | |
| | Niagara | 1,718·36 | 1,821·77 | 941,911·27 | 527,757·58 | 531,297·71 | 5,695·32 | | | | | | |
| | Yerilla | 1,311·91 | 3,817·12 | 290,062·53 | 173,619·32 | 178,748·35 | 4,762·41 | | | | | | |
| Broad Arrow | .... | .... | .... | .... | .... | .... | .... | 21,981·82 | 27,983·44 | 1,360,332·83 | 741,655·69 | 791,620·95 | 5,426·35 |
| North-East Coolgardie | Kanowna | 106,535·77 | 13,526·67 | 1,008,791·51 | 627,095·08 | 747,157·52 | 3,042·72 | 119,371·26 | 21,825·58 | 1,022,485·83 | 645,935·81 | 787,132·65 | 3,055·43 |
| | Kurnalpi | 12,835·49 | 8,298·91 | 13,694·32 | 18,840·73 | 39,975·13 | 12·71 | | | | | | |
| East Coolgardie | East Coolgardie | 33,707·96 | 41,138·13 | 79,487,493·85 | 34,447,142·11 | 34,521,988·20 | 5,309,111·17 | 61,113·18 | 57,172·70 | 79,675,273·65 | 34,579,432·25 | 34,697,718·13 | 5,309,124·09 |
| | Bulong | 27,405·22 | 16,034·57 | 187,779·80 | 132,290·14 | 175,729·93 | 12·92 | | | | | | |
| Coolgardie | Coolgardie | 17,030·16 | 18,537·35 | 2,923,315·85 | 1,511,912·80 | 1,547,480·31 | 38,112·00 | 18,550·86 | 24,320·73 | 3,287,727·55 | 1,765,149·75 | 1,808,021·34 | 38,871·53 |
| | Kunanalling | 1,520·70 | 5,783·38 | 364,411·70 | 253,236·95 | 260,541·03 | 759·53 | | | | | | |
| Yilgarn | .... | .... | .... | .... | .... | .... | .... | 2,197·92 | 5,816·49 | 7,749,043·02 | 2,349,783·64 | 2,357,798·05 | 198,247·20 |
| Dundas | .... | .... | .... | .... | .... | .... | .... | 2,250·77 | 16,368·47 | 5,268,297·12 | 2,415,559·37 | 2,434,178·61 | 1,392,834·16 |
| Phillips River | .... | .... | .... | .... | .... | .... | .... | 607·11 | 823·32 | 130,659·24 | 110,617·83 | 112,048·26 | 39,933·85 |
| Outside Proclaimed Goldfield | .... | .... | .... | .... | .... | .... | .... | 1,499·15 | 1,153·75 | 4,586·58 | 12,169·07 | 14,821·97 | 37,576·25 |
| **Totals** | .... | .... | .... | .... | .... | .... | .... | **334,958·05** | **312,016·44** | **141646392·13** | **60,324,607·61** | **60,971,582·10** | **7,989,103·06** |

# TABLE IV.

Total output of Gold Bullion, Concentrates, etc., entered for export and received at the Perth Branch of the Royal Mint from 1st January, 1886.

| Year | Export | Mint | Total | Estimated Value |
|---|---|---|---|---|
| | Fine ozs. | Fine ozs. | Fine ozs. | £A |
| 1886 | 270·17 | .... | 270·17 | 1,147 |
| 1887 | 4,359·37 | .... | 4,359·37 | 18,518 |
| 1888 | 3,124·82 | .... | 3,124·82 | 13,273 |
| 1889 | 13,859·52 | .... | 13,859·52 | 58,871 |
| 1890 | 20,402·42 | .... | 20,402·42 | 86,664 |
| 1891 | 27,116·14 | .... | 27,116·14 | 115,182 |
| 1892 | 53,271·65 | .... | 53,271·65 | 226,284 |
| 1893 | 99,202·50 | .... | 99,202·50 | 421,385 |
| 1894 | 185,298·73 | .... | 185,298·73 | 787,099 |
| 1895 | 207,110·20 | .... | 207,110·20 | 879,749 |
| 1896 | 251,618·69 | .... | 251,618·69 | 1,068,808 |
| 1897 | 603,846·44 | .... | 603,846·44 | 2,564,977 |
| 1898 | 939,489·49 | .... | 939,489·49 | 3,990,697 |
| 1899 | 1,283,360·25 | 187,244·41 | 1,470,604·66 | 6,246,732 |
| 1900 | 894,387·27 | 519,923·59 | 1,414,310·86 | 6,007,610 |
| 1901 | 923,698·96 | 779,729·56 | 1,703,416·52 | 7,235,654 |
| 1902 | 707,039·75 | 1,163,997·60 | 1,871,037·35 | 7,947,661 |
| 1903 | 833,685·78 | 1,231,115·62 | 2,064,801·40 | 8,770,719 |
| 1904 | 810,616·04 | 1,172,614·03 | 1,983,230·07 | 8,424,226 |
| 1905 | 655,089·88 | 1,300,226·00 | 1,955,315·88 | 8,305,654 |
| 1906 | 562,250·59 | 1,232,296·01 | 1,794,546·60 | 7,622,749 |
| 1907 | 431,803·14 | 1,265,750·45 | 1,697,553·50 | 7,210,750 |
| 1908 | 356,353·96 | 1,291,557·17 | 1,647,911·13 | 6,999,881 |
| 1909 | 386,370·58 | 1,208,898·83 | 1,595,269·41 | 6,776,274 |
| 1910 | 233,970·34 | 1,236,661·68 | 1,470,632·02 | 6,246,848 |
| 1911 | 160,422·28 | 1,210,445·24 | 1,370,867·52 | 5,823,075 |
| 1912 | 83,577·12 | 1,199,080·87 | 1,282,657·99 | 5,448,385 |
| 1913 | 86,255·13 | 1,227,788·15 | 1,314,043·28 | 5,581,701 |
| 1914 | 51,454·65 | 1,181,522·17 | 1,232,976·82 | 5,237,352 |
| 1915 | 17,340·47 | 1,192,771·23 | 1,210,111·70 | 5,140,228 |
| 1916 | 26,742·17 | 1,034,655·87 | 1,061,398·04 | 4,508,532 |
| 1917 | 9,022·49 | 961,294·67 | 970,317·16 | 4,121,646 |
| 1918 | 15,644·12 | 860,867·03 | 876,511·15 | 3,723,183 |
| 1919 | 6,445·89 | 727,619·90 | 734,065·79 | 3,618,509 |
| 1920 | 5,261·13 | 612,581·00 | 617,842·13 | 3,598,981 |
| 1921 | 7,170·74 | 546,559·92 | 553,730·66 | 2,942,526 |
| 1922 | 5,320·16 | 532,926·12 | 538,246·28 | 2,525,812 |
| 1923 | 5,933·82 | 498,577·59 | 504,511·41 | 2,232,186 |
| 1924 | 2,585·20 | 482,449·78 | 485,034·98 | 2,255,927 |
| 1925 | 3,910·59 | 437,341·56 | 441,252·15 | 1,874,920 |
| 1926 | 3,188·22 | 434,154·98 | 437,343·20 | 1,857,715 |
| 1927 | 3,359·10 | 404,993·41 | 408,352·51 | 1,734,572 |
| 1928 | 3,339·30 | 390,069·19 | 393,408·49 | 1,671,093 |
| 1929 | 3,037·12 | 374,138·96 | 377,176·08 | 1,602,142 |
| 1930 | 1,753·09 | 415,765·00 | 417,518·09 | 1,864,442 |
| 1931 | 1,726·66 | 508,845·36 | 510,572·02 | 2,998,137 |
| 1932 | 3,887·07 | 601,674·33 | 605,561·40 | 4,403,642 |
| 1933 | 2,446·97 | 634,760·40 | 637,207·37 | 4,886,254 |
| 1934 | 3,520·40 | 647,817·95 | 661,338·35 | 5,558,873 |
| 1935 | 9,868·71 | 639,180·38 | 649,049·09 | 5,702,149 |
| 1936 | 55,024·58 | 791,183·21 | 846,207·79 | 7,373,539 |
| 1937 | 71,646·91 | 928,999·84 | 1,000,646·75 | 8,743,755 |
| 1938 | 113,620·06 | 1,054,171·13 | 1,167,791·19 | 10,363,023 |
| 1939 | 98,739·88 | 1,115,497·76 | 1,214,237·64 | 11,842,964 |
| 1940 | 71,680·47 | 1,119,801·08 | 1,191,481·55 | 12,696,503 |
| 1941 | 65,925·94 | 1,043,391·96 | 1,109,317·90 | 11,851,445 |
| 1942 | 15,676·48 | 832,503·97 | 848,180·45 | 8,865,495 |
| 1943 | 6,408·34 | 540,057·08 | 546,475·42 | 5,710,669 |
| 1944 | 1,824·99 | 464,439·76 | 466,264·75 | 4,899,997 |
| 1945 | 5,029·38 | 463,521·34 | 468,550·72 | 5,010,541 |
| 1946 | 6,090·14 | 610,873·52 | 616,963·66 | 6,640,069 |
| 1947 | 5,220·09 | 698,666·29 | 703,886·38 | 7,575,574 |
| 1948 | 4,653·72 | 660,332·07 | 664,985·79 | 7,156,909 |
| 1949 | 4,173·14 | 644,252·48 | 648,425·62 | 7,962,808 |
| 1950 | 4,161·53 | 606,171·88 | 610,333·41 | 9,466,270 |
| 1951 | 5,589·45 | 622,189·64 | 627,779·09 | 9,725,343 |
| 1952 | 9,608·62 | 720,366·44 | 729,975·06 | 11,847,917 |
| 1953 | 5,396·30 | 818,515·65 | 823,911·95 | 13,299,092 |
| 1954 | 3,089·08 | 847,451·09 | 850,540·17 | 13,313,618 |
| 1955 | 4,091·55 | 837,913·72 | 842,005·28 | 13,175,559 |
| 1956 | 2,331·10 | 810,048·68 | 812,379·78 | 12,705,581 |
| 1957 | 2,042·27 | 894,638·71 | 896,680·98 | 14,038,185 |
| 1958 | 1,810·69 | 865,376·80 | 867,187·49 | 13,554,934 |
| 1959 | 2,321·99 | 864,286·87 | 866,608·86 | 13,541,929 |
| 1960 | 2,068·66 | 853,690·02 | 855,758·68 | 13,371,661 |
| 1961 | 2,942·58 | 868,902·39 | 871,844·97 | 13,706,870 |
| Total | 11,581,965·18 | 50,925,149·39 | 62,507,114·57 | 457,379,014 |

| | 1960 £A | 1961 £A |
|---|---|---|
| Estimated Mint value of above production | 439,878,316 | 453,500,893 |
| Overseas Gold Sales Premium distributed by Gold Producers Association, 1920–1924 | 2,589,602 | 2,589,602 |
| Overseas Gold Sales Premium distributed by Gold Producers Association from 1952 | 1,204,206 | 1,288,519 |
| Estimated Total | £A443,672,124 | £A457,379,014 |
| Bonus paid by Commonwealth Government under Commonwealth Bounty Act, 1930 | 161,448 | 161,448 |
| Subsidy paid by Commonwealth Government under Gold Mining Industry Assistance Act, 1954, from 1955 | 3,154,223 | 3,629,474 |
| Gross estimated value of gold won | £A446,987,795 | £A461,169,936 |

# TABLE V.

*Quantity and Value of Minerals, other than Gold, Reported during the year* 1961

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Metallic Content | Value |
|---|---|---|---|---|---|
| | | **ASBESTOS (Chrysotile)** | Long Tons | | £A |
| M.C. 48, etc. | West Pilbara | Hancock, L. G. | 107·24 | .... | 1,600·00 |
| L.T.T. 1454H | Pilbara | Hancock, L. G. | 48·89 | .... | 1,029·00 |
| | | | 156·13 | .... | (*b*) 2,629·00 |
| | | **ASBESTOS (Crocidolite)** | | | |
| M.C. 53, etc. | West Pilbara | Australian Blus Asbestos Ltd. | 14,086·59 | .... | 1,532,540·00 (*b*) |
| | | **BAUXITE (*f*)** | | | |
| M.L. 385H | South-West* | Western Aluminium No Liability.... | 9,849·00 | See | Footnote |
| | | **BENTONITE** | | | |
| M.C. 537H, etc. | South-West* | Collins, A. C. | 506·20 | .... | 1,265·50 |
| M.C. 437H, etc. | South-West* | Noonan, E. J. | 80·50 | .... | 332·75 |
| | | | 586·70 | .... | (*a*) 1,598·25 |
| | | **BISMUTH (*f*) (*g*)** | lb. | Bi. lb. | |
| Crown Lands | Gascoyne | Sundry Persons | 911·00 | 602·26 | (*b*) 370·55 |
| | | **BUILDING STONE** | Tons | | |
| P.A. 1464Y | East Coolgardie | Mason, T. L. | 4·45 | .... | (*c*) 53·00 |
| | | **BERYL (*f*) (*g*)** | | BeO Units | |
| M.C. 614 | Pilbara | Butterfield, D. J. | 1·55 | 16·94 | 228·60 |
| M.C. 304 | Pilbara | White, A. L. | 10·08 | 115·45 | 1,558·55 |
| M.C. 106 | Pilbara | Hasleby, H. M. and H. B. | 8·95 | 103·03 | 1,449·75 |
| M.C. 116 | Pilbara | Tabba Tabba Mining Syndicate | 2·70 | 32·11 | 456·80 |
| Crown Lands | Pilbara | Sundry Persons | 55·40 | 634·34 | 7,750·35 |
| P.A. 265 | West Pilbara | Eddison, J. | 1·15 | 10·80 | 135·25 |
| P.A. 267, etc. | West Pilbara | Nomads Pty. Ltd. | 82·96 | 930·58 | 12,698·75 |
| Crown Lands | West Pilbara | Sundry Persons | 1·34 | 17·58 | 237·50 |
| P.A. 43 | Gascoyne | Poland, W. C. | 1·51 | 17·48 | 235·95 |
| P.A. 41 | Gascoyne | Kempton Bros. | 23·39 | 275·51 | 3,961·95 |
| P.A. 51 | Gascoyne | Starr, J. | 4·15 | 48·40 | 646·30 |
| Crown Lands | Gascoyne | Sundry Persons | 51·70 | 601·83 | 8,430·45 |
| Crown Lands | Murchison | Sundry Persons | 0·44 | 3·70 | 50·50 |
| M.C. 27 | Yalgoo | Todd, Dan | 11·24 | 116·94 | 1,561·70 |
| M.C. 26 | Yalgoo | Todd, Donald and Palmer, L. | 3·75 | 44·63 | 596·40 |
| P.A. 7492 | Coolgardie | Evans, D. J. | 0·54 | 6·04 | 80·50 |
| | | | 260·85 | 2,975·36 | (*b*) 40,079·30 |
| | | **CLAYS (Cement Clay)** | | | |
| M.C. 492H, etc. | South-West* | Cockburn Cement Ltd. | 11,042·00 | .... | 13,787·25 |
| M.C. 725H | South-West* | D. F. D. Rhodes Pty. Ltd. | 6,822·00 | .... | 4,122·00 |
| | | | 17,864·00 | .... | (*c*) 17,909·25 |
| | | **CLAYS (Fireclay)** | Long Tons | | |
| M.C. 522H, etc. | South-West* | Bridge, J. S. and T. D. | 14,506·00 | .... | 20,429·30 |
| M.C. 304H, etc. | South-West* | Clackline Refractories Ltd. | 2,021·00 | .... | 2,021·00 |
| Private Property | South-West* | Darling Range Firebrick Co. Pty. Ltd. | 836·75 | .... | 795·00 |
| M.C. 685H | South-West* | Kargotich, T. J. P. and S. | 4,300·00 | .... | 4,838·00 |
| M.C. 585H | South-West* | Le Vaux, M. L. | 1,066·00 | .... | 799·50 |
| M.C. 732H | South-West* | Midland Brick Co. Pty. Ltd. | 3,654·00 | .... | 1,827·00 |
| | | | 26,383·75 | .... | (*c*) 30,709·80 |
| | | **CLAYS (White Clay—Ball Clay)** | | | |
| P.A. 5306E | East Coolgardie | Gardner, J. A. | 19·60 | .... | 58·80 |
| M.C. 109H | South-West* | H. L. Brisbane & Wunderlich Ltd. | 752·00 | .... | 3,008·00 |
| | | | 771·60 | .... | (*c*) 3,066·80 |
| | | **CLAYS (†Brick, Pipe and Tile Clay)** | | | |
| M.C. 672H, etc. | South-West* | Stoneware Pipes and Tiles Pty. Ltd. | 12,218·00 | .... | 12,791·30 |
| M.C. 690H | South-West* | Swaby, F. W. | 4,000·00 | .... | 5,000·00 |
| | | | 16,218·00 | .... | (*c*) 17,791·30 |

*Footnote.*—Assay $Al_2O_3$% and Value not available for publication.

† Incomplete.—Figures relate only to production reported from holdings under the Mining Act.

Table V.—*Minerals other than Gold*—continued

*Quantity and Value of Minerals, other than Gold, Reported during the year* 1961

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Metallic Content | Value |
|---|---|---|---|---|---|
| | | **COAL** | Long Tons | | £A |
| M.L. 314, etc. | Collie | Griffin Coal Mining Co. Ltd. | 463,202·13 | .... | 883,349·24 |
| M.L. 437, etc. | Collie | Western Collieries Ltd. | 302,537·60 | .... | 796,909·50 |
| | | | 765,739·73 | .... | 1,680,258·74 (*e*) |
| | | **COPPER (Metallic By-Products) (*f*) (*g*) (*j*)** | | | |
| G.M.L. 5873, etc. | Coolgardie | Northern Mineral Syndicate | .... | Copper Tons (*g*) ‡ 16·46 | (*b*) 2,128·35 |

‡ From Gold/Copper Concentrates exported.

Gold and Silver content transferred to respective items.

**COPPER ORE AND CONCENTRATES (*f*) (*g*)**

| | | | | | Copper Units | |
|---|---|---|---|---|---|---|
| M.C. 35, etc. | Phillips River | Ravensthorpe Copper Mines N.L. | 6,188·72 | 146,125·00 | (*b*) 320,370·75 |

Gold and silver content transferred to respective items.

**CUPREOUS ORE AND CONCENTRATES (Fertiliser)**

| | | | | Av. Assay Cu% | |
|---|---|---|---|---|---|
| M.C. 374L | Pilbara | Clarke, J. | 43·68 | 14·65 | 1,558·70 |
| G.M.L. 314L | Pilbara | Copper Hills Copper Mine | 1,603·52 | 16·93 | 72,884·90 |
| M.C. 117L | Pilbara | Kelly, F. J. | 18·51 | 16·29 | 603·10 |
| P.A. 817L | Pilbara | Henderson, C. B. | 30·46 | 16·27 | 1,128·40 |
| P.A. 816L | Pilbara | Henderson, J. M. | 38·74 | 13·23 | 972·15 |
| P.A. 809L | Pilbara | Hodges, J. | 3·98 | 8·88 | 63·10 |
| L.T.T. 1449H | West Pilbara | Alac, M. | 206·15 | 7·82 | 2,642·55 |
| P.A. 284 | West Pilbara | Simpson, W. | 14·55 | 10·45 | 307·90 |
| P.A. 74 | West Kimberley | Latham, A. | 3·10 | 17·07 | 127·00 |
| M.C. 23 | Ashburton | Copper Consolidated Syndicate | 9·50 | 14·60 | 329·40 |
| M.C. 25, etc. | Ashburton | Copper Consolidated Syndicate | 124·86 | 8·79 | 1,995·15 |
| P.A. 325 | Ashburton | Cumming, C. C. | 3·26 | 15·91 | 108·50 |
| M.L. 165, etc. | Ashburton | Parkinson, L. T., Camp, F. J., and Armstrong, N. G. | 19·33 | 13·22 | 753·90 |
| Crown Lands | Ashburton | Rose, W. | 7·45 | 9·56 | 114·15 |
| P.A. 3684 | Murchison | Seivwright, K. C. | 6·35 | 4·95 | 31·40 |
| P.A. 3531N | Murchison | Bondini, L. | 14·00 | 6·32 | 107·75 |
| G.M.L. 1990N | Murchison | Motter, Z. | 238·49 | 4·17 | 1,852·65 |
| P.A. 1545 | East Murchison | Howarth, C. A. | 8·17 | 4·15 | 25·40 |
| P.A. 1553 | East Murchison | Howarth, C. A. | 9·66 | 6·60 | 95·65 |
| P.A. 1539 | East Murchison | Terelinck, A. G. | 10·48 | 10·05 | 178·95 |
| M.C. 2B | East Murchison | Rinaldi, Motter and Motter | 10·52 | 9·00 | 151·50 |
| M.C. 64P | Peak Hill | Warman, A. C., and Hilditch, A. S. | 38·61 | 17·58 | 1,891·40 |
| M.C. 63P | Peak Hill | Parkinson, L. T. | 315·35 | 18·89 | 17,218·45 |
| M.L. 68P | Peak Hill | Thaduna Copper Mining Co. | 3,895·48 | 6·53 | 38,189·55 |
| M.C. 65P | Peak Hill | Lee, R. | 45·82 | 11·29 | 1,204·65 |
| M.C. 65P | Peak Hill | Ricci, A. | 71·55 | 8·00 | 445·10 |
| M.C. 14 | Yalgoo | O'Callaghan and Howlett | 192·99 | 9·31 | 3,089·70 |
| M.C. 6F | Mt. Margaret | Alac, M. | 68·66 | 6·88 | 815·10 |
| P.A. 1667F | Mt. Margaret | Poletti, M. | 74·03 | 7·34 | 889·50 |
| P.A. 1669F | Mt. Margaret | Cable, J. L. | 10·43 | 10·50 | 232·60 |
| P.A. 5349W | Broad Arrow | Brockhoff, B. L. | 9·60 | 7·85 | 133·75 |
| G.M.L. 5551Z | North Coolgardie | Arthur, G. D. | 7·43 | 6·90 | 64·10 |
| M.C. 41 | Phillips River | Kuzmins, W. | 5·00 | 7·67 | 120·95 |
| M.C. 80 | Phillips River | Kuzmins, W. | 45·10 | 14·58 | 2,104·00 |
| M.L. 410 | Phillips River | Kuzmins, W. | 54·00 | 13·44 | 2,199·00 |
| M.C. 35, etc. | Phillips River | Ravensthorpe Copper Mines N.L. | 43·61 | 8·62 | 1,174·70 |
| Temp. Reserve 2104H | Outside Proclaimed | United Aborigines Mission | 81·40 | 10·81 | 1,683·05 |
| | | | 7,383·82 | 9·87 | 157,487·80 (*a*) (*b*) |
| | | **DOLOMITE** | | | |
| M.L. 9, etc. | Murchison | Westralian Ores Pty. Ltd. | 374·00 | .... | (*a*) 1,496·00 |
| | | **FELSPAR** | | | |
| M.L. 80, etc. | Coolgardie | Australian Glass Mnfrs. Co. Pty. Ltd. | 1,190·00 | .... | (*a*) 5,209·90 |
| | | **FULLER'S EARTH** | | | |
| M.C. 452H | South-West* | Read, D. J. and T. I. | 40·76 | .... | (*a*) 163·05 |
| | | **GLASS SAND** | | | |
| M.C. 417N, etc. | South-West* | Australian Glass Mnfrs, Co. Pty. Ltd. | 7,622·48 | .... | 4,972·50 |
| M.C. 365H, etc. | South-West* | Leach, R. J. | 592·50 | .... | 888·75 |
| | | | 8,214·78 | .... | (*c*) 5,861·25 |

Table V.—*Minerals other than Gold*—continued

*Quantity and Value of Minerals, other than Gold, Reported during the year* 1961

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Metallic Content | Value |
|---|---|---|---|---|---|
| | | GYPSUM | | | £A |
| M.C. 30, etc. | Yilgarn | Ajax Plaster Co. Pty. Ltd. | 6,329·00 | .... | 5,203·00 |
| M.C. 51, etc. | Yilgarn | H. B. Brady Co. Pty. Ltd. | 8,476·00 | .... | 6,407·00 |
| M.C. 9, etc. | Yilgarn | Perth Modelling Works | 9,454·00 | .... | 6,854·20 |
| M.C. 126H, etc. | South-West* | Perth Modelling Works | 119·00 | .... | 107·10 |
| M.C. 25, etc. | Dundas | Garrick Agnew Pty. Ltd. | 14,478·73 | .... | 37,889·30 |
| M.C. 612H, etc. | South-West* | Hewitt, B. | 3,667·00 | .... | 4,169·00 |
| M.C. 712H | South-West* | House, R. P., Parry, J., and Lyne, H. | 194·00 | .... | 213·00 |
| M.C. 485H | South-West* | Fitzgerald, E. J. | 2,427·30 | .... | 2,001·50 |
| | | | 45,145·03 | .... | 62,844·10 (*a*) (*b*) |

Includes 14,478·73 tons for Export and 194·00 tons for Agricultural purposes.

Plaster of Paris reported as manufactured during the year being 16,480·00 tons from 23,756 tons of Gypsum.

Gypsum used in the manufacture of Cement = 4,714·30 tons.

IRON ORE (For Pig)

| | | | | Pig Iron Recovered Tons | |
|---|---|---|---|---|---|
| Temp. Reserve 1258H | Yilgarn | Charcoal Iron and Steel Industry | 80,437·00 | 50,586·00 | 1,088,192·00 (*c*) (*d*) |

Average Assay of ore used = 61·70% Fe.

IRON ORE (For Export)

| | | | | Av. Assay Fe% | |
|---|---|---|---|---|---|
| M.L. 10, etc. | West Kimberley | Australian Iron and Steel Ltd. | 1,284,768·00 | 62·75 | 1,274,053·00 (*b*) |

LEAD ORE AND CONCENTRATES (*f*) (*g*)

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Lead Content | | Silver Content | |
|---|---|---|---|---|---|---|---|
| | | | Long Tons | Tons | Value £A | Fine ozs. | Value £A |
| M.L. 256 | Northampton | Gurkha Lead Mine Pty. Ltd. | 315·62 | 240·94 | 15,127·75 | 162·01 | 66·05 |
| M.L. 234 | Northampton | Mary Springs Lead Mine | 83·74 | 61·69 | 3,666·00 | 37·75 | 15·40 |
| M.L. 276 | Northampton | Nooka Mining Syndicate | 197·69 | 130·54 | 6,971·65 | 89·25 | 36·40 |
| | | | 597·05 | 433·17 | (*b*) 25,765·40 | 289·01 | 117·85 |

Silver :—Quantity and Value transferred to Silver item.

| | | LIMESTONE § | Quantity Long Tons | | Value £A |
|---|---|---|---|---|---|
| M.C. 461H | South-West* | Lime Fertilisers (W.A.) | 455·00 | .... | 159·25 |
| M.C. 723H | South-West* | Plozza, C. W. and W. A. | 150·00 | .... | 187·50 |
| M.C. 432H | South-West* | Anticich, J. | 665·15 | .... | 665·15 |
| M.C. 692H, etc. | South-West* | Franconi, D. and S. | 6,993·00 | .... | 10,012·00 |
| M.C. 532H | South-West* | Gibbs, C. E. and A. J. | 1,889·00 | .... | 2,361·25 |
| M.C. 702H | South-West* | Makrides, J. | 495·00 | .... | 990·00 |
| M.C. 575H, etc. | South-West* | Susac, F. and Y. | 3,520·00 | .... | 4,400·00 |
| M.C. 710H | Outside Proclaimed | Lister, J., Lang, K. J., and Dunn, H. E. | 32·00 | .... | 64·00 |
| | | | 14,199·15 | .... | (*c*) 18,839·15 |

§ Incomplete :—Figures relate only to production reported from holdings under the Mining Act.

MAGNESITE

| | | | | | |
|---|---|---|---|---|---|
| M.C. 76, etc. | Phillips River | Basic Materials Co. Pty. Ltd. | 9,624·92 | .... | (*b*) 64,977·10 |

MANGANESE (Metallurgical Grade) (*f*)

| | | | | Av. Assay Mn% | |
|---|---|---|---|---|---|
| M.C. 268, etc. | Pilbara | Northern Mineral Syndicate | 32,375·91 | 51·88 | 505,988·85 |
| M.C. 517, etc. | Pilbara | Pindan Pty. Ltd. | 11,994·83 | 43·05 | 100,883·50 |
| M.C. 194L, etc. | Pilbara | D. F. D. Rhodes Pty. Ltd. | 8,851·00 | 48·72 | 107,595·00 |
| M.C. 244L, etc. | Pilbara | Westralian Ores Pty. Ltd. | 4,219·14 | 42·81 | 39,957·50 |
| M.C. 289L | Pilbara | Wright Prospecting Pty. Ltd. | 487·20 | 49·50 | 6,189·50 |
| M.C. 24P, etc. | Peak Hill | Westralian Ores Pty. Ltd. | 8,884·50 | 45·37 | 113,028·00 |
| | | | 66,812·58 | 48·43 | (*b*) 873,642·35 |

MANGANESE (Battery Grade)

| | | | | Av. Assay $MnO_2$% | |
|---|---|---|---|---|---|
| M.L. 61P | Peak Hill | Westralian Ores Pty. Ltd. | 285·00 | 75·00 | (*b*) 6,288·75 |

Table V.—*Minerals other than Gold*—continued

*Quantity and Value of Minerals, other than Gold, Reported during the year* 1961

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Metallic Content | Value |
|---|---|---|---|---|---|
| | | **MANGANESE (Low Grade)** | | | £A |
| M.C. 24P, etc. .... | Peak Hill .... .... | Westralian Ores Pty. Ltd. .... | 554·56 | Av. Assay Mn% Not known | (*a*) 4,331·25 |
| | | **MINERAL BEACH SANDS (Ilmenite) (*f*)** | | | |
| | | | | Av. Assay $T_1O_2$% | |
| D.C. 56H .... .... | South-West* .... | Cable (1956) Ltd. .... .... .... | 10,985·12 | 55·05 | See Footnote |
| D.C. 13, etc. .... .... | South-West* .... | Ilmenite Pty. Ltd. .... .... .... | 22,852·00 | 55·16 | |
| M.C. 619N, etc. .... | South-West* .... | Westralian Oil Ltd. .... .... | 28,631·00 | 59·42 | |
| M.C. 516, etc. .... | South-West* .... | Western Titanium N.L. .... .... | 61,070·34 | 55·31 | |
| | | | 123,538·46 | 56·21 | (*b*) 557,889·05 |
| | | **MINERAL BEACH SANDS (Monazite) (*f*) (*g*)** | | | |
| | | | | $ThO_2$ Units | |
| M.C. 516, etc. .... | South-West* .... | Western Titanium N.L. .... .... | 1,005·20 | 6,842·43 | (*b*) 25,698·45 |
| | | **MINERAL BEACH SANDS (Rutile) (*f*) (*g*)** | | | |
| | | | | $T_1O_2$ Tons | |
| M.C. 516, etc. .... | South-West* .... | Western Titanium N.L. .... .... | 552·84 | 533·22 | (*b*) 11,953·15 |
| | | **MINERAL BEACH SANDS (Leucoxene) (*f*) (*g*)** | | | |
| | | | | $T_1O_2$ Tons | |
| M.C. 516, etc. .... | South-West* .... | Western Titanium N.L. .... .... | 268·10 | 242·72 | (*b*) 4,120·10 |
| | | **MINERAL BEACH SANDS (Zircon) (*f*) (*g*)** | | | |
| | | | | $ZrO_2$ Tons | |
| M.C. 516, etc. .... | South-West* .... | Western Titanium N.L. .... .... | 6,098·90 | 4,039·55 | (*b*) 61,313·50 |
| | | **OCHRE (Red)** | | | |
| M.C. 26, etc. .... .... | Murchison .... .... | Universal Milling Co. Pty. Ltd. .... | 117·22 | .... | (*a*) 702·00 |
| | | **OCHRE (Yellow)** | | | |
| M.C. 30 .... .... | Murchison .... .... | Universal Milling Co. Pty. Ltd. .... | 177·05 | .... | (*a*) 1,068·00 |
| | | **PETALITE (*g*)** | | | |
| | | | | $Li_2O$ Units | |
| M.L. 80, etc. .... .... | Coolgardie .... .... | Australian Glass Mnfrs. Co. Pty. Ltd. | 96·00 | 409·92 | (*a*) 409·10 |
| | | **PHOSPHATIC GUANO** | | | |
| M.C. 714H .... .... | South-West* .... | Ward, R. J. .... .... .... .... | 115·00 | .... | (*a*)(*c*) 807·00 |
| | | **PYRITES ORE AND CONCENTRATES (*g*)** | | | |
| | | | | Sulphur Content Tons | |
| G.M.L. 5345E, etc. .... | East Coolgardie .... | Gold Mines of Kalgoorlie (Aust.) Ltd. (*j*) | 13,396·00 | 5,550·17 | 69,377·23 |
| G.M.L. 1460, etc. .... | Dundas .... .... | Norseman Gold Mines N.L. .... | 39,001·00 | 18,411·91 | 299,717·00 |
| | | | 52,397·00 | 23,962·08 | (*a*) 369,094·23 |
| | | **QUARTZ GRIT** | | | |
| Q.A. 2 .... .... .... | Collie .... .... | Rowden, E. .... .... .... .... | 58·50 | .... | (*c*) 58·35 |
| | | **SPODUMENE (*g*)** | | | |
| | | | | $Li_2O$ Units | |
| M.C. 23 .... .... | Phillips River .... | Frayne, W. L. .... .... .... | 5·00 | 31·95 | (*b*) 84·80 |
| | | **SILVER** | | | |
| | | | Fine ozs. | | |
| | | By-product of Gold Mining .... .... .... .... .... | 171,796·06 | .... | 71,686·25 |
| | | By-product of Copper Mining .... .... .... .... | 7,907·05 | .... | 3,213·75 |
| | | By-product of Lead Mining .... .... .... .... .... | 289·01 | .... | 117·85 |
| | | | 179,992·12 | .... | 75,017·85 |

*Footnote.*—Current values for separate Companies not available for publication.

Table V.—*Minerals other than Gold*—continued

*Quantity and Value of Minerals, other than Gold, Reported during the year* 1961

| Number of Lease, Claim or Area | Goldfield or Mineral Field | Registered Name of Producer | Quantity | Metallic Content | Value |
|---|---|---|---|---|---|
| | | **TALC** | | | |
| | | | | | £A |
| Private Property .... | South-West* .... | Three Springs Talc Pty. Ltd. .... | Tons 5,149·28 | .... | (*c*) 64,581·00 |
| | | **TANTO/COLOMBITE ORES AND CONCENTRATES (*f*) (*g*)** | | | |
| | | | | Units | |
| M.C. 116 .... .... | Pilbara .... .... | Tabba Tabba Mining Syndicate .... | 0·72 | † 32·59 | 1,708·00 |
| M.C. 107 .... .... | Pilbara .... .... | Wilson, L. J. .... .... .... | 0·51 | † 32·06 | 1,802·00 |
| Crown Lands .... .... | Pilbara .... .... | Sundry Persons .... .... .... | 5·62 | † 227·73 | 9,619·95 |
| P.A. 267, etc. .... | West Pilbara .... | Nomads Pty. Ltd. .... .... .... | 2·67 | † 84·95 | 2,804·40 |
| P.A. 269 .... .... | West Pilbara .... | Nomads Pty. Ltd. .... .... .... | 1·52 | ‡ 107·54 | 1,260·00 |
| Crown Lands .... .... | Gascoyne .... .... | Sundry Persons .... .... .... | 0·07 | † 3·65 | 305·40 |
| M.L. 80, etc. .... .... | Coolgardie .... .... | Australian Glass Mnfrs. Co. Pty. Ltd. | 0·52 | ‖ 18·00 | 104·30 |
| M.C. 69, etc. .... .... | Greenbushes .... | Austin Bros. .... .... .... .... | (*k*) 2·44 | † 104·85 | 5,225·00 |
| L.T.T. 1399H .... | Greenbushes .... | Coghlan, R. J. .... .... .... | (*k*) 0·06 | † 2·45 | 60·00 |
| Crown Lands .... .... | Greenbushes .... | Sundry Persons .... .... .... | (*k*) 0·07 | † 2·88 | 28·15 |
| | | | 14·20 | 616·70 | (*b*) 22,917·20 |
| | | **TIN (*f*) (*g*)** | | | |
| | | | | Tons | |
| D.C. 43, etc. .... .... | Pilbara .... .... | Northern Mineral Syndicate .... | 85·52 | 61·68 | 63,328·50 |
| D.C. 201, etc. .... | Pilbara .... .... | Mineral Concentrates Pty. Ltd. .... | 105·56 | 69·29 | 71,091·55 |
| D.C. 48, etc. .... .... | Pilbara .... .... | Pilbara Exploration N.L. .... .... | 21·00 | 14·52 | 14,986·30 |
| D.C. 254 .... .... | Pilbara .... .... | Johnston, J. A. .... .... .... | 40·50 | 25·98 | 26,324·65 |
| D.C. 16, etc. .... .... | Pilbara .... .... | Leonard, H. V. .... .... .... | 47·89 | 33·21 | 34,058·40 |
| Crown Lands .... .... | Pilbara .... .... | Sundry Persons .... .... .... | 20·60 | 14·56 | 14,471·50 |
| M.C. 30 .... .... | Coolgardie .... .... | Cotter, J. G., J. F. and K. A. .... | 0·76 | 0·44 | 457·15 |
| M.C. 69, etc. .... .... | Greenbushes .... | Austin Bros. .... .... .... .... | 18·63 | 11·39 | 10,518·65 |
| M.C. 126 .... .... | Greenbushes .... | Angus, A. J. .... .... .... | 0·34 | 0·21 | 225·35 |
| Crown Lands .... .... | Greenbushes .... | Sundry Persons .... .... .... | 0·36 | 0·16 | 118·05 |
| | | | 341·16 | 231·44 | (*b*) 235,580·10 |

† $Ta_2O_5$ (Tantalite) ‡ $Ta_2O_5$ (Tantalite) plus $Nb_2O_5$ (Columbite) combined. ‖ $Nb_2O_5$ (Columbite).

REFERENCES.

* Previously Outside Proclaimed Goldfield.
(*a*) Value F.O.R.
(*b*) Value F.O.B.
(*c*) Value at Works.
(*d*) Value of Mineral Recovered.
(*e*) Value at Pit Head.
(*f*) Only results of shipments finalised during the period under review.
(*g*) Metallic Content calculated on Assay basis.
(*h*) Subject to Revision.
(*i*) Concentrates.
(*j*) By-product of Gold Mining.
(*k*) By-product of Tin Mining.

# TABLE VI.–TOTAL MINERAL OUTPUT OF WESTERN AUSTRALIA

Recorded mineral Production of the State to 31st December, 1961, showing for each mineral, the progressive quantity produced and value thereof, as reported to the Department of Mines ; including Gold (Mint and Export) as from 1886, and Other Minerals as from commencement of such records in 1899.

| Mineral | | Quantity | Value |
|---|---|---|---|
| | | | £ |
| Abrasive Silica Stone | Tons | 1·50 | 9·00 |
| Alunite (Crude Potash) | ,, | 9,073·05 | 215,864·72 |
| Antimony Concentrates (*a*) | ,, | 9,829·69 | 242,497·00 |
| Arsenic (*a*) | ,, | 38,674·08 | 747,205·00 |
| Asbestos— | | | |
| Anthophyllite | ,, | 509·35 | 6,773·31 |
| Chrysotile | ,, | 9,898·76 | 405,990·85 |
| Crocidolite | ,, | 94,396·57 | 10,711,794·93 |
| Tremolite | ,, | 1·00 | 25·00 |
| Barytes | ,, | 2,372·71 | 15,760·80 |
| Bauxite (*e*) | ,, | 36,741·00 | .... |
| Bentonite | ,, | 7,691·40 | 27,023·16 |
| Beryl | ,, | 3,249·00 | 414,568·12 |
| Bismuth | lb. | 12,203·00 | 3,730·10 |
| Building Stone (*i*) | Tons | 44·45 | 1,353·00 |
| Calcite | ,, | 5·00 | 25·00 |
| Chromite | ,, | 14,419·05 | 208,296·75 |
| Clays— | | | |
| Brick, Pipe and Tile Clay (*i*) | ,, | 43,512·00 | 41,284·30 |
| Cement Clay | ,, | 214,574·32 | 148,672·01 |
| Fireclay | ,, | 187,119·51 | 199,884·88 |
| White Clay—Ball Clay | ,, | 19,705·60 | 55,441·30 |
| White Clay—Kaolin | ,, | 5,103·23 | 8,624·17 |
| Coal | ,, | 31,042,282·29 | 45,035,653·83 |
| Copper Ore and Concentrates | ,, | 271,864·79 | 2,631,254·00 |
| Copper (Metallic By-product) (*a*) | ,, | 21·18 | 2,859·65 |
| Corundum | ,, | 63·15 | 655·00 |
| Cupreous Ore (Fertiliser) | ,, | 66,746·51 | 1,022,764·73 |
| Diamonds (*f*) | carats | .... | 24·00 |
| Diatomaceous Earth | Tons | 411·00 | 5,860·75 |
| Dolomite | ,, | 3,041·82 | 13,021·60 |
| Emeralds (Cut and Rough) | carats | 18,381·68 | 1,922·00 |
| Emery | Tons | 21·15 | 375·00 |
| Felspar | ,, | 62,745·61 | 209,632·81 |
| Fergusonite | ,, | 0·30 | 391·40 |
| Fuller's Earth | ,, | 162·40 | 708·05 |
| Gadolinite | ,, | 1·00 | 112·00 |
| Glass Sand | ,, | 86,460·90 | 61,784·66 |
| Glauconite (*g*) | ,, | 6,467·00 | 150,384·50 |
| Gold (Mint and Export) | fine ozs. | 62,507,114·57 | 457,379,014·00 |
| Graphite | tons | 153·20 | 1,304·20 |
| Gypsum | ,, | 718,207·00 | 706,047·00 |
| Iron Ore— | | | |
| For Pig Iron (*g*) | ,, | 412,415·32 | 5,291,428·06 |
| For Export | ,, | 6,082,988·00 | 6,031,258·69 |
| For Flux | ,, | 58,064·35 | 37,048·00 |
| Jarosite | ,, | 9·54 | 37·50 |
| Kyanite | ,, | 4,215·69 | 21,781·00 |
| Lead Ores and Concentrates | ,, | 466,925·90 | 4,762,417·11 |
| Limestone (*i*) | ,, | 119,232·63 | 52,063·90 |
| Magnesite | ,, | 18,533·87 | 85,571·64 |
| Manganese— | | | |
| Metallurgical Grade | ,, | 499,132·76 | 6,540,071·76 |
| Battery Grade | ,, | 1,255·75 | 26,314·60 |
| Low Grade | ,, | 1,902·86 | 16,039·40 |
| Mica | lb. | 32,930·00 | 3,984·24 |
| Mineral Beach Sands— | | | |
| Ilmenite Concentrates | tons | 438,979·51 | 2,093,370·43 |
| Monazite Concentrates | ,, | 1,356·71 | 42,227·90 |
| Rutile Concentrates | ,, | 1,471·70 | 36,062·70 |
| Leucoxene Concentrates | ,, | 628·45 | 9,480·20 |
| Zircon Concentrates | ,, | 14,791·69 | 151,711·90 |
| Crude Concentrates (Mixed) | ,, | 155·95 | 776·50 |
| Ochre— | | | |
| Red | ,, | 8,657·96 | 96,065·80 |
| Yellow | ,, | 447·60 | 2,977·75 |
| Petalite | ,, | 183·96 | 823·04 |
| Phosphatic Guano | ,, | 11,758·06 | 71,720·45 |
| Pyrites Ore and Concentrate (For Sulphur) (*b*) (*g*) | ,, | 920,422·08 | 5,294,044·80 |
| Quartz Grit | ,, | 748·50 | 636·35 |
| Semi Precious Stones— | | | |
| Chrysoprase | lb. | 5·00 | 5·00 |
| Opaline | ,, | 25·00 | 3·75 |
| Prase | ,, | 2,240·00 | 40·00 |
| Tiger Eye Opal | ,, | 120·00 | 97·00 |

TABLE VI.—TOTAL MINERAL OUTPUT OF WESTERN AUSTRALIA—*continued.*

| Mineral | Quantity | Value |
|---|---|---|
| | | £ |
| Sillimanite .... tons | 2·00 | 13·00 |
| Silver (*c*) .... fine ozs. | 10,216,371·95 | 2,080,273·73 |
| Soapstone .... tons | 565·40 | 1,927·85 |
| Spodumene .... ,, | 8·89 | 141·65 |
| Talc .... ,, | 36,108·90 | 476,669·83 |
| Tanto-Columbite Ores and Concentrates .... ,, | 498·89 | 476,250·00 |
| Tin .... ,, | 19,686·80 | 2,949,204·00 |
| Tungsten Ore and Concentrates— | | |
| Scheelite .... ,, | 155·70 | 64,840·57 |
| Wolfram .... ,, | 303·42 | 61,758·65 |
| Vermiculite .... ,, | 1,832·96 | 11,830·60 |
| Zinc (Metallic By-product) (*d*) .... ,, | 408·40 | 1,990·07 |
| Zinc Ore (Fertiliser) .... ,, | 20·00 | 100·00 |
| Total Value to 31st December, 1961 .... | .... | £557,471,652·00 (*h*) |

(*a*) By-product from Gold Mining.
(*b*) Part By-product from Gold Mining.
(*c*) By-product from Gold, Copper and Lead Mining.
(*d*) By-product from Lead Mining.
(*e*) Value not yet available for publication.
(*f*) Quantity not recorded
(*g*) Value of mineral recovered.
(*h*) Excludes Value of Bauxite.
(*i*) Incomplete—being only production reports from holdings under the Mining Act.

*Footnote.*—Comprehensive mineral production records maintained in the Statistical Branch of the Department of Mines show locality, producers, period, quantity, assayed or metallic content, and value, of the various minerals listed above.

# TABLE VII.

## SHOWING AVERAGE NUMBER OF MEN EMPLOYED ABOVE AND UNDER GROUND IN THE LARGER GOLDMINING COMPANIES OPERATING IN WESTERN AUSTRALIA DURING THE YEARS FROM 1952 TO 1961 INCLUSIVE.

| COMPANY | 1952 | | | 1953 | | | 1954 | | | 1955 | | | 1956 | | | 1957 | | | 1958 | | | 1959 | | | 1960 | | | 1961 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total | Above | Under | Total |
| Anglo-Westralian Mining Pty. | 47 | 4 | 51 | 37 | 5 | 42 | 28 | 6 | 34 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| †Boulder Perseverance, Ltd. | 151 | 115 | 266 | 155 | 112 | 267 | 152 | 114 | 266 | 171 | 114 | 285 | 181 | 113 | 294 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Broken Hill Pty. Co. Ltd. | 6 | .... | 6 | 4 | .... | 4 | 2 | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Blue Spec Gold Mines, Ltd. | 36 | 21 | 57 | 33 | 15 | 48 | 30 | 15 | 45 | 17 | 9 | 26 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Big Bell Mines Ltd. | 203 | 205 | 408 | 200 | 215 | 415 | 179 | 167 | 346 | 44 | 16 | 60 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Burbidge Gold Mines N.L. | 1 | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Consolidated Gold Area N.L. | 1 | .... | 1 | 1 | 1 | 2 | 1 | 2 | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Comet Gold Mines Ltd. | 10 | 8 | 18 | 10 | 6 | 16 | 4 | 2 | 6 | 3 | .... | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Central Norseman Gold Corporation N.L. | 151 | 212 | 363 | 155 | 228 | 383 | 158 | 227 | 385 | 166 | 225 | 391 | 159 | 209 | 368 | 165 | 226 | 391 | 166 | 232 | 398 | 173 | 214 | 387 | 169 | 209 | 378 | 163 | 220 | 383 |
| Eclipse Gold Mines N.L. | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 27 | 8 | 35 | 17 | 10 | 27 | 17 | 15 | 32 | 18 | 13 | 31 |
| Golden Horseshoe (New) Ltd. | 38 | .... | 38 | 42 | .... | 42 | 42 | .... | 42 | 39 | .... | 39 | 35 | .... | 35 | 6 | .... | 6 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Gold Mines of Kalgoorlie Ltd. | 185 | 182 | 367 | 184 | 182 | 366 | 199 | 186 | 385 | 257 | 192 | 449 | 228 | 223 | 451 | 417 | 500 | 917 | 392 | 538 | 930 | 374 | 455 | 829 | 375 | 446 | 821 | 374 | 430 | 804 |
| Great Boulder Pty. Ltd. | 344 | 339 | 683 | 349 | 359 | 708 | 342 | 372 | 714 | 359 | 379 | 729 | 349 | 380 | 729 | 330 | 400 | 730 | 323 | 387 | 710 | 308 | 399 | 707 | 290 | 385 | 675 | 296 | 385 | 681 |
| *Great Western Consolidated | 148 | 60 | 208 | 186 | 113 | 299 | 191 | 150 | 341 | 224 | 271 | 441 | 232 | 270 | 502 | 220 | 223 | 443 | 220 | 241 | 461 | 207 | 218 | 425 | 197 | 174 | 371 | 164 | 124 | 288 |
| Hill 50 Gold Mine N.L. | 59 | 48 | 107 | 68 | 63 | 131 | 73 | 63 | 136 | 82 | 73 | 155 | 98 | 85 | 183 | 108 | 94 | 202 | 103 | 103 | 206 | 95 | 88 | 183 | 97 | 87 | 184 | 97 | 93 | 190 |
| †Kalgoorlie Enterprise Ltd. | 8 | 93 | 101 | 8 | 98 | 106 | 8 | 89 | 97 | 7 | 101 | 108 | 8 | 100 | 108 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| §Kalgurli Ore Treatment Co. Ltd. | 81 | .... | 81 | 77 | .... | 77 | 78 | .... | 78 | 65 | .... | 65 | 40 | .... | 40 | 33 | .... | 33 | 28 | .... | 28 | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Lake View and Star Ltd. | 486 | 529 | 1,015 | 494 | 519 | 1,013 | 488 | 498 | 986 | 482 | 487 | 969 | 471 | 523 | 994 | 460 | 517 | 977 | 433 | 525 | 958 | 451 | 535 | 986 | 432 | 513 | 945 | 417 | 514 | 931 |
| Moonlight Wiluna Gold Mines Ltd. (Timoni) | 42 | 41 | 83 | 39 | 37 | 76 | 42 | 34 | 76 | 39 | 33 | 72 | 37 | 32 | 69 | 36 | 31 | 67 | 35 | 31 | 66 | 31 | 27 | 58 | 31 | 24 | 55 | 30 | 30 | 60 |
| Mountain View Gold N.L. | 5 | 3 | 8 | 4 | 6 | 10 | 3 | 6 | 9 | 3 | 1 | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Mt. Charlotte (Kalgoorlie) Gold Mines N.L. | 2 | 3 | 5 | 3 | 6 | 9 | 3 | 2 | 5 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| North Kalgurli (1912) Ltd. | 112 | 293 | 405 | 76 | 207 | 283 | 83 | 193 | 276 | 95 | 236 | 331 | 156 | 239 | 395 | 158 | 250 | 408 | 163 | 263 | 426 | 181 | 251 | 432 | 181 | 249 | 430 | 187 | 246 | 433 |
| Northern Minerals Syndicate Ltd. (Paris Mine) | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6 | 4 | 10 | 15 | 11 | 26 | 20 | 17 | 37 |
| Gold Mines of Kalgoorlie (Aust.) Ltd. (Barbara and Bayleys Leases) | 65 | 109 | 174 | 68 | 108 | 176 | 77 | 95 | 172 | 79 | 95 | 174 | 37 | 73 | 110 | 34 | 61 | 95 | 23 | 48 | 71 | 19 | 36 | 55 | 18 | 37 | 55 | 18 | 36 | 54 |
| New Coolgardie Gold Mines N.L. (Callion Leases) | 6 | 29 | 35 | 7 | 34 | 41 | 9 | 42 | 51 | 8 | 35 | 43 | 3 | 11 | 14 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Ora Banda Amalgamated Ltd. | 1 | .... | 1 | 3 | 2 | 5 | 1 | 2 | 3 | .... | 2 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Paringa Mining and Exploration Co. Ltd. | 10 | 6 | 16 | 2 | 2 | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Porphyry (1939) Gold Mines Ltd. | 1 | .... | 1 | 3 | 3 | 6 | 2 | 2 | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Radio Gold Mines | 4 | 4 | 8 | 5 | 5 | 10 | 5 | 5 | 10 | 6 | 6 | 12 | 6 | 6 | 12 | 7 | 7 | 14 | 6 | 6 | 12 | 6 | 6 | 12 | 6 | 6 | 12 | 6 | 5 | 11 |
| †South Kalgurli Consolidated | 67 | 102 | 169 | 67 | 107 | 174 | 64 | 106 | 170 | 53 | 99 | 152 | 13 | 84 | 97 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Sons of Gwalia Ltd. | 121 | 118 | 239 | 102 | 157 | 259 | 102 | 138 | 240 | 102 | 146 | 248 | 105 | 156 | 261 | 107 | 146 | 253 | 109 | 142 | 251 | 99 | 137 | 236 | 106 | 139 | 245 | 103 | 143 | 246 |
| Sunshine Reward Amalgamated Leases | 9 | 7 | 16 | 8 | 7 | 15 | 8 | 7 | 15 | 7 | 4 | 11 | 8 | 7 | 15 | 2 | .... | 2 | 8 | 3 | 11 | 5 | 2 | 7 | 3 | 1 | 4 | 2 | 2 | 4 |
| Wiluna Gold Mines Ltd. | 13 | .... | 13 | 2 | 1 | 3 | 1 | 1 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| All other Operators | 851 | 598 | 1,449 | 846 | 523 | 1,369 | 734 | 495 | 1,229 | 634 | 388 | 1,022 | 544 | 407 | 951 | 498 | 349 | 847 | 476 | 313 | 789 | 521 | 398 | 919 | 469 | 290 | 759 | 509 | 283 | 792 |
| State Average (inc. Diggers) | 3,265 | 3,129 | 6,394 | 3,238 | 3,121 | 6,359 | 3,109 | 3,019 | 6,128 | 2,933 | 2,912 | 5,845 | 2,710 | 2,918 | 5,628 | 2,581 | 2,804 | 5,385 | 2,512 | 2,840 | 5,352 | 2,493 | 2,780 | 5,273 | 2,406 | 2,586 | 4,992 | 2,404 | 2,541 | 4,945 |

* Including Copperhead, Frasers, Nevoria, Corinthian and Pilot Groups.
‡ Effective workers only and totally excluding non-workers for any reason whatsoever.

† Absorbed by Gold Mines of Kalgoorlie (Aust.) Ltd. from 1957.
§ Absorbed by Gold Mines of Kalgoorlie (Aust.) Ltd. from 1959.

By Authority: ALEX. S. DAVIES, Government Printer