1960

Report of the

DEPARTMENT OF MINES

WESTERN AUSTRALIA

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

REPORT OF THE
DEPARTMENT *of* MINES
WESTERN AUSTRALIA
FOR THE YEAR 1960

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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 1960, 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, 1961.

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STATE OF WESTERN AUSTRALIA

Report of the Department of Mines for the Year 1960

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 1960.

The estimated value of the mineral output of the State for the year was £12,088,854 (calculating gold at £4 4s. 11.45d. per fine ounce), an increase of £153,060 in value compared with the preceding twelve months.

The estimated value of the exchange premium paid to gold producers by the Mint amounted to £A9,736,199, added to which, the overseas gold sales premium of £A433 received by the Gold Producers' Association from sales of West Australian Gold distributed in March, 1960, brought the gross value of all minerals to £A21,825,486, an increase of £A28,881 when compared with the total for the previous year and constituted an all time record.

The estimated value of the gold received at the Perth Branch of the Royal Mint and exported in gold-bearing material was £A13,371,228, but with the additional overseas gold sales premium mentioned above, totalled £A13,371,661, being the fourth highest annual value recorded for that mineral. The estimated gold value equalled 61.266 per cent. of the value of all minerals for 1960.

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

Other minerals realised; Coal £2,439,195; asbestos £1,420,369 iron ore (for pig iron), £1,098,825; iron ore (for export), £830,124; manganese, £753,005; ilmenite concentrates, £485,562; pyrites (for sulphur), £366,739; copper ore and concentrates, £199,007; tin concentrates, £168,775; cupreous ore (fertiliser) £140,252; lead ore and concentrates, £119,139; silver, £80,613; talc, £69,114; clays, £60,244; gypsum £55,628; zircon concentrates, £49,270; beryl, £33,024; tanto-columbite concentrates, £16,982; rutile concentrates, £15,686; limestone, £14,935; monazite concentrates, £9,319; felspar, £8,283; glass sand, £6,102; glauconite, £5,550; dolomite, £1,616; bentonite, £1,533; building stone, £1,300; ochre, £1,040; phosphatic guano, £938; copper (metallic by-product), £731; leucoxene concentrates, £392; quartz grit, £243; silver lead ore and concentrates, £153; semi-precious stones, £197.

The value of minerals other than gold and coal produced during 1960 reached another all time high of £6,014,630, an increase of £116,488 compared with the preceding twelve months.

Although gold and coal have long monopolised mining interest in this State, the increasing value of other minerals produced, especially during the last decade, is indicative of a widening sphere of activity in the industry, which will reflect greatly to the future benefit of the State in more ways than one. The extent of such growth is illustrated in the following comparative figures:—

Period	Gold and Coal Value	Percentage of Total	Other Minerals Value	Percentage of Total
	£ Millions		£ Millions	
1901–1950....	309·767	96·835	10·124	3·165
1951–1960....	154·852	80·365	37·833	19·635
Year 1960....	15·811	72·442	6·014	27·558

Dividends paid by gold mining companies amounted to £A2,131,784, an increase of £A37,800 when compared with the previous year. (See Table 6, Part II).

To the end of 1960 the total amount distributed by gold mining companies was £A64,515,328.

To the same date the progressive value of the mineral production of the State amounted to £353,890,950, of which gold accounted for £261,809,692 (based on the normal value of £4 4s. 11.45d. per fine ounce); but the premium on the sale of gold during the years 1920-1924, increasing exchange premium since 1930, payments under the Gold Bounty Act, 1930, plus additional premiums from overseas sales distributed between 1952 and 1960, increase the total value of gold and mineral production by £182, 023,880, making a gross progressive value of £535,914,830.

GOLD

The quantity of gold reported as being received at the Perth Branch of the Royal Mint (853,690.02 fine ounces), together with that contained in gold-bearing material exported for treatment (2,068.66 fine ounces), totalled 855,758.68 fine ounces, which was 10,850.18 fine ounces less than the previous year, and the fourth highest figure since 1941 (vide Table 1 (a) of Part II).

The total gold yield for the year reported directly to the Department by the producers was 869,966.40 fine ounces, an increase of 8,977.40 fine ounces and constituted the second highest reported gold yield since 1941. (see Table 3 of Part II).

The variation between the two annual totals is principally due to the fact that the gold reported 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.

The calculated average value of the ore treated as a whole decreased from 24.730 shillings per ton in 1959 to 24.181 shillings per ton in 1960, calculating gold at the old rate of £4 4s. 11.45d. per fine ounce, but the exchange premium rate of 267.84 per cent. would more than treble this estimate (increasing it to 88.948 shillings per ton on current value). For East Coolgardie Goldfield (which produced 61.15 per cent of the State gold yield) the calculated average value of ore treated decreased slightly from 22.019 shillings to 21.842 shillings per ton. The estimates for Murchison (Hill 50 Gold Mine N.L.), Mt. Margaret (Sons of Gwalia Ltd.), Dundas (Central Norseman Gold Corporation, N.L.) and Yilgarn (Great Western Consolidated N.L.) 46.200s. (48.177s.); 20.593s. (20.552s.); 45.043s. (47.066s.); 14.512s. (15.023s.) respectively. Figures for 1959 being shown in parenthesis.

The tonnage of ore reported to have been treated in 1960, viz. 3,056,445 tons, was 97,243 tons in excess of the previous year and constituted 71.22 per cent of the State record tonnage established in 1940.

The following tonnage increases were reported from the respective Goldfields—Pilbara 4,335, Gascoyne 37, Peak Hill 458, East Murchison 63, Murchison 663, East Coolgardie 98,914, Dundas 7,974, Phillips River 165, Outside Proclaimed Goldfields 9; those fields showing a reduction in tonnage being West Pilbara 8, Yalgoo 269, Mt. Margaret 710, North Coolgardie 3,663, Broad Arrow 284, North East Coolgardie 386, Coolgardie 9,110 and Yilgarn 945.

The output of 2,069,164 tons from East Coolgardie Goldfield was a record annual tonnage for the Goldfield and exceeded the previous year by 98,914 tons. Increases in output by Gold Mines of Kalgoorlie (Aust.) Limited, Lake View and Star Limited and North Kalgurlie (1912) Limited of 79,550 tons, 14,023 tons and 10,709 tons respectively offset a reduction of 6,076 tons reported by Great Boulder Gold Mines Limited and practically accounted for the increased tonnage for the Goldfield. The grade of ore treated by Gold Mines of Kalgoorlie (Aust.) Limited and Great Boulder Gold Mines Limited showed a slight increase while that treated by Lake View and Star Limited and North Kalgurli (1912) Limited was slightly lower when compared with the previous year.

An increase of 7,974 tons occurred in the Dundas Goldfield, where although the output of Central Norseman Gold Corporation N.L. showed an increase of 7,663 tons, the average grade of ore treated by the Company decreased from 11.061 dwts. to 10.624 dwts. per ton.

The Murchison Goldfield had a slight increase of 663 tons. Hill 50 Gold Mine N.L. showed an increase of 1,373 tons with a slight increase in the grade of ore treated. A reduction of 545 tons was shown by Eclipse Gold Mine N.L. while its average grade of ore treated decreased from 32.06 dwts. to 22.068 dwts per ton.

A decrease of 710 tons was shown in the Mt. Margaret Goldfield. The Sons of Gwalia Limited recorded an increase of 2,686 tons at a slightly decreased average grade of ore treated.

Although the output from Great Western Consolidated N.L. declined by 2,899 tons, the Yilgarn Goldfield output exceeded the previous year by 7,974 tons and was due to the Company mentioned assisting other leaseholders in the treatment of low grade lateritic deposits.

Due to the stagnant price of gold and to offset rising costs the principal producers have been forced to resort to increased mechanisation and greater efficiency, especially over the last few years in order to preserve their life line of ore reserves.

West Australian gold included in sales on open dollar markets by the Gold Producers' Association Ltd. during July, 1959, totalled 76,804.96 fine ounces; the extra premium received therefrom in excess of the Mint Value, amounted to £A433, an overall average of 1.353 pence per fine ounce. This amount less expenses was distributed to producer members during the year and approximated 0.739 pence per fine ounce.

Subsidy payments made by the Commonwealth Government during the year under the Gold Mining Industry Assistance Act, 1954, totalled £A698,242, of which £A671,980 went to Large Producers and £A26,262 to Small Producers in this State.

PART II.—MINERALS.

During the year Royalty totalling £81,307 was collected under legislation passed in 1958, on certain prescribed minerals obtained from land held under the Mining Act.

Gold was excluded 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.

COMPARATIVE MINERAL STATISTICS

	1959	1960	Variation	
GOLD—				
Reported to Department (Mine Production):				
Ore (tons)	2,959,202	**3,056,445**	+	97,243
Gold (fine ozs.)	860,969	**869,966**	+	8,997
Average Grade (dwts. per ton)	5·819	**5·693**	—	0·126
Persons Engaged:				
(a) Effective Workers (excluding Absentees)	5,273	**4,992**	—	281
(b) Total Pay Roll	5,769	**5,430**	—	339
Dividends (£A)	2,093,984	**2,131,784**	+	37,800
Mint and Export (Realised Production):				
Gold (fine ozs.)	866,609	**855,759**	—	10,850
Estimated Value (£A) (including overseas Gold Sales Premium)	13,541,929	**13,371,661**	—	170,268
COAL—				
Reported to Department (Mine Production):				
Tons	911,434	**922,393**	+	10,959
Value (£A)	2,356,534	**2,439,195**	+	82,661
Persons Engaged:				
Effective Workers (excluding Absentees)	1,011	984	—	27
OTHER MINERALS—				
Reported to Department:				
Value (£A)	5,898,142	**6,014,630**	+	116,488
Persons Engaged:				
Effective Workers (excluding Absentees)	1,192	**1,296**	+	104
TOTAL ALL MINERALS—				
Value (£A)	21,796,605	***21,825,486**	+	28,881
Persons Engaged:				
Effective Workers	7,476	**7,270**	—	204

Excluding Oil Search Men which engaged an average of 149 men in the field in 1959 and 87 men in the field in 1960.
* All time record.

Particulars for the year are shown hereunder:—

Mineral	Amount per ton s.	d.	Royalty Collected £	s.	d.
Asbestos	1	6	848	17	0
Bauxite		6	672	6	0
Bentonite		6	6	8	6
Beryl	2	0	8	0	1
Building Stone	1	0	2	0	0
Clay		6	969	0	6
Coal		3	11,131	16	0
Felspar		6	50	11	0
Glass Sand and Quartz Grit		6	228	9	3
Gypsum		6	1,101	8	2
Iron Ore (Export only)	1	6	58,670	6	6
Limestone		6	232	1	3
Magnesite	1	6	1	7	9
Manganese	1	6	4,824	12	9
Phosphatic Guano	1	6	1	14	0
Ochre		6	2	12	0
Pyrites	1	0	2,498	2	0
Tanto/Columbite Conc.	*		33	15	6
Tin Conc.	2	0	23	10	0
Total			£81,306	18	3

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

The search for minerals has been carried on vigorously again this year and several large mining companies have applied for temporary reservations to search for all minerals except gold and iron.

There were many enquiries regarding iron ore, but pending the Commonwealth Government's decision on export licenses the State Government retained the blanket reserve on all iron deposits. late in December the Commonwealth Government announced its policy on exports of iron ore, but it was too late for action by the State Government to consider its policy regarding the exploration and development of the State's deposits until the New Year.

During the year the Department drilled the Tallering Peak and Mt. Goldsworthy deposits and on contract the Broken Hill Proprietary Ltd. drilled the Koolyanobbing deposits.

In November the State Government and Broken Hill Proprietary Company Ltd. signed an Agreement relating to the establishment of an Integrated Iron and Steel Works in Western Australia using ore from Koolyanobbing deposits and this Agreement was ratified by the Broken Hill Proprietary Company's Integrated Steel Works Agreement Act, 1960 in December.

Further work has been carried on in the search for nickel, bauxite, gypsum, evaporites and vanadium on Temporary Reservations granted for that purpose to several large companies.

COAL

During the year ended the 31st December, 1960 the coal production amounted to 922,393 tons, an increase of 10,959 tons on the production for 1959.

Tenders were called for coal contracts for Government requirements and the successful tenderers were the Griffin Coal Mining Company Limited and the Western Collieries Limited. As a result of this the Amalgamated Collieries of W.A. Limited decided to cease mining operations and all their mines have now been closed down.

OIL

No new discoveries of oil were made during the year, but the companies have been carrying on exploration work on their Permits to Explore and Licenses to Prospect.

WATER

The Department's two percussion drilling plants were engaged throughout the year on water exploration in the Hill River area. A bore on the Department of Agriculture's Experimental Farm at Badgingarra was put down to 1,047 feet and a previously drilled hole in the Badgingarra recreation ground was developed and tested. A bore to 235 feet was completed on a road reserve near Location 3737 and No. 4 Bore had advanced to 762 feet at the close of the year. When this and a fifth hole are drilled and tested the Hill River programme will have been completed.

Our Failing rotary drill was transferred to water drilling towards the end of the year and a hole drilled at Tenindewa.

All these bores, on Crown Land, found useful supplies of potable water.

TABLE 1

Quantity and Value of Minerals, other than Gold and Silver, produced during Years 1959 *and* 1960

Western Australia

Description of Minerals	1959		1960		Increase or Decrease for Year compared with 1959	
	Quantity	Value	Quantity	Value	Quantity	Value
	Tons	£A	Tons	£A	Tons	£A
Asbestos (Chrysotile)	631·66	17,249	61·26	1,602	— 570·40	— 15,647
(Crocidolite)	14,680·17	1,611,293	12,921·59	1,418,767	— 1,758·58	— 192,526
Bauxite	....	....	26,892·00	†	+ 26,892·00	†
Bentonite	133·00	532	382·00	1,533	+ 249·00	+ 1,001
Beryl	266·71	48,052	181·17	33,024	— 85·54	— 15,028
Building Stone	....	....	40·00	1,300	+ 40·00	+ 1,300
Clays (Cement Clay)	22,321·00	23,055	13,015·00	10,844	— 9,306·00	— 12,211
(Fireclay)	26,202·10	33,346	20,346·50	26,512	— 5,855·60	— 6,834
(White Clay—Ball Clay)	1,005·00	4,020	....	....	— 1,005·00	— 4,020
(White Clay—Kaolin)	185·00	925	....	....	— 185·00	— 925
(Brick, Pipe and Tile Clay)	*2,298·00	605	*24,966·00	22,888	+ 22,698·00	+ 22,283
Coal	911,434·52	2,356,534	922,393·50	2,439,195	+ 10,958·98	+ 82,661
Copper Ore and Concentrates	4,408·75	230,078	3,552·13	199,007	— 856·62	— 31,071
Copper (Metallic By-Product)	....	....	4·72	731	+ 4·72	+ 731
Cupreous Ore and Concentrates	11,858·80	184,006	7,726·81	140,252	— 4,131·99	— 43,754
Dolomite	....	....	403·92	1,616	+ 403·92	+ 1,616
Felspar	1,395·80	6,352	1,942·00	8,283	+ 546·20	+ 1,931
Glass Sand	6,827·54	4,555	8,636·95	6,102	+ 1,809·41	+ 1,547
Glauconite (Recovered)	102·00	5,103	111·00	5,550	+ 9·00	+ 447
Gypsum	37,730·55	54,207	44,216·30	55,628	+ 6,485·75	+ 1,421
Iron Ore (For Pig)	57,206·00	808,644	79,085·00	1,098,825	+ 21,879·00	+ 290,181
(For Export)	672,239·00	666,601	837,147·00	830,124	+ 164,908·00	+ 163,523
Lead and Silver/Lead Ore and Concentrates	1,902·89	89,003	2,263·69	119,292	+ 360·80	+ 30,289
Limestone	....	....	*11,327·75	14,935	+ 11,327·75	+ 14,935
Magnesite	18·50	74	....	....	— 18·50	— 74
Manganese (Metallurgical, Low and Battery Grade)	69,979·24	1,020,824	53,788·84	753,005	— 16,190·40	— 267,819
Mineral Beach Sands (Ilmenite)	73,627·67	353,076	114,661·72	485,562	+ 41,034·05	+ 132,486
(Monazite)	109·55	7,210	241·96	9,319	+ 132·41	+ 2,109
(Rutile)	297·45	8,424	621·41	15,686	+ 323·96	+ 7,262
(Leucoxene)	276·25	3,930	20·10	392	— 256·15	— 3,538
(Zircon)	4,068·34	41,129	4,624·45	49,270	+ 556·11	+ 8,141
Ochre (Red)	104·00	1,040	104·00	1,040	....	....
Phosphatic Guano	....	....	86·79	938	+ 86·79	+ 938
Pyrites Ore and Concentrates (For Sulphur)	53,030·39	371,989	53,298·79	366,739	+ 268·40	— 5,250
Quartz Grit	312·00	260	288·00	243	— 24·00	— 17
	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	
Talc	4,047·69	58,085	5,470·39	69,114	+ 1,422·70	+ 11,029
Tanto/Columbite Ores and Concentrates	8·46	9,833	10·57	16,982	+ 2·11	+ 7,149
Tin	249·70	154,729	280·82	168,775	+ 31·12	+ 14,046
Total	....	8,174,763	....	8,373,212	....	+ 198,449

TABLE 1 (a).—*Quantity and Value of Gold and Silver exported and minted during Years* 1959 *and* 1960.

Description of Minerals	1959		1960		Increase or Decrease for Year compared with 1959	
	Quantity	Value	Quantity	Value	Quantity	Value
	Fine ozs.	£A	Fine ozs.	£A	Fine ozs.	£A
Gold (Exported and Minted)	866,608·86	‡13,541,929	855,758·68	‡13,371,661	— 10,850·18	— 170,268
Silver (Exported and Minted)	193,561·53	79,913	193,821·63	80,613	+ 260·10	+ 700
Total	....	13,621,842	....	13,452,274	....	— 169,568
GRAND TOTAL	....	21,796,605	....	21,825,486	....	+ 28,881

* 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.

Comparative Statistical Diagrams

showing:

OUTPUT AND VALUE OF GOLD AND OTHER MINERALS, LANDS LEASED FOR GOLD MINING IN WESTERN AUSTRALIA

and the

GOLD PRODUCTION OF AUSTRALASIA FOR THE YEAR 1960

Fig. 1 Output of Gold from various Goldfields as reported to Mines Dept.

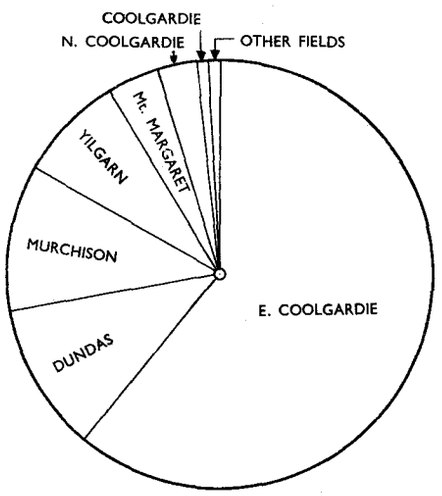


Fig. 2 Gold produced from various Goldfields as given by the Export and Mint Returns

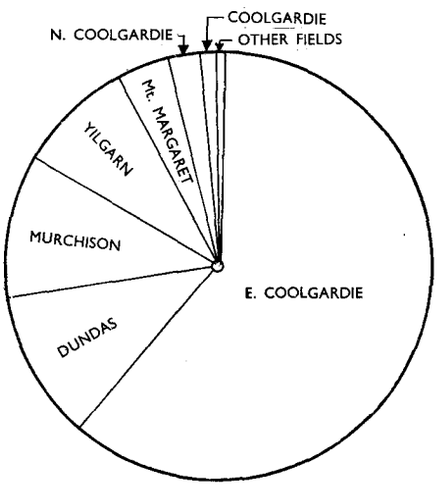


Fig. 3 Value of Gold and other Minerals

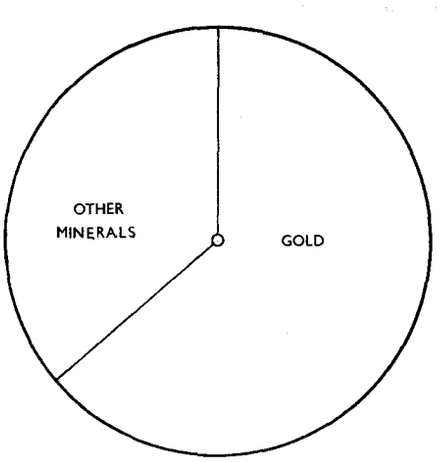


Fig. 4 Value of Minerals other than Gold

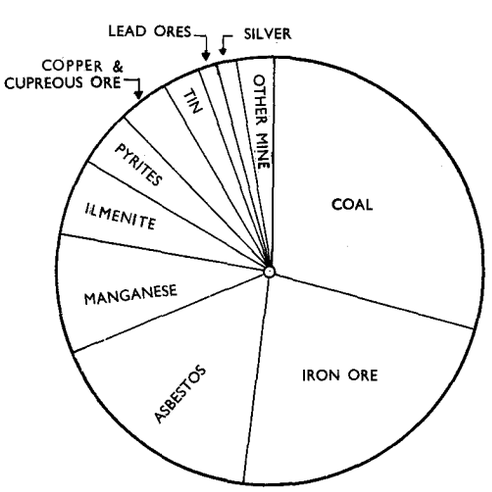


Fig. 5 Areas of land leased for Goldmining on various Goldfields

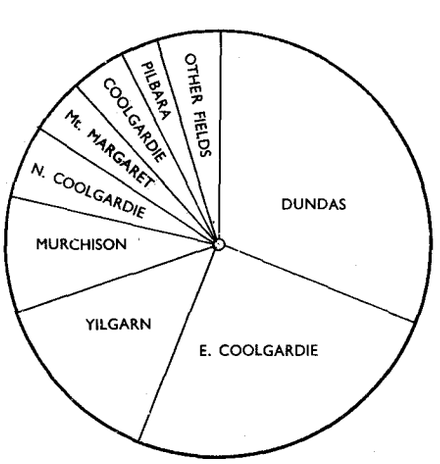


Fig. 6 Output of Gold in the States of Australia and the Dominion of New Zealand

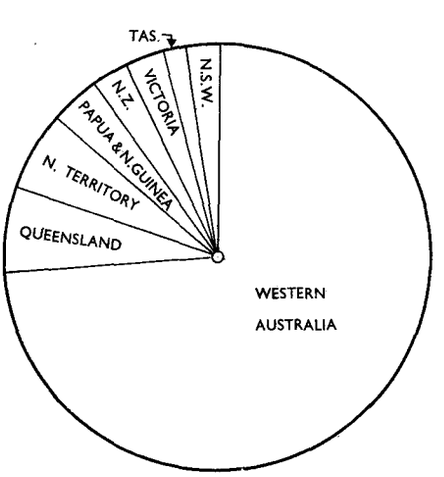
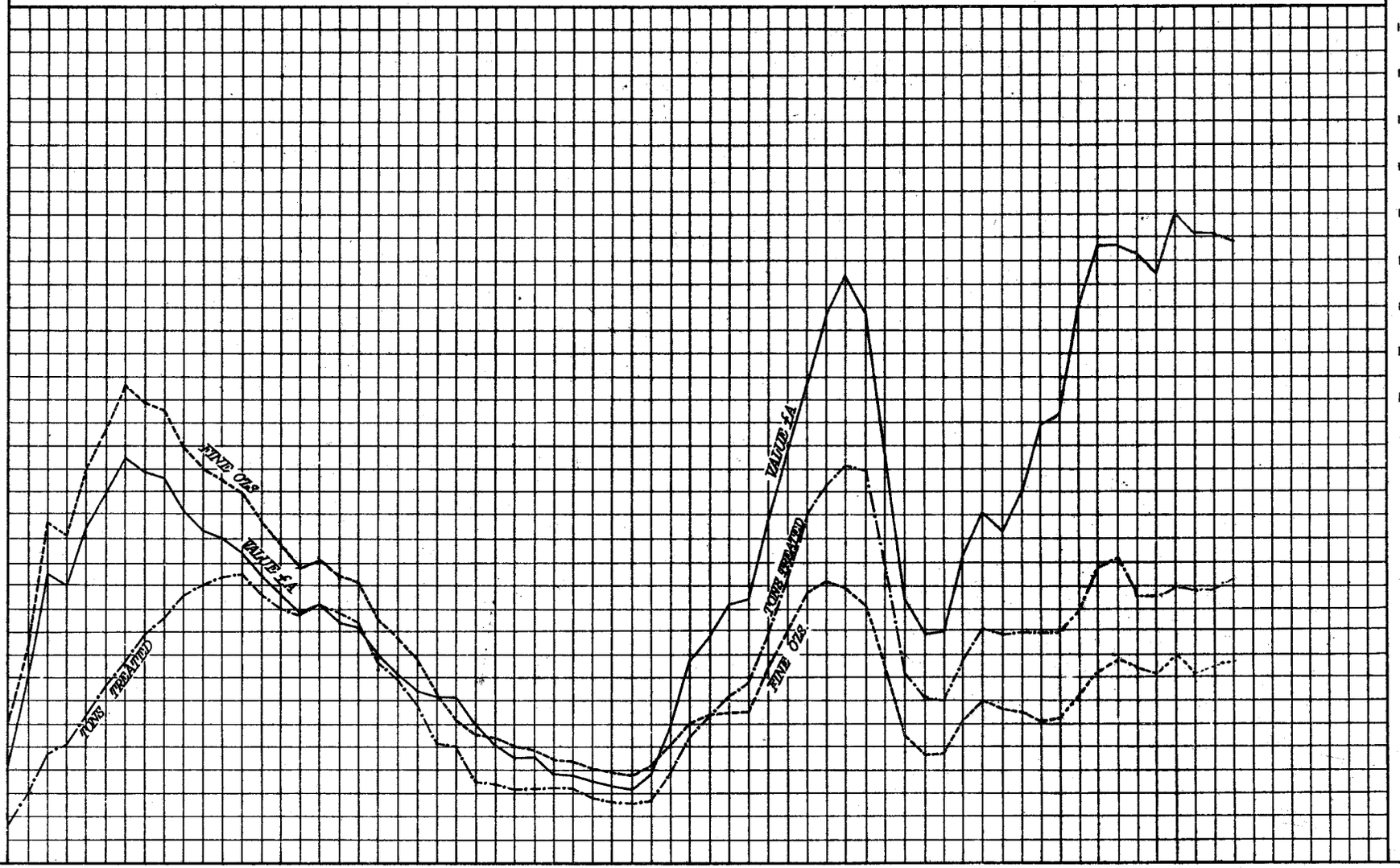


DIAGRAM OF GOLD OUTPUT

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	10,324,732	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	21,825,486

† Including Ship's 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 of Gold per ton of ore treated

Goldfield	Reported Yield		Percentage for each Goldfield		Average Value per ton of Ore Treated (Gold at £4 4s. 11·45d. per fine oz.)	
	1959	1960	1959	1960	1959	1960
	Fine oz.	Fine oz.	%	%	Shillings	Shillings
1. Kimberley	38	18	·005	·002	....	....
2. West Kimberley	....	....	....	....	....	....
3. Pilbara	1,071	2,944	·125	·338	45·294	39·419
4. West Pilbara	11	5	·001	·001	33·636	22·767
5. Ashburton	....	1	....	....	....	....
6. Gascoyne	43	141	·006	·016	....	....
7. Peak Hill	436	501	·051	·058	9·289	9·556
8. East Murchison	732	381	·085	·044	77·076	37·257
9. Murchison	95,361	91,970	11·072	10·572	48·177	46·200
10. Yalgoo	61	1	·008	....	19·154	....
11. Mt. Margaret	34,191	34,106	3·972	3·920	20·552	20·593
12. North Coolgardie	22,458	20,250	2·609	2·328	46·184	45·666
13. Broad Arrow	1,663	1,543	·193	·177	32·152	31·878
14. North-East Coolgardie	385	141	·045	·016	35·095	21·897
15. East Coolgardie	510,382	531,981	59·280	61·150	22·019	21·847
16. Coolgardie	17,393	12,342	2·021	1·419	54·748	58·593
17. Yilgarn	73,302	70,689	8·511	8·125	15·023	14·512
18. Dundas	101,643	101,555	11·806	11·673	47·066	45·043
19. Phillips River	1,366	1,331	·159	·153	....	....
20. Outside Proclaimed Goldfields	432	66	·051	·008	....	....
Totals and Averages	860,969	869,966	100·000	100·000	24·730	24·181

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.

TABLE 4

Average Quantities of Gold Ore raised and treated, and Gold produced therefrom, per man employed on the several Goldfields of the State, during 1959 *and* 1960

Goldfield	1959				1960			
	Tons of Gold Ore raised and treated		Fine ounces of Gold produced therefrom		Tons of Gold Ore raised and treated		Fine ounces of Gold produced therefrom	
	Per man employed underground	Per man employed above and underground	Per man employed underground	Per man employed above and underground	Per man employed underground	Per man employed above and underground	Per man employed underground	Per man employed above and underground
	Tons	Tons	Fine oz.	Fine oz.	Tons	Tons	Fine oz.	Fine oz.
1. Kimberley	....	....	....	....	....	....	....	....
2. West Kimberley	....	....	....	....	....	....	....	....
3. Pilbara	282·64	30·44	99·36	16·23	528·67	111·30	245·33	51·65
4. West Pilbara	....	....	....	....	....	....	....	....
5. Ashburton	....	....	....	....	....	....	....	....
6. Gascoyne	....	....	....	....	....	....	....	....
7. Peak Hill	798·60	399·30	87·20	43·60	1,112·75	445·10	125·25	50·10
8. East Murchison	80·70	32·28	73·20	29·28	96·67	54·38	42·33	23·81
9. Murchison	1,194·71	552·31	676·32	312·66	1,119·41	573·28	652·27	311·76
10. Yalgoo	134·50	44·83	30·50	10·17	....	....	....	....
11. Mt. Margaret	961·96	550·23	232·60	133·04	937·99	530·94	227·37	128·70
12. North Coolgardie	590·50	250·52	320·83	136·11	588·63	244·62	316·41	131·49
13. Broad Arrow	137·41	64·66	51·97	24·46	124·64	61·39	46·76	23·03
14. North-East Coolgardie	155·33	51·78	64·17	21·39	91·00	30·33	23·50	7·83
15. East Coolgardie	1,141·51	632·50	295·70	163·85	1,274·12	694·82	327·57	178·64
16. Coolgardie	270·04	142·13	173·93	91·54	168·81	87·29	116·43	60·21
17. Yilgarn	1,425·26	684·41	251·90	120·96	1,880·94	803·51	321·31	137·26
18. Dundas	768·05	424·92	425·28	235·28	886·75	482·46	470·16	255·81
19. Phillips River	....	....	....	....	....	....	....	....
20. Outside Proclaimed Goldfields	....	....	....	....	....	....	....	....
Total Averages	1,064·46	562·27	309·70	163·59	1,181·92	614·11	336·41	174·80

TABLE 5

Output of Gold from the several States of Australia, the Northern Territory, Papua and the Mandated Territory of New Guinea and the Dominion of New Zealand, during 1960

State	Output of Gold	Value*	Percentage of Total	
			Output of Commonwealth	Output of Australasia
	Fine oz.	£	%	%
Western Australia	855,759	3,635,029	76·896	74·660
Victoria	27,234	115,683	2·447	2·376
New South Wales	13,800	58,619	1·240	1·204
Queensland	75,852	322,199	6·816	6·618
Tasmania	23,015	97,761	2·068	2·008
South Australia	36	153	0·003	0·003
Territory of Papua and New Guinea	45,151	191,789	4·057	3·939
Northern Territory	72,030	305,964	6·473	6·284
New Zealand	33,326	141,560	....	2·908
Total	1,146,203	£4,868,757	100·000	100·000

* Par Value (£4 4s. 11·45d. per fine ounce).

TABLE 6

Dividends, etc., paid by Western Australian Mining Companies during 1960, *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	
		1960	Grand Total to end of 1960
		£	£
Pilbara	Various Companies	....	26,513
Peak Hill	do. do.	....	199,305
East Murchison	do. do.	....	1,914,053
Murchison	Eclipse Gold Mine N.L.	37,800	37,800
	Hill 50 Gold Mine N.L.	600,000	5,640,626
	Various Companies	....	2,764,945
Mt. Margaret	Sons of Gwalia Ltd.	....	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.	202,265	2,396,618
	Great Boulder G.Ms. Ltd.	218,750	8,934,400
	Lake View & Star Ltd.	437,500	(*b*) 9,368,250
	North Kalgurli (1912) Ltd.	180,469	2,768,904
	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	4,582,500
	Various Companies	....	786,162
	Totals	£2,131,784	£64,515,328

(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 £42,000 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 7

Quantity and Value of Minerals, other than Gold and Silver, reported to the Mines Department during 1960

Goldfield, District or Mineral Field	1960		Increase or Decrease as compared with 1959	
	Quantity	Value	Quantity	Value
	Tons	£A	Tons	£A
ASBESTOS (Chrysotile)—				
West Pilbara	61·26	1,602	— 536·05	— 14,926
Pilbara	....	....	— 34·35	— 721
ASBESTOS (Crocidolite)—				
West Pilbara	12,921·59	1,418,767	— 1,758·58	— 192,526
BAUXITE—				
Outside Proclaimed Goldfields	26,892·00	†	— 26,892·00	†
BENTONITE—				
Outside Proclaimed Goldfields	382·00	1,533	+ 249·00	1,001
BERYL—				
Ashburton	0·33	63	— 4·91	— 901
Coolgardie	0·75	121	— 13·29	— 2,333
Gascoyne	95·41	17,833	+ 49·90	+ 9,363
Murchison	0·44	85	+ 0·44	+ 85
Phillips River	5·93	957	+ 5·93	+ 957
Pilbara	73·75	13,143	— 125·34	— 22,493
West Kimberley	0·98	190	+ 0·98	+ 190
West Pilbara	2·33	409	+ 2·33	+ 409
Yalgoo	1·25	223	— 1·35	— 265
Outside Proclaimed Goldfields	....	....	— 0·23	— 40
BUILDING STONE—				
Outside Proclaimed Goldfields	40·00	1,300	+ 40·00	+ 1,300
CLAYS (Cement Clay, Fireclay, White Clays, Brick, Pipe and Tile Clay)—				
Outside Proclaimed Goldfields	58,357·50	60,244	+ 6,346·40	— 1,706
COAL—				
Collie River Mineral Field	922,393·50	2,439,195	+ 10,958·98	+ 82,661
COPPER ORE AND CONCENTRATES—				
Phillips River	3,552·13	199,007	— 856·62	— 31,071
COPPER (Metallic by-Product)—				
Coolgardie	4·72	731	+ 4·72	+ 731
CUPREOUS ORE AND CONCENTRATES—				
Ashburton	54·15	1,947	+ 54·15	+ 1,947
Broad Arrow	51·79	549	+ 51·79	+ 549
Mt. Margaret	25·54	183	+ 4·88	+ 5
Murchison	218·00	2,302	+ 65·90	+ 494
Peak Hill	4,258·94	51,889	— 1,928·53	— 22,034
Phillips River	122·90	4,140	+ 58·47	+ 1,236
Pilbara	2,573·86	71,763	— 2,328·86	— 24,323
West Pilbara	1·85	64	— 261·86	— 5,077
Yalgoo	419·78	7,415	+ 307·22	+ 5,194
East Murchison	....	....	— 155·15	— 1,745
DOLOMITE—				
Murchison	403·92	1,616	+ 403·92	+ 1,616
FELSPAR—				
Coolgardie	1,942·00	8,283	+ 549·00	+ 1,945
Outside Proclaimed Goldfields	....	....	— 2·80	— 14
GLASS SAND—				
Outside Proclaimed Goldfields	8,636·95	6,102	+ 1,809·41	+ 1,547
GLAUCONITE—				
Outside Proclaimed Goldfields	111·00	5,550	+ 9·00	+ 447
GYPSUM—				
Yilgarn	25,386·00	19,222	+ 1,833·00	+ 1,489
Dundas	13,342·30	30,703	+ 2,173·60	— 2,792
Outside Proclaimed Goldfields	5,488·00	5,703	+ 2,479·15	+ 2,724
IRON ORE (for Pig)—				
Yilgarn	79,085·00	1,098,825	+ 21,879·00	+ 290,181
IRON ORE (for Export)—				
West Kimberley	837,147·00	830,124	+164,908·00	+ 163,523
LEAD ORE AND CONCENTRATES—				
Northampton	2,259·86	119,139	+ 819·34	+ 49,510

† Value not available for Publication.

TABLE 7—*continued*

Quantity and Value of Minerals, other than Gold and Silver, reported to the Mines Department during 1960—*continued*

Goldfield, District or Mineral Field	1960		Increase or Decrease as compared with 1959	
	Quantity	Value	Quantity	Value
	Tons	£A	Tons	£A
SILVER/LEAD ORE AND CONCENTRATES—				
Gascoyne	3·83	153	+ 3·83	+ 153
Ashburton	....	....	— 41·50	— 2,336
Pilbara	....	....	— 420·87	— 17,039
LIMESTONE—				
Outside Proclaimed Goldfields	11,327·75	14,935	+ 11,327·75	+ 14,935
MAGNESITE—				
Phillips River	....	....	— 18·50	— 74
MANGANESE—				
Peak Hill	11,377·75	136,107	— 19,327·05	— 222,466
Pilbara	42,411·09	616,898	+ 3,144·25	— 45,321
East Coolgardie	....	....	— 7·60	— 32
MINERAL BEACH SANDS (ILMENITE)—				
Outside Proclaimed Goldfields	114,661·72	485,562	+ 41,034·05	+ 132,486
MINERAL BEACH SANDS (MONAZITE)—				
Outside Proclaimed Goldfields	241·96	9,319	+ 132·41	+ 2,109
MINERAL BEACH SANDS (RUTILE)—				
Outside Proclaimed Goldfields	621·41	15,686	+ 323·96	+ 7,262
MINERAL BEACH SANDS (LEUCOXENE)—				
Outside Proclaimed Goldfields	20·10	392	— 256·15	— 3,538
MINERAL BEACH SANDS (ZIRCON)—				
Outside Proclaimed Goldfields	4,624·45	49,270	+ 556·11	+ 8,141
OCHRE (RED)—				
Murchison	104·00	1,040	....	....
PHOSPHATIC GUANO—				
Outside Proclaimed Goldfields	86·79	938	+ 86·79	+ 938
PYRITES ORE AND CONCENTRATES—				
Dundas	39,003·00	294,120	+ 94·00	— 8,599
East Coolgardie	14,295·79	72,619	+ 174·40	+ 3,349
QUARTZ GRIT—				
Collie River Mineral Field	288·00	243	— 24·00	— 17
SEMI-PRECIOUS STONES (PRASE)—	lb.		lb.	
Coolgardie	2,240·00	40	+ 2,240·00	+ 40
SEMI-PRECIOUS STONES (TIGER EYE OPAL)—				
Gascoyne	120·00	97	+ 120·00	+ 97
TALC—	Tons		Tons	
Outside Proclaimed Goldfields	5,470·39	69,114	+ 1,422·70	+ 11,029
TANTO/COLUMBITE ORES AND CONCENTRATES—				
Pilbara	6·03	12,848	+ 2·93	+ 8,505
Greenbushes	4·54	4,134	— 0·82	— 1,356
TIN—				
Pilbara	260·68	157,364	+ 33·93	+ 15,453
Greenbushes	20·14	11,411	— 2·81	— 1,407

TABLE 8

Total Coal output from Collie River Mineral Field 1959 *and* 1960, *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—								
1959	800,856	2,097,825	153	804	957	5,234	995	836
1960	798,184	2,153,096	146	778	924	5,467	1,025	833
Open Cut Mining—								
1959	110,578	258,709	54	....	54	2,047	....	2,047
1960	124,209	286,099	60	....	60	2,070	....	2,070
Totals—								
1959	911,434	2,356,534	207	804	1,011	4,403	1,133	901
1960	922,393	2,439,195	206	778	984	4,477	1,185	937

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

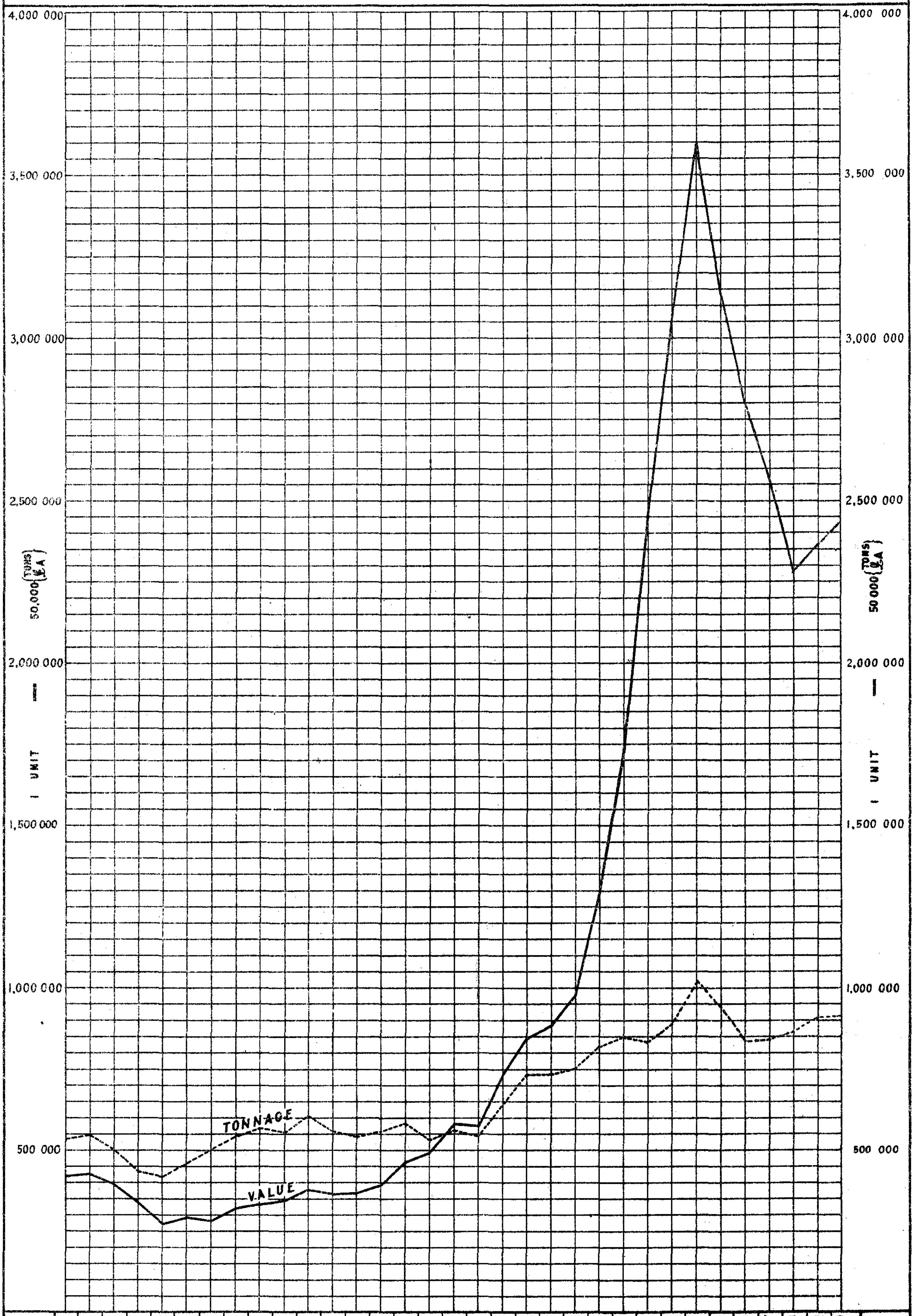
TABLE 9

Total Number and Acreage of Leases, Mineral Claims, Dredging Claims and Prospecting Areas held for Mining on the 31*st December,* 1959 *and* 1960

Leases and Other Holdings	1959		1960	
	No.	Acreage	No.	Acreage
Gold Mining Leases on Crown Lands	1,099	20,146	**1.027**	**18,788**
Gold Mining Leases on Private Property	30	653	**24**	**518**
Mineral Leases on Crown Lands	226	40,337	**225**	**40,368**
Mineral Leases on Private Property	12	1,961	**13**	**1,986**
Dredging Claims—				
Gold	4	492	**4**	**492**
Minerals	137	10,141	**128**	**7,406**
Mineral Claims	597	42,787	**626**	**51,289**
Prospecting Areas—				
Gold	473	8,340	**461**	**7,717**
Minerals	37	806	**48**	**965**
Total	2,615	125,663	**2,556**	**129,529**

GRAPH OF COAL OUTPUT

Showing Quantities and Values as reported to Mines Dept.



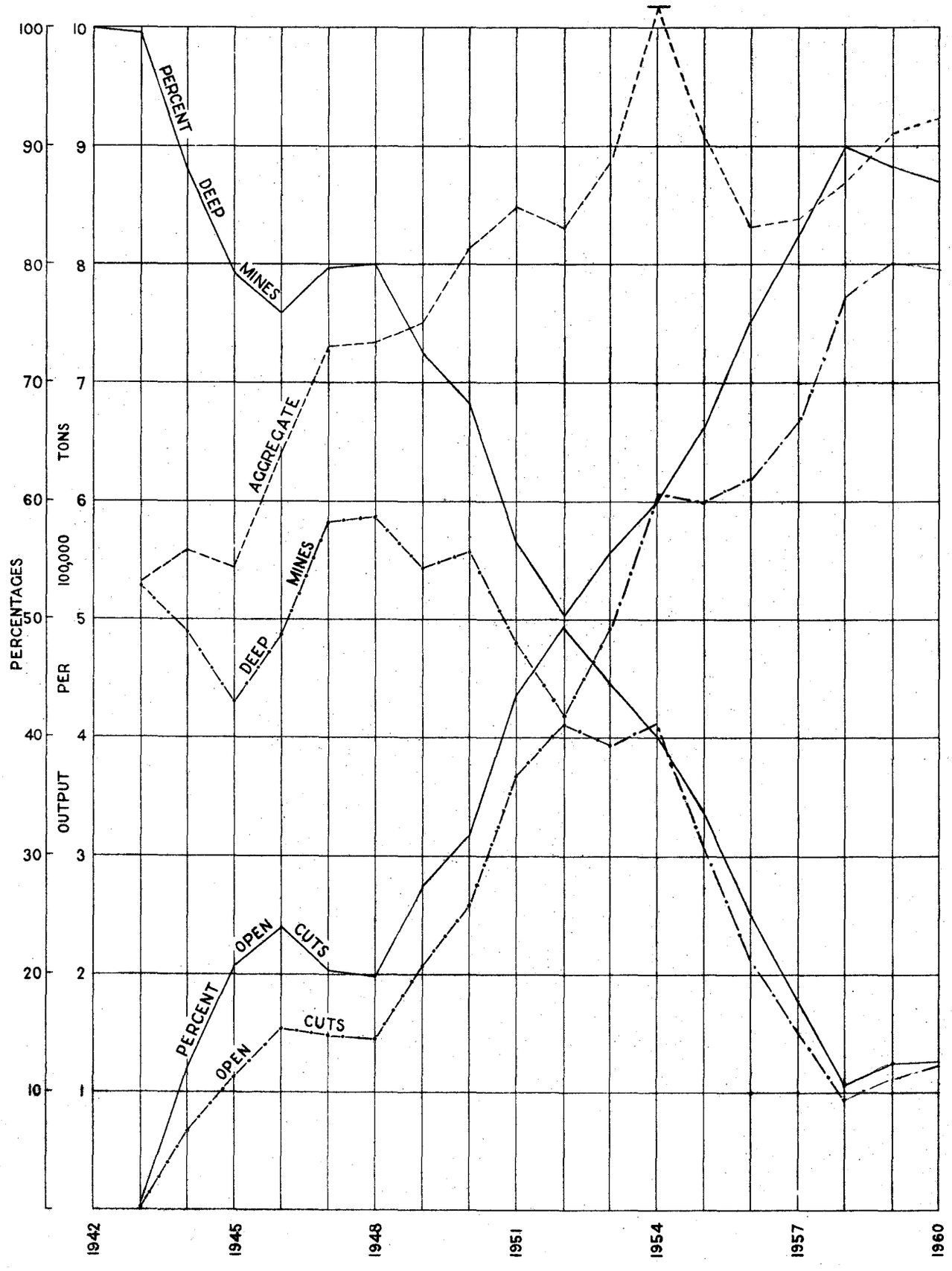
YEAR	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
VALUE £A	420145	426706	394758	336178	270630	289806	278704	318013	331565	340444	375083
TONS	528420	544719	501425	432400	415719	458399	500343	537188	565075	553510	604793

YEAR	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
VALUE £A	362811	364500	389278	461495	489721	583075	572896	730104	840249	880236	972245
TONS	557535	539427	556574	581176	531546	558372	543363	642267	730506	732938	750534

YEAR	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
VALUE £A	1,287749	1,716788	2,457295	3073073	3,588,848	3,182,074	2,797,606	2,556,655	2,280,649	2,356,534	2,439,135
TONS	814351	848475	830461	886182	1018343	903,782	899,008	834,660	867,882	917,434	922,393

GRAPH OF TREND IN COAL OUTPUT

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



PART–IV. MEN EMPLOYED

TABLE 10

** Average number of Men reported as engaged in Mining during* 1959 *and* 1960

Goldfield	District	Total 1959	Total 1960
Kimberley		4	4
West Kimberley		....	....
Pilbara	Marble Bar	47	28
	Nullagine	19	29
West Pilbara		2	3
Ashburton		....	....
Gascoyne		....	....
Peak Hill		10	10
East Murchison	Lawlers	7	8
	Wiluna	3	3
	Black Range	15	5
Murchison	Cue	34	32
	Meekatharra	18	18
	Day Dawn	7	9
	Mt. Magnet	246	236
Yalgoo		6	4
Mt. Margaret	Mt. Morgans	5	4
	Mt. Malcolm	246	255
	Mt. Margaret	6	6
North Coolgardie	Ularring	30	30
	Niagara	6	4
	Yerilla	24	24
	Menzies	105	96
Broad Arrow		68	67
North-East Coolgardie	Kanowna	15	15
	Kurnalpi	3	3
East Coolgardie	East Coolgardie	3,109	2,972
	Bulong	6	6
Coolgardie	Coolgardie	172	187
	Kunanalling	18	18
Yilgarn		606	515
Dundas		432	397
Phillips River		2	2
State Generally		2	2
Total, Gold Mining		5,273	4,992
Minerals Other than Gold—			
Asbestos		352	345
Bauxite		....	4
Beryl		38	51
Clays		8	11
Coal		1,011	984
Copper		135	136
Cupreous Ore (Fertiliser)		59	73
Felspar		5	6
Glass Sand		3	2
Glauconite		2	2
Gypsum		18	18
Iron Ore		166	257
Lead		47	33
Limestone		....	6
Manganese		97	77
Magnesite		....	2
Mineral Beach Sands (Ilmenite, etc.)		97	119
Pyrites		117	105
Talc		4	5
Tanto/Columbite		1	1
Tin		43	43
Total, Other Minerals		2,203	2,280

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

[2]—46622

PART V.–ACCIDENTS.

TABLE 11

MEN EMPLOYED IN MINES KILLED AND INJURED IN MINING ACCIDENTS DURING 1959 AND 1960

A.—*According to Locality of Accident*

Goldfield	Killed		Injured		Total Killed and Injured	
	1959	1960	1959	1960	1959	1960
1. Kimberley	....	....	....	....	....	....
2. West Kimberley	....	....	3	7	3	7
3. Pilbara	....	....	1	2	1	2
4. West Pilbara	....	1	10	5	10	6
5. Ashburton	....	....	....	....	....	....
6. Gascoyne	....	....	....	....	....	....
7. Peak Hill	....	....	....	....	....	....
8. East Murchison	....	....	....	1	....	1
9. Murchison	....	....	9	10	9	10
10. Yalgoo	....	....	....	....	....	....
11. Mount Margaret	....	....	24	31	24	31
12. North Coolgardie	....	....	5	12	5	12
13. North-East Coolgardie	....	....	....	....	....	....
14. Broad Arrow	....	....	....	....	....	....
15. East Coolgardie	1	5	277	286	278	291
16. Coolgardie	....	....	3	6	3	6
17. Yilgarn	....	2	54	39	54	41
18. Dundas	....	1	38	24	38	25
19. Phillips River	....	2	13	36	13	38
Mining Districts—						
Northampton	....	....	7	3	7	3
Greenbushes	....	....	....	....	....	....
Collie	2	1	123	146	125	147
South-West	....	2	5	5	5	7
Total	3	14	572	613	575	627

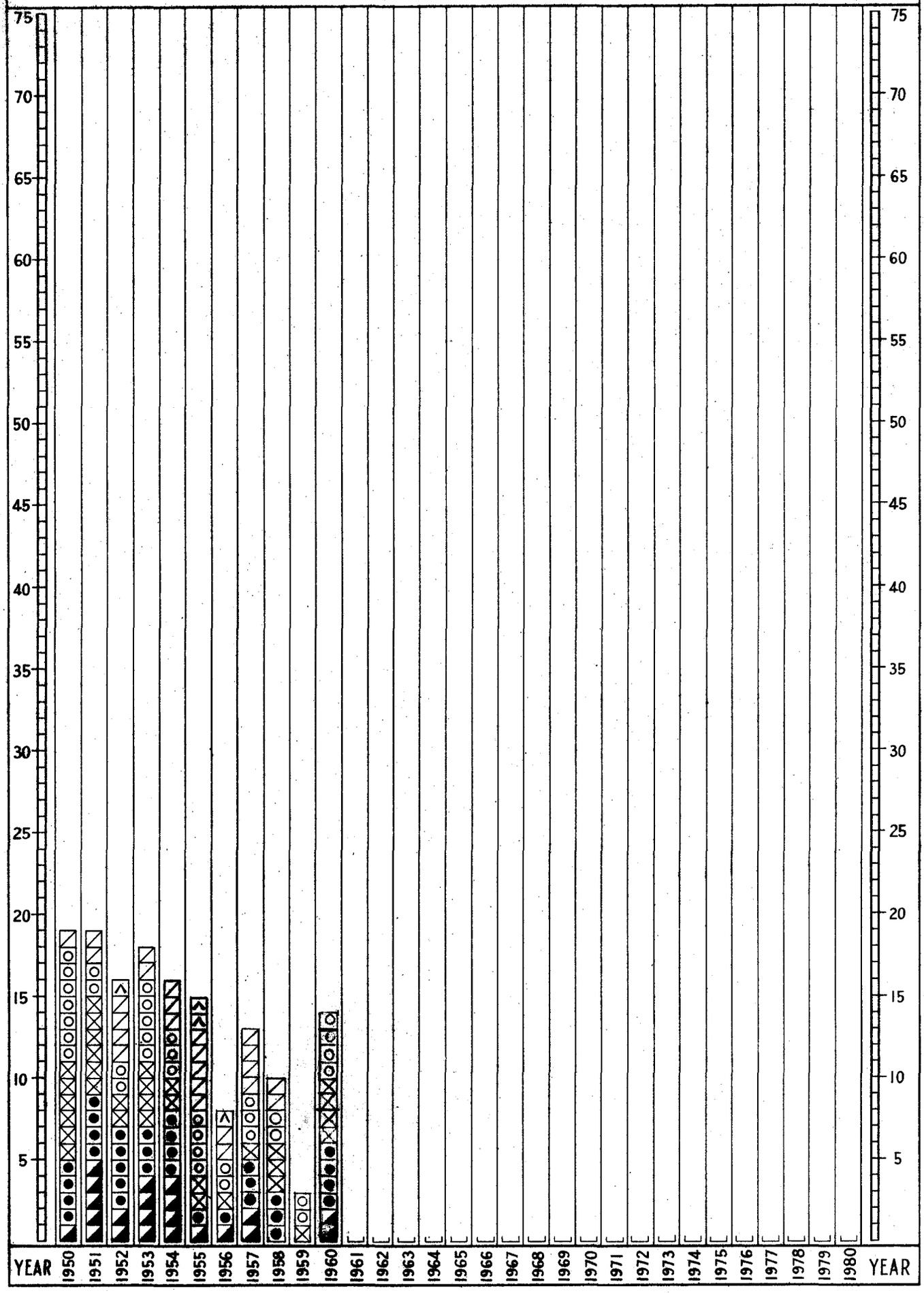
B.—*According to Causes of Accidents*

Cause	1959		1960		Comparison with 1959	
	Fatal	Serious	Fatal	Serious	Fatal	Serious
1. Explosives	....	2	2	....	+ 2	— 2
2. Falls of Ground	....	39 (*a*)	4	52 (*c*)	+ 4	+ 13
3. In Shafts	1	10	4	10	+ 3	....
4. Miscellaneous Underground	2	390	4	452	+ 2	+ 62
5. Surface	....	131 (*b*)	....	99 (*d*)	....	— 32
6. Fumes	....	....	....	....	....	....
Total	3	572	14	613	+ 11	+ 41

(*a*) Includes one serious accident in a quarry. (*b*) Includes four serious accidents in quarries. (*c*) Includes one serious accident in a quarry. (*d*) Includes four serious accidents in quarries.

DIAGRAM OF ACCIDENTS

Showing the number of deaths arranged in six classes in the Mines and Quarries of Western Australia



PART VI.—STATE AID TO MINING.

(a) *State Batteries.*

At the end of the year there were twenty-one State Batteries including the Northampton Base Metal Plant.

From inception to the end of 1960, gold, tin, tungsten, lead, copper and columbite ores to the value of £17,682,765 have been treated at the State Batteries. Included in the above amount is gold premium of £6,484,254, and premium paid by sales of gold by the Gold Producers Association Ltd., of £40,554. £17,298,566 came from 3,284,617 tons of gold ore, £94,577 from 81,818 tons of tin ore, £18,850 from 3,960 tons tungsten ore, £268,124 from 25,003.25 tons of lead ore and £2,648 from 130 tons of copper ore.

During the year 39,219 tons of gold ores were crushed for 17,349 ozs. bullion, estimated to contain 14,704 ozs. fine gold, equal to 7 dwts. 12 grs. per ton. The average value of sands after amalgamation was 2 dwts. 20 grs. per ton, making the average head value 10 dwts. 8 grs. per ton. Cyanide plants produced 3,418 ozs. fine gold, giving a total estimated production for the year of 18,122 ozs. fine gold valued at £283,417.

The working expenditure for the year for all plants was £195,057 and the revenue was £40,573 giving a working loss of £154,484, which does not include depreciation or interest. Since the inception of State Batteries, the Capital expenditure has been £769,325, made up of £589,682 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 £20,178, compared with £19,050 for 1959.

The working expenditure from inception to the end of 1960 exceeds revenue by £1,357,003.

(b) *Prospecting Scheme.*

During the year 56 men were approved for assistance and for the same period 56 cancellations were effected and 9 men were under suspension as at 31st December, 1960, leaving a total of 52 men in receipt of assistance, a decrease of nine men for the corresponding period, 1959.

The cost of maintaining prospectors for the twelve months amounted to £12,341 14s. 7d., whilst refunds from crushings amounted to £2,687 13s. 2d. These amounts are included in the grand total of £82,023 0s. 4d. refunded, and £405,166 14s. 4d. expended since the inception of the prospecting scheme. Included in the latter figure is £80,346 1s. 9d. subsidised by the Commonwealth Government.

Crushings by assisted prospectors amounted to 3,110.75 tons for a return of 1,210 ozs. 15 dwts. making a progressive total of 111,945 tons for a return of 53,559 ozs. 8 dwts. since inauguration of of the Scheme in 1933.

From the above figures it will be seen that Refunds, Expenditure and gold won show an increase on 1959, whereas the amounts of ore crushed was less than in 1959.

(c) *Drilling Programmes.*

In connection with the Iron Ore Resources Survey two of the Department's drills were engaged at Mt. Goldsworthy, where four holes were completed and a fifth hole had reached a depth of 475 feet at the end of the year. One of these drills has now been moved to Wilgie Mia where drilling of the iron ore deposits will be carried out.

Drilling for gold on Crown land was carried out at the old "Forest King" at Coolgardie and at Paddy's Flat, Meekatharra.

Apart from drilling done for the Department assistance was rendered to other departments and private drilling contractors. For a considerable part of the year specialised equipment and advice was supplied to the Public Works Department for drilling being done at Logue's Brook.

Equipment was loaned to Western Aluminium N.L., Westphal Bros., drilling contractors, Davis, Hankinson, Baker Bros., Midland Drilling Services and Australian Blue Asbestos.

(d) *Geological Survey of Western Australia.*

The principal work of the Geological Survey Branch for the year 1960 is covered by the following reports published in Division IV of this Report:—

- Report on Lime Shell Deposits, Hamelin Pool, W.A.
- Activities of the Hydrological Section of the Geological Survey during 1960.
- Report on Subterranean Water Potentialities on Rottnest Island.
- Report on Regional Survey of Boorabbin 4-mile Sheet.
- Report on M.L. 70P for Manganese at Murphy's Well, Peak Hill Goldfield, W.A.
- Report on Some Limonitic Iron Ore Deposits in the vicinity of Port Hedland, Pilbarra Goldfield, W.A.
- Report on a Deposit of Bog Iron Ore at the Scott River, South West Land Division, W.A.
- Progress Report on the Balfour Downs 4-mile to an inch sheet.
- The Search for Oil in Western Australia in 1960.
- Report on the Copper Mine on M.C. 14, Warriedar Centre, Yalgoo Goldfield.
- Report on the Exploratory Drilling of Part of the Mt. Goldsworthy (Ellarine Hills) Hematite Iron Ore Deposits, Pilbara Goldfield, W.A.
- Summary Report on the "Coronation" G.M.L. 1137, Wyman's Well Centre, Pilbara Goldfield, W.A.
- Summarised Report on an Occurrence of Lateritic Iron Ore approximately Five Miles N.E. of Collie, S.W. Division.
- Notes on the Cooper (W.A.) and Mann (S.A.) Four-Mile Sheets on the West Australia-South Australia Border.
- Report on Exploratory Diamond Drill Hole No. P.F.1., Site A, Paddy's Flat, Meekatharra, Murchison Goldfield.
- Notes on "Waroonga Extended South" G.M., G.M.L. 1356, Agnew, East Murchison, G.F.
- Preliminary Report on the Diamond Drill Exploration of the Ord River No. 2 Main Damsite, Ord River, East Kimberley Division.
- Reconnaissance Survey of Commercial Lime Deposits within a 15-mile radius of Albany.
- Report on M.C. 720H for Building Stone near Watheroo, S.W. Land Division.
- Report on M.C. 719H for Building Stone near Watheroo, S.W. Land Division.
- Report on Diamond Drilling of Abandoned Gold Shows, No. C4 Site B2, Forest King G.M. late G.M.L. 284, Coolgardie.
- Report on Examination of G.M.L. 1942N, "Margueritta" G.M.. Chesterfield, Murchison Goldfield.
- Report on Subsidised Diamond Drilling, Mountain View North Prospect, G.M.L's 573D, 671D, 674D, Day Dawn, Murchison Goldfield.
- Report on G.M.L. 5999 "Little Nipper", Ryan's Find, Coolgardie Goldfield.

During the year, the following publications were issued:—

- Mineral Resources Bulletin No. 7—Iron Ores in Western Australia.
- Bulletin No. 113—Miscellaneous Reports for 1956.
- Bulletin No. 114—Miscellaneous Reports for 1957.
- Annual Progress Report for 1958.

The following reports have been compiled and await publication:—

- Annual Progress Report for 1959.

In course of preparation:—

- A Bulletin on the Geology of the Nullagine and Marble Bar 4-mile Sheets.
- A Mineral Resources Bulletin on the Manganese and Chromite Resources of W.A.
- A Mineral Resources Bulletin on the Copper Deposits of W.A.
- A Geological Map of the Balfour Downs 4-mile Sheet with Explanatory Notes.
- A Geological Map of the Boorabbin 4-mile Sheet with Explanatory Notes.

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 332, a decrease of 33 by comparison with 1959.

Previously the School year was divided into three terms; in 1960 it was divided into two terms and mid-year examinations were held instead of three examinations as previously.

No students were holding either an Entrance or Senior Scholarship offered by the Mines Department.

Twelve students held Chamber of Mines Scholarships and all but two completed a good year's work. Eight students have now completed Associateship Courses under the Chamber of Mines Scholarship Scheme.

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

During the year 12 students completed Associateship Courses; 11, Certificate Courses; and 5, Technical Courses.

On May 24th a graduation ceremony was held in the Kalgoorlie Town Hall. Diplomas, Certificates, and Prizes awarded at the end of 1959 were presented by the Hon. Minister for Mines, Mr. A. F. Griffith. The Guest Speaker was Mr. R. G. Thomas, Chief of the Division of Mineral Chemistry, C.S. & I.R.O., who selected "Mineral Research" as the subject of his talk. The talk was well received by a large audience and was later published in the "Kalgoorlie Miner."

The School continued to provide the usual services to the public in addition to its teaching activities. During the year 404 samples were received from prospectors for assay and/or mineral determination. Once again more samples were submitted for gold assay than for anything else.

No new buildings were added during the year and only minor repairs were done on existing buildings. During the year approval was given for £23,500 to be spent on new buildings over a period of 2 years and in addition some £5,000 is to be spent on repairs and renovations.

The Advisory Committee met on eleven occasions. In September Mr. Harwood left Kalgoorlie and Mr. Kay, who succeeded Mr. Harwood as Warden, was appointed Chairman. At a special meeting members of the Committee thanked Mr. Harwood for his interest in the work of the Committee and in the School.

One Report of Investigation and 395 Certificates were issued during the year by the Kalgoorlie Metallurgical Laboratory. In addition numerous free assays were made for prospectors and others. The Senior Research Metallurgist continued as a member of the Chamber of Mines Metallurgical Committee.

The Students' Association was again very active during the year and is to be congratulated on the work done.

At the end of the year Mr. S. C. Parker retired from the position of Head of the Department of Engineering. Mr Parker served the School well over a long number of years and was held in high regard by his fellow staff members and by students.

(b) *Norseman.*

The number of enrolments during the year was 61, an increase of 6 by comparison with the previous year.

Twenty subjects were taught at Norseman, and use was again made of the Workshops of Central Norseman Gold Corporation for practical instruction in Workshops Practice, in Practical Electricity and in Welding.

Mr. J. T. Lewis was appointed to the Staff as Lecturer on 8/2/60 and seven part-time lecturers were employed during the year.

The Reg. Dowson Scholarships for 1960 were awarded to A. J. Hill and A. L. Benoit. The two students awarded Scholarships at the end of 1959 both completed a satisfactory year's work in 1960.

The Wesley Ladies Guild Prize, whch is awarded to the student obtaining the highest marks in Engineering Drawing 1, was awarded to R. Riher of Norseman.

The buildings and grounds are in good condition and adequate for the needs of the School.

The Advisory Committee, with D. L. Dutton as Chairman, continued to meet and to take an interest in the affairs of the School. It is with regret that I record the death of Mr. E. L. Walker, who was a member of the Advisory Committee since 1953.

(c) *Bullfinch.*

The number of students enrolled was 63, an increase of 15 by comparison with the previous year.

Mr. Lloyd and Mr. Browne continued as Officer-in-Charge and part-time Registrar respectively and seven part-time lecturers were employed.

Twelve subjects were taught at the School.

The buildings, including the quarters, are in satisfactory condition and adequate for the needs of the School.

The Advisory Committee did not meet during the year.

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 7,341 against 7,141 for the preceding year, showing in increase of 200 boilers after all adjustments.

Of the 7,341 useful boilers 2,113 were out of use at the end of the year, 4,336 thorough and 892 working inspections were made and 4,347 certificates were issued.

Permanent condemnations total 69 and temporary condemnations 14; 131 boilers were transferred beyond the jurisdiction of the Act.

The total number of machinery groups registered was 43,370 against 42,007 for the previous year, showing an increase of 1,363.

Inspections made total 28,627 and 6,659 certificates were granted.

The total miles travelled for the year, were 93,718 against 91,467 miles for the previous year, showing an increase of 2,251. The average miles travelled per inspection were 2.77 as against 2.56 miles per inspection for the previous year.

405 applications were received and dealt with for Engine Drivers and Boiler Attendants' certificates, and 381 certificates for all classes were granted as follows:—

Winding Competency (including certificates issued under Regulation 40 and Section 60)	25
First Class Competency (including certificates issued under Regulations 40 & 45, and Sections 60 & 63)	17
Second Class Competency (including certificates issued under Regulation 40 and Section 60 of the Act)	12
Third Class Competency (including certificates issued under Regulations 40 & 45 and Sections 60 & 63)	11
Locomotive & Traction Competency (including certificates issued under Regulation 40 & Section 60)	3
Diesel Locomotive "A" Class Certificates of Competency (including certificates issued under Regulation 40 & Sections 53 & 56)	3
Diesel Locomotive "B" Class Certificates of Competency (including certificates issued under Regulation 40 & Sections 53 & 56)	2
Internal Combustion Competency (including certificates issued under Regulation 40 and Section 60)	39

Crane & Hoist Competency (including certificates issued under Regulation 40 and Section 60)	185
Boiler Attendant Competency (including certificates issued under Regulation 40 & Section 60)	80
Copies	4
	381

The total Revenue from all sources during the year was £15,568 18s. 4d. as against £15,495 0s. 7d. in the previous year, showing an increase of £73 17s. 9.

The total Expenditure for the year was £38,253 2s. 11d. against £34,187 4s. 7d. for the previous year, showing an increase of £4,065 18s. 4d.

PART IX.—GOVERNMENT CHEMICAL LABORATORIES.

Two major administrative changes were made during 1960. The section of the staff dealing with sewage was moved to the new laboratory at the sewage treatment works at Subiaco and for administrative efficiency transferred to the Metropolitan Water Supply, Sewerage and Drainage Department as from the 1st February, 1960. In the reorganisation of the Department of Industrial Development it was decided to transfer the Bureau of Research and Development from that Department to our Laboratories and this transfer took effect from the 1st June, 1960. This is now designated the Engineering Chemistry Division, and with this the Laboratories now consist of 6 Divisions.

The total number of registrations during 1960 was 3,151 covering 12,020 samples. This was a marked decrease on the numbers for 1959, namely, 3,591 and 17,483 respectively. This large decrease was due to the transfer of the metropolitan sewage to the Metropolitan Water Supply, Sewerage and Drainage Department. While the number of samples received each year does give some measure of the activities of the Laboratories it does not completely describe the work. A major factor in this is the enormous variation in the amount of work associated with different samples.

Samples were allocated as shown hereunder:—

Agriculture, Forestry and Water Supply Division	4,999
Engineering Chemistry Division	5
Food, Drugs & Toxicology & Industrial Hygiene Division	4,262
Fuel Technology Division	146
Industrial Chemistry Division	83
Mineralogy, Mineral Technology & Geochemistry	2,563
Director	1
Total	12,059

Agriculture, Forestry and Water Supply Division.

The 344 samples of soils received was a considerable reduction on the number received in 1959 and was more comparable with the number received in 1958.

A series of 83 soils from stations in the vicinity of the proposed Ord River dam in the Kimberleys which had been sampled in 1944 and 1945 were analysed in detail to provide fundamental information about soils of this area.

The number of water samples received in 1960 was almost the same as 1959. There has been a gradual tendency over the past few years for the proportion of samples from Government Departments to increase, changing from about one third of the total water samples received in 1958 to about one half in 1960.

The majority of samples from Government Departments were received in connection with the routine examination of Canning Dam, Mundaring Weir, Serpentine Dam and Wellington Dam. Samples were also received from Northampton Town Water Supply and Broome Water Supply.

Investigations were made into the suitability of commercial domestic water softeners for softening excessively hard water.

Generally this year Department of Agriculture Fertiliser Inspectors have paid more attention to sampling fertilisers for the use of primary producers, and have not been so concerned about home garden fertilisers.

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

Engineering Chemistry Division.

Owing to the shortage of staff, and uncertain position in the Department of Industrial Development, which was in the course of reorganisation, only one original research project, viz. the upgrading of local ilmenite, was continued during the year. All other work listed in the report was done for outside interests.

The work done for these outside interests included the production of char from Collie coal, calcination of Bauxite and Dolerite, calcination of Pellets for production of lightweight aggregate for concrete, calcination of Galvanizing Residues, calcination of Zircon in the Rotary Kiln, and the production of Sponge Iron from low-grade iron ores.

Food, Drugs, Toxicology and Industrial Hygiene Division.

Most of the work carried out by this Division during 1960 consisted of chemical examinations for the Departments of Public Health, Police and Agriculture, as well as the Milk Board of Western Australia and the Swan River Conservation Board, but a wide variety of miscellaneous work was performed for other Government Departments and the general public.

A total of 361 samples of foods of various kinds was examined and 189 of these were of cows milk.

There was a marked increase in the number of samples received under the classification of Human Toxicology, 421 samples from 108 cases being submitted in connection with death from suspected poisoning.

A large number of blood-alcohol analyses were carried out for the Police Department in connection with traffic accidents or sudden death from various causes.

The number of samples received in connection with suspected poisoning of animals was less than usual, only 15 cases being submitted in 1960.

The considerable increase in the volume of industrial hygiene work which occurred in 1959 was maintained and 327 such samples were received and examined.

Samples were received and examined in connection with pollution surveys of the Swan River and Leschenault Inlet, Bunbury.

Fuel Technology Division.

146 samples of coal, wood, oil gas and miscellaneous were reported on during 1960. Two examinations of steam supply and boiler efficiency of an extensive nature were conducted in the course of which directive advice was given on boilers and fuel for institutional requirements which are under the Public Works Department's supervision.

Further work was done in connection with the flash-drying of ilmenite and flash calcining of gypsum.

Industrial Chemistry Division.

As in previous years, the work of this Division can be placed under three headings:—

(1) Technical enquiries.

(2) Physical and chemical testing in connection with developing projects and the examination of material failures.

(3) Research work.

In 1960 a total of 4,102 technical enquiries were received. Of these 1,416 were referred to specialists and at the end of the year 36 queries were still to be dealt with and 24 of these probably cannot be answered satisfactorily.

Physical and Chemical testing of 83 samples was carried out for various Government Departments and for the public.

Research work was done on some plastics and other materials.

Mineralogy, Mineral Technology and Geo-Chemistry Division.

In 1960 this Division handled 2,563 samples, over a thousand more than in the preceding year, and exceeding the total in any other post-war year.

This large increase was due mainly to two major iron-drilling programmes undertaken at Koolyanobbing and Mt. Goldsworthy.

Ninety specimens were added to the Division's Mineral Collection, bringing the total number of specimens to 2,615. Of these new specimens 13 were received from the Royal Ontario Museum in exchange for Western Australian specimens. All other additions to the collection were from within the State.

Most work on alloys and metals, as in previous years, was carried out at the request of metal merchants. The materials analysed included copper drillings, lead ingots, brass and white metal.

Samples received and examined included building materials, burnt lime, cement and concrete and aggregates.

Sixteen new localities for various minerals were recorded throughout the year and mineral determinations made.

A large number of minerals and ore specimens were submitted for identification and assay.

The Division participated in a programme initiated by the National Standards of Testing Authorities, one aim of which was to examine methods for the determination of phosphorous in low phosphorous cast iron.

PART X.–EXPLOSIVES.

Since May, 1960, about one half of the State's requirements of explosives have been railed direct to Kalgoorlie from Melbourne. The remainder have been shipped to Woodman's Point Explosives Reserve.

No new compositions appeared locally during the year. Acceptance of the ammonium nitrate-fuel oil admixtures was steady but not spectacular except in the geoseismic field.

Once again the greatest amount of explosives was used in gold mining which consumed 60.2 per cent. Geoseismic work accounted for 12.7 per cent., quarries 6.5 per cent., coal 5.2 per cent., base metals and pyrite 4.2 per cent. The remainder was used for public works, railways, timber and general.

This year the use of fibreboard cases in place of wooden cases for railage was introduced and waxless ended plugs were supplied to the mining industry.

The quality of explosives was well maintained and there was no evidence of defective manufacture.

Inspections were carried out as usual and no flagrant disregard for regulations came under notice.

With increasing road traffic, inspection of motor vehicles intended for casual or regular explosives conveyance assumed greater importance.

Some further work was done in connection with the heavy wax sealing on explosives cartridges which was suspected as an aggravating factor in carbon monoxide formation. Although the data was insufficient for expression on a quantitative basis, the new waxless ended plugs impressed the mining industry and will in future replace the fully waxed ones.

Several conferences were attended in the Eastern States concerning explosives and dangerous goods, and the opportunity taken to discuss other technical matters after the conferences closed.

The usual vigilance and inspection was observed regarding fireworks, but once again there is a public outcry to prohibit all fireworks.

PART XI.–MINERS' PHTHISIS ACT AND MINE WORKERS' RELIEF ACT.

The State Public Health Department, under arrangement 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, Phillips River, Peak Hill, Pilbara, West Pilbara, Murchison, East Murchison, Coolgardie, North Coolgardie, Yilgarn and Mt. Margaret Goldfields, the Northampton Mineral Field and Esperance, Outside Proclaimed Field.

Examinations under the Mine Workers' Relief Act during the year totalled 5,759, a decrease of 59 on last year's figure. Under the Mines Regulation Act a further 1,626 miners were examined, an increase of 175 over the number for 1959. Details of the results of these examinations are given in the Report of the Superintendent in Division IX of the Annual Report.

The amount of compensation paid during the year under the Miners' Pthisis Act totalled £12,734 1s. 10d. compared with £13,718 9s. 8d. for the previous year. The number of beneficiaries under the Act on the 31st December, 1960 was 114, being 9 ex-miners and 105 widows.

On the 19th September, 1960, Warden Arthur Edward Kay was appointed Government Member and Chairman of the Mine Workers' Relief Board vice-Warden Maurice Harwood, transferred.

PART XII.– CHIEF DRAFTSMAN.

There has been a further increase in all sections of the work of the branch again this year.

Three contract surveyors have been employed on the Department's surveys and in addition to normal surveys of tenements a special survey was undertaken in connection with blue asbestos holdings at Wittenoom Gorge.

The main mapping programme carried out included four maps of areas in the Pilbara Goldfield on 80 chains to an inch scale prepared; four 80 chains to an inch scale plans published; twelve twenty chains to an inch lithographs published; fifty-six plans prepared for the Geological Surveys. Many other plans and prints were prepared for the various activities of the Department.

The great number of public enquiries exemplified the increased interest in the mining industry generally.

General liaison was maintained with various Government Departments, private companies and the public.

STAFF.

Once again, I would like to take the opportunity of thanking all members of the staff both at Head office and at Outstations, for the loyal and efficient manner in which they have carried out their duties.

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.

At the time of writing this report I regret to record that in February 1961, Mr. Morgan, the Chief Coal Mining Engineer, was retired on account of ill-health, and that on the 23rd April, he died. Mr. Morgan was a very capable officer who carried out his duties conscientiously.

On the 15th May, Mr. H. A. Ellis retired from the position of Government Geologist. Mr. Ellis was held in high regard professionally by all. During his term as Government Geologist he carried out the duties of his office most efficiently and his loyalty to the Department generally and the Geological Survey in particular was of the highest order.

(Sgd) A. H. TELFER,
Under Secretary for Mines.

Department of Mines,
Perth.

DIVISION II

Report of the State Mining Engineer for the Year 1960

Under Secretary for Mines:

The Annual Report on the activities of the Branch for 1960 has been prepared by the Assistant State Mining Engineer.

The only staff change was caused by the resignation of Assistant Inspector Shenton and the subsequent appointment of Mr. A. J. Murphy to the vacant position.

The figures for accidents and particularly fatal accidents are disappointing particularly when compared with the very good results for the previous year.

Two accidents each resulted in the death of two men and there were two fatal accidents in quarries in the Metropolitan Area.

Every effort has been made to prevent those practices which are regarded as dangerous.

It is pleasing to note that several quarries have split their faces into benches and so reduced one of the major risks.

There has been little change in the gold mining industry. Sons of Gwalia and Great Western Consolidated are having some trouble to find sufficient ore of millable grade. A new mine is expected to come into production at Widgiemooltha in the near future and there have been some good finds by prospectors.

Mineral production is slightly up, the fall in production of asbestos and manganese being balanced by significant increases in Ilmenite and Iron. Supplies of carbonate copper ore for use as fertilizer are becoming increasingly difficult to obtain.

Although no production of magnesite is recorded a considerable tonnage of ore has been broken and screened ready for export.

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.

10th August, 1961.

State Mining Engineer:

Mining activities for the year 1960 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.

On the 5th February, Assistant Inspector E. F. Shenton resigned to accept a staff position with Great Boulder Gold Mines and the vacancy was filled by the appointment of Mr. A. J. Murphy on the 9th May, 1960.

Accidents.

Fatal and serious accidents, in metal mines and quarries, reported to the Department are shown below. The corresponding figures for 1959 are shown in brackets.

There were 13 (1) fatal and 467 (449) serious accidents.

In gold mines there were 8 (1) fatal and 403 (402) serious accidents. The number of men employed in such mines was 5,430 (5,769). The accident rate per 1,000 men was thus 1.47 (0.17) for fatal accidents and 74.22 (69.68) for serious accidents.

Two men were killed by falls of stone in quarries. One man was killed in a fall at an asbestos mine and two men were killed in an explosive accident in a copper mine.

Oil exploration companies, employing 87 men in the field, reported 2 serious and 12 minor accidents.

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 employed classified according to mineral mined.

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

TABLE A.

Serious Accidents for 1960.

Class of Accident	West Kimberley	Pilbara	West Pilbara	Murchison	East Murchison	North-ampton	Mount Margaret	North Coolgardie	East Coolgardie	Coolgardie	Yilgarn	Dundas	Phillips River	South-West	Total
Major Injuries—Exclusive of Fatal—															
Fractures :															
Head	....	....	....	....	....	1	....	....	1	....	1	....	....	....	3
Shoulder	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Arm	....	....	....	....	....	....	....	....	2	....	1	1	....	....	4
Hand	....	....	....	....	....	....	....	....	3	....	....	....	....	....	3
Spine	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1
Rib	....	....	....	....	1	....	....	2	3	....	1	2	2	....	11
Pelvis	....	....	....	....	....	1	....	....	1	....	....	....	....	....	2
Thigh	....	....	....	....	....	....	....	....	2	....	....	....	....	....	2
Leg	....	....	....	2	....	....	....	....	4	....	....	1	1	....	8
Ankle	....	....	....	....	....	....	....	....	3	....	....	....	....	....	3
Foot	....	....	2	....	1	....	....	1	6	....	....	....	....	....	11
Amputations :															
Arm	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Hand	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Finger	....	....	....	....	1	....	....	....	5	....	....	....	....	....	6
Leg	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Foot	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Toe	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Loss of Eye	....	....	....	....	....	....	....	1	....	....	....	....	....	....	1
Serious Internal	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Hernia	....	....	1	....	....	....	1	....	5	....	1	1	....	2	11
Dislocations	....	....	....	....	....	....	1	....	....	....	....	....	....	....	1
Other Major	....	....	....	....	....	....	....	....	3	....	....	....	....	1	4
Total Major	....	....	2	1	3	2	1	1	4	3	39	....	4	7	3	3	73
Minor Injuries—															
Fractures :															
Finger	....	....	....	2	....	....	....	....	4	....	11	....	1	1	2	1	22
Toe	....	....	....	....	....	....	....	....	3	....	5	....	....	....	....	....	8
Head	....	....	....	....	....	....	....	....	....	....	3	....	....	....	2	....	5
Eyes	....	....	....	....	....	1	....	....	1	1	9	....	....	....	2	....	14
Shoulder	....	....	....	....	....	....	....	....	2	....	5	....	3	....	3	....	13
Arm	....	....	....	1	....	....	....	1	2	....	21	....	2	....	1	....	28
Hand	....	....	....	....	1	3	....	1	8	4	68	3	6	5	9	....	108
Back	....	....	....	1	....	1	....	....	3	1	36	1	8	2	4	1	58
Rib	....	....	....	....	....	....	....	....	1	....	3	....	....	....	....	....	4
Leg	....	....	....	1	....	1	....	....	2	1	42	2	9	6	7	....	71
Foot	....	....	....	....	....	2	....	....	....	1	30	....	5	3	2	....	43
Other Minor	....	....	....	....	1	....	1	....	1	1	14	....	1	....	1	....	20
Total Minor	....	....	5	1	2	8	....	2	27	9	247	6	35	17	33	2	394
Grand Total	....	....	7	2	5	10	1	3	31	12	286	6	39	24	36	5	467

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

TABLE B

Minerals other than Coal and Oil

Mineral	Men Employed	Accidents		
		Fatal	Serious	Minor
Asbestos	345	1	5	26
Beryl	51	....	....	....
Copper	209	2	37	122
Gold	5,430	8	403	1,369
Ilmenite	119	....	....	....
Iron Ore	257	....	7	31
Lead	33	....	3	6
Manganese	77	....	....	....
Pyrite	105	....	7	12
Tin	43	....	....	....
Other Minerals	57	....	....	....
Rock Quarries	301	2	5	9
Totals	7,027	13	467	1,575

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	....	....	....	....	....	....	....	....	....	3	....	4	....	7
Pilbara	....	....	....	....	....	....	....	....	....	....	....	2	....	2
West Pilbara	....	....	....	1	....	....	....	....	1	3	....	1	1	5
Ashburton	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Peak Hill	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Gascoyne	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Murchison	....	....	....	....	....	....	....	....	....	6	....	4	....	10
East Murchison	....	....	....	1	....	....	....	....	....	....	....	....	....	1
Yalgoo	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Northampton	....	....	....	1	....	1	....	....	....	1	....	....	....	3
Mount Margaret	....	....	....	3	....	....	....	....	....	19	....	9	....	31
North Coolgardie	....	....	....	1	....	....	....	....	....	10	....	1	....	12
Broad Arrow	....	....	....	....	....	....	....	....	....	....	....	....	....	....
North-East Coolgardie	....	....	....	....	....	....	....	....	....	....	....	....	....	....
East Coolgardie	....	....	2	22	2	4	....	....	1	224	....	36	5	286
Coolgardie	....	....	....	2	....	....	....	....	....	3	....	1	....	6
Yilgarn	....	....	....	2	2	1	....	....	....	30	....	6	2	39
Dundas	....	....	....	4	....	1	....	....	1	13	....	6	1	24
Phillips River	2	....	....	1	....	3	....	....	....	26	....	6	2	36
Greenbushes	....	....	....	....	....	....	....	....	....	....	....	....	....	....
South-West	....	....	2	1	....	....	....	....	....	....	....	4	2	5
Total for 1960	2	....	4	39	4	10	....	....	3	338	....	80	13	467
Total for 1959	....	1	....	37	1	10	....	....	....	291	....	110	1	449

FATAL ACCIDENTS

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

Name and Occupation	Date	Mine	Details and Remarks
Rutherford, Arnold Thomas (Machine Miner)	5/1/60	Lake View Shaft, Lake View and Star Ltd., Fimiston	Crushed by a fall of rock whilst working in the 2,100 ft. level West Lode East Branch stope.
Sloper, Donald Frederick (Hoist Driver)	Injured 20/1/60 Died 22/1/60	Regent Shaft, Central Norseman Gold Corporation, Norseman	Suffered multiple injuries when struck by the unlighted leading truck of an ore train on the 1,600 ft. level.
Haning, Francis Samuel (Machine Miner)	15/2/60	Nevoria Mine, Great Western Consolidated	Died from multiple injuries received when he lost control of a stoping machine he was holding in an ascending cage.
Lukstins, Martens (Quarryman)	25/3/60	Australian Blue Metal Ltd., Gosnells	Lukstins was killed when he fell about 80 feet down the face of the quarry. He was either hit by stone which fell from above or lost his grip on his rope whilst dodging the falling stone.
Sadler, Robert Frederick (Mechanical Loader Operator)	22/4/60	Perseverance Shaft, Gold Mines of Kalgoorlie (Aust.) Ltd., Fimiston	Suffered multiple injuries when he fell about 50 feet down the No. 10 level ore pass. He was in the pass freeing hung up ore when the ore ran and the rope attached to his safety belt broke.
Beattie, James (Machine Miner)	27/4/60	Ivanhoe Shaft, Lake View and Star Ltd., Fimiston	Struck by a fall of rock whilst barring down in the No. 30 level 10 lode leading stope.
Ryan, Edward (Shift Boss)	30/5/60	Pilot Shaft, Southern Cross, Great Western Consolidated	Died from head injuries received when he was ascending in the skip of the inclined shaft. It is thought that his head was caught between the lip of a chute and the back of the skip.
Volner, Louis (Machine Miner)	2/6/60	Colonial Mine, Australian Blue Asbestos Ltd., Wittenoom	Suffered head injuries when he fell about 50 feet down the No. 5 level 51 south chute.
McKay, Arthur Stanley (Pass Runner); O'Reilly, Patrick Joseph (Timberman)	24/8/60	Horseshoe No. 2 Shaft, Lake View and Star Ltd., Fimiston	Four men were ascending in a cage in which there was also timberman's gear. About the 2,000 ft. level there was a bump and two men plus the equipment were dragged from the cage. At the time of the accident, one side of the cage was not fitted with a gate.
Young, Ronald Henry (Machine Miner); Calvey, Patrick (Machine Miner)	12/10/60	Elverdton Shaft, Ravensthorpe Copper Mines, Ravensthorpe	Both men were killed in an explosive accident while lighting fuses on the No. 5 level north drive face. It would appear that cartridges or master fuses were not used and that the men had trouble in lighting wet fuses and stayed too long at the face after igniting the first fuse.
Papadopoulos, Aristides (Quarry Owner)	16/12/60	Limestone Quarry, Burns Beach Road, Wanneroo	Suffered head injuries when he was buried under a fall of stone from a previously undercut face.

WINDING MACHINERY ACCIDENTS.

Eighteen accidents involving winding machinery were reported during the year and are briefly as follows:—

Fatal.—(3) Four men lost their lives in three accidents which occurred during hoisting operations. These accidents have been summarised under the heading of fatal accidents.

Overwinds.—(4) An overwind occurred on the 24th March at the Imperial Shaft of Lake View and Star Ltd. Levels were being cleaned up and due to a misunderstanding of signals the driver declutched the loaded south cage which started to move downwards. To assist the brake, the driver left his stand and attempted to stop the south drum by bearing heavily against it with a piece of timber. Before leaving his stand the driver failed to return the control lever to the neutral position and left power on causing the north cage to become suspended in the thimble.

On the 2nd May the south skip of Timoni Gold Mine was overwound when the driver entered the tip too fast. The detaching hook operated and no damage resulted.

On the 6th July at the Nevoria shaft of Great Western Consolidated the driver raised the east cage too far when clearing the chairs and an overwind resulted. No damage resulted.

At the Timoni mine on the 18th July a faulty micro switch allowed the south skip to overshoot the bin tipping tracks and enter the overwind position.

Cage Hung Up.—(1) A mechanical loader was being raised at Hill 50 N.L. on the 17th December when it was dislodged and caught between the cage and the No. 1 level plat. The attachment between the rope and cage was broken but the grippers operated and allowed the cage to fall only 1¾ inches—new shackles, chains, safety hook and rope were fitted after this accident.

Cage Out of Control.—(1) The winding engine ran out of control, at Fraser's shaft of Great Western Consolidated N.L. on the 16th September when the brakes failed to hold an empty cage which was out of balance but in gear. The cage hung up above the No. 6 plat. and 1050 feet of rope, which broke away from the drum, fell down the shaft and onto the cage. Some damage was done to shaft timbers.

Derailments.—(4) Central Norseman Gold Corporation reported four derailments. It is thought that spillage caused these accidents which occurred in the Regent and Royal shafts. No personal injury resulted from any of these accidents.

Mechanical Failures.—(4) The main drum crank shaft of the winder at the Enterprise Shaft of Gold Mines of Kalgoorlie (Aust.) Ltd. broke during shaft maintenance operations on the 23rd January. No other damage resulted.

A power failure at the Lake View Shaft of Lake View and Star Ltd. on the 9th March caused a mishap. The power was cut due to a failure in the overload circuit of the main oil circuit breaker. The power failed when one rope was on the first crossover on the drum and the sudden application of the brakes caused the rope to flick over the flange and wedge between the drum and the concrete foundation. The damaged rope was replaced by a new rope.

About one third of a flange fell off the winder drum at the Timoni mine on the 10th May. Investigation showed that the flange had been cracked over a length of 7½ inches for some time but paint and oil hid the defect.

The failure of a cheek plate of the winder on the Pilot mine of Great Western Consolidated N.L. caused the rope to slip from the drum and damage the clutch and depth indicator mechanisms.

MISCELLANEOUS.—(1). The north skip in the Ivanhoe Shaft of Lake View and Star Ltd. became jammed in the shaft on the 30 December. The skips were geared into the 3,100 ft. level and it was decided to take the south skip up into the kickup to observe its action in the tip. In doing this the north skip went below the 3100 ft. level and actually went below the shaft skids. When the south skip was lowered, the ascending north skip pulled seven shaft sets out of position before the winder was stopped. The skip suffered only minor damage and the rope was cut and reshod.

PROSECUTIONS.

It was found necessary to prosecute two persons during the year. Both cases were successfully conducted by our Inspectors.

A miner was fined ten pounds for storing fuses with detonators attached in the same container as other explosives.

A miner was fined ten pounds for boring in a face which contained unexploded fracteur.

SUNDAY LABOUR PERMITS.

Two applications for permission to employ labour on Sundays were received and granted. Central Norseman Gold Corporation N.L. made both applications which covered work in connection with the construction of the No. 19 plat. off the Regent shaft and its connection to the Crown Reef workings.

AUTHORISED MINE SURVEYORS.

The Survey Board issued two certificates during the year.

CERTIFICATES OF EXEMPTION.

(Section 46).

Nine certificates were issued as compared with four in 1959.

PERMITS TO FIRE OUTSIDE PRESCRIBED TIMES.

(Regulation 51).

One permit was issued.

Central Norseman Gold Corporation N.L. was permitted to fire outside the recognised firing times in the Regent Shaft No. 29 level west crosscut. This was a major heading affecting the future of the mine and the return air from the crosscut did not interfere with other mining operations.

PERMITS TO RISE.

(Regulation 64).

Seventy permits were issued and they related to 104 rises totalling 11,686 feet. Thirty-eight rises were constructed using the rising gig method, and two rises followed boreholes.

ADMINISTRATIVE.

Mines Regulation Act.—The *Government Gazette* (No. 66) of 1st August, 1960, includes an amendment to Regulation 14 which covers wages of Workmen's Inspectors.

Mining Act.—Regulation 55 subregulation (1) was amended, by notice in the *Government Gazette* of the 12th February, to include Talc in the list of minerals that a miner may peg as a mineral claim.

The *Government Gazette* of the 31st May contains an amendment to Regulation 112 which extends the time before labour conditions have to be complied with on a gold mining lease.

The area known as "The Island" outside the Port Hedland Townsite was exempted from occupation for mining by a notice in the *Government Gazette* of the 29th July.

Ilmenite producers were exempted from paying royalties, for the year, by an amendment to Regulation 205F which appeared in the *Government Gazette* of the 30th August.

Amendments to Regulations, appearing in the *Government Gazette* of the 28th September, deal with fees payable in the Warden's Court.

Mine Workers' Relief Act.—No amendments were made to this Act during the year.

VENTILATION.

Inspections of all major metalliferous mines throughout the State have been made at regular intervals. Air flow, dust counts and temperatures

were recorded at all working places both surface and underground. Regular inspections of underground workings during afternoon shift were introduced during the year. Investigations, carried out by Gold Mines of Kalgoorlie (Aust.) Ltd. staff and our own officers, proved the effectiveness of the air-water blast as compared with compressed air blast in reducing the dust hazard after firing. There was also a quicker dispersion of fumes with the air-water blast operating.

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

Dust Samples from	No. of Samples	Samples giving over 1,000 p.p.c.c.	Average Count
Development	390	5	181
Stoping	720	9	177
Levels	326	9	189
Surface	86	5	272
Totals	1,522	28	186

The average dust count was slightly higher than the 170 p.p.c.c. recorded in 1959. This increase would have been caused by the high dust counts recorded at Wittenoom and in the Kalgoorlie mines during afternoon shift.

It is with pleasure that I report that for the fourth year in succession there has not been a fatal accident due to fumes of explosives. Twenty-four minor fuming accidents were reported and all were investigated. A report on fumes, written by Mr. J. M. Faichney, District Inspector of Mines, appears as an appendix to this report.

Two occurrences of methane gas were reported during the year; one in the 2,800 ft. level East crosscut off the Enterprise shaft and the other at the 1,100 level diamond drill site of the Paringa South shaft.

No major alterations were made to primary ventilation circuits in the major mines during the year, but a start has been made to shift the Jeffrey Aerovane fan from the 2,977 ft. level of Horseshoe No. 2 shaft to the 3,140 level of Ivanhoe. With the continued expansion of hydraulic fill in stopes more attention is being paid to ventilation circuits and increased air flows to reduce the humidity in the workings. There has been an increase in the use of electric driven fans underground for secondary ventilation. Larger diameter ducting is gaining favour especially in long headings where both blowing and exhaust systems are in use.

Aluminium Therapy.—This prophylactic treatment with aluminium powder was continued throughout the year. In some change rooms the dispersal of the powder has become rather haphazard due no doubt to the waning interest of both men and management. Differences of opinion, between medical men, on the effectiveness of the treatment has not assisted the situation.

GOLD MINING.

The ore treated during the year amounted to 3,056,445 tons as compared with 2,959,202 tons in the previous year. Gold recovered amounted to 869,966 fine ounces as compared with 860,969 fine ounces for 1959.

Grade of ore mined was slightly lower, recovery being 5.69 dwts. per ton as against 5.82 dwts. per ton for 1959.

The calculated value of the gold produced was £13,593,462, which included £237 distributed by the Gold Producers' Association from the sale of 76,805 fine ounces of gold at an average premium of 1.35d. per fine ounce.

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

There was a decrease in the number of men employed in the industry, from 5,769 in 1959 to 5,430 in 1960. Average production of ore per man was 563 tons valued at 88.95 shillings per ton as compared with 513 tons valued at 90.93 shillings per ton for 1959. Gold recovery per man averaged 160.21 fine ounces as compared with 149.24 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 1960 by Goldfields.
Table "F"—Classification of Gold Output, 1956-1960.
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.
1929	628,400	372,064	1,580,426	50·30	4,108	84·96	11·34
1930	645,344	419,767	1,874,484	58·09	4,284	89·33	13·01
1931	982,163	518,045	3,042,019	61·54	5,961	117·44	10·55
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

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	18	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18
West Kimberley	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pilbara	385	8	165	2	404	....	....	1	1,990	....	....	....	....	....	....	....	....	....	....	2,944
West Pilbara	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Ashburton	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Peak Hill	2	7	206	1	293	....	....	....	....	....	....	....	....	....	....	....	....	....	....	501
Gascoyne	141	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	141
Murchison	172	13	445	6	675	....	....	....	....	1	7,690	....	....	....	....	1	82,988	....	....	91,970
East Murchison	168	3	78	1	135	....	....	....	....	....	....	....	....	....	....	....	....	....	....	381
Yalgoo	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Mount Margaret	1,004	3	18	1	101	....	....	....	....	....	....	....	....	1	32,983	....	....	....	....	34,106
North Coolgardie	1,376	15	411	5	1,886	....	....	1	1,986	....	....	1	14,591	....	....	....	....	....	....	20,250
Broad Arrow	653	6	232	3	658	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1,543
North-East Coolgardie	65	1	76	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	141
East Coolgardie	956	18	546	2	529	1	520	1	2,257	....	....	....	....	....	....	1	87,841	3	439,332	531,981
Coolgardie	1,057	14	390	1	412	2	1,402	....	....	1	9,081	....	....	....	....	....	....	....	....	12,342
Yilgarn	324	12	260	9	2,476	....	....	3	4,195	....	....	....	....	....	....	1	63,434	....	....	70,689
Dundas	107	3	157	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	101,291	101,555
Phillips River	18	....	....	....	....	....	....	1	1,313	....	....	....	....	....	....	....	....	....	....	1,331
State Generally	54	1	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	66
Totals	6,507	104	2,996	31	7,569	3	1,922	7	11,741	2	16,771	1	14,591	1	32,983	3	234,263	4	540,623	869,966

TABLE F

Classification of Gold Output, 1956–1960

Range of Output	1960			1959			1958			1957			1956		
	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	4	540,623	62·1	4	517,525	60·1	4	547,565	62·6	3	428,334·08	50·5	2	289,315	35·5
50,001–100,000	3	234,263	26·9	3	238,014	27·6	3	238,049	27·2	4	302,421·19	35·6	5	377,203	46·3
40,001– 50,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30,001– 40,000	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	....	....	....	....	....	....	....	....	....	....	....	....	1	27,376	3·4
10,001– 20,000	1	14,591	1·7	3	41,782	4·9	2	27,561	3·2	3	38,930·24	4·6	4	63,742	7·8
5,001– 10,000	2	16,771	1·9	....	....	....	....	....	....	2	13,499·79	1·6	3	21,112	2·6
4,001– 5,000	....	....	....	....	....	....	....	....	....	....	....	....	1	4,045	0·5
3,001– 4,000	....	....	....	....	....	....	....	....	....	2	6,318·31	0·7	1	3,906	0·5
2,001– 3,000	1	2,257	0·3	1	2,217	0·3	1	2,942	0·3	2	5,160·59	0·6	2	5,376	0·7
1,001– 2,000	6	9,484	1·1	5	7,221	0·8	6	9,937	1·1	1	1,864·91	0·2	3	4,074	0·5
501– 1,000	3	1,922	0·2	5	4,219	0·5	5	3,617	0·4	6	4,205·13	0·5	5	3,798	0·5
101– 500	31	7,569	0·9	26	5,511	0·6	30	6,117	0·7	31	6,595·81	0·8	33	7,817	0·9
Up to 100	104	2,996	0·4	121	3,079	0·4	104	2,690	0·3	117	3,284·65	0·4	112	2,893	0·4
Sundry Claims, etc.	....	6,507	0·7	....	7,932	0·9	....	6,072	0·7	....	8,082·88	0·9	....	2,960	0·4
Totals	156	869,966	100·0	169	860,969	100·0	156	874,819	100·0	172	849,740·67	100·0	172	813,617	100·0

TABLE G

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

Mine	1960			1959			1958			1957			1956		
	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
Boulder Perseverance Ltd.	....	....	....	....	....	....	Now included in Gold Mines of Kalgoorlie (Aust.) Ltd.						122,397	18,354	3·00
Callion (New Coolgardie G.M. N.L.)	....	....	....	....	....	....	....	....	....	....	....	....	8,305	4,045	9·74
Central Norseman Gold Corporation N.L.	190,679	101,291	10·62	182,996	101,203	11·06	182,822	108,176	11·83	168,846	91,913	10·89	160,961	89,039	11·06
Eclipse Gold Mines N.L.	6,969	7,690	22·07	7,514	12,048	32·07	2,840	2,942	20·72	....	....	....	....	....	....
Gold Mines of Kalgoorlie (Aust.) Ltd.	569,116	150,319	5·28	496,981	134,002	5·39	519,168	147,310	5·67	523,617	147,341	5·63	222,456	61,217	5·50
Great Boulder Pty. Gold Mines Ltd.	448,398	123,875	5·52	454,474	124,041	5·46	488,761	134,307	5·50	459,734	128,928	5·61	428,571	122,313	5·71
Great Western Consolidated N.L.	390,353	63,434	3·25	393,252	67,100	3·41	459,119	76,641	3·34	462,799	77,079	3·33	444,185	76,279	3·43
Hill 50 Gold Mines N.L.	156,844	82,988	10·58	155,471	81,907	10·54	133,081	77,209	11·60	107,128	83,193	15·53	106,479	83,720	15·72
Kalgoorlie Enterprise Mines Ltd.	....	....	....	....	....	....	Now included in Gold Mines of Kalgoorlie (Aust.) Ltd.						66,744	12,839	3·85
Lake View and Star Ltd.	683,950	165,032	4·83	669,927	162,576	4·85	665,998	161,899	4·86	664,895	159,811	4·81	657,105	158,487	4·82
New Coolgardie G.M. N.L.	....	....	....	....	....	....	Now included in Gold Mines of Kalgoorlie (Aust.) Ltd.						32,560	16,109	9·90
North Kalgurli (1912) Ltd.	372,053	87,841	4·72	361,344	89,007	4·93	345,983	84,199	4·87	337,888	75,327	4·46	351,374	66,948	3·81
South Kalgurli Consolidated Ltd.	....	....	....	....	....	....	Now included in Gold Mines of Kalgoorlie (Aust.) Ltd.						70,631	15,375	4·35
State Batteries	39,219	14,704	7·50	39,048	14,700	7·53	41,806	13,498	6·46	42,837	15,813	7·38	35,740	13,218	7·40
The Sons of Gwalia Ltd.	138,618	32,983	4·76	135,932	33,469	4·92	137,377	30,269	4·41	137,934	31,043	4·50	113,598	27,376	4·82
Timoni (Moonlight Wiluna G.M. Ltd.)	29,880	14,591	9·77	32,229	15,879	9·85	31,838	15,746	9·89	31,445	15,781	10·04	30,754	17,174	11·17
Total	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	2,851,860	782,493	5·49
Other Sources (excluding large Retreatment Plants)	30,366	12,613	8·31	30,034	12,051	8·02	12,279	10,623	17·30	13,888	10,072	14·50	18,413	14,784	16·06
Total (excluding large Retreatment Plants)	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	2,870,273	797,277	5·56
Golden Horseshoe Sands Retreatment	....	....	....	....	....	....	....	....	....	....	....	....	....	5,003	....
Lake View and Star Retreatment	....	9,187	....	....	9,844	....	....	8,989	....	....	9,934	....	....	8,515	....
State Batteries Tailing Treatment	....	3,418	....	....	3,142	....	....	3,011	....	....	3,506	....	....	2,822	....
Grand Total	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	2,870,273	813,617	5·67

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.	9	2,451	642	1,302	19,369	23,773
	Hill 50 Eclipse	....	594	393	796	661	2,444
Mount Margaret	Sons of Gwalia	....	2,168	496	2,379	9,545	14,588
North Coolgardie	Timoni	128	847	585	61	1,164	2,785
East Coolgardie....	Lake View and Star Ltd.	....	19,765	2,862	5,243	20,434	48,304
	Great Boulder Pty. Gold Mines Ltd.	166	12,522	1,005	3,623	10,701	28,017
	North Kalgurli (1912) Ltd.	....	12,201	1,199	2,092	20,182	35,674
	Gold Mines of Kalgoorlie (Aust.) Ltd.	....	19,199	5,992	5,267	39,469	69,927
	Haoma	....	300	8	30	1,226	1,564
Coolgardie	Gold Mines of Kalgoorlie (Aust.) Ltd.	....	1,794	369	758	2,437	5,358
	Paris Gold Mine	150	701	294	470	4,966	6,581
Yilgarn	Great Western Consolidated N.L.	....	5,537	1,244	1,443	7,645	15,869
	Radio	....	205	48	50	....	303
Dundas	Central Norseman Gold Corporation N.L.	....	6,788	3,385	3,218	42,771	56,162
	Total in Gold Mines	453	85,072	18,522	26,732	180,570	311,349
Asbestos—							
West Pilbara	Australian Blue Asbestos	....	2,911	290	1,070	71	4,342
Pyrite—							
Dundas	Norseman Gold Mines N.L.	....	....	....	76	....	76
Copper—							
Phillips River	Ravensthorpe Copper Mines N.L.	101	1,382	97	458	89	2,127
Pilbara	Copper Hills Copper Mine	....	137	....	201	1,734	2,072
	Total in Copper Mines	101	1,519	97	659	1,823	4,199
Lead—							
Northampton	Gurkha	....	190	....	112	....	302
	Kathleen Hope	33	140	4	80	....	257
	Total in Lead Mines	33	330	4	192	....	559
Iron Ore—							
West Kimberley	Australian Iron and Steel	....	....	....	....	1,074	1,074
	Total in All Mines	587	89,832	18,913	28,729	183,538	321,599

OPERATIONS OF THE PRINCIPAL MINES.

EAST COOLGARDIE GOLDFIELD.

The total ore treated in this goldfield amounted to 2,069,164 tons with a recovery of 531,981 fine ounces of gold at an average of 5.14 dwts. per ton. This production was equal to 61.1 per cent. of the gold production for the State. In the previous year 1,970,250 tons of ore averaging 5.18 dwts. were treated for a recovery of 510,382 fine ounces of gold.

There was very little activity in the *Bulong District,* the total production being 35 fine ounces from the treatment of 386 tons of ore.

In the *East Coolgardie District* 531,946 fine ounces were recovered from the treatment of 2,068,778 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 683,950 tons of ore for a return of 165,032 fine ounces of gold at an average of 4.83 dwts. was the State's leading producer. Retreatment of tailings yielded an additional 9,187 fine ounces.

The previous year's production was 162,576 fine ounces from the treatment of 669,927 tons plus 9,844 fine ounces from tailings retreatment.

Ore reserves are listed at 3,548,000 short tons of an average grade of 4.84 dwts.

Some changes in mining methods were introduced on the western group of the Lake View and Star. New stopes below the 2,000 ft. level are now mined as flat back stopes and hydraulically filled with deslimed tailings. Existing sand filled rill and step stopes will continue as such but indications are that future new stoping will be by the flat back cut and fill method. Slime lines have been placed in the Ivanhoe, Chaffers and Horseshoe No. 2 shafts, with the necessary horizontal connections to the stoping blocks. A desliming plant for the preparation of a fill product from mill tailings was also installed.

The Internal shaft off the 2,300 ft. level Lake View shaft was unwatered and repaired. Development work is now progressing in favourable ore channels on the 26 level.

Gold Mines of Kalgoorlie (Aust.) Ltd. produced 150,319 fine ounces from the treatment of 569,116 tons at an average recoverey of 5.28 dwts. per ton. The Kalgoorlie group of mines produced 141,238 ounces from 556,247 tons with an average recovery of 5.1 dwts. per ton. The remainder of production came from the Bayley's mine at Coolgardie.

Total ore reserves of the company are stated as 1,287,000 tons at 5.8 dwts. per ton.

Virtually all stoping operations off the Perseverance shaft have now been changed over to flat back cut and fill. The fill, deslimed tailings, is hydraulically placed in the stopes. Circular steel ore passes together with ball and chain chutes are in exclusive use in these stopes. The ore is scraped into these passes using electric scraper hoists pulling a 48 inch scraper hoe.

The sand filling of empty shrink stopes in the upper workings continues. It is estimated that some 150,000 tons of sand have been placed in the Perseverance to stabilise the upper levels.

In the Paringa-Iron Duke section, development in the Federal lode has revealed lengths of ore up to 140 feet on the No. 7 level and smaller blocks have been located on cross lodes.

On the bottom or No. 28 level of the Enterprise numerous lodes have been developed, the most noteworthy being the Australia lode which was previously worked in the upper levels on the South Kalgurli and Perseverance.

Great Boulder Pty. Gold Mines Ltd. treated 448,398 tons of ore for a recovery of 123,875 fine ounces of gold, average recovery being 5.52 dwts. per ton. During the previous year 454,474 tons yielded 124,041 fine ounces at an average grade of 5.46 dwts. per ton.

Mine ore reserves are 2,027,400 short tons at 5.62 dwts. per ton. The internal shaft from the 2,950 level was sunk a further 166 feet to 185 feet below the 3,550 foot plat. Development from the 3,250 level has proved extensions of known lodes at depth.

Production of ore is still in the ratio of 50 per cent. from cut and fill stopes and 50 per cent. from shrink stopes. No major changes in mining methods were introduced during the year but improvements were made to slime water disposal after stope filling operations.

The conversion of the Hamilton shaft winding engine from steam to electric power was completed on the 4th April. In the power generating plant, storage tanks, heating and pumping units with the necessary purification and clarification units were installed, and two engines were converted to use heavy oil fuel.

North Kalgurli (1912) Ltd. treated 372,053 tons of ore for a recovery of 87,841 fine ounces of gold at an average recovery of 4.72 dwts. per ton. In the previous year 89,007 ounces were recovered from 361,344 tons of ore.

Development on known ore channels and diamond drill intersections has maintained ore reserves at a satisfactory figure. Completed during the year were 12,201 feet of driving, 1,199 feet of crosscutting, 1,916 feet of winzing, 176 feet of rising and 20,182 feet of diamond drilling.

No new major items of plant were installed during the year.

Kalgoorlie Southern Gold Mines N.L.—Diamond drilling exploration south of the Golden Mile was continued throughout the year. Hole No. SE.12 was advanced 5,531 feet to 5,599 feet. Some short scout drilling holes brought the total footage for the year to 6,151 feet.

The *Rosemary* mine at *Mount Monger* produced 2,257 fine ounces of gold from 1,506 tons of ore. The ore was won from a quartz reef 1 to 4 feet in width and striking 30-40 degrees west of north and dipping steeply to the east. This ore body was discovered west of the main reef on the 200 foot level.

The *Daisy* mine at the same centre produced 520 ounces from 606 tons. All of this ore was treated at W. Lydiate's mill at the mine.

The *Mount Monger Mining Syndicate* which has been mining remnants of ore left in the Haoma mine, obtained 353 fine ounces of gold from the treatment of 522 tons of ore. It is reported that a favourable new ore channel has been located near the Milano shaft.

DUNDAS GOLDFIELD.

The production of 101,555 fine ounces of gold from the treatment of 191,538 tons of ore represented 11.7 per cent of the State's total production. In the previous year 183,564 tons of ore yielded 101,643 fine ounces.

Central Norseman Gold Corporation treated 190,679 tons for a recovery of 101,291 ounces. Gold recovery was at a rate of 10.62 dwts. per ton which was slightly lower than the previous year's grade of 11.1 dwts. per ton when 182,996 tons yielded 101,203 ounces.

Estimated ore reserves are 504,000 tons at 9.15 dwts. per ton.

The main ore supplies came from the Regent, Princess Royal, and Crown shafts. Very little ore is left in the Regent workings where most of the work is concentrated on the removal of pillars. In the Princess Royal mine much of the ore is won from stripping areas that have previously been stoped. The future of the company seems linked with the Crown reef where intensive development on the No. 16 level has included five winzes being sunk to the No. 22 level. The mining programme of the No. 22 level includes driving, stope preparation, and the start of winzes to the No. 25 level.

Encouraging returns were obtained from *Beete.* Battaglia and Party crushed 67 tons for a return of 66 fine ounces. This ore came from sinking the shaft from 120 to 200 feet and driving some 50 feet. At *Eldridges Find* 84 ounces were obtained from 86 tons of ore.

MURCHISON GOLDFIELD.

169,117 tons of ore were treated in this goldfield for a return of 91,970 fine ounces of gold. This production was equal to 10.6 per cent. of the State's total. In the previous year 95,361 ounces were obtained from the treatment of 168,453 tons.

The *Cue District* production was 313 ounces from the treatment of 775 tons of ore. Included in this total was 217 obtained from a clean up from around the Big Bell mine.

In the *Meekatharra District* 658 ounces were recovered from the treatment of 4,001 tons of ore. The most successful producers were the *Haveluck* with 109 ounces, *Pharlap* with 130 ounces and the *Prohibition* with 117 ounces.

Very little mining activity took place in the *Day Dawn District* where 14 ounces were obtained from the treatment of 53 tons of ore.

Mount Magnet District produced 90,985 fine ounces of gold from the treatment of 164,288 tons of ore. The principal producer was *Hill 50 Gold Mines N.L.* with 82,988 fine ounces from 156,844 tons. Average recoverey was 10.58 dwts. per ton which was slightly higher than the previous year's average of 10.54 dwts.

Ore reserves are quoted as 639,000 short tons averaging 9.8 dwts.

It was found necessary to scale, pin and retimber some 200 feet, of the bottom section of the main shaft. This work was put in hand after it was found that rock pressure at depth had buckled some of the shaft timbers. Consideration is now being given to the establishment of an internal shaft to provide access to the ore body below the 1,800 foot horizon.

No major alterations were made to the primary air circuit in this mine.

Eclipse Gold Mines N.L.—Production for 1960 was 7,690 fine ounces of gold from 6,969 tons of ore, recovery being at the rate of 22 dwts. per ton treated. The main shoot of ore has diminished at depth to a very small pipe, but horizontal development has located additional ore shoots which will permit continued operations for a limited period. This company also carried out some exploratory work on the adjoining Lady Margaret lease.

YILGARN GOLDFIELD.

Production for the year was 70,689 fine ounces of gold from 413,806 tons averaging 3.4 dwts. per ton. In the previous year 414,751 tons yielded 73,302 fine ounces at the rate of 3.5 dwts. per ton. This goldfield was responsible for 8.1 per cent. of the State's Production.

Great Western Consolidated N.L. milled 390,353 tons for a recovery of 63,434 fine ounces of gold averaging 3.25 dwts. per ton. Production for the previous year was 67,100 fine ounces from 393,252 tons.

The *Copperhead* mine at Bullfinch, which has been the main producing mine of the company, showed a drop in production compared with previous years. Level development was restricted to 212 feet of driving and 36 feet of crosscutting.

Diamond drilling to test the Northern and Southern Series ore bodies at depth was carried out from the No. 22 level. Operations in the Northern Series open cut ceased in November and preparations were begun to make this area ready for the disposal of the mill tailings.

On the *Corinthian* mine, the development of the No. 3 level was completed and the developed block of ore almost stoped out. Total development comprised 172 feet of driving, 102 feet of crosscutting and 46 feet of rising.

The No. 4 level of the *Pilot* mine was developed during the year. A fall of earth in the open cut blocked off several mill holes, and development was necessary to form a new mill hole to extract the ore, which is broken by sublevelling and benching into the open cut.

On the *Fraser's* mine the No. 4 level was advanced to test ore prospects north of the No. 1 shaft. An open cut was commenced on the main lode and is a source of higher than verage grade ore.

At Nevoria mine, the development of No. 4 level blocks 1, 2 and 5 was completed. An open cut was commenced in the Block 5 area.

In the Burbidge and Golden Valley areas, the company operated on laterite deposits and obtained 187 ounces from 3,090 tons.

Ore reserves of Great Western Consolidated N.L. is given as 577,000 tons averaging 3.45 dwts. 1960 output from the various mines operated by the company is listed below.

Mine	Ore Treated	Gold	Average
	tons	fine ozs.	dwts./ton
Burbidge	900	87	1·93
Copperhead	185,082	24,330	2·63
Corinthian	26,271	3,960	3·02
Fraser's	40,519	11,647	5·75
Golden Valley	2,190	100	0·92
Nevoria	66,221	12,120	3·66
Pilot	69,170	11,187	3·23
Sands Retreatment	....	3	....
Totals	390,353	63,434	3·25

The *Radio* mine in the Golden Valley centre produced a total of 1,871 fine ounces of gold from the treatment of 1,702 tons of ore and retreatment of 2,430 tons of sands. The sands were treated by Great Western Consolidated. Barr Bros., who operate the mine, employed ten men throughout the year.

King Solomon Gold Mines at Edwards Find obtained 165 fine ounces from 631 tons of ore and 320 tons of sands. Other producers in the Marvel Loch area include the *Cornwall* with 239 ounces from 2,995 tons, *Patalena* with 106 ounces from 40 tons, *Prince George* with 436 ounces from 4,140 tons and the *Frances Furness* with 306 ounces from 460 tons.

In the Mount Rankin area the *Marjorie Glen Reward* produced 204 ounces from 240 tons and the *Golden View* 409 ounces from 43 tons.

MOUNT MARGARET GOLDFIELD.

The total ore treated in this goldfield was 140,698 tons which yielded 34,106 fine ounces of gold at an average rate of 4.8 dwts. per ton. This output represented 3.9 per cent. of the State's total. In the previous year 141,408 tons averaging 4.8 dwts. recovery were treated for a yield of 34,192 fine ounces.

In the *Mount Morgans District* 48 ounces were produced from 106 tons. Three-quarters of this output was alluvial gold reported to have been picked up in the vicinity of the Mount Margaret Mission.

The *Sons of Gwalia Ltd.* operating in the *Mount Malcolm District* produced 32,983 fine ounces from the treatment of 138,618 tons of ore. The average recovery was 4.76 dwts. per ton which was a little less than the 4.92 dwts. for the previous year when 135,932 tons yielded 33,469 ounces.

This mine employed an average of 273 men throughout the year, 114 on the surface and 159 underground.

A total of 2,168 feet of driving was completed on the West, and Hanging Wall lodes between the No. 10 and No. 27 levels. 2,351 feet of rising was completed using diamond drill holes for ventilation.

The only small producer of note was the *Monte Christo* at Lake Darlot where 101 ounces were obtained from 1,144 tons of lateritic ore.

In the *Mount Margaret District* 22 ounces were obtained from 163 tons. Prospecting in this goldfield is at a low ebb and the future of the field at present hinges on the continued operations of the Sons of Gwalia which has received financial assistance from the Government.

NORTH COOLGARDIE GOLDFIELD.

Production from this goldfield amounted to 20,250 fine ounces of gold recovered from 37,672 tons of ore averaging 10.8 dwts. per ton recovery. As a comparison the production for the previous year was 22,458 ounces from 41,335 tons averaging 10.9 dwts. Output from this goldfield was 2.3 per cent. of the total.

In the *Menzies District* the main producer was *Moonlight Wiluna Gold Mines Ltd.* operating the Timoni mine at Mount Ida. From this mine 14,591 ounces were obtained from 29,880 tons. An extensive prospecting campaign to find a repetition of the Timoni ore body was successful in the southern workings. At present drives are being advanced in good ore on the Nos. 3, 5 and 6 levels.

The more successful of the smaller producers were the *First Hit* with 431 ounces from 964 tons and the *Goodenough* with 209 ounces from 739 tons. Treatment of sands at the State Battery yielded 920 fine ounces of gold.

In the *Ularring District* the production was 1,165 fine ounces of gold from the treatment of 1,223 tons of ore. The *Oakley* mine at Davyhurst produced 456 ounces from 280 tons. This ore came from underhand stoping below the 900 foot level of the underlay shaft. At Mulline the *Golden Wonder* produced 388 ounces from 229 tons. Most of this ore came from shaft sinking operations.

The principal producer in the *Niagara District* was the *Altona* with 402 ounces from 623 tons of ore crushed. The main shaft was sunk approximately 100 feet during the year and driving commenced at water level which is about 50 feet below the No. 5 level.

In the *Yerilla District* 3,048 tons were treated for a return of 2,126 fine ounces of gold. Practically all of this production came from the *Yilgangie Queen* which produced 1,986 ounces from 2,361 tons. This mine is operated under a tribute agreement with the Western Mining Corporation and the ore is treated at the Yarri State Battery.

COOLGARDIE GOLDFIELD.

During 1960, 17,894 tons of ore were treated for a return of 12,342 fine ounces of gold at an average recovery rate of 13.8 dwts. per ton. In the previous year 27,004 tons yielded 17,393 fine ounces.

Gold Mines of Kalgoorlie (Aust.) Ltd. operating the Bayley's mine at Coolgardie reported the production of 9,081 fine ounces from 12,869 tons of ore. Most of this ore was obtained by mining small rich shoots on Price's reef at the Nos. 6 and 7 levels. An internal shaft has been sunk below the No. 11 level and development has indicated payable ore on Price's reef at both the No. 12 and No. 13 levels.

The *Northern Mineral Syndicate* which has reopened the old Paris Group Mine produced 900 ounces from the treatment of 2,140 tons. The syndicate has reconditioned Findlay's shaft and sunk it to the 230 feet horizon. Lister's shaft was also put in order and a drive along the 230 level has connected with Findlay's workings. A power house has been erected and a treatment plant is partially completed.

Among the smaller mines, the best returns were from the *Jackpot* with 502 ounces from 857 tons and the *Little Nipper* at Ryans Find with 412 ounces from 16 tons.

Very little mining was undertaken in the *Kunanalling District* where 315 tons of ore yielded 134 fine ounces of gold.

PILBARA GOLDFIELD.

In this goldfield 2,944 fine ounces of gold were recovered from 6,344 tons of ore averaging 9.3 dwts. per ton.

North West Mining N.L. operating the *Blue Spec* mine at Nullagine treated 3,401 tons for a recovery of 1,990 ounces. Most of the ore came from an old stope above the No. 4 level. Further development will be required at the mine to ensure future ore reserves.

The *Barton* mine at Middle Creek produced 112 ounces from 455 tons of ore.

There was very little activity at Bamboo Creek during the year. Attempts to gain access to and exploit favourable intersections, obtained during diamond drilling by the Mines Department, have slowed down. The only producer of note in this district was the *Prince Charlie* with a return of 292 ounces from 683 tons treated.

BROAD ARROW GOLDFIELD.

Total production for the year was 1,543 fine ounces of gold from the treatment of 4,113 tons of ore. Two finds of note were the rich patch located at *Cave Hill* by Messrs. Shirley and Dempster, and the *Sleeping Beauty* at Ora Banda by the Argus family. At Cave Hill a good patch was located a few feet off the wall of an old shaft and two parcels yielded 253 ounces from 260 pounds of ore. A further crushing of 20 tons yielded 197 ounces of gold.

At the *Sleeping Beauty* which has been developed to 40 feet the production was 267 ounces from 646 tons of ore.

Other producers in this goldfield included the *Prince of Wales* with 206 ounces from 126 tons and the *Gimlet South* with 185 ounces from 980 tons of ore.

PHILLIPS RIVER GOLDFIELD.

Ravensthorpe Copper Mines N.L. obtained 1,313 fine ounces of gold as a by-product of copper mining. From sundry claims in this goldfield an additional 18 ounces were obtained from 166 tons.

PEAK HILL GOLDFIELD.

Production totalled 501 fine ounces of gold from the treatment of 4,451 tons of ore. The *Horseshoe Lights* was the main producer with 293 ounces from 2,015 tons. Virtually all the remaining production came from the treatment of low grade surface material.

EAST MURCHISON GOLDFIELD.

There was very little activity in this goldfield where 381 ounces were recovered from the treatment of 870 tons of ore. At the *Goanna Patch* S. Sims obtained 110 ounces from 230 tons mined from a stope off the shaft at 45 feet. Some alluvial gold was also reported from the area. The *Kim Prospecting and Development Syndicate* have made preparations for the further sinking of their shaft on the Emu mine at Agnew. Results of development work on the 196 foot horizon were not encouraging.

NORTH EAST COOLGARDIE GOLDFIELD.

This goldfield produced 141 fine ounces from 546 tons of ore. The only producer of note was the *Kanowna Red Hill* with 76 ounces from 276 tons.

GASCOYNE GOLDFIELD.

Sundry claims within this goldfield produced 141 ounces from 37 tons of ore.

Other sources within the State produced 91 fine ounces of gold from 29 tons of ore.

MINERALS OTHER THAN GOLD AND COAL.

The production of minerals, other than gold and coal, for 1959 and 1960 is shown in the table below.

PRINCIPAL MINERALS OTHER THAN GOLD AND COAL.

Mineral	1959		1960	
	Tons	Value £A	Tons	Value £A
Asbestos—				
Chrysotile	631·66	17,249	61·26	1,602
Crocidolite	14,680·17	1,611,293	12,921·59	1,418,767
Bauxite	....	....	26,892·00	*
Bentonite	133·00	532	382·00	1,533
Beryl	266·71	48,052	181·17	33,024
Building Stone	....	....	40·00	1,300
Clays—				
Cement Clay	22,321·00	23,055	13,015·00	10,844
Fireclay	28,500·10	33,950	20,346·50	26,512
Brick Clays	....	....	24,996·00	22,888
White Clay	1,190·00	4,945	....	....
Copper—				
Ore and Concentrates	4,408·75	230,078	3,556·85	199,738
Fertiliser Grade	11,858·80	184,006	7,726·81	140,252
Dolomite	....	....	403·92	1,616
Felspar	1,395·80	6,352	1,942·00	8,283
Glass Sand	6,827·54	4,555	8,636·95	6,102
Glauconite	102·00	5,103	111·00	5,550
Gypsum	37,730·55	54,207	44,216·30	55,628
Ilmenite	73,627·67	353,076	114,661·72	485,562
Iron Ore—				
Exported	672,239·00	666,601	837,147·00	830,124
For Pig	57,206·00	808,644	79,085·00	1,098,825
Lead Ore and Concentrates	1,902·89	89,004	2,263·69	119,292
Leucoxene	276·25	3,930	20·10	392
Limestone	....	....	11,327·75	14,935
Magnesite	18·50	74	....	....
Manganese	69,980·24	1,020,824	53,788·84	753,005
Monazite	109·55	7,210	241·96	9,319
Ochre—Red	104·00	1,040	104·00	1,040
Phosphatic Guano	....	....	86·79	938
Pyrites	53,030·39	371,989	53,298·79	366,739
Quartz Grit	312·00	260	288·00	243
Rutile	297·45	8,424	621·41	15,686
Semi-Precious Stones—				
Prase	....	....	1·00	40
Tiger Eye Opal	....	....	0·05	97
Silver (fine oz.)	193,561·53	79,913	193,821·63	80,613
Talc	4,047·69	58,085	5,470·39	69,114
Tantalo/Columbite	8·46	9,833	10·57	16,982
Tin Concentrates	249·70	154,729	280·82	168,775
Zircon	4,068·34	41,129	4,624·45	49,270
Totals	....	5,898,142	....	6,014,630

* Value not available for publication.

Brief notes on mineral production are given below.

Asbestos.

There was very little activity at Nunyerry where production of chrysotile declined to 61 tons valued at £1,602. Peak production was in the years 1957 and 1958 when 1,389 and 1,378 tons were mined.

At Wittenoom Gorge, Australian Blue Asbestos Ltd. produced 12,922 tons of crocidolite valued at £1,418,767. Demand for the fibre remained firm throughout the year.

Extensions were made to the milling section and improved fibre recovery techniques were introduced to give a higher recovery in the mill. In the Colonial mine, the lower seam of fibre was opened up and this seam now contributes a considerable portion of the ore production. Development work in the mine included 2,911 feet of driving, 290 feet of crosscutting, and 1,070 feet of rising. The labour force of 345 men, 166 underground and 179 surface, was slightly below the previous year's average of 352.

Planned extensions to the water supply were completed during 1960 and Wittenoom now draws water from bores situated to the north of the town.

Bauxite.

Trial parcels totalling 26,892 tons have been exported by Western Aluminium N.L. Most of the mining operations were concentrated at Dwellingup where the deposit has been mined to about eleven feet.

Bentonite.

Following local increased demand, the production of bentonite at Marchagee rose to 382 tons valued at £1,533.

Beryl.

One hundred and eighty one tons, containing 2,101 units of beryllium oxide, valued at £33,024 were obtained from claims mostly in the Gascoyne and Pilbara goldfields. Main producing centres were Yinnietharra with 1,062 units, Marble Bar with 333 units, Nimingarra with 283 units, and Mount Francisco with 144 units.

Building Stone.

Forty tons of granite suitable for building facing stone were reported as being produced at Jerramungup and Karlgarin. This production figure only relates to holdings under the Mining Act and would only represent a small fraction of the State's output.

Clays.

Clay production from the metropolitan area, Clackline and Glen Forrest totalled 58,357 tons valued at £60,244.

Copper.

Production of the fertilizer grades of copper ores fell to 7,727 tons which was a little ahead of the 1958 level. This production of carbonate ore was insufficient to meet the demands of agriculture.

The State's leading producer was the *Copper Hills Copper Mine* in the Pilbara which produced 2,499 tons of a mixed ore and concentrate averaging 12.69 per cent. Cu. This output was valued at £68,567. Sulphide ore from this mine is concentrated by flotation at the *Comet* plant and then roasted. This copper sulphate is then blended with finely ground Copper Hills oxide and carbonate ores. Eleven men were employed at the mine and 22 in the treatment plant.

The *Thaduna Copper Mining Coy.* in the Peak Hill Goldfield produced 3,520 tons of 6.75 per cent. copper valued at £29,652. Some of the ore was concentrated over Wilfley tables before being railed to Perth.

From *Kumarina* 447 tons of 15.8 per cent. Cu ore were mined and finely ground for a return of £19,277. This mine continues to yield high grade ore.

Ravensthorpe Copper Mines N.L. produced 3,552 tons of concentrate containing 90,596 units valued at £199,007. This production was exported. In addition 1,313 fine ounces of gold, 4,983 fine ounces of silver, and 707 units of copper for fertilizer were produced.

The bulk of the ore was obtained from workings off the Elverdton shaft. This shaft has been sunk to a depth of 716 feet and at the 650 foot horizon the No. 5 level has been established. Winzes are being sunk from the No. 3 level and it is anticipated that stopes in the Desmond area will contain higher grade ore. The *Cattlin* shaft was unwatered and reconditioned. The old workings proved to be in good order and a considerable quantity of ore was available without further development.

Dolomite.

Westralian Ores Pty. Ltd. mined 404 tons from their mineral leases situated at the southern end of the Mount Magnet townsite.

Felspar.

Australian Glass Manufacturers Co. Pty. Ltd. obtained 1,942 tons from their quarry at Londonderry. This production was valued at £8,283 f.o.r. Coolgardie.

Glass Sand.

Production from the Lake Gnangarra deposit amounted to 8,637 tons valued at £6,102.

Glauconite.

One hundred and eleven tons of glauconite valued at £5,550 were recovered from the treatment of 555 tons of greensand obtained from the Gingin deposit.

Gypsum.

Plaster manufacturers obtained their supplies of raw material from Nukarni, Baandee, Lakes Brown, Seabrook and Cowcowing. Output of 30,874 tons was valued at £24,925. In addition *Garrick Agnew Pty. Ltd.* obtained 13,342 tons of gypsum, from Lake Cowan at Norseman, for export through Esperance.

Ilmenite, Leucoxene, Monazite, Rutile, Zircon.

Overseas shipments of Ilmenite totalled 114,662 tons valued at £485,562 f.o.b. Bunbury. This mineral production was more than one and one half times the output for the previous year.

Cable (1956) Ltd. operating at Bunbury sold 19,858 tons assaying 55.22 per cent TiO_2. The Wonnerup deposit, operated by *Ilmenite Pty Ltd.* yielded 22,757 tons of 53.86 per cent. titanium oxide. *Westralian Oil Ltd.* obtained 9,319 tons of 59.67 per cent. TiO_2 from their deposit at Yoganup. The State's leading producer, *Western Titanium N.L.* operating at Capel produced 62,728 tons having an average assay of 55.01 per cent. TiO_2. This company was also responsible for the total output of 20.1 tons of Leucoxene containing 18.5 tons of TiO_2. The same producer also reported the sale of 242 tons of monazite containing 1,553 units of ThO_2; 621 tons of rutile containing 600 tons TiO_2; and 4,624 tons of zircon containing 3,037 tons of ZrO_2.

Iron Ore.

During 1960, 837,147 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 63.3 per cent. Fe. This production exceeded the previous year's output by 165,000 tons.

Additional equipment purchased during the year included a 6 cubic yard electric shovel and several 45 ton capacity self tipping Euclid trucks. The development of the quarry benches has progressed to the stage where the lowest bench is now at the level of the tipping site of the primary crusher.

The *Charcoal Iron and Steel Industry* at Wundowie obtained 79,085 tons of ore averaging 61.9 per cent. Fe from the Koolyanobbing deposit. Over the last four years pig iron production has increased from 14,000 tons in 1957 to over 52,000 tons in 1960.

Lead.

There was a small increase in production as compared with the previous year. Production for 1960 was 2,264 tons of concentrate containing 1,739 tons of lead valued at £119,292 f.o.b. Geraldton.

The *Gurkha Lead Mine Pty. Ltd.* produced 1,540 tons of concentrate containing 1,202 tons of lead. This production came from the Gurkha and the Kathleen Hope mines. Except for a few remnants, all available ore has been extracted from both these mines. The company did some exploration work on the Block 7 lead mine but results were discouraging. Some further examination may be warranted if there is an improvement in the price of lead. A start was made on the re-opening of the Wheal May which has been idle for fifty years.

The two other producers on the Northampton Mineral Field were the *Wheal Fortune Extended* with 583 tons of concentrate, and the *Mary Springs Lead Mine* with 137 tons of concentrates. All ore remaining in stopes in the Wheal Fortune Extended was worked out early in the year and the mine was closed down after salvage operations had been completed.

Mines that were re-opened during 1960 and should be producing in the coming year were the Nooka, Yiapa and the Wheal May lead mines.

Limestone.

Limestone quarries in the Wanneroo district produced 11,328 tons valued at £14,935. This stone was used for home foundations, lime burning, and road foundations. The recorded output is only a small portion of the State's production as the quarry operators on private property are not required to report production to this Department.

The main areas of limestone production are Beaconsfield, Spearwood, Coogee, Mosman Park, Wanneroo and Yanchep.

Manganese.

Mining activity in the Pilbara was relatively quiet during part of the year. Exports from Port Hedland totalled 42,411 tons of 51 per cent. Mn ore valued at £616,898 f.o.b. The *Northern Mineral Syndicate* operating at Woody Woody and Ripon Hills exported 29,425 tons. The remainder came from other producers operating at Mount Sydney, Mount Cooke and Nimingarra.

No manganese was mined at the Horseshoe centre of the Peak Hill Goldfield during 1960. However, 10,264 tons of ore from this centre, stockpiled at Geraldton, were exported. Other sales of Peak Hill manganese included 11 tons of battery grade and 1,103 tons of low grade material.

Ochre.

A total of 104 tons were produced from Mineral Claim 26 at Wilgie Mia in the Murchison Goldfield.

Phosphatic Guano.

Eighty seven tons valued at £938 were obtained from Jurien Bay.

Pyrites.

Norseman Gold Mines N.L. railed 39,003 tons of concentrate, containing 18,430 tons of sulphur, to superphosphate works in the metropolitan area. This output was valued at £294,120 f.o.r. Norseman. Virtually no development took place in 1960. Stoping by ring hole boring above the No. 6 level and stope preparation above the No. 7 level yielded 105,000 tons of ore.

Gold Mines of Kalgoorlie (Aust.) Ltd forwarded to works at Fremantle 14,296 tons of auriferous pyritic concentrate containing 5,810 tons of sulphur valued at £72,619.

Quartz Grit.

Two hundred and eighty eight tons for local use were produced at Collie.

Semi-Precious Stones.

One ton of prase valued at £40 was obtained from Spargoville. A deposit on Byro Station in the Gascoyne yielded 120 lbs. of tiger eye opal valued at £97.

Silver.

Silver as a by-product of gold, copper and lead mining amounted to 193,822 fine ounces valued at £80,613.

Talc.

Three Springs Talc Pty. Ltd. produced 5,470 tons valued at £69,114 from their operations at Three Springs. This new company was formed by Western Mining Corporation Ltd. and the Universal Milling Co. Pty. Ltd. the previous owners. The deposit, previously worked by underground methods, has been converted to an open cut.

Tantalo-Columbite.

Ten and one half tons of concentrate containing 513.4 units of Ta_2O_5 valued at £16,982 were produced in the State. In the Pilbara 6 tons were obtained in the Tabba Tabba, Pilgangoora and Marble Bar centres. In the Greenbushes Mineral Field 4½ tons were produced as a by-product of tin sluicing operations.

Tin.

Production for the year was 281 tons of concentrates containing 190 tons of the metal. At Greenbushes 18 tons of concentrates were obtained mostly from the sluicing of old tailings. Deposits in the Pilbara yielded 263 tons, the principal producers being the Northern Mineral Syndicate with 99 tons, J.A. Johnston with 49 tons, and Mineral Concentrates Pty. Ltd. with 44 tons.

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

APPENDIX No. 1.
EXPLORATORY DRILLING.

STATE MINING ENGINEER:
REPORT ON DRILLING ACTIVITIES
FOR YEAR ENDED 31st DECEMBER, 1960.

Much of the work done by this section in the period under review has been let to private contractors under arrangements whereby the Department hires out the necessary plant and equipment.

The only major item of plant added to our establishment during the year was a Leyland Comet 100 truck of 12 tons gross rating valued at £4,000.

Mines Department Rig No. 1, the BBS4 was disposed of by tender during the year and a nil footage return was submitted from this machine.

Rig No. 2, the Failing M1 Rotary Drill. A major overhaul of the rig was completed and a short shakedown run was given in Perth. A six inch hole was completed at a depth of 120 feet in the Government Chemical Laboratories yard for the purpose of water supply. Another six inch hole was drilled to 87 feet in the store yard for the purpose of establishing a water supply. After minor re-adjustments the plant was taken to Tenindewa where a hole 549 feet deep was drilled and some testing done for water supply purposes. At the close of the year this rig was on site at Mendel Wongoondy, where further water supply drilling is to be done.

No. 3 Rig (A.3000 Mindrill). This plant was taken from Mullewa to Mount Goldsworthy where two holes of 826 feet and 941 feet respectively were drilled in the Iron Ore Resources Survey. Some two and a half months' driling time were lost due to floods on the De Grey river making it impossible to reach the sites from Port Hedland. The Rig was transported to Wilgie Mia where it is on site for further drilling at the close of the year. A total of 1,767 feet was drilled by this machine under a contract arrangement, by Mr. A. Horsham.

No. 4 Rig (A.2000 Mindrill). Hole "Forest King" 2 at Coolgardie was advanced from 289 feet to 1,112 feet. A total of 823 feet when it was returned to Welshpool for overhaul. At the completion of overhaul a short trial hole of 93 feet was drilled using rotary bits for the Department of Industrial Development at Welshpool for water supply purposes. The footage completed for the year by this machine was 916 feet.

Rig No. 5 (A.2000 Mindrill.) The hole at Meekatharra, P.F.1. was drilled from 870 feet to a depth of 1,820 feet an advance of 950 feet. At this depth considerable caving was experienced and the hole was not taken to its planned depth. The equipment was stored at Meekatharra but the A.2000 machine has since been taken on hire by Mr. K. McCallum of Cue.

Rig No. 6 A.2000. This machine was taken overland to Port Hedland where some two and one half months' drilling time was lost due to floods on the De Grey river making it impossible to reach the drill sites at Mount Goldsworthy. Hole 1 was drilled to 832 feet. Hole 2 was completed at 931 feet and Hole 3 was at a depth of 475 feet at the end of the year. This work was done on a contract basis and considerable trouble has been experienced due to the broken nature of the extremely hard hematite and the soft enclosing clays. Hole 3 is to be reamed to AX casing size to 475 feet and cased, when drilling will be recommenced. Total footage completed by this rig for the year was 2,238.

Rig No. 7 (Mindrill F.20). During the year this machine was hired to the Public Works Department where 4 short holes at 31 feet each were drilled in Port Hedland Harbour for investigation purposes. From Port Hedland the rig was taken under hire by Australian Blue Asbestos to Wittenoom Gorge where about seventy feet of drilling was done. The machine proved unsuitable for the hard country encountered and it was returned to our store at Welshpool.

Rig No. 8 E.500. The head from this machine was under hire to a Mr. Burrows who was drilling on the Main Ord River Dam site for most of the year and the machine did no work for the Mines Department Drilling Section in the period.

HYDROLOGICAL SECTION.

The Ruston-Bucyrus 22 RW Drill No. 1 was engaged from January to July in recovering casing from No. 2 Hole at Badgingarra and in production tests from this hole. On termination of this work the rig started Hole 4 which was advanced to 852 feet at the end of the year.

Ruston Bucyrus rig No. 2 drilled hole No. 3A to a depth of 235 feet and production tests were made. The rig was then returned to Hole No. 1 at Badgingarra where testing was carried out from May to September. At the completion of this work the plant was being transferred to Tenindewa when it overturned on the road. Since this date the machine has been in Sandovers workshop for repairs and modifications to the towing arrangements.

The total footage made by these rigs for the year was 1,087.

Apart from the footages drilled as detailed above considerable work devolved on this section due to the assistance rendered other departments and private drilling contractors. For a considerable part of the year specialised equipment and advice was tendered to the Public Works Department in some diamond drilling being done at Logue's Brook.

Equipment was loaned to Western Aluminium N.L., an offshoot of Western Mining Corporation, to Westphal Bros. drilling contractors, Davis, Hankinson, Baker Bros., Midland Drilling Services and Australian Blue Asbestos.

During the year also the staff of the section were engaged in transporting our equipment from the Ord River Main Damsite and returning it to Perth for storage and maintenance.

J. HADDOW,
Inspector of Mines (Drilling).

20th January, 1961.

TABLE SHOWING FOOTAGE DRILLED FOR YEAR ENDED, 31st DECEMBER, 1960

Rig No.	Machine	Place	Purpose	Footage	Total	Basis	
1	BBS.4	Welshpool	....	*Nil*	....	....	Sold by tender
2	Failing	Perth	Water Supply	120	....	Wages	
		Welshpool	Water Supply	87		Wages	
		Tenindewa	Water Supply	549	756	Contract	
3	A.3000	Mount Goldsworthy	Iron Ore Survey	1,767	1,767	Contract	
4	A.2000	Coolgardie	Goldfields Exploration	823		Wages	
		Welshpool	Water Supply	93	916	Wages	
5	A.2000	Meekatharra	Goldfields Exploration	950	950	Contract	
6	A.2000	Mount Goldsworthy	Iron Ore Survey	2,238	2,238	Contract	
7	F.20	Port Hedland	Public Works Department Investigations	124			
		Wittenoom Gorge	Australian Blue Asbestos prospecting	70	194		
8	E.500	....	....	*Nil*	....	....	
			Total	6,821	6,821		

APPENDIX No. 2.

State Mining Engineer:

SAMPLING OF FUMES.

During the period 14th June to 8th July, a total of 26 samples of the fume created in development ends after the firing of the explosives, were collected and submitted to the Government Analyst for the determination of carbon monoxide, carbon dioxide and oxygen. The results are tabulated later in this report.

The object of the sampling was to test the toxicity of the fumes created when a non end waxed explosive was used in the firing of the development end.

In November 1956 during the testing of explosives one sample was collected after a development end had been charged and fired with 60 per cent. AN gelignite from which approximately 50 per cent. of the wrapper and about 70-80 per cent. of the wax had been removed. The results obtained viz. 0.27 per cent. CO, 2.27 per cent. CO_2 and ratio $CO:CO_2$ of 1:8.4, indicated that excess wax on the plug of explosive was responsible for the high percentages of carbon monoxide and low $CO:CO_2$ ratios obtained during previous tests.

Representations were made by the Chamber of Mines and the Mines Department to have the explosives prepared without excess of wax.

The present tests have been carried out with the explosives produced as a result of these representations. The explosive material has been wrapped in a pre-waxed paper and the ends of the plug merely folded in without the usual sealing by wax. The final spraying with wax has also been eliminated.

The collection of the sample was carried out in the same manner as for previous tests. Briefly, the face was bored and charged by the miner in his usual manner. It was fired at the regular firing time and five minutes after the last report had been accurately counted two men equipped with Proto apparatus collected the samples in aspirator bottles. All safety precautions were properly observed.

Two methods of firing were used—Safety Fuse and electric.

During discussion it was considered that the smoke emitted by the burning safety fuse might contribute to the amount of fume liberated during the explosion. As a consequence it was considered that by firing electrically this extra fume would be eliminated. Hence the samples from electric firings. It was impossible to count the reports of the explosions when firing electrically, so the sample was collected five minutes after the leads were disconnected from the shot-firer. (The leads were removed immediately after firing).

As well as the comparison obtained when assessing results from fuse and electric firing it was decided to burn equivalent fuse in a development end. Two hundred feet of fuse cut into twenty—ten feet lengths and placed in two cartridges with one foot of master fuse per cartridge were burnt and samples collected at times corresponding to five, ten, and thirty minutes after an equivalent explosive firing time. The results indicate that there is no great amount of carbon monoxide liberated. The analysis resulted:

Percentage of CO.	Percentage of CO_2	Percentage of O_2	Ratio $CO:CO_2$	Remarks
Less than 0·01	0·15	20·50	Not calculated	5 mins. after equivalent firing.
„ „ 0·01	0·16	20·54	„	10 mins. after equivalent firing.
„ „ 0·01	0·19	20·45	„	30 mins. after equivalent firing.

In an endeavour to obtain results which could be considered consistent, tests with each explosive and method of firing were repeated four times.

Previously only one test for each possible cause of excess fume had been made and it was thought that the results so obtained were not exactly conclusive. With four consistent results the case for decreased waxing would be increased considerably. It will be noted that in each series of tests there is one sample taken at thirty minutes after firing. This sample was taken to ascertain the percentage of carbon monoxide that would be met by a miner returning to his development end after the elapse of thirty minutes (a normal crib-time break) if he had neglected to blow out the end with compressed air.

The result of the analyses is shown in Table A on page 39.

Consider the $CO:CO_2$ ratios. An average of the analysis results for the samples taken five minutes after firing only, of the 60 per cent. AN gelignite with fuse firing is 1:6.25. With 60 per cent. AN gelignite and electric firing a similar average is 1:7.15. The average of the ratios for Semigel and fuse firing is 1:5.05 whilst this explosive with electric firing gives an average ratio of 1:4.85. In tabulated form it appears thus:

———	Average of 4 samples	Comments
60%AN Gelignite—fuse firing....	1 : 6·25	This result was expected.
„ „ —electric firing	1 : 7·15	
Semigel—fuse firing	1 : 5·05	Note that the fuse firing gives a better result than the electric firing. This is unexpected and inconsistent with the results obtained with 60 per cent. AN Gelignite.
„ —electric firing	1 : 4·85	

Attached to this report is a Summary of the Analysis of all tests during the period 5.1.56 to 8.7.60 (includes results of current tests). (See Table B.)

The average of $CO-CO_2$ ratios for similar explosives in the period prior to this years tests were 1:3.7 for 60 per cent. AN gelignite and 1:3.2 for semigel. The average for this current test are 1:6.7 for 60% AN gelignite and 1:4.95 for semigel.

Thus:	60% AN gelignite	Semigel
Previous tests	$CO:CO_2$=1:3.7	1:3.2
Current tests	$CO:CO_2$=1:6.7	1:4.95

These results indicate that some improvement has been obtained by decreasing the wax on the wrapping of the explosive. However they still do not compare with an average ratio of 1:11 for 60% AN gelignite obtained by Mr. T. N. Kirton during similar testing in 1938. At that time Mr. Kirton also had percentages of carbon monoxide varying from 0.065 to 0.103.

Mr. A. Greaves of the Explosives Branch was present at the commencement of this series of tests and inaugurated the collection of a sample of the fume in the working end. From this sample a determination of the percentages of oxides of nitrogen (NO2) was made. These samples were collected at the same time as the other samples and their relationship to the fume samples appears in the following tabulation. Several blank samples were taken in the development ends before firing.

Fume Sample	Explosive	Per cent. NO_2 V/V at N.T.P.
5	Blank before firing	*Nil*
	60% AN gelignite—fuse firing	0·050
11	60% AN gelignite—fuse firing	0·017
1	60% AN gelignite—electric firing	0·064
	Blank before firing	*Nil*
9	60% AN gelignite—electric firing	0·033
3	Semigel—fuse firing	0·010
16	Semigel—fuse firing	0·014
	Blank before firing	*Nil*
7	Semigel—electric firing	0·031
10	Semigel—electric firing	0·004

A sample taken when 202 feet of fuse were burnt gave a nil result.

Mr. Greaves will report on the testing for oxides of nitrogen.

Plugs of explosives were retained from some of the cases used in the charging and firing of the development ends. The Explosives Branch intend to make determinations of the velocity of detonation on some of these plugs. The results of these determinations could be of great interest. Mr. Kirton at one time wrote "all endeavours should be made to supply to the mines explosives of all grades which have a reasonably high velocity of detonation . . ." During his testing in 1938 he made velocity of detonation determinations on the explosives he was testing and the velocity for 60% AN gelignite was 5,433 metres per second. I understand that if the velocity of detonation is not high then the explosive tends to burn rather than explode. This could do much to increase the percentage of toxic gas.

The conclusion to be drawn from this sampling:

(1) The percentage of carbon monoxide has been reduced by the decrease in the amount of wax on the plug of explosive. The ratios of $CO:CO_2$ have accordingly improved but not to the standard required. The improvement with the non end waxed plug of 60% AN gelignite is greater than that shown in a similar plug of semigel. This may be due to the waxing of the wood meal constituent of semigel explosive.

(2) The comparison of fuse and electric firing shows that electric firing gives a lower percentage of carbon monoxide and a consequent higher ratio of $CO:CO_2$ with the 60% AN gelignite. However testing of the carbon monoxide created when fuse only is burnt shows the amount of this gas to be almost negligible. Is it possible that the physical action during the explosion causes the lower carbon monoxide? Would the rapid succession of shots with electric firing cause more of the toxic gases to be entrapped in the broken dirt than is the case with the more leisurely action of fuse firing?

(3) This sampling shows that wax is the direct cause of the increased percentage of the toxic gases met with during the testing from January, 1956 up to the recent date, but is there not some other contributing factor, such as the velocity of detonation of the explosive? I will be very interested to learn the velocity of detonation for these explosives and to compare them with the results obtained by Mr. T. N. Kirton in 1938.

I wish to acknowledge the assistance given by the Chamber of Mines through Lake View and Star Ltd. and the officials of this Company; the Proto-trained First aid-men of this company in Messrs. R. Trewhella, S. Harvey and G. Moderana who collected the samples; machine miners Messrs. R. Florence, L. Spence, M. Battaglia and F. Donkin who bored, charged and fired the faces of the development ends; Mr. Dick Martin of the Great Boulder Gold Mines Ltd., an experienced supervisor, who supervised the charging and electrically fired the faces required for the tests with electric firing.

J. M. FAICHNEY,
District Inspector of Mines.

2nd August, 1960.

TABLE A

Results of Analysis

60% *AN Gelignite with Fuse Firing*

Sample	CO	CO_2	O_2	Ratio CO : CO_2	Remarks
5	0·56	2·75	19·04	1 : 4·9	5 mins. after firing.
6	0·20	1·05	19·95	1 : 5·2	30 ,, ,, ,,
11	0·36	2·55	19·36	1 : 7·1	5 ,, ,, ,,
21	0·24	1·52	19·90	1 : 6·3	5 ,, ,, ,,
23	0·23	1·53	19·65	1 : 6·7	5 ,, ,, ,,

60% *AN Gelignite with Electric Firing*

Sample	CO	CO_2	O_2	Ratio CO : CO_2	Remarks
1 and 2	0·035	0·32	20·53	1 : 9·1	5 mins. after firing.
	0·17	1·18	20·01	1 : 6·9	30 ,, ,, ,,
	Discard these results as it appears that the samples were mixed. Samples 25 and 26 were collected to replace samples 1 and 2.				
25	0·38	2·40	19·14	1 : 6·3	5 mins. after firing.
26	0·12	0·91	20·00	1 : 7·6	30 ,, ,, ,,
9	0·30	2·29	19·47	1 : 7·6	5 ,, ,, ,,
12	0·45	3·38	18·88	1 : 7·5	5 ,, ,, ,,
17	0·50	3·61	18·63	1 : 7·2	5 ,, ,, ,,

Semigel with Fuse Firing

Sample	CO	CO_2	O_2	Ratio CO : CO_2	Remarks
3	0·28	1·51	19·64	1 : 5·4	5 mins. after firing.
4	0·26	1·39	19·72	1 : 5·3	30 ,, ,, ,,
16	0·38	2·16	19·26	1 : 5·7	5 ,, ,, ,,
22	0·16	0·90	20·12	1 : 5·6	5 ,, ,, ,,
24	0·61	2·11	19·17	1 : 3·5	5 ,, ,, ,,

Semigel with Electric Firing

Sample	CO	CO_2	O_2	Ratio CO : CO_2	Remarks
7	0·25	1·35	19·75	1 : 5·4	5 mins. after firing.
8	0·21	1·10	19·79	1 : 5·2	30 ,, ,, ,,
10	0·27	1·23	19·74	1 : 4·6	5 ,, ,, ,,
13	0·27	1·20	19·83	1 : 4·4	5 ,, ,, ,,
18	0·36	1·79	19·40	1 : 5·0	5 ,, ,, ,,

TABLE B

Summary of Analysis during Sampling over Period, 5th January, 1956, to 8th July, 1960

60% *AN Gelignite—5 minutes after firing*

Date of Sampling	Per cent. of CO	Per cent. of CO_2	Ratio CO : CO_2	Per cent. of O_2	Weight of Explosive used	Spacers	Method of Firing	Remarks
					lb. oz.			
23/2/56	0·92	4·21	1 : 4·6	18·62	40 0	*Nil*	Fuse	
to	0·67	1·96	1 : 2·9	19·67	38 12	Wooden	,,	
16/3/56	0·81	2·71	1 : 3·35	19·39	37 13	Ceramic	,,	
	0·50	2·08	1 : 4·1	19·54	38 12	*Nil*	Fuse	Special A.
	0·44	1·59	1 : 3·6	19·91	30 0	,,	,,	,, B.
14/11/56	0·72	3·54	1 : 4·9	18·91	30 3	,,	,,	,, C.
to	0·27	2·27	1 : 8·4	19·65	31 14	,,	,,	,, A with approx. 50% warapper and 70–80% wax removed.
21/11/56	0·88	3·50	1 : 4·0	18·77	33 2	,,	,,	,, A with no tamping.
	0·71	2·44	1 : 3·4	19·30	32 13	,,	,,	,, A with excess tamping.
11/7/57 to 12/7/57	0·32	2·01	1 : 6·3	19·65	50 0	*Nil*	Fuse	Explosive in new wrapping (Chocolate brown with white stripes).
	0·56	2·75	1 : 4·9	19·04	30 10	*Nil*	Fuse	Non-end waxed cartridges.
	0·36	2·55	1 : 7·1	19·36	33 2	,,	,,	
14/6/60	0·24	1·52	1 : 6·3	19·90	33 2	,,	,,	
to	0·23	1·53	1 : 6·7	19·65	30 10	,,	,,	
8/7/60	0·38	2·40	1 : 6·3	19·14	36 14	,,	Electric	
	0·30	2·29	1 : 7·6	19·47	46 14	,,	,,	
	0·45	3·38	1 : 7·5	18·88	48 2	,,	,,	
	0·50	3·61	1 : 7·2	18·63	46 4	,,	,,	

60% *AN Gelignite—30 minutes after firing*

(Development end not disturbed by ventilation or compressed air)

					lb. oz.			
14/11/56 to 21/11/56	0·06	0·89	1 : 15·0	20·22	38 12	*Nil*	Fuse	Special A.
14/6/60 to 8/7/60	0·20	1·05	1 : 5·2	19·95	30 10	,,	,,	Non-end waxed cartridge.
	0·12	0·91	1 : 7·6	20·00	36 14	,,	Electric	

Semigel—5 minutes after firing

Date of Sampling	Per cent. of CO	Per cent. of CO_2	Ratio CO : CO_2	Per cent. of O_2	Weight of Explosive used	Spacers	Method of Firing	Remarks
					lb. oz.			
5/1/56	1·38	3·26	1 : 2·4	....	....	Wooden	Fuse	Sample collected 1 hour after firing.
	0·88	2·19	1 : 2·5	....	....	,,	,,	,, ,, 1½ hours after firing.
	0·63	1·67	1 : 2·7	....	....	,,	,,	,, ,, 1¾ hours after firing.
23/2/56	0·42	1·24	1 : 2·95	19·77	35 7	*Nil*	Fuse	
to	0·46	1·38	1 : 3·0	19·78	36 14	Wooden	,,	
16/3/56	0·51	1·57	1 : 3·1	19·68	36 0	Ceramic	,,	
14/11/56	0·26	0·95	1 : 3·7	20·10	45 10	*Nil*	Fuse	Special A.
to	0·31	1·05	1 : 3·4	20·04	44 4	,,	,,	,, B.
21/11/56	0·23	1·06	1 : 4·6	20·12	39 14	,,	,,	,, C.
11/7/57 to 12/7/57	0·11	0·55	1 : 5·0	20·35	39 10	*Nil*	Fuse	Explosive in new wrapping (Chocolate brown with white stripes).
	0·28	1·51	1 : 5·4	19·64	41 3	*Nil*	Fuse	Non-end waxed cartridge.
	0·38	2·16	1 : 5·7	19·26	29 15	*Nil*	,,	
	0·16	0·90	1 : 5·6	20·12	43 1	,,	,,	
14/6/60	0·61	2·11	1 : 3·5	19·17	37 2	,,	,,	
to	0·25	1·35	1 : 5·4	19·75	33 4	,,	Electric	
8/7/60	0·27	1·23	1 : 4·6	19·74	35 9	,,	,,	
	0·27	1·20	1 : 4·4	19·83	37 7	,,	,,	
	0·36	1·79	1 : 5·0	19·40	39 5	,,	,,	

Semigel—30 minutes after firing

(Development end not disturbed by ventilation or compressed air)

					lb. oz.			
14/6/60 to 8/7/60	0·26	1·39	1 : 5·3	19·72	41 3	*Nil*	Fuse	Non-end waxed cartridge.
	0·21	1·10	1 : 5·2	19·79	33 4	,,	Electric	

APPENDIX A.

Nitrogen Oxides.

In the course of the tests eight additional samples were taken five minutes after firing for investigation of nitrous fumes in the gas. Samples were taken in 600 ml. stoppered Pyrex bottles which were perfectly clean and dry at the time of sampling. As soon as possible after they were brought to the surface small amounts dilute caustic soda and hydrogen peroxide were added. The bottles were then taken to the laboratory and samples analysed about one week later. These reagents adequately absorb nitrous gases and convert them to nitrate so that it was only necessary to wash out the solution and determine the nitrate present by a sensitive colorimetric method using a Unicam Spectrophotometer.

Three samples were taken in the mine before firing of the tests and treated in the same way. They all gave negative results so that no blank allowance was necessary.

Nitrous fumes were finally expressed as per cent. volume/volume of NO_2 and results are given in the table:

SUMMARY OF NITROUS FUME ANALYSES, ON SAMPLES TAKEN 5 MIN. AFTER FIRING.

	Per Cent. Semigel	V/V NO_2 Gelignite
Fuse Firing	0.010	0.017
	0.014	0.050
Electric Firing	0.031	0.033
	0.004	0.064

The values for NO_2 vary widely from 0.004 per cent. to 0.064 per cent. but it may be noted that Gelignite appears to give higher results than Semigel. The average of four tests with Gelignite is 0.041 while for Semigel it is 0.015. The tests are too few in number for definite conclusions but there does appear to be some difference in this respect. The more significant observation from the results is that nitrous fume concentration is appreciable and is high enough to be quite severely toxic. Stafford Strouts & Stubbings in their book "The Determination of Toxic Substances in Air", Table 1, give a concentration of 100 parts per million (0.01 per cent.) as sufficient to produce severe toxic symptoms on exposure for one minute. In the same table 0.04 per cent. CO is said to produce severe symptoms in one hour. The gases shortly after firing are dangerous not only for carbon monoxide but perhaps more so on account of nitrous fumes.

Nitrous gases are, however, all easily soluble in water and it can be expected that under wet conditions they will be rapidly absorbed. It is not suggested that concentrations up to 0.06 per cent. after firing create any dangerous situation since they will soon be reduced by both absorption and by ventilation. It is however possible that unusual situations might arise in which these gases could be as toxic or more so than the carbon monoxide produced at the same time.

G. A. GREAVES,
Inspector of Explosives.

1st August, 1960.

APPENDIX NO. 3.

10th August, 1961.

The Chairman,
Board of Examiners for
Mine Managers' and Underground
Supervisor's 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 during the year 1960.

Mining Law Examination.—An examination in Mining Law for the Mine Manager's Certificate was held on the 11th April, 1960. Details of the examination are as follows:—

Entries	5
Passed	4
Failed	1

The names of the successful candidates are as follows:—

Annear, C. H.
Antulov, V.
Baker, S. R.
Henderson, G.

Copies of the examination papers are attached hereto.

Underground Supervisors' Examination.—An examination for the Underground Supervisor's Certificate of Competency was held on the 5th September, 1960.

Applications to sit for the examination were received from the following centres:—

Bullfinch	2
Cockatoo Island—Yampi	1
Gwalia	1
Kalgoorlie	14
Norseman	3
Perth	1
Ravensthorpe	3
Southern Cross	1
Total	26

Two applications were not admitted on the grounds that the applicants did not have sufficient underground experience, another was not admitted, owing to the applicant not having had First Aid training, and another application was withdrawn by the applicant as he had insufficient knowledge of First Aid.

Details of the examination results are as follows:

Examined	22
Passed	14
Failed	8

NAMES OF SUCCESSFUL CANDIDATES

Ball, E.
Gibson, P. H.
Kelly, E. J.
O'Mara, G. K.
Sullivan, T. M.
Christian, L. W.
Honey, S. J.
MacFarlane, K.
Proud, D. J. B.
Shackleton, E. C.
Cooper, W. H.
Hornhardt, R. H.
Morris, J. H.
Russell, W. E.

Copies of the examination papers in Mining and Mining Law are attached hereto.

Eighteen (18) Certificates of Competency were issued. Four of these were to candidates whose applications were deferred from the previous year. The names of the candidates whose applications had been deferred, are as follows:—

Bishop, R. W.
Cheesewright, S. W.
Smith, C. L.
Giovanazzi, G.

One duplicate certificate was also issued.

Mine Managers' Certificates.—Three applications for the Mine Manager's Certificate were dealt with; one was approved and two not approved. The succesful applicant was:

Wolff, D.

One duplicate Mine Manager's Certificate of Competency was also issued.

General.—Five meetings of the Board of Examiners were held during the year. Members of the Board visited the following centres and examined candidates orally for the Underground Supervisor's Certificate.

Gwalia.
Kalgoorlie.
Norseman.
Perth.
Ravensthorpe.
Southern Cross.

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, 1960.

Attempt six (6) questions from Section A.

Attempt four (4) questions from Section B.

Time allowed—Three 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 to 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) Electric Firing.
   (b) Transport of Explosives.
2. (a) Construction of an underground dam.
   (b) Penthouses.
   (c) Unconsciousness resulting from the inhalation of fumes.
3. (a) The placement of winzes, and the arrangements of pipes, valves, hoses and ladders during winze sinking operations.
   (b) Rises.
4. (a) Clearing chutes and passes which have become "hung up."
   (b) The burning rate of safety fuse.
   (c) Times of blasting.
5. (a) Ventilation officers.
   (b) Internal combustion engines underground.
   (c) Recirculation of air.
6. (a) Signals to be used when firing adjacent to a shaft.
   (b) Platmen and bracemen.
7. Examination of ropes and winding appliances.
8. (a) Men working alone.
   (b) Firing in winzes.
   (c) Hours and days of employment underground.

SECTION B.

Mining Act Regulations.

Attempt four (4) questions from this section. Do not attempt more than four (4) questions from this section.

Marks allowed are ten (10) per question.

1. Describe briefly the circumstances under which, and the procedure necessary before—
   (a) Leases may be amalgamated.
   (b) Concentration of labour on Gold Mining Leases may be granted.

   Quote the number of men it is necessary to employ in either case to comply with labour conditions.
2. (a) An application for a lease has been submitted in accordance with the requirements of the Mining Act.

   What rights does this immediately confer upon the applicant?

   (b) If a lease is surrendered what must the lessee do with regard to any tailings on the lease if he wishes to retain possession of the tailings.
3. (a) For what purposes may Crown Lands be granted as a Lease?
   (b) What is the term of a Gold Mining Lease?
   (c) State the procedure to be adopted at the end of the prescribed period of a lease if the lessee desires to hold the ground for a further period.
4. (a) What are the obligations of a lessee regarding exploratory bore holes drilled on his property?
   (b) How would you mark off (peg) a Gold Mining Lease of 18 acres,
      (i) in a newly found field;
      (ii) which is identical with a previously surveyed lease which has been forfeited or surrendered?
5. (a) When must labour conditions be complied with on:
      (i) a Gold Mining Lease.
      (ii) a Mineral Lease.
      (iii) a Mineral Claim.
   (b) A lease may be declared void, cancelled, or forfeited. If this is done when is the land open for selection?
6. (a) What is Private Land?
   (b) What procedures are necessary before a miner may enter upon and search for minerals on private land?

Western Australia.

MINES REGULATION ACT, 1946.

Examination for Certificate of Competency as Underground Supervisor.

MINING.

September, 1960.

Time Allowed: Three (3) Hours.

Attempt four (4) questions from section A. Two (2) questions from section B.

Note.—Read the Examination Paper Carefully.

Answers must be written in ink.

Candidates should illustrate with sketches where possible.

SECTION A.

Attempt four (4) questions from this section.

1. Two levels have been driven on an orebody which is nearly vertical. One level is 200 feet below the other. It is desired to connect these levels by both a rise and a winze:
   (a) Describe how you would connect the levels by rising.
   (b) Describe how you would connect the levels by winzing.

   In each case state, what equipment you would use, what safety precautions you would take and draw sketches showing your lay-out when each has advanced 100 feet.

   It is not necessary to describe the 'cuts' used other than to name them, nor are sketches of the 'cuts' necessary.
2. Describe two of the following and in each case give the circumstances under which each would be used:—
   (a) Cut and fill stope.
   (b) Shrinkage stope.
   (c) Mill hole stope.
3. Describe fully, the precautions you would take for safe working:—
   (a) Timber pass repairing.
   (b) Operating a mechanical loader in a drive.
   (c) Firing a drive face electrically.
4. Describe two methods of timbering a level for stoping. Explain when and why each of the methods is used.

   Draw sketches to illustrate both methods.

5. Write a summary on:—
   (a) The safe storing, handling and use of nitro glycerine explosives.
   (b) Charging a face in a wet winze.
   (c) The prevention of 'fuming'.
6. Loose rock which had been used to fill a stope, broke through into the level below and caused about 50 feet of the timbered drive to collapse. How would you recondition the drive?

SECTION B.

Attempt two (2) questions only from this section.

Read the following short accounts of three fatal accidents which have actually occurred.

Write your own opinion of the safety principles involved.

(1) Two men approach a mullock pass which they know to be blocked at the top from an intermediate level. They found it blocked below that level. The pass was on an underlay but steep enough for the fine filling to run.
One man put on a safety belt with 28 feet of slack rope and got on to the material and started to work it down the pass.
The fill suddenly ran carrying him down with it.
His mate attempted to get him out but the pass above him started to run and he had then no chance of effecting a rescue.

(2) A miner was picked up by a platman in a cage to be shifted to a level above.
He had with him a rising feed machine and took it into the cage with him.
It was not secured but was held in place by the miner.
During the trip it escaped from his grip and he was killed.

(3) A miner was lowered into a winze from which there were short drives in opposite directions.
A few minutes later he rang one but there was nothing in the kibble when it reached the top of the winze.
He was subsequently found dead near the bottom of the winze.
The winze was ventilated by a fan and duct but this was found to be broken about half way down the winze.
The air pipe had a valve at the brace and one at the bottom of the winze.
The air supply was not turned on.
Post-mortem evidence showed that he died of carbon monoxide poisoning.

Western Australia.
MINES REGULATION ACT, 1946.

Examination for Certificate of Competency as Underground Supervisor.

MINING LAW.

September, 1960.

PAPER A.

Time Alowed: One and a half hours.

Attempt ten (10) 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 TEN (10) of the following:—

(1) Raising or lowering material in a cage or skip.
(2) Control of main magazine.
(3) Who is allowed to use explosives underground?
(4) Use of igniters.
(5) Clearing passes and chutes.
(6) First Aid outfits.
(7) Drawing off ore from shrink stope.
(8) Precautions to be taken when raising or lowering men in a cage or skip. Name any THREE of these precautions.
(9) Signals to be given when firing adjacent to a shaft.
(10) Who may take charge of a hoist not exceeding 12 horsepower and used for temporary winding purposes?
(11) Recirculation of air.
(12) Use of cyanide tailings underground.
(13) Supply of drinking water underground.
(14) Rail tracks used by locomotives underground.
(15) Who may fire electrically?

Western Australia.

MINES REGULATION ACT, 1946.

Examination for Certificate of Competency as Underground Supervisor.

MINING LAW.

September, 1960.

PAPER B.

Time Allowed: Half (½) an hour.

Attempt All Questions.

Note.—Read the Examination Paper Carefully. Answers must be written in ink.

For this Paper you are provided with a copy of the Mines Regulation Act.

1. What Section of the Act or what Regulation or Regulations refer to each of the following:—
   Example.
   Question: What Section of the Act or what Regulation refers to "Guides in shafts"?
   Answer: Regulation 102.

   (a) Handling of explosives.
   (b) Time of blasting.
   (c) Sunday labour in mines.
   (d) Use of electricity from lighting or power cables for firing shots.
   (e) Safety belts.
   (f) Information to be given to engine driver when shaft is being repaired.
2. Answer each of the following questions and give the number of the Regulation containing the answer:—
   Example.
   Question: What is the maximum grade for any road to be used by an underground locomotive?
   Answer: Shuttle car—1 in 10. Other type locomotive—1 in 12. Regulation 174.

   (a) The quantity of explosives which may be stored in a main magazine which is a building on the surface of the ground constructed in accordance with the requirements of the Mines Regulation Act?
   (b) Age for employment as a braceman.
   (c) Limit of speed of cage used to raise men when cage is within 200 feet of surface.
   (d) Quantity of fresh air to be supplied to each working place.

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LIST OF TABLES

DIVISION III

Report of the Superintendent of State Batteries—1960

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, 1960.

Crushing Gold Ores.

One 15 head, five 10 head, and eleven 5 head mills crushed 39,219 tons of ore made up of 601 separate parcels, an average of 65.26 tons per parcel. The bullion produced amounted to 17,349 ozs. which is estimated to contain 14,704 ozs. of fine gold, equal to 7 dwts. 12 grs, of gold per ton of ore.

The cost of crushing, including administration was 71s. 9d. per ton, an increase of 4s. 11d. per ton compared with the previous year when 39,048 tons were crushed at a cost of 66s. 10d. per ton.

The average value of the ore after amalgamation, but before cyanidation was 2 dwts. 20 gr. Thus the average head value of the ore was 10 dwts. 8 grs. which is 5 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	13,902·25	35·4
1 dwt. 18 grs. to 2 dwts. 8 grs. per ton	4,054·50	10·4
Under 1 dwt. 18 grs. per ton	20,743·75	52·9
Refractory	518·50	1·3
	39,219·00	100·0

Cyaniding.

Seven plants treated 20,827 tons of tailings from amalgamation for a production of 3,418 fine ozs. of gold worth £53,560. The average content was 4 dwts. 10 grs. before cyanidation, while the residue after treatment averaged 1 dwt 4 grs. The theoretical extraction was therefore 74 per cent. The actual extraction was 74 per cent.

The cost of cyaniding was 43/9 per ton, an increase of 5s. 2d. per ton on the previous year, when 21,409 tons were treated at a cost of 38s. 7d. per ton.

Estimated Overall Recovery.

Figures for estimated recovery are:—

	Content	Per ton crushed		Per cent.
	Fine oz.	dwts.	grs.	
Head Value	20,253	10	8	100
Amalgamation Recovery	14,704	7	12	72·6
Cyanidation Recovery	3,418	1	18	16·9
Total Recovery	18,122	9	6	89·5

Treatment of Ores other than Gold.

Lead Ores.—during the year the Northampton State Battery crushed 2,894.75 tons or lead ore with an estimated average content of 14.4 per cent. lead. There were 11 separate parcels, giving an average of 263.2 tons of ore per parcel.

A total of 483.86 tons of concentrates were produced. The concentrates averaged 75.8 per cent lead giving an estimated content of 366.7 tons of lead in concentrates.

2,410.9 tons of tailings were disgarded. These had an average content of 2.1 per cent lead, giving a total of 51.4 tons of lead discarded in tailings.

The recovery of lead in the concentrates was 87.7 per cent. of the lead in the ore delivered to the plant.

The cost of operating the Northampton State Battery, including administration, was £8,860 16s. 11d. being 61s. 3d. per ton of ore crushed. Revenue received was £3,101 12s. 6d., 21s. 5d. per ton. The corresponding figures for 1959, when 4,214.25 tons of ore were crushed, were operating cost £10,140 5s. 8d. 48s. 1d. per ton, and revenue £4,290 0s. 0d. 20s. 4d. per ton.

Sales of lead concentrates from the Northampton State Battery for the year were valued at £25,509.

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

	1960 £	Grand Total £
Par production—		
Crushing	62,460	8,638,874
Cyanidation	14,665	2,134,884
Gold Premium—		
Crushing	167,295	5,041,168
Cyanidation	38,895	1,443,086
Open Market Premium—		
Crushing	83	30,294
Cyanidation	19	10,260
Total Gold Production	£283,417	£17,298,566

OTHER ORES REALISED

	£	£
Tin—		
Ores	*Nil*	94,005
Residues	*Nil*	572
Tungsten Concentrates	*Nil*	18,850
Agricultural Copper Ore	*Nil*	2,648
Lead Concentrates	25,509	268,124
Total Other Ores	25,509	384,199
Grand Total	£308,926	£17,682,765

FINANCIAL

	Tons	Expenditure	Receipts	Loss
			£	£
Crushing—				
Gold Mills	39,219	140,673	18,646	122,027
Northampton....	2,894·75	8,861	3,102	5,759
Cyaniding	20,827	45,525	18,825	26,698
		£195,057	£40,573	£154,484

The loss of £154,484 is an increase of £13,935 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.
Bamboo Creek—			
Water Supply	3,110	14	4
Coolgardie—			
Dynamo and Warman Pump	8	5	5
Alterations to crushing plant	3,091	7	5
Lake Darlot—			
Cyanide Plant	5,178	10	11
Leonora—			
Erect Building over Battery	1,029	4	11
Yarri—			
Improvements to Living Quarters	41	18	2
Various—			
Renewal of Electrical Wiring	524	4	1
	£12,984	5	3

Cartage Subsidies.

	Tons	Cost
Ore carted to State Plants	12,986	£6,661 0 0

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
				£		£	£
1958	41,806	19,517	46·7	9,674	*Nil*	*Nil*	9,674
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

Administrative.

Expenditure amounted to £20,178 1s. 5, equivalent to 6s. 5d. per ton of ore crushed and cyanided, compared with an expenditure of £19,050 3s. 7d. 6s. 3d. per ton, for 1959.

	1959			1960		
	£	s.	d.	£	s.	d.
Salaries	10,144	19	0	11,320	10	1
Pay Roll tax	2,877	14	4	2,964	13	9
Workers' Compensation	4,026	1	2	3,728	18	0
Travelling and Inspection	1,572	5	8	1,659	15	6
Sundries	429	3	5	504	4	1
	£19,050	3	7	£20,178	1	5

Staff.

During the year two Acting managers were appointed to take the places of two Managers who died late in 1959.

B. McPherson was appointed Acting Manager at Yarri.

D. Marr was appointed Acting Manager at Ora Banda.

Manager Thompson was transferred from Yarri to Meekatharra.

I wish to thank all Officers at Head Office and at the Batteries for their capable and willing service during the year.

General.

The tonnage and grade of gold ore crushed were practically the same as for 1959. The tonnage and grade of tailings cyanided were lower than for 1959, but the amount of gold recovered per ton was considerably higher, resulting in an increase of 276 fine ozs gold recovered by cyaniding. Due to low lead prices, the lead ore crushed by the Northampton State Battery was 1,319.50 tons lower.

The costs per ton for crushing and cyaniding gold ores, and for crushing lead ores all showed increases. The increased costs for gold ores were caused by increases in salary and wages rates, and increases in costs for supplies. Also, as State Battery employees are paid fortnightly, and for 1960 the first pay period ended on January 1st, there were 27 pays during the year. The extra pay increased expenditure by over £4,000. The lower tonnage crushed at Northampton caused much of the increased cost per ton.

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, 1960

Battery	Tons Crushed	Gold Yield Bullion ozs.	Value per Ton in shillings	Total Value without Premium
				£ s. d.
Bamboo Creek	962·50	272·30	20·36	980 5 7
Boogardie	475·25	340·55	51·62	1,225 19 7
Coolgardie	2,799·50	1,833·00	47·13	6,598 16 0
Cue	862·25	398·40	33·27	1,434 4 10
Kalgoorlie	8,411·25	4,279·65	36·63	15,406 14 9
Lake Darlot	1,567·50	261·00	11·99	939 12 0
Leonora	765·00	233·95	22·02	842 4 5
Marble Bar	1,016·25	321·25	22·77	1,156 10 0
Marvel Loch	1,926·50	1,249·40	46·68	4,497 16 10
Meekatharra	4,035·75	674·95	12·04	2,429 16 5
Menzies	3,535·75	2,046·15	41·66	7,366 2 10
Norseman	1,093·75	362·55	23·86	1,305 3 7
Nullagine	1,026·50	631·20	44·25	2,272 6 5
Ora Banda	2,768·00	1,055·30	27·45	3,799 1 7
Peak Hill	4,583·50	709·75	11·15	2,555 2 0
Sandstone	244·75	78·60	23·10	282 19 2
Yarri	3,145·00	2,601·40	59·56	9,365 0 10
Total	39,219·00	17,349·40	31·85	62,457 16 10

SCHEDULE No. 2

Number of Parcels Treated, Tons Crushed and Head Value for the Year ended 31st December, 1960

No. of Parcels Treated	Battery	Tons Crushed	Yield by Amalgamation Bullion	Yield by Amalgamation Fine Gold	Tailings Gross at 100 per cent.	Total Contents of ore Fine Gold	Average per Ton Fine Gold	Gross Value per Ton Fine Gold at £4 4s. 11½d. Per Ounce
			oz. dwts.	oz. dwts.	oz. dwts.	oz. dwts.	dwts. grs.	£ s. d.
7	Bamboo Creek	962·50	272 6	230 15	410 19	641 14	13 8	2 16 8
15	Boogardie	475·25	340 11	288 12	136 9	425 1	17 22	3 16 1
79	Coolgardie	2,799·50	1,833	1,553 10	447 15	2,001 5	14 7	3 0 9
23	Cue	862·25	398 8	337 13	148 6	485 19	11 7	2 8 0
122	Kalgoorlie	8,411·25	4,279 13	3,627 1	1,227 13	4,854 14	11 13	2 9 0
9	Lake Darlot	1,567·50	261	221 4	285 8	506 12	6 11	1 7 5
23	Leonora	765·00	233 19	198 5	102 1	300 6	7 22	1 13 8
10	Marble Bar	1,016·25	321 5	272 5	143 9	415 14	8 4	1 14 8
37	Marvel Loch	1,926·50	1,249 8	1,058 17	315 2	1,373 19	14 6	3 0 7
53	Meekatharra	4,035·75	674 19	572 1	580 3	1,152 4	5 17	1 4 3
76	Menzies	3,535·75	2,046 3	1,734 3	599 4	2,333 7	13 5	2 16 1
21	Norseman	1,093·75	362 11	307 5	142 10	449 15	8 5	1 14 10
13	Nullagine	1,026·50	631 4	534 19	158 10	693 9	13 13	2 17 6
47	Ora Banda	2,768·00	1,055 6	894 7	421 4	1,315 11	9 12	2 0 4
24	Peak Hill	4,583·50	709 15	601 10	222 11	824 1	3 15	15 5
4	Sandstone	244·75	78 12	66 13	24 11	91 4	7 11	1 11 8
38	Yarri	3,145·00	2,601 8	2,204 12	184 1	2,388 13	15 5	3 4 7
601	Total	39,219·00	17,349 8	14,703 12	5,549 16	20,253 8	10 8	2 3 11

Average Tons per Parcel .... 65·26
Average Yield by Amalgamation per ton (Fine Gold) ....7 dwts. 12 grs.
Average Value by Amalgamation per ton (Fine Gold) .... £1 11s. 10d.
Average Head Value of Tailings per ton (Fine Gold) ....2 dwts. 20 grs.
Average Value of Tailings per ton (Fine Gold) .... 12s. 1d.

SCHEDULE No. 3

Segregation of Tailings Produced according to Value, Year ended 31st December, 1960

Battery	Payable			2 dwts. 8 grains to 1 dwt. 18 grains			1 dwt. 18 grains and under			Refractory			Total		
	Tons	oz.	dwts.	Tons	oz.	dwts.	Tons	oz.	dwts.	Tons	oz.	dwts.	Tons	oz.	dwts.
Bamboo Creek	736·50	386	9	226·00	24	10	....	....	....	....	....	....	962·50	410	19
Boogardie	304·00	123	9	84·25	8	19	87·00	4	1	....	....	....	475·25	136	9
Coolgardie	1,038·00	324	15	127·75	12	14	1,633·75	110	6	....	....	....	2,799·50	447	15
Cue	202·25	59	17	82·75	8	6	543·25	18	4	34	61	19	862·25	148	6
Kalgoorlie	2,792·75	940	11	768·00	76	11	4,850·50	210	11	....	....	....	8,411·25	1,227	13
Lake Darlot	1,346·00	270	16	200·00	13	2	21·50	1	10	....	....	....	1,567·50	285	8
Leonora	413·00	79	18	23·50	2	12	328·50	19	11	....	....	....	765·00	102	1
Marble Bar	526·25	102	2	285·00	29	14	205·00	11	13	....	....	....	1,016·25	143	9
Marvel Loch	1,241·00	241	8	203·00	21	5	242·50	12	2	240	40	7	1,926·50	315	2
Meekatharra	2,042·75	460	19	244·50	26	2	1,516·50	61	15	232	31	7	4,035·75	580	3
Menzies	1,111·75	417	13	576·50	59	....	1,847·50	122	11	....	....	....	3,535·75	599	4
Norseman	292·00	84	15	233·50	25	10	568·25	32	5	....	....	....	1,093·75	142	10
Nullagine	452·00	115	18	153·00	16	1	421·50	26	11	....	....	....	1,026·50	158	10
Ora Banda	1,280·75	307	....	457·75	41	5	1,017·00	60	18	12·50	12	1	2,768·00	421	4
Peak Hill	37·00	16	16	315·00	34	....	4,231·50	171	15	....	....	....	4,583·50	222	11
Sandstone	78·25	16	....	....	....	....	166·50	8	11	....	....	....	244·75	24	11
Yarri	8·00	1	15	74·00	7	15	3,063·00	174	11	....	....	....	3,145·00	184	1
Total	13,902·25	3,950	1	4,054·50	407	6	20,743·75	1,046	15	518·50	145	14	39,219·00	5,549	16

SCHEDULE No. 4

Details of Extraction Tailings Treatment, 1960

Battery	Tons Treated	Head Value		Contents	Tail Value		Contents	Recovery	Call	Recovery	Shortage	Surplus
		dwts.	grs.	dwts.	dwts.	grs.	dwts.	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coolgardie	4,082	4	1	16,420	1	2	4,488	73	2,534 5 9	2,501 7 4	32 18 5	....
Kalgoorlie	4,384	5	1	22,009	1	4	5,126	77	3,500 17 7	3,494 17 4	6 0 3	....
Lake Darlot	4,550	3	21	17,708	....	18	3,498	80	3,018 4 8	3,098 19 10	....	80 15 2
Marble Bar	1,333	5	22	7,894	2	....	2,657	66	1,112 6 8	1,194 3 8	....	81 17 0
Marvel Loch	2,103	2	11	5,160	....	16	1,400	73	798 10 3	769 3 6	29 6 9	....
Menzies	3,875	5	15	21,785	1	17	6,551	70	3,235 11 6	3,434 5 9	....	198 14 3
Ora Banda	500	1	20	923	....	11	221	76	149 2 4	227 7 0	....	78 4 8
Total	20,827	4	10	91,899	1	4	23,941	74	14,348 18 9	14,720 4 5	68 5 5	439 11 1

Net Surplus	£371 5s. 8d.
Head Value	4 dwts. 10 grains
Tail Value	1 dwt. 4 grains
Theoretical Recovery	74%
Actual Recovery	74%

SCHEDULE No. 5

Direct Purchase of Tailings, Year Ended 31*st December*, 1960

Battery	Tons of Tailings Purchased	Amount Paid at £4 4s. 11½d. per oz.	Amount Paid Account of Premium
		£ s. d.	£ s. d.
Bamboo Creek	570·50	730 10 2	1,677 0 7
Boogardie	442·25	288 4 6	677 14 11
Coolgardie	1,066·75	542 19 0	1,805 16 0
Cue	182·75	103 19 7	238 14 1
Kalgoorlie	2,200·50	1,599 15 6	4,747 0 5
Lake Darlot	1,235·75	342 2 3	1,270 13 6
Leonora	476·75	113 6 11	260 4 1
Marble Bar	519·00	215 8 7	794 13 2
Marvel Loch	1,023·00	196 8 10	521 6 2
Meekatharra	1,167·75	460 0 5	1,056 1 3
Menzies	1,569·50	1,173 18 1	3,498 0 1
Norseman	352·50	181 9 7	416 12 5
Nullagine	406·50	181 0 5	415 11 4
Ora Banda	1,187·50	471 2 7	1,081 11 2
Sandstone	70·25	21 17 7	50 4 6
Yarri	15·25	12 3 5	27 18 9
Total	12,486·50	6,634 7 5	18,539 2 5

SCHEDULE No. 6

Cyanide Yield, 1960

Battery	Tons	Fine oz.	Value	Premium	Total
			£	£	£
Coolgardie	4,082	589·52	2,504·113	6,707·112	9,211·225
Kalgoorlie	4,384	818·81	3,494·867	9,327·322	12,822·189
Lake Darlot	4,550	729·56	3,098·992	8,300·466	11,399·458
Marble Bar	1,333	274·90	1,177·559	3,127·753	4,305·312
Marvel Loch	2,103	181·08	769·175	2,060·183	2,829·358
Menzies	3,875	782·59	3,440·088	8,903·862	12,343·950
Ora Banda	500	41·16	180·004	468·275	648·279
Total	20,827	3,417·62	14,664·798	38,894·973	53,559·771

SCHEDULE No. 7

Statement of Receipts and Expenditure for the Year ended 31st December, 1960

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
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.
Bamboo Creek	962·50	1,280 10 10	2,729 3 0	1,218 17 2	5,228 11 0	108 8	727 14 8	839 11 9	6,795 17 5	141 3	533 6 1	11 1	....	6,262 11 4
Boogardie	475·25	339 16 7	613 12 7	182 12 1	1,136 1 3	47 10	85 1 0	509 0 11	1,730 3 2	72 10	246 2 5	10 4	....	1,484 0 9
Coolgardie	2,799·50	1,229 4 2	2,218 14 9	1,955 4 2	5,403 3 1	38 7	5,633 2 0	1,424 1 11	12,460 7 0	89 0	1,169 4 3	8 4	....	11,291 2 9
Cue	862·25	2,241 18 8	744 14 0	521 5 5	3,507 18 1	81 4	338 8 2	547 15 10	4,394 2 1	101 11	447 0 1	10 4	....	3,947 2 0
Kalgoorlie	8,411·25	5,113 12 10	5,493 1 0	4,674 12 1	15,281 5 11	36 4	2,048 14 10	2,886 9 9	20,216 10 6	48 1	3,510 18 0	8 4	....	16,705 12 6
Lake Darlot	1,567·50	1,503 8 11	2,847 8 4	984 17 0	5,335 14 3	68 1	1,742 15 5	1,055 9 8	8,133 19 4	103 9	860 16 3	11 0	....	7,273 3 1
Laverton	....	....	168 0 0	....	168 0 0	....	178 1 5	54 12 0	400 13 5	....	62 0 0	....	....	338 13 5
Leonora	765	2,177 0 3	1,631 2 9	683 6 1	4,491 9 1	117 5	693 16 8	1,146 12 9	6,331 18 6	165 6	406 7 3	10 7	....	5,925 11 3
Marble Bar	1,016·25	2,929 8 10	1,432 6 3	1,145 19 5	5,507 14 6	108 5	1,367 14 10	1,061 17 4	7,937 6 8	156 3	653 1 8	12 10	....	7,284 5 0
Marvel Loch	1,926·50	1,882 8 10	3,782 16 0	1,221 11 0	6,886 15 10	71 6	866 15 1	780 8 10	8,533 19 9	88 7	986 2 4	10 3	....	7,547 17 5
Meekatharra	4,035·75	1,957 3 7	5,451 1 5	2,137 6 3	9,545 11 3	47 4	1,320 18 11	1,685 2 8	12,551 12 10	62 2	1,633 16 0	8 1	....	10,917 16 10
Menzies	3,535·75	1,631 12 8	3,109 18 6	1,310 15 3	6,052 6 5	34 3	566 8 2	1,232 15 9	7,851 10 4	44 5	1,626 0 11	9 2	....	6,225 9 5
Norseman	1,093·75	555 18 2	1,546 5 1	646 9 2	2,748 12 5	50 3	484 2 8	891 12 7	4,124 7 8	75 5	535 17 11	9 10	....	3,588 9 9
Nullagine	1,026·50	640 13 3	2,566 14 2	821 8 9	4,028 16 2	78 6	1,208 16 0	1,314 7 0	6,551 19 2	127 8	507 17 3	9 11	....	6,044 1 11
Ora Banda	2,768	2,419 2 4	2,127 8 10	1,730 17 3	6,277 8 5	45 4	990 19 7	1,129 1 3	8,397 9 3	60 8	1,374 17 10	9 11	....	7,022 11 5
Paynes Find	....	....	110 6 7	....	110 6 7	....	....	10 9 9	120 16 4	....	31 0 0	....	....	89 16 4
Peak Hill	4,583·50	1,605 10 0	5,637 0 10	1,385 17 2	8,628 8 0	37 8	485 16 7	2,166 19 9	11,281 4 4	49 2	1,840 13 0	8 10	....	9,440 11 4
Sandstone	244·75	356 8 0	140 4 9	138 1 8	634 14 5	51 10	116 7 6	308 11 6	1,059 13 5	86 7	215 5 6	17 7	....	844 7 11
Yarri	3,145	2,151 15 1	5,372 16 3	1,875 19 8	9,400 11 0	59 9	938 14 9	1,460 9 6	11,799 15 3	75 0	1,992 12 6	12 8	....	9,807 2 9
Head Office	....	....	....	....	....	....	....	....	....	....	12 17 11	....	12 17 11	....
	39,219	30,015 13 0	47,722 15 1	22,634 19 7	100,373 7 8	51 2	19,794 8 3	20,505 10 6	140,673 6 5	71 9	18,645 17 2	9 6	12 17 11	122,040 7 2
Northampton (Lead)	2,894·75	2,836 6 10	2,420 5 8	1,059 0 2	6,315 12 8	43 8	1,215 12 6	1,329 11 9	8,860 16 11	61 3	3,101 12 6	21 5	....	5,759 4 5
Total	42,113·75	32,851 19 10	50,143 0 9	23,693 19 9	106,689 0 4	50 8	21,010 0 9	21,835 2 3	149,534 3 4	71 0	21,747 9 8	10 4	12 17 11	127,799 11 7
Net Loss	....	....	....	....	....	....	....	....	....	....	....	....	....	127,786 13 8

SCHEDULE No. 8

Receipts and Expenditure, 1960

Cyaniding

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
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.
Coolgardie	4,082	644 10 7	4,313 4 11	1,091 19 7	6,049 15 1	29 8	475 7 8	1,775 13 1	8,300 15 10	40 8	3,719 18 11	18 3	....	4,580 16 11
Cue	....	....	....	101 15 6	101 15 6	....	52 18 9	6 19 7	161 13 10	....	....	....	....	161 13 10
Kalgoorlie	4,384	1,796 6 1	3,931 10 4	2,830 13 1	8,558 9 6	39 1	142 16 10	1,691 14 10	10,393 1 2	47 5	2,459 19 1	11 3	....	7,933 2 1
Lake Darlot	4,550	414 10 8	2,094 15 9	1,720 7 9	4,229 14 2	18 7	3,284 1 11	2,038 3 1	9,551 19 2	42 0	5,837 13 11	25 8	....	3,714 5 3
Marble Bar	1,333	391 0 6	1,441 7 0	505 18 9	2,338 6 3	35 1	124 15 5	530 2 7	2,993 4 3	44 11	1,323 5 2	19 10	....	1,669 19 1
Marvel Loch	2,103	490 6 8	1,440 17 9	832 3 1	2,763 7 6	26 3	289 18 4	1,145 13 6	4,198 19 4	40 0	2,028 5 6	19 3	....	2,170 13 10
Meekatharra	....	....	116 0 0	....	116 0 0	....	148 16 5	20 2 6	284 18 11	....	....	....	....	284 18 11
Menzies	3,875	895 14 4	4,533 17 9	1,320 14 2	6,750 6 3	34 10	32 0 8	1,348 12 11	8,130 19 10	42 0	5,131 13 2	26 6	....	2,999 6 8
Ora Banda	500	214 1 8	508 19 8	339 4 6	1,062 5 10	42 6	210 19 3	234 7 4	1,507 12 5	60 4	484 16 7	19 5	....	1,022 15 10
Total Receipts	20,827	4,846 10 6	18,380 13 2	8,742 16 5	31,970 0 1	30 8	4,761 15 3	8,791 9 5	45,523 4 9	43 9	20,985 12 4	20 2	....	24,537 12 5
Interest Paid to Treasury	....	....	....	....	....	....	....	....	....	....	2,160 0 0	....	....	2,160 0 0
Gross Loss	....	....	....	....	....	....	....	....	....	....	18,825 12 4	....	....	26,697 12 5

STATE BATTERIES

Trading and Profit and Loss Account for the Year Ended 31st December, 1960

1959		1960	
£		£	£
96,467	Trading Costs— Wages	106,222	
31,915	Stores	32,437	
23,791	Repairs, Renewals and Battery Spares	25,772	
29,695	General Expenses and Administration	30,626	
181,863		....	195,057
	Earnings—		
41,318	Milling and Cyaniding Charges	....	40,573
140,550	Operating Loss for the Year	....	154,484
	Other Charges—		
23,799	Interest on Capital	24,376	
12,743	Depreciation	12,708	
2,371	Superannuation—Employers, Share	2,413	
38,913		....	39,497
£179,463	Total Loss for the Year	....	£193,981

STATE BATTERIES

Balance Sheet as at 31st December, 1960

31st December, 1959	Funds Employed	31st December, 1960	
£		£	£
576,858	Capital— Provided from General Loan Fund	589,682	
137,245	Provided from Consolidated Revenue Fund	137,235	
714,103		....	726,917
	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—		
949,422	Interest on Capital	....	973,798
	Other Funds—		
1,200,487	Provided from Consolidated Revenue Fund (Excess of payments over collections)	....	1,357,003
2,906,420			3,100,126
	Deduct—		
	Profit and Loss :		
2,540,250	Loss at Commencement of year	2,719,713	
179,463	Loss for Year	193,981	
2,719,713	Total Loss from Inception	....	2,913,694
£186,707			£186,432
	Employment of Funds		
	Fixed Assets—		
708,512	Plant, Buildings and Equipment	721,326	
603,871	*Less* Depreciation	616,579	
104,641		....	104,747
	Current Assets—		
3,349	Debtors	4,331	
58,598	Stores	64,820	
1,957	Battery Spares	1,914	
	Purchase of Tailings—		
3,193	Treasury Trust Account	9,899	
49,056	Tailings not treated	42,097	
6,971	Estimated Gold Premium	5,957	
123,124		....	129,018
227,765	Total Assets	....	233,765
	Deduct—		
	Current Liabilities :		
5,315	Creditors	10,443	
24,523	Liability to Treasurer (Superannuation—Employers' Share)	26,937	
	Purchase of Tailings :		
4,249	Creditors	3,996	
6,971	Estimated Premium Due	5,957	
41,058		....	47,333
£186,707			£186,432

DIVISION IV

Annual Progress Report of the Geological Survey Branch of the Mines Department for the year 1960

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DIVISION IV

Annual Progress Report of the Geological Survey Branch of the Mines Department for the Year 1960

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 1960, together with reports on investigations not made specifically for departmental purposes.

STAFF.

Staff members as at 31st December, 1960, were as follows:—

Professional :

Ellis, H. A., B.Sc., A.O.S.M. (N.Z.)	Government Geologist
Lord, J. H., B.Sc. (W.A.), F.G.S., M.Inst.M.M.	Deputy Government Geologist
Berliat, K., D.Sc. (Switzerland)	Senior Geologist
Sofoulis, J., B.Sc. (W.A.)	Geologist, Grade 1
de la Hunty, L. E., B.Sc. (W.A.)	Geologist Grade 1
Low, G. H., B.Sc. (W.A.)	Geologist, Grade 1
Noldart, A. J., B.Sc. (Syd.)	Geologist, Grade 1
Wyatt, J. D., B.A. (W.A.)	Geologist, Grade 2
Connolly, R. R.	Geologist, Grade 2
Bartram, G. D., B.Sc. (W.A.)	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

Clerical :

Robinson, G.	Clerk (Temporary)
Cook, Miss M. L.	Typist (Temporary)
Macliver, R. D.	Junior Clerk

Laboratory :

Fimmell, L. H.	Laboratory Technician

Promotions, Resignations, Appointments.

There were no resignations or promotions of professional officers during the year.

As a result of my pending retirement in May, 1961, a decision was made by the Government to create the position of Deputy Government Geologist, and on 12th December, 1960, Mr. J. H. Lord commenced duties in that capacity.

Mr. K. H. Morgan and Mr. W. R. K. Jones commenced duties as Geologists, Grade 2, on May 23rd and July 4th respectively.

Mrs. J. B. Miller, on account of her proficiency as a technical stenographer and typiste, skills which she acquired in her service with this Branch, was transferred to the Public Service Commissioner's Office as stenographer to the Swan River Pollution Committee. Her place was taken by Miss M. L. Cook, transferred from the National Parks Board of W.A. on February 24th, 1960.

Mr. R. E. Baker, Clerk, was successful in an application for a higher position in another Department, and he ceased duty with this Branch on September 30th, 1960, after little over a year of service. The position of Clerk was filled on a temporary basis by Mr. G. Robinson on transfer from the Department of Child Welfare.

Mr. R. D. Macliver commenced duties as Junior Clerk on February 15th, 1960, replacing Mr. J. Rogers.

PROFESSIONAL STAFF.

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

Government Geologist	1
Deputy Government Geologist	1
Senior Geologist	1
Geologists—Grade 1	4
Geologists—Grade 2	6
Total	13

During the year the newly created position of Deputy Government Geologist was filled and the two vacancies for Geologists Grade 2 were also filled, bringing the strength up to 13 professional officers.

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 (June)
		sq. miles		
Jan.-May.	10	975,920	97,592	730,581
May-June	11	....	88,720	....
July-Dec.	12	....	81,327	....

Activities of Professional Officers:

H. A. Ellis, Government Geologist.

In addition to head office administrative and consulting duties, field work for various purposes was undertaken as follows:—

February.—Ravensthorpe, Londonderry and Marda (Pollucite and Iron Ore).

March.—Attended conference of State and Commonwealth Government Geologists at Canberra.

April.—Koolyanobbing and Bungalbin (Iron Ore).

July.—Accompanied Minister for Mines on tour of Yalgoo and Murchison Districts (Gold).

August.—Nullagine District (Regional Geology), Mt. Goldsworthy (drilling for Iron Ore) and Hamelin Pool (Limestone).

October.—Lease pegging for B.H.P. at Koolyanobbing and Bungalbin (Iron ore).

K. Berliat, Senior Geologist.

January-December.—Participation in and supervision of Hydrological Surveys of the North and Central parts of the Perth Basin, and supervision of exploratory drilling in the Hill River and Tenindewa areas. Miscellaneous Water Supply investigations.

J. Sofoulis, Geologist, Grade 1.

January.—Report writing and map compilation in connection with the regional survey of the Balfour Downs 4-mile Sheet.

February.—Iron ore investigations, Bungalbin area.

March.—Air photo interpretation in preparation for regional survey of Boorabbin 4-mile Sheet.

April-October.—Regional Survey of Boorabbin 4-mile Sheet.

November-December.—Report writing and map compilation consequent on regional survey.

L. E. de la Hunty, Geologist, Grade 1.

January-March.—Balfour Downs 4-mile Sheet, compilation and report writing.

April-July.—Field work on Balfour Downs 4-mile Sheet.

August-September.—Sampling Iron Ore deposits near Pt. Hedland.

October.—Inspection of Scott River iron deposit.

November.—Annual leave and inspection of manganese deposit near Peak Hill.

December.—Report writing.

G. H. Low, Geologist, Grade 1.

January.—Investigation of Cardup Shales for lightweight concrete aggregate. Progress report on Widgiemooltha Survey.

February.—Investigations and reports on oil search in W.A., Iron Ore investigation at Collie.

March.—Preparation of Mineral Resources Bulletin "Copper Resources in W.A.".

April.—Copper Bulletin compilation and supervision of exploratory diamond drilling of Mt. Goldsworthy Iron Ore deposits (commencing 20th April).

May-November.—Supervision Mt. Goldsworthy Iron Ore drilling. Investigation into coal reserves at Muja depression, Collie. Examination of "Prince Charlie" G.M., Bamboo Creek, and "Coronation" G.M., Marble Bar.

December.—Report writing and annual leave.

A. J. Noldart, Geologist, Grade 1.

January.—Completion Leonora/Gwalia Survey report.

February.—Pilbara Survey Bulletin compilation.

March-May.—Miscellaneous inspections: Kooolyanobbing/Bungalbin, Agnew, Coolgardie. Compilation Pilbara Survey Bulletin.

June.—Investigations nickel deposits on W.A./S.A. border.

July-August.—Compilation of Pilbara Survey Bulletin.

September-October.—Field work for Pilbara Survey.

November-December.—Compilation Pilbara Survey Bulletin; sampling underground diamond drill core from Bayley's, Surprise and Barbara Goldmines, Coolgardie.

J. D. Wyatt, Geologist, Grade 2.

January-April.—Miscellaneous investigations.

May-October.—Ord River Damsite mapping and drilling supervision.

November-December.—Report writing and miscellaneous investigations.

R. R. Connolly, Geologist, Grade 2.

January-August.—Miscellaneous inspections and laying out Weld Range Iron Ore Exploratory Drilling Programme.

September-December.—Preparation for and supervision of main office shift to new premises.

G. D. Bartram, Geologist, Grade 2.

January-March.—Collation of field information from 1959 season.

March-May.—Hydrological Survey Three Springs area.

June-August.—Hydrological Survey Northampton Area.

September-November.—Hydrological Survey of Mandurah area.

December.—Collation of field information and annual leave.

W. M. Bock, Geologist, Grade 2.

January.—Completion of Leonora/Gwalia Survey report.

February.—Bungalbin Iron Ore investigations in company of Mr. Sofoulis.

March.—Preparation of data for Regional Survey of Boorabbin 4-mile Sheet.

April-October.—Regional Survey of Boorabbin 4-mile Sheet.

November-December.—Collation of field information on the Boorabbin 4-mile Survey.

K. H. Morgan, Geologist, Grade 2.

Commenced duties May 23rd, 1960.

June-July.—Hydrological Surveys Mundijong and Northampton areas.

August-December.—Hydrological Surveys in Mundijong, Pinjarra, Rockingham areas and selection of bore sites in North Dandalup area.

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

Commenced duties July 4th, 1960.

July-October.—Preparation of data for Northampton Survey and miscellaneous inspections.

November-December.—Supervision of diamond drilling of the Mountain View North Prospect, Day Dawn, and miscellaneous investigations.

REORGANIZATION

The Government announced about half way through last year that it was intended to "double the staff of the Geological Survey". Earlier in the year it was suddenly realised that I would be compulsorily retired in May of 1961, and steps were taken to appoint a long promised Deputy Government Geologist in order that my potential successor would be in a better position to supervise the work of the Branch.

The Deputy Government Geologist commenced duties on December 12th, 1960, and in accordance with the "double the staff of the Geological Survey" policy, plans are being made to sectionize the activities of the professional staff in order that the proposed increase may become effective in 1961.

ACCOMMODATION

On October 31st the head office of the Survey shifted from the Museum Buildings on the corner of Beaufort and Francis Streets to renovated rented quarters at 26 Francis Street, Perth. The quarters at present being occupied house only part of the staff and are quite inadequate to provide for a double increase.

If the Geological Survey is to be regarded as of considerable importance in the economic life of the State, as it richly deserves to be, then surely it is worthy of suitable housing. It is not encouraging to be shifted from quarters which we occupied since 1903 (and to be still inadequately housed) to make room for the expansion of an Art Gallery to cater for modern "art". The move was organized and supervised in a most capable manner by Mr. R. R. Connolly.

FIELD WORK

Major Field Work completed during the Year or in Progress as at 31st December, 1960.

(1) Completion of diamond drilling at Paddy's Flat, Meekatharra;

(2) Completion of diamond drilling at Coolgardie;

(3) Completion of diamond drilling at Mt. Goldsworthy;

(4) Completion of the regional geological survey of the Balfour Downs 4-mile Sheet;

(5) Completion of the damsite test drilling at Bandicoot Bar, Ord River;

(6) Continuation of the regional Geological Survey of an area between Coolgardie and Norseman covered by the 4-mile Sheets Boorabbin, Widgiemooltha, Lake Johnston and Norseman;

(7) Continuation of the supervision of damsite test drilling at the main damsite, Ord River;

(8) Geological mapping, the collection of underground data and supervision of drilling for water in various parts of the State;

(9) Supervision of diamond drilling on the Mountain View North Prospect, Day Dawn.

Field Work Planned for 1961.

(1) Continuation of the Coolgardie-Norseman regional survey;

(2) Continuation of supervision of Ord River damsite test drilling;

(3) A detailed geological survey of the Northhampton Mineral Field;

(4) Continuation of Underground Water Surveys;

(5) Supervision of exploratory drilling of iron ore deposits, Weld Range (N.W. of Cue);

(6) Field work in connection with the preparation of a Mineral Resources Bulletin on the copper deposits of W.A.;

(7) Field work in connection with the preparation of a Mineral Resources Bulletin on Manganese and Chromite Resources of W.A.

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 31-12-60	Mileage for 1960	Date purchased (new)	Remarks
909	Willys Jeep	5	54,608	4,065	1953	
3135	Fargo Utility	15	73,760	9,698	1954	
3678	Dodge Utility	15	51,000	8,347	1955	
3535	Landrover L.W.B. Utility	10	66,148	11,763	1955	
3876	do. do.	10	50,289	9,292	1956	
4559	do. do.	10	51,823	13,754	1957	
4475	do. do.	10	55,350	18,594	1957	
4691	International F.W.D. Utility	20	37,116	10,703	1957	
5009	do. do.	20	30,560	11,251	1958	
4793	do. do.	20	32,590	14,404	1958	
5352	do. do.	20	15,995	10,745	1959	
5712	Landrover L.W.B. Utility	10	14,132	14,132	1960	Purchased 30/3/60
5958	do. do.	10	3,110	3,110	1960	Purchased 14/10/60
6060	do. do.	10	*Nil*	*Nil*	1960	Purchased 21/12/60

Total Miles: 139,858.

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.

SERVICE TO THE GENERAL PUBLIC, MINING INTERESTS, AND GOVERNMENT DEPARTMENTS.

The year saw no diminution in the services required from this Branch in matters coming under the above heading. Each year sees an increase in the demands made on us for information and consultations on matters correctly referable to this Branch, and an increase in staff will enable us to give even better service in the future.

ACTIVITIES OF THE COMMONWEALTH BUREAU OF MINERAL RESOURCES.

A regional geological survey was made by a Bureau party of the two 4-mile sheets Macdonald and Rawlinson covering an area near the eastern W.A. border between the south-east Canning and Western Amadeus Basins.

Some geophysical gravity surveying was done in the Kimberleys and airborne magnetometer and scintillograph surveys were continued in the Ravensthorpe and Norseman areas.

PUBLICATIONS.

Issued during 1960.

Mineral Resources Bulletin No. 7.—Iron Ores in Western Australia.

Bulletin 113.—Miscellaneous Reports for 1956.

Bulletin 114.—Miscellaneous Reports for 1957.

Annual Progress Report for 1958.

In the Press.

Annual Progress Report for 1959.

In Course of Preparation.

A Bulletin on the Geology of the Nullagine and Marble Bar 4-mile sheets.

A Mineral Resources Bulletin on the Manganese and Chromite Resources of W.A.

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

A Geological Map of the Balfour Downs 4-mile Sheet with Explanatory Notes.

A Geological Map of the Boorabbin 4-mile Sheet with Explanatory Notes.

H. A. ELLIS,
Government Geologist.

REPORT ON LIME SHELL DEPOSITS— HAMELIN POOL, W.A.

Approximate latitude 26° S.
Approximate longitude 114° E.

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

Locality.

Hamelin Pool is a large bay in the south-eastern portion of the major geographical feature known as Shark Bay, in which Dirk Hartog Island and Peron Peninsular are prominent well-known features. The principal shell bearing area can be visualised as lying about 170 miles airline N. 10° W. from Geraldton, or about 200 miles by good road from that port.

Nature and Extent.

The deposits are composed essentially of three forms of vast accumulations of the shells of a small bivalve measuring about $\frac{3}{8}$ in. x $\frac{3}{8}$ in. x $\frac{1}{8}$ in. deep with which are associated in minor quantities fragments of shells of other species and varying amounts of quartz sand and other detrital mineral impurities.

The three forms are:—

(a) Discontinuous patches of unconsolidated shell dunes comparatively free of impurities extending over lengths of about 20 chains with widths varying from 2 to 5 chains and up to 20 feet deep (see analysis of H.P. 1 below).

(b) Discontinuous patches of consolidated shell bed forming escarpments in places and backing form (a) inland. These patches vary greatly in purity and in degree of consolidation.

(c) Very extensive low lying dune areas consisting of very small communited shell fragments with a few complete single valves and some nodular calcareous material of extremely fine grain size. This form contains visible free silica grains and some black detrital mineral (see analysis of H.P. 2 below).

These three types of deposits occur over a coast-line distance of about 130 miles, commencing at Gladstone due west of Yaringa N. homestead, on the east side of Hamelin Pool and continuing to a point on the west side of Lharidon Bight opposite Petit Point, the most northerly point on Nanga Station.

The highest grade and most extensive deposits of type (a) are situated on the coast adjacent to the shore line ½ mile N-W of Hamelin Pool telegraph station; on the coast about 4 miles S-W of Yaringa S. homestead; and at the south end of Lharidon Bight, N-W of Nanga Station.

The consolidated form is best known from the localities N-W of Hamelin Pool telegraph station and S-W of Yaringa S. homestead. These are the two principal localities from which shell-blocks have been quarried for building purposes.

The finely granular form (c) is wide-spread over the distance quoted above.

The good quality unconsolidated shell from near the Hamelin Pool telegraph station and S-W of Yaringa S. homestead has been heavily drawn upon as road surfacing material in the sealing of the Geraldton-Carnarvon Road, and the good grade loose shell N-W of Nanga Station is the main source of supply of poultry farming shell grit.

Local residents of the Hamelin Pool area informed the writer that unusually strong N-W storms in the winter months bring large quantities of dead shell ashore, and some shell terraces were visible on the tidal flats well below high-water mark on August 20, 1960.

Availability of Supplies.

There are vast quantities of the three forms of material described above in the limits mentioned, but as the grade does vary noticeably from point to point in each form of deposit, anyone requiring material of a particular specification should undertake a proper sampling campaign before mining any of the material.

Analyses.

Sample H.P.1.—From a mass of loose shell situated ½ mile N-W of the Hamelin Pool telegraph station on the east shore of Hamelin Pool. The sample is a grab sample taken over a length of 660 feet from a sloping face of shell about 15 feet high.

Sample H.P. 2.—From a large mass of dune material on the shore line on the west side of Hamelin Pool about ½ mile S-E of abandoned Nilemah homestead. The sample is a surface grab sample taken over an area of 20 square yards.

The Deputy Government Mineralogist reports as follows on the above samples:—

Report on Two Samples of Shell Deposit from Hamelin Pool, received 30th August, 1960

Lab. No. (1960)	8868	8869
Marks	H.P. No. 1	H.P. No. 2
Chemical Analysis—	Per cent. as received	
CaO	53·6	42·8
MgO	0·31	0·80
Fe (total)	0·14	0·12
Acid-insoluble	1·10	18·9
Water-soluble	1·25	1·58

(Pure limestone contains 56% CaO.)

Calcination—

The colour of the samples after calcination was off-white.

Sizing—

Sizing test on Sample H.P. No. 2 gave the following figures :—

Size fraction (B.S. screens)		Per cent.
	+ 3/8th″	*Nil*
—3/8th″	+ 3/16th″	1·0
—3/16th″	+ 7	1·7
— 7	+ 14	11·3
—14	+ 25	52·3
—25	+ 52	30·8
—52	+100	2·7
—100		0·2

H. A. ELLIS,
Government Geologist.

29/9/60.

ACTIVITIES OF THE HYDROLOGICAL SECTION OF THE GEOLOGICAL SURVEY DURING 1960.

A.—Exploratory Drilling.

Hill River Area.

In July 1958 a program of exploratory drilling was undertaken in the Hill River district. The objective of the program was to determine whether there existed an aquifer or aquifers of large lateral extent the depth to which (taking into consideration the ground elevation) could be predicted with reasonable accuracy in any particular locality. Exploration had to be limited to 900 ft., a depth that the State Mining Engineer's Branch considered as the capacity of the Ruston-Bucyrus RW22 plant (difficulties had been experienced in some of the early deeper bores).

Up to the end of 1960 a total of five holes have been completed, three of which (Nos. 2, 3A, 4) were entirely or partly drilled during the current year. The results of the program are summarised below:

Hill River No. 1.

Location: Recreation and Hall site, Badgingarra.
Commenced: 24 July, 1958.
Completed: 11 November, 1958.
Total depth: 720 ft.
Aquifer: 706 to 720 ft.
Yield: 13,000 galls/day.
Total Mineral Matter: 38.9 grs/gall (NaCl: 32.0 grs/gall).
Stratigraphic Correlation: Yarragadee Formation.

Hill River No. 2.

Location: Melbourne Loc. 7312 (Agricultural Research Station, Badgingarra).
Commenced: 8 June, 1959.
Completed: 11 July, 1960.
Total depth: 1047 ft.
Aquifer: 750 ft.-763 ft.
Yield: 12,000 galls/day.
Total Mineral Matter: 81.8 grs/gall. (NaCl: 57.3 grs/gall).
Stratigraphic Correlation: Yarragadee Formation.

Hill River No. 3.

Location: On Crown Land (not surveyed) approximately 5 miles west-north-west from Hill River No. 1.
Commenced: 9 June, 1959.
Completed: 6 November, 1959.
Total depth: 1,132 ft.
Aquifer: 205 ft.-215 ft.
Yield: 11,000 gals/day (Test carried out on completion of hole only).
Total Mineral Matter: 59.3 grs/gall. (NaCl: 40.4 grs/gall).
Stratigraphic Correlation: Yarragadee Formation.

Hill River No. 3A.

Location: Alongside Hill River No. 3. This hole was drilled for the purpose of testing the top aquifer encountered in Hill River No. 3 (205 ft.-215 ft.).
Commenced: 17 December, 1959.
Completed: 26 February, 1960.
Total depth: 235 ft.
Aquifer: 196 ft.-230 ft.
Yield: 9,000 galls/day.
Total Mineral Matter: 36.5 grs./gall. (NaCl 28.8 grs/gall).
Stratigraphic Correlation: Yarragadee Formation.

Hill River No. 4.

Location: On Crown land, south-west corner of Melbourne Loc. 3702 approximately 4 miles north-east from Hill River No. 1.
Commenced: 15 July, 1960.
Status: Depth on 29 December, 1960: 820 ft.—Drilling ahead to 900 ft.
Aquifers: 30 ft.-35 ft. 408 ft.-418 ft. 480 ft.-520 ft.
Yield: 30 ft.-35 ft.: 2,000 galls/day. 408 ft.-418 ft.: 12,000 galls/day. 480 ft.-520 ft.: Not yet tested.
Total Mineral Matter: 30 ft.-35 ft.: NaCl: 75 grs./gall. 408 ft. — 418 ft.: 206 grs./gall. (NaCl 162 grs./gall.).
Tentative Stratigraphic Correlation: Yadgena Beds-Mogumber Beds.

Result of Drilling Operations.—An analysis of the results obtained in bores so far drilled clearly demonstrates the lateral discontinuity of the various aquifers encountered. The sedimentary rocks penetrated include claystones, shales, sandstones and silt-stones of many varieties. They have greatly varying permeabilities and have therefore radical effects on the behaviour of the groundwater. The lenticularity and areal discontinuity of the beds result in important differences being found at the same horizon in different localities.

The lithological and stratigraphical nature of the formations in the Badgingarra area makes it very unlikely that the picture obtained so far will be substantially altered by further drilling.

The practical advice that can be given to local residents is that there exists no widespread uniform water-bearing formation, and that therefore the depth to water in any particular locality cannot be predicted. However the geological conditions are such that ample supplies of good quality water are almost certainly obtainable at depths varying from 200 ft. to 700 ft. below the surface.

Tenindewa Area.

Following representations by the Tenindewa Progress Association an exploratory site was selected and subsequently drilled in the district. Results are summarized below:

Location: S.W. corner of Loc. 23772 (Lands Dept. Litho 156/80). Close to 40-Mile Peg on the Geraldton-Mullewa Road.
Drilling Plant: Failing M.1.
Commenced: 8 October, 1960.
Completed: 1 November, 1960.
Total Depth: 549 ft.
Aquifer: 485 ft.
Static Level: 458 ft.
Yield: 6,000 galls/day.
Total Mineral Matter: 236 grs./gall. (NaCl 204 grs/gall.).
Statigraphic Correlation: Yarragadee Formation.

B.—Hydrological Surveys.

The hydrological survey of the sedimentary areas in the South-west Division, initiated in 1959 was continued in 1960.

The purpose of these investigations was, in the first place, to obtain factual data on the occurrence of groundwater in different areas. Details of as many bores as possible were collected and tabluated on standard record sheets. The information recorded includes the following items:—

(a) The location of the bore;
(b) The height above sea level;
(c) The total depth;
(d) The depth below surface at which water was cut;
(e) The static level;
(f) The yield in gallons per day;
(g) The salinity of the water.

The essential part of the survey was, however, to critically examine the data obtained in relation to the regional geology. It was thus possible to summarize the occurrence of groundwater by delineating a number of distinct hydrological provinces. This serves a very useful purpose for concise presentation of groundwater conditions over large areas, and has already proved most helpful when dealing with the numerous enquiries regarding the occurrence of groundwater, which the Geological Survey receives day after day.

The areas surveyed during the year are covered by the following Lands Department lithos:—

123/80 (Yandanooka).
159/80 (Port Gregory).
160/80 (Northampton).
161/80 (Tallering).
191/80 (Ajana).
192/80 (Gantheaume Bay).
341A/40 (Jandakot).
341B/40 (Armadale).
341C/40 (Serpentine).
341D/40 (Rockingham).
380A/40 (Mandurah).
380B/40 (North Dandalup).

The survey work was shared by the writer and Messrs. G. D. Bartram, B. Sc. and K. Morgan, B. Sc. (the latter since his appointment 23rd May). The selection of drill sites, and the supervision of the exploratory boring program was the sole responsibility of the writer.

K. BERLIAT,
Senior Geologist.

6/2/61.

REPORT ON SUBTERRANEAN WATER POTENTIALITIES ON ROTTNEST ISLAND.

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

General.

In view of the growing importance of Rottnest Island as a tourist resort, and the present precarious water supply position, the Hon. Minister for Mines requested that the subterranean water potentialities of the island be re-examined.

Geologically Rottnest is part of the Perth Artesian Basin. Its surface is characterized by rolling sand dune topography, reaching a maximum elevation of 154 feet. The only rocks exposed are Quaternary aeolianites, known as "Coastal Limestones." Salt lakes cover an area of some 500 acres at the eastern end of the island. They represent shallow arms of the sea, isolated in recent times by bar and dune formations.

The position on the island at the present time is that domestic supplies are obtained entirely from surface catchments, whilst water for sanitary and ablution purposes is derived from four shallow wells. Three of these wells, which are used for the needs of the settlement, yield, at the present rate of pumping, a daily total of some 24,000 gallons, an output that only just equals the required daily consumption. The fourth well at "The Basin" only serves the limited local requirements.

Three of the wells have a depth of 6 to 7 feet, only one (near the Hostel) reaching a depth of 23 feet. Salinities range from 90 grains to 400 grains per gallon of sodium chloride.

When attempting to assess the subsurface water potential of Rottnest a clear distinction must be made between groundwater, that is shallow water occurring under atmospheric pressure only, and deep, artesian water, which is under hydrostatic pressure.

Groundwater.

From a study of the salinities and depths of the wells sunk in the past there is ample evidence to show that comparatively fresh water occurs only as a thin sheet, resting upon and in contact with a body of salt water that pervades the mass of the porous rocks of the island. If a well is sunk to a depth not exceeding that of the upper fresh water layer, then with a slow, controlled rate of pumping, a limited amount of useful water will be obtained. However, this class of supply is quite inadequate for the purposes of a town supply, where a constant draught is made upon the water.

It has long been recognised that pumping seriously affects the quality of this kind of groundwater. When wells, such as those under consideration, are heavily pumped the deeper saline water will rise, as the force of gravity operates on the general body of groundwater, and tends to eliminate the cone of depression from the water table. In the event of there being an overdeepening of the well the rise of the saline water is all the easier, and the deterioration of the quality of the water pumped all the more rapid.

Shallow groundwater of the nature discussed above can only be utilized for the necessary extension of the "2nd class water" system on the island (ablution and sanitary purposes), where the salinity is not of paramount importance. It has been noted that all the wells on the island at present in use are located in the lowest parts of the topography. This, in the writer's opinion, is a mistake.

It must be understood that the water table is not a level surface, but has irregularities comparable and related with those of the land surface. In other words, under areas of low ground the water table is depressed, and the level of the salt water rises, whilst under high ground the thickness of the fresh water layer is greatest. It is recommended therefore to select future well sites on high ground, such as the high level depressions in the central part of the island, particularly those in the vicinity of the lighthouse.

Consideration must be given to the pumping method in order to keep the salinity at as low a level as possible. This will be best achieved by a slow, intermittent rate of pumping, thus creating a broad and shallow cone of depression that will check the tendency of the deeper water to rise in response to gravitational forces.

Artesian Water.

The only artesian bore ever drilled on Rottnest Island was completed towards the end of 1912. It was located on Thompson Bay, close to the present settlement, at a surface elevation of approximately 10 ft. above mean sea level. It reached a total depth of 2,582 ft., and struck an artesian flow of 30,000 gallons per day of "seawater" at a depth of 2,244 ft. The bore penetrated Tertiary and Cretaceous strata which are correlated with formations known from bores in the Metropolitan area. According to Glenister, Hassell and Kneebone[1] the following correlations hold:—

Depth Feet	Predominant Rock Types	Correlation and Age
0– 233	Coastal limestone	Quaternary aeolianite.
233– 933	Coarse grained red, brown and yellow sandstone	Doubtful—may partly represent an ancient delta of the Swan River.
933–2185	Grey sandy shale, impure sandstone, thin beds of impure limestone	King's Park shale. Middle to Upper Eocene.
2185–2582	Sandy glauconitic claystone and shale and dense sandstone	South Perth formation. Lower Cretaceous.

The failure of the Rottnest Island bore to yield a useful supply is a phenomenon rather difficult to explain. To the best of the writer's knowledge there is no evidence to suggest a break in the artesian slope between the Metropolitan area and Rottnest Island. It is true that a comparison of the depths of the Tertiary and Cretaceous formation tops reveals some differences. For instance in the South Perth bore the South Perth formation was identified at 1,632 ft., and in King's Park No. 1 and No. 2 bores the King's Park shale was recognised at 120 ft. The corresponding figures for the Rottnest bore are 2,185 ft. and 933 ft., a difference of 553 ft. and 813 ft. respectively. However, differences of that order over a large distance do certainly not justify the postulation of faulting. They are easily accounted for by very slight regional dips. It must be realised that a dip of only one degree over a distance of say nine miles accounts for a difference in altitude of 829 ft.

Therefore, if there is structural continuity between the mainland and Rottnest, then the failure of the Rottnest bore could be explained by assuming a hydraulic connection between the aquifer and the open body of sea water. The writer is inclined to think that the artesian aquifer has a submarine outcrop to the west of Rottnest (possibly coinciding with the continental slope), and that lateral migration of sea water takes place through the porous formations. Conditions of this nature have been observed in a number of coastal areas throughout the world.

[1]Brian F. Glenister, C. W. Hassell and E. W. S. Kneebone, "Geology of Rottnest Island". Journ. Roy. Soc. W.A. Vol. 42 (1959) Part 3.

The extent of the zone of salt water encroachment, in other words the eastern limit of the salt water wedge is not known, but must be somewhere between the longitude of the Rottnest Island bore and that of Garden Island, where three deep bores located artesian supplies of domestic quality.

If the theory outlined above is correct, then the only logical area where useful artesian water might be located on Rottnest would be east of the old bore. The easternmost point on the island is Phillip Point, only approximately one mile east of the bore, and it is very highly probable that such a distance is not great enough to bring about a sufficiently large decrease in salinity. The only thing that could be said in favour of a deep bore at Phillip Point is that in all probability it would conclusively prove that no artesian supplies of domestic quality are available on Rottnest Island.

In the writer's opinion the future of the potable water supply problem on the Island hinges on sealed surface catchments. With an adequate rainfall (29 inches per annum), and a favourable topography the main considerations are of a financial nature only.

K. BERLIAT,
14th February, 1961. Senior Geologist.

PROGRESS REPORT ON REGIONAL SURVEY OF BOORABBIN 4 MILE SHEET.

John Sofoulis, B.Sc., Geological Survey of W.A.

Introduction.

The Boorabbin 4 mile sheet is delimited by latitudes 30° and 32° south and longitudes 120° and 121° 30′ east. It occupies some 6,000 square miles of country and lies within the southern portion of the West Australian Pre-Cambrian Shield.

Mapping of this sheet forms part of the programme to delineate the geology of, and establish continuity between the three important gold mining centres of Kalgoorlie, Coolgardie and Norseman. This work was undertaken to gain a better understanding of the overall geology and distribution of gold mineralisation within these areas, and to ultimately select favourable structures or particular belts for more detailed investigation or exploratory drilling.

Previous Geological Work.

The known auriferous country located in the north east sector of the sheet has been the subject of numerous geological investigations, the principal contributions being those contained in Bulletins Nos. 53, 56, 91, and 107 of the G.S.W.A. More recently, a small section of this auriferous country has been reported on by Low (1959 A.P.R. of G.S.W.A.). The remaining country, approximately 80% of the 4 mile sheet, was known to be of a granitic nature but until the present investigations, had not been subject to any particular attention.

Present Field Work.

The present investigations commenced on April 4th, the field party consisting of departmental geologists J. Sofoulis (party leader), and W. Bock, accompanied by two field assistants. Two four-wheel drive vehicles were used, and the township of Coolgardie was the base for communications and supplies.

Fieldwork for the season was terminated at the end of October, the Boorabbin 4 mile sheet being completed during this period. Auriferous areas previously mapped by the G.S.W.A. were re-mapped or re-interpreted to conform with the present style of mapping.

Photo Reference and Maps.

Aerial photographs on a scale of 40 chains = 1 inch covering the Boorabbin 4 mile sheet were supplied for the survey. Geological information was initially plotted on these photos and subsequently transferred to the relevant controlled photomosaics (scale 1 mile = 1 inch). For speed of work, the 1 mile photomosaics were used in the place of compilation sheets, and on completion were submitted to the Mines Drafting Office for redrafting at the same scale.

These will be reduced to a 4 mile = 1 inch scale and reproduced as a "4 mile Geological Series" publication together with explanatory notes similar to the 4 mile series produced by the Bureau of Mineral Resources.

An index to the 1 mile photomosaics covering the Boorabbin 4 mile sheet and relationship of the Boorabbin 4 mile sheet to adjoining 4 mile sheets is shown on the accompanying plate.

Aeromagnetic maps on a scale of 1 mile = 1 inch were available for the Boorabbin 4 mile sheet but were of limited value to the field work. Principal anomalies corresponded to the metamorphic rock belts, which in any case formed mappable surface features. The maps were of no help in delineating intricate fold structures, separating individual horizons within belts, or giving indications of metamorphic rock extensions below soil and alluvium cover.

Principal Mapping Units.

With the exception of the metamorphic rocks present in the north east sector and a short narrow north west trending belt located in the south east corner of sheet 530, the Boorabbin 4 mile area is made up of Pre-Cambrian granites and gneisses. Actual outcrop conditions are poor, a large proportion of the area being masked by widespread developments of sand plain, residual granitic erosion soils, and by broad alluvial tracts of ancient trunk and tributary drainage systems.

Because of this, it was necessary to modify the usual style of geological mapping and to separate the solid geology from the various residual soil and alluvial forms. The resultant map is thus an outcrop map, which as well as being of geological and geophysical value, will serve immediately as a basis for forestry and pastoral utilisation, and future hydrological and pedological studies.

Principal units mapped on the Boorabbin 4 mile sheet include:—sand plains, granitic erosion soils, trunk and tributary alluvia, granite-gneiss outcrop areas, and various meta-igneous and sedimentary phases within the metamorphic belts.

In addition to the above, all relevant information such as access roads, railway lines, tracks, woodline formations, fences, dams, bores, wells etc. were mapped and will be included on the published map.

Physiography.

General Description.—The area constitutes a portion of the great inland plateau of W.A., and lies within the Salt Lake or Salinaland physiographic division of Jutson[1].

Extensive flat to undulating plateau areas are formed by sand plains which vary from 1,000 feet to 1,500 feet above sea level but seldom show elevation differences greater than 200 feet in any one locality.

Isolated granitic rocks and remnant metamorphic belts rise above the plateau level and form the only elements of positive relief in the area. Lowland sectors have been stripped of the sand plain cover and appear as granitic erosion plains traversed by alluvial drainage tracts up to 4 miles in width.

Granitic erosion plains are generally of low relief but clusters of more resistant granitic hills occur in the interfluve areas or are exposed along valley flanks.

Where extensively stripped, as in the south east sector, the sand plains survive only in the watersheds and appear as small islands bounded locally by low breakaways.

Drainage Systems.—The drainage systems of the area are ancient in origin and probably evolved during the more active Tertiary cycle of erosion. They appear now as alluvium-filled trunk valleys with tributary alluvial valleys extending downslope from the sand or erosional plains to form broad tracts generally at right angles to the trunk valleys.

Valley floors may vary from 100 feet to 250 feet below the plateau or sand plain level. Salt lakes are restricted to trunk valleys only. Tributary valleys have a slightly steeper gradient and usually show faint or reasonably defined channels which are seldom incised to depths greater than 4 feet. These channels become ill defined or lost on entering the trunk valleys but locally may terminate in a salt lake.

A watershed approximately 5 miles in width divides the area in a north-south line and separates the north-north west draining system in the western half of the area from the east-north east draining systems in the eastern half.

The drainages of the western sector are considered to eventually link with the Avon-Swan River system draining to the Indian Ocean. The recipients of the drainages from the eastern sector (Lakes Dundas, Lefroy etc.) are believed to have been linked to the Southern Ocean during the Tertiary period.

Salt Lakes.—Salt lakes within the area are confined to the trunk valleys. Lake floors are generally from 20 feet to 50 feet below the valley floors. The lakes appear as isolated features but may show connecting channels where closely associated.

Low breakaways fringe the west and north west shores, whilst kopi or sandy lunettes have accumulated on the east and south east shores. These features indicate a prevailing wind direction from the west and north west. The scouring action of this wind has been responsible for the breakaway formation and in conjunction with transportation and deposition of materials along the opposite shores, has resulted in the westerly elongations and migrations noted in a great number of lakes.

Geology—Stratigraphy and Nomenclature.

Loosely consolidated deposits which mask the basement rocks in plateau areas and in broad drainage tracts, are regarded as Tertiary-Quaternary in age. These include formations of sand plain, lateritic weathering crusts, granitic soils and alluvium. The formations have not been named.

Age determinations on some of the basement rocks of this and adjoining areas would place the age of the Pre-Cambrian units as Archaean. Metamorphic rocks have been described in general terms as belonging to the Greenstone Series and the Whitestone Series, respectively representing meta-igneous and meta-sedimentary phases of the Kalgoorlie-Yilgarn System.

In the adjacent Kalgoorlie area, these phases have been further subdivided and in the literature have been described as Kurrawang, Black Flag, Younger Greenstones, Yindarlgoorda Series, etc. McMath in the Coolgardie area has also distinguished and named granitic bodies at Mungari, Bonnievale, South Grosmont and East Gibraltar.

It is now evident that the granitic and metamorphic groups of the Boorabbin 4 mile area are forming portions or extensions of the same units. It is therefore proposed to defer the naming of these units according to the "Stratigraphical Nomenclature Code" until their extensions and linkages to the earlier mapped areas have been established.

[1]JUTSON, J. T., 1934. The Physiography (Geomorphology) of Western Australia. W.A. Geological Survey Bulletin No. 95.

A tentative stratigraphical table for the Boorabbin 4 mile sheet, based on the old nomenclature, is presented in the following table:—

Classification	Series or Phase	System	Age	Remarks
Aeolian deposits and transported soils	....	....	Quaternary	Gypseous and sandy lunettes of lake margins salt, silts, muds, clays, of lake floors, valley sand accumulations.
Alluvium and calcareous sub soils, granitic erosional soils	....	....	Quaternary	Sandy loams of tributary and trunk valleys. Sandy loam with granitic weathering product fragments, gritty soil accumulations.
Sand Plains	....	....	Tertiary	Includes ferruginous, siliceous and calcareous cements.
Laterite and duricrusts	....	....	Tertiary	
Kaolinisation	....	....	Tertiary	
Quart dolerite dykes	....	....	Pre Cambrian ?Proterozoic	Includes quartz gabbro, norite and olivine dolerites of E.N.E. trend.
Granites and gneisses, allied acid igneous derivatives including quartz veins, aplite dykes, pegmatitic and ore formation	....	....	Archaean	Period of granitisation and ore formation.
Porphyries	....	....	Archaean	Probably generated from recrystallisation of meta-arenaceous and rudaceous sediments (Kurrawangs) of the Whitestone phase.
Meta-sedimentary rocks	Whitestone	Kalgoorlie-Yilgarn	Archaean	Includes thin jaspilites, meta dolomites, argillaceous, arenaceous and rudaceous rocks.
Basic and ultra basic meta igneous rocks	Greenstone	Kalgoorlie-Yilgarn	Archaean	Includes metamorphosed basic lavas, pyroclastics, intrusions, and ultrabasic rocks. Younger greenstones also grouped with this complex. Some may represent recrystallised versions of above greenstones.

Tertiary—Quaternary.—The formations of this age which have been distinguished in the Boorabbin 4 mile area are merely superficial and their development and distribution is related to present landscape evolution, associated with deterioration of climate and development of drainage from Tertiary times onward.

This has resulted in a partial dissection and stripping of the one deeply weathered plateau surface, with a general tendency towards deposition on lower ground. The formations are as follows:—

Sand Plains: The bulk of the sand plain areas occur over granitic terrains and appear as brown-yellow sand plains up to 50 feet or more in thickness, and are underlain by a thin lateritic layer. This sand is considered to be a soil of fossil or residual character which formed during a period when conditions were more humid than the present.

Some local reworking of sand in the form of down-slope movement and stripping about the fringes has occurred but in general these plains are in situ and are well stabilised by the characteristic spinifex, mallee, tamar, and wodjil vegetation.

The equivalents of the sand plain on the metamorphic rocks are the red sandy soils. These contain hematitic grains as a fine constituent and generally show a heavy surface veneer of hematitic pisolites. They are finer in texture and contain a higher clay content than the granitic sand plains. A characteristic vegetation is also supported and they are similarly underlain by a lateritic layer.

Other restricted forms of sand plain occur as surface accumulations along alluvial valley floors. These appear as red, or bleached white sand plains resulting from wind and water action. Reddish or bleached yellow-white aeolian sand dunes are also general about the east and south east lake margins.

These transported sands are unrelated to the lateritic profile and are comparatively recent in origin.

Lateritic Weathering Crusts: The weathering crusts form part of the "pan Australian duricrust" developed during Tertiary times. Principal exposures occur along the sand plain margins where stripping has exposed pisolitic ironstone gravels, and cavernous crusts of case hardened and locally silicified mottled zones, above weathered granitic and metamorphic rocks.

Such weathering crusts may assume differing forms, particularly in the metamorphic rocks where they can appear as massive ironstone cappings, pisolitic gravels, siliceous and calcareous veneers or cements, which form duricrusts above kaolinised pallid zones of variable depth.

Granitic Erosion Plains: Granitic erosion plains occupy the headwater or interfluve areas below the stripped sand plains. They consist of broad areas of brownish-red sandy loam containing surface veneers of granitic weathering products. These products include kaolinised and fresh granite, ferruginous and mottled fragments, calcareous nodules and local saline encrustations.

The plains contain groups or isolated masses of fresh granite outcrops about which are numerous run off accumulations of gritty soils. Some of these gritty soils fill depressions in the granitic surface and provide the sources of good potable water (e.g. Gnarlbine Soaks, Yerdanie Well).

The granitic erosion plains pass transitionally into the alluvial valleys described below.

Alluvial Valleys: Lowland areas are occupied by alluvial floors formed by a fine textured red-brown sandy loam which has a well defined powdery and nodular lime subsoil.

Alluvial floors vary from ½ to 2 miles in width but may broaden to 4 miles in width in the trunk valleys.

The lime subsoil is frequently exposed on breakaway sections of the west and north west lake margins, above the lateritic profile.

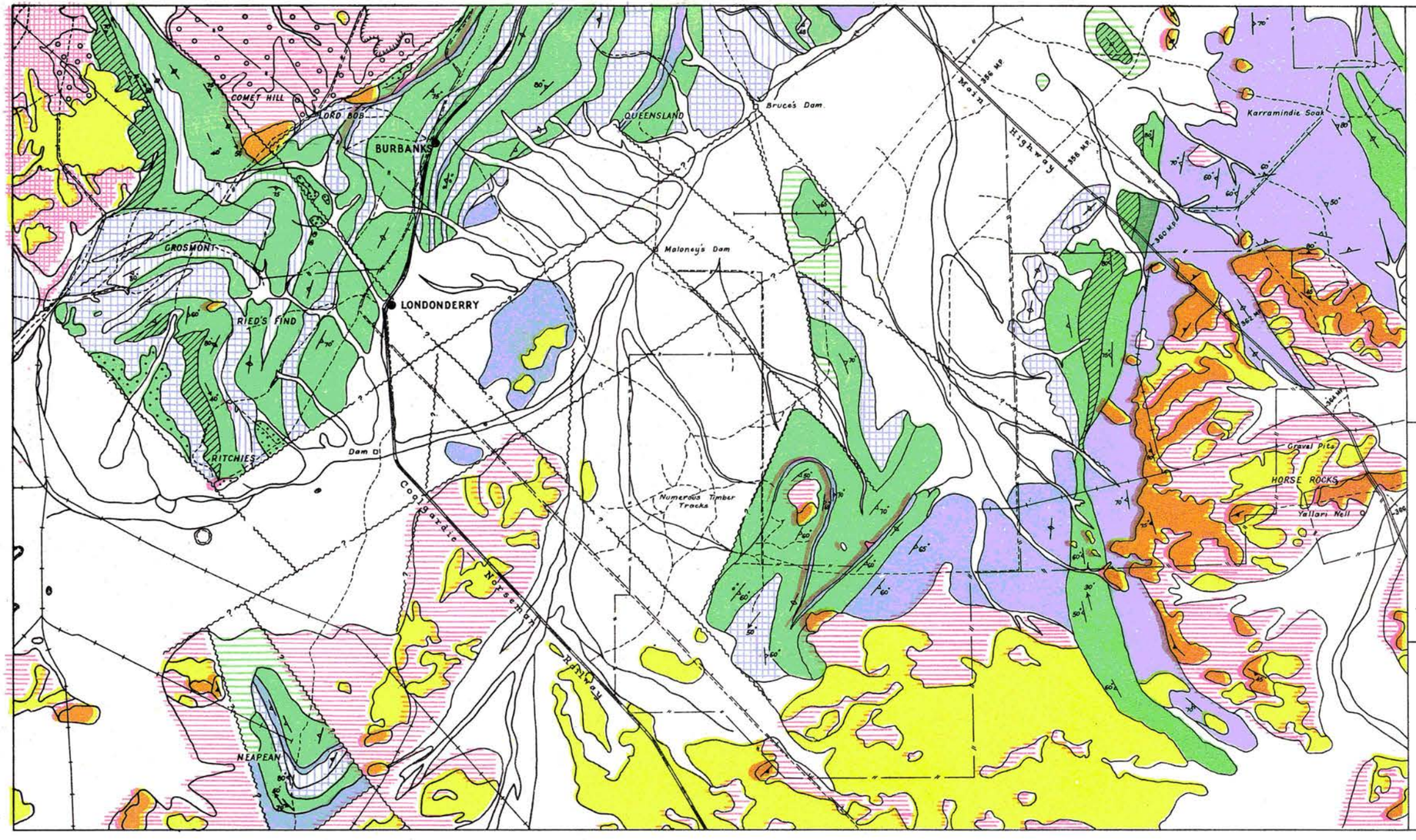
Archaean.—Granitic rocks form the younger Archaean members in this area and comprise approximately 85% of the Boorabbin 4 mile sheet. These terrains include granites, gneisses and allied acid igneous rocks and derivatives.

Remnant belts of folded metamorphic rocks are preserved in a restricted belt in the south west sector (Bremer Range Metamorphics) and as a widespread development in the north east section (Coolgardie-Kalgoorlie Metamorphics).

The metamorphic rocks include meta-igneous (Greenstone) and meta-sedimentary (Whitestone) horizons which form the potentially auriferous belts of the area.

Both granitic and metamorphic members are intruded by the younger quartz dolerite (norite, quartz gabbro) dyke suite of east north east trend.

PLATE I



LEGEND

QUATERNARY	Alluvium	Red-brown, sandy loam with calcareous subsoil	
	Granitic Erosional Soils	Over granite	Sandy loam with kaolinised mottled and fresh granitic fragments quartz stone, gritty soils, calcareous nodules
		With laterite and quartz stone	
		Over gneiss	
TERTIARY	Sand Plain	Yellow-brown, sandy soils, lateritic subsoil and veneers	
ARCHAEAN	Granite	Medium grained biotite granite Pegmatite	
	Kalgoorlie-Yilgarn System — Whitestone Phase — Meta-Sedimentary Rocks	Mainly kaolinised argillaceous and arenaceous rocks	Include thin meta-igneous horizons.
	Meta-Dolomitic Rocks	Includes carbonate& tremolitic, talcose and Serpentinous derivatives	
	Greenstone Phase — Ultra Basic Rocks	Undifferentiated of meta-dolomitic, and ? meta-igneous origins.	
	Medium-Coarse Grained Doleritic Rocks	Sills or recrystallised lavas	Include thin meta-sedimentary horizons.
	Porphyritic Basic Lavas		
	Fine-Medium Grained Basic Lavas	Duricrust Undifferentiated	

REFERENCE TO SIGNS

- Strike and dip of schistosity
- Strike and dip of foliation
- Vertical schistosity
- Vertical foliation
- Direction and plunge of foliation
- Suggested faults
- Drainage channels
- Breakaway
- Fence or location boundary
- Tracks
- Tramline formation
- Railway
- Main road
- Telegraph line

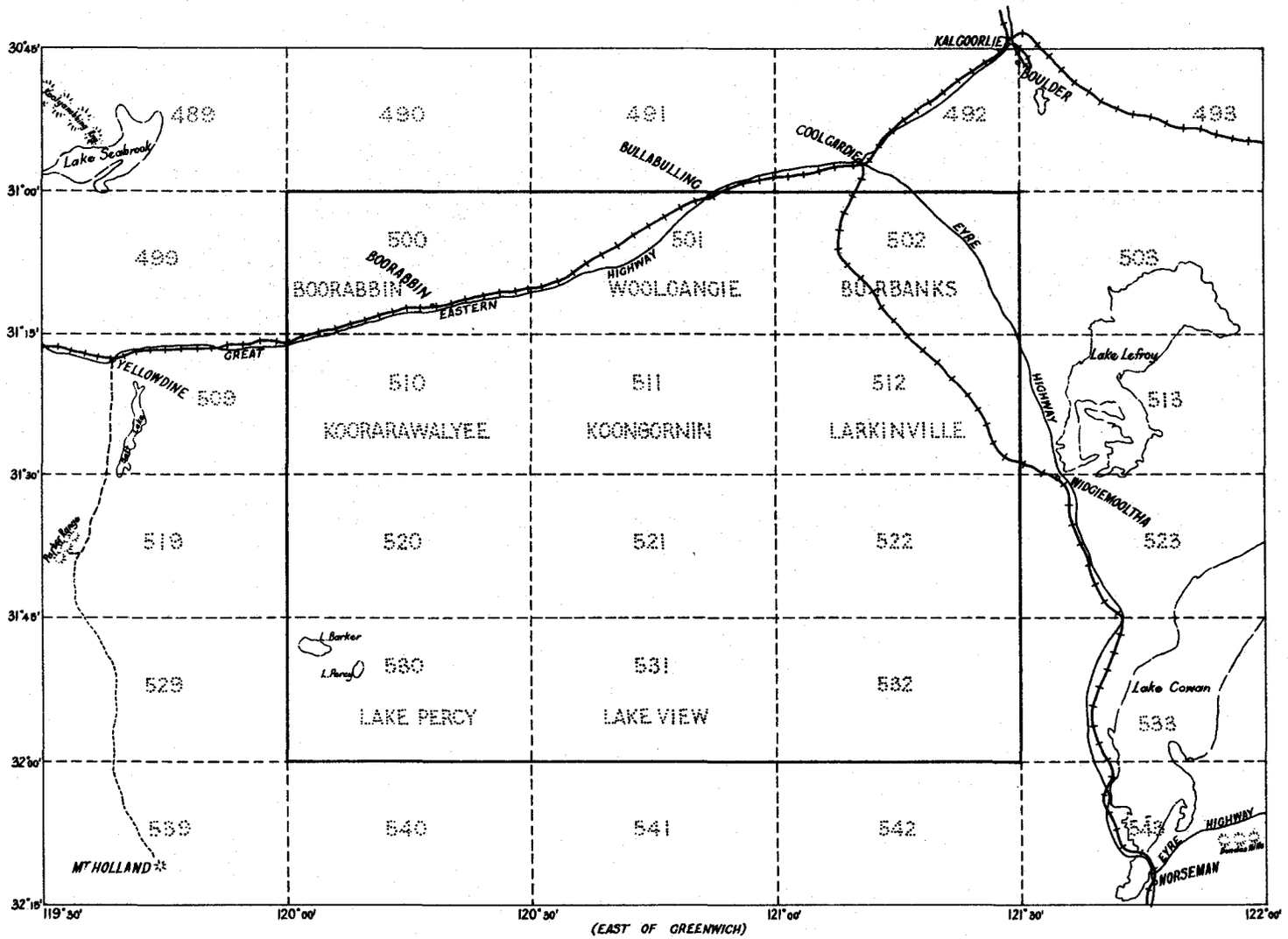
G. S. W. A.

GEOLOGICAL MAP OF PORTION OF BURBANKS SHEET Nº 502

BOORABBIN SH 51-13
INTERNATIONAL SERIES

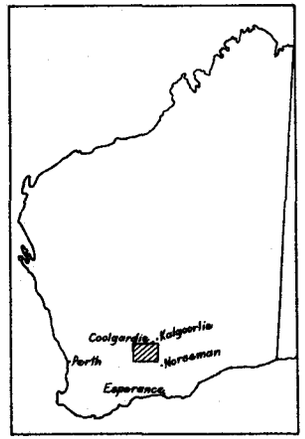
Scale : 2 Mile to an Inch

Survey and geology by J. Sofoulis and W. Bock, 1960.



INDEX TO ADJOINING SHEETS INTERNATIONAL SERIES

JACKSON	KALGOORLIE	KURNALPI
SOUTHERN CROSS	BOORABBIN	WIDGIEMOOLTHA
HYDEN	L. JOHNSTON	NORSEMAN



G. S. W. A.

LOCALITY PLAN AND INDEX OF ONE MILE MAPS

BOORABBIN SHEET — SH51-13
INTERNATIONAL SERIES

Scale : 20 miles to an inch

Bremer Range Metamorphics.

Metamorphic rocks mapped in the south east corner of sheet 530 form a north west trending belt of rocks up to 2½ miles in width which extend some 10 miles into the area. They represent the north west extension of the Bremer Range metamorphics as mapped by Honman[2] and are therefore more extensive than as shown on the Geological Sketch Map of Western Australia (1957 edition).

This belt is thought to represent the keel of a south east plunging syncline and is flanked by granitic rocks.

Major outcrops in the form of low hills are mainly of meta-volcanic origin but some prominent jaspilitic ridges are known within the belt below the southern boundary. Other metasediments locally outcrop in the lower ground and their existence is further indicated by numerous surface veneers and screes of metasedimentary fragments.

A possible extension of the Bremer Range metamorphics may be represented to the north by the Bungalbin-Ryan's Find belt. This belt terminates a few miles north of sheet 500 but there is no apparent linkage as the intervening section is now occupied by granitic rocks.

Coolgardie—Kalgoorlie Metamorphics.

These form the most important belts of the Boorabbin 4 mile sheet as they make up portions or extensions of the principal gold-bearing belts of the Coolgardie-Kalgoorie districts. The belts present a diversity of rock types (see Bulletin 107) and are intricately folded. Major granitic intrusions and porphyry emplacements within these belts are thought to have been responsible for the forms of mineralisation introduced.

Isolated blocks of metamorphic rocks are distinguished at Nepean and at the Prince of Wales area south of Bullabulling. These are thought to represent downfaulted outliers of the major structural belts. A possible faulting pattern which may be present is further discussed under Structural Features.

Other findings or suggestions which could have some immediate economic bearing on these and adjoining belts are commented on below:—

Meta-Dolomitic Rocks: Some of the greenstone horizons previously mapped in the Coolgardie area are now interpreted as being metamorphosed equivalents of dolomitic limestones. Gradations from what are considered as recognisable dolomites to the metamorphosed ultrabasic equivalents (tremolitic, talcose, carbonated, and serpentinous forms) are known, and as such rocks have frequently formed the host rocks for gold mineralisation, a relationship to the carbonisation in some of the adjacent Kalgoorlie ores is suggested.

Porphyries: Major albitic porphyries appear in the metamorphic rocks of the Coolgardie-Spargoville areas and from their occurrence and relationships it is thought that the porphyritisation has not been by injection but rather by regeneration from the pre-existing arenaceous and rudaceous metasediments.

Some of these porphyries are associated with areas of gold mineralisation but this association may be structural rather than genetic.

Granitic Rocks: Although the major portion of the Boorabbin 4 mile area is of granitic character, the most important granitic bodies would be those associated with the metamorphic belts as these have no doubt been responsible for the major forms of mineralisation introduced. A lithologic and structural control is suggested by the Horse Rocks—Depot Rocks granite. This is emplaced within an anticlinal section of a metasedimentary belt but whether this form of occurrence is local or general is not possible to assess at this stage.

Outside the metamorphic terrains it has been possible to delineate individual granites and gneissic sections. In general outcrop shapes are elongated parallel to foliation trends and the foliation patterns which have been recorded should materially assist in the regional structural interpretations.

Quartz Dolerite Greenstones: The meta-gabbro, meta-dolerite, and epidiorite rocks described in Bulletin 107 as occurring in the Coolgardie area are equated to the quartz dolerite greenstones (referred to in the literature as Younger Greenstones) forming the host rocks in the Kalgoorlie area.

As far as can be ascertained, those of the Coolgardie sector (and probably those at Kalgoorlie) form part of the normal greenstone complex. Some are recognised as being intrusive in form but it is also likely that some of them represent recrystallised versions of basic lavas.

It is preferable that these rocks now be grouped with the normal greenstones complex as they are comparable in age and form concordant bodies which have undergone the same folding as the associated belts. The term "Younger Greenstones" would also tend to have these rocks confused with the younger quartz dolerites described below.

Quartz Dolerite Dyke Suite: Dykes of this suite range from quartz dolerites in the more acid members to norites gabbros and olivine dolerites at the more basic end. They form an east north east trending suite which cuts across granitic and metamorphic rocks. They locally appear as mottled rocks due to the arrangement of the ferromagnesian constituents and vary in colour from black to green and various shades of brown.

Epidote is a common alteration product and secondary epidote veins are a common feature.

Some of these dykes were noted in the Widgiemooltha locality whilst a dyke of the same suite mapped in the southern sector of the area was traceable for some 30 miles in length.

The norite dyke at Norseman and the similar trending dykes mapped by the writer in the Phillips River Goldfield (Bulletin 110) are considered to belong to the same suite. The dykes are post gold.

Structural Features: Some complex fold patterns are indicated by the distribution of metamorphic belts. Principal folding directions are along north to north west lines and are probably of echelon form.

Strike terminations of some belts and opposing lineation phenomena noted would also suggest the existence of cross-fold flexures which are complementary to the main fold axes.

Major faults affecting the metamorphic belts are difficult to establish as they are not recognised on the ground. Some of the abrupt termination of belts along particular lines are suggestive of a block faulting pattern.

As this could have an important bearing on mining in this and adjacent areas, the suggested pattern is indicated on the accompanying plate (portion of Sheet 502 Burbanks). These show a complementary set of faults along north east and north west lines and a few subsidiary transverse faults.

Other lineal features are reflected in the granitic sand plain soils as thin vegetation lines. These are thought to have resulted from a water condition associated with major faulting or jointing planes in the underying granitic rocks. They are particularly prominent in burnt sand plain areas where they stand out as locally radiating, or east to south east trending parallel vegetation lines, some of which are traceable for over 30 miles in length.

Current Activities in the Area.

The Perth to Kalgorlie and Coolgardie to Norseman railway lines, bitumen highways, telegraph lines, and Goldfields Water Supply pipelines pass through the area respectively in the north west and north east quadrants. Most of the human activities are associated with the maintenance of these utilities, and minor centres and sidings are established along these routes.

Mining and pastoral activities are restricted to the north east and east fringes and except for a few isolated timber-cutting camps in the central section, the remainder of the area is uninhabited. Some general notes on these industries are given below.

[2]HONMAN, C. S. 1914. The Bremer Range Country, Dundas Goldfield. Misc. Report No. 46, G.S.W.A. Bulletin No. 59.

Gold Mining.—Mining groups located within this area have received full attention in Bulletin 107. There has been little activity since this period, and the area is liberally distributed with abandoned workings. Several old mines are still held under existing leases but are no longer operative. General activities have been mainly restricted to week-end prospecting and the small gold productions which have resulted have been principally from scavenging in and about old workings.

The nearest active gold producer is "Bayley's Mine" at Coolgardie.

Pegmatitic Minerals.—Pegmatite quarrying is still active at Londonderry where approximately 2,000 tons of felspar are produced annually. Other pegmatitic minerals recovered from the same quarries are stock piled and periodically a parcel is sold.

Road Materials.—Numerous small quarries have been developed along the major highway and railway routes and have provided the sources of road surfacing and railway ballasting materials. Principal materials utilised have been the lateritic gravels of the stripped sand plains and the nodular lime gravels of the alluvial drainage areas. A rock quarry for supplying metal for highway surfacing and railway ballasting has recently been developed in the large granitic outcrops at Boorabbin.

Pastoral.—Pastoral activities are confined to the metamorphic terrains in the east and north east sectors. Granitic sandplain areas west of the Coolgardie-Norseman road are regarded as unsuitable for pastoral purposes and have not been utilised. The only other areas which may have some pastoral potential are the trunk valleys containing the salt lake chains.

Forestry.—Areas which have been utilised for mining timber and fuel purposes are located in the metamorphic and granitic terrains, the principal sections being those of the trunk and tributary alluvial valleys.

These have supported good stands of salmon gum, ribbon gum, gimlet, grey gum, and boree. Blackbutt varieties which have also been utilised were confined to the metamorphic terrains.

Old cutting areas were previously served by a network of woodlines. These lines have since been removed but the formations are still recognisable and are useful for navigating purposes.

These old cutting areas are at present being allowed to regenerate. Current wood cutting activities are now restricted to the alluvial valleys of the central portion of the area (Sheets 511, 521).

Water Supplies:

Large granitic rock outcrops on which contour drains and rock walls have been constructed constitute valuable catchment areas which have provided useful water for railway, woodline, pastoral, and domestic purposes (Burra Rocks, Cave Hill, Woolgangie, Bullabulling etc.).

In the more remote areas, depressions in granitic rocks and marginal gritty soils have provided catchments and soaks which have served as good sources of potable water (Thursday Rock, Diamond Rock, Gnarlbine etc.).

Stock waters for the pastoral industry have been provided by a few scattered wells and bores but the main sources have been from excavated dams located along drainage channels or alluvial floors.

Small sidings, centres, and pastoral properties established along the major routes are served by the Goldfields Water Supply pipelines. Some domestic waters have also been provided from roof catchment.

Groundwater levels within the mining areas range from 50 feet to 200 feet but the available waters are mostly saline. In these areas the water table is commonly related to the base of the zone of alteration. In the past some useful supplies have been provided by small catchments, dams, rock holes, but most waters for mining purposes have been obtained from adjacent granite catchments, or carted from the nearest pipeline standpipe.

Concluding Remarks.

The regional survey of the Boorabbin 4 mile sheet has been completed. The resultant map will be produced as a "4 mile Geological Series" publication, together with explanatory notes to conform with the standard "4 Mile Geological Series" as produced by the Bureau of Mineral Resources.

Field work proposed for the 1961 season is the mapping of the Widgiemooltha 4 mile sheet, adjoining the Boorabbin 4 mile sheet to the east.

JOHN SOFOULIS,
Geologist.

28/2/61.

REPORT ON M L 70P FOR MANGANESE AT MURPHY'S WELL, PEAK HILL GOLDFIELD, W.A.

By L. E. de la Hunty, B.Sc., Geological Survey of W.A.

Location and Access.

Mineral Lease 70P is about 10 miles south-west of Peak Hill, in the vicinity of Murphy's Well. A track leaves the Meekatharra-Horseshoe road about 61 miles north of Meekatharra and heads south-westerly for 6.3 miles to the deposit. The turn-off is signposted and the track crosses only one small sandy creek.

Geology.

The deposit is in the form of a ferruginous, manganiferous capping on weathered schistose Archean rocks in a low north-south ridge which rises from a red soil plain. The lease is for 2 acres and, although the deposit covers more than half of this area, the manganese ore of marketable grade is confined to the eastern and western flanks of the ridge.

The deposit exhibits horizontal (or flat-dipping) banding and varies in character from massive manganese oxide with small radiating crystals of pyrolusite and some concretionary development (together with some small lumps of silica) to a layered porous ferruginous manganiferous rock with a strong development of fine needles, crystals and cobwebs of quartz in the cavities. Other parts of the deposit contain more iron than manganese.

The deposit has been formed by the deposition of manganese, iron and silica from surface waters and is not the result of lateritic weathering on the underlying rocks.

Test Work.

The leaseholder drilled 11 holes on the deposit with a wagon drill and samples were taken every 3 feet. Unfortunately some of the samples lost their labels and were useless for assay purposes. The other assay results were produced for the remaining 8 holes but there was also some doubt about the superposition of the groups of samples for particular holes. However, the assay values did show the presence of ore of marketable grade which could be won by selective mining and hand-picking.

Holes in the north-east, south-east and western parts of the deposit were blasted by the owner. "About a case of fracture" was used to "bull" and blast each of the three holes and the resulting pits were about 12 feet in diameter and 3-4 feet deep. These revealed the patchy and layered nature of the ore.

Tonnage Estimate.

There is a total of some 2,800 tons of manganese ore, above 40 per cent Mn grade, available from this lease. This tonnage of indicated ore is made up of 1,300 tons in the patch on the western flank and 1,500 tons along the eastern face—most of this latter tonnage being in the south-east corner of the deposit. Although some assay values of higher than 50 per cent Mn were recorded, the average value of the tonnage estimated should be below 45 per cent. Mn.

L. de la HUNTY,
Geologist.

28/11/60

REPORT ON SOME LIMONITIC IRON ORE DEPOSITS IN THE VICINITY OF PORT HEDLAND, PILBARA GOLDFIELD, W.A.

By L. E. de la Hunty, B.Sc.,
Geological Survey of W.A.

Introduction.

These deposits—the existence of which was first reported by Woodward in 1890—were inspected and sampled by the author in August 1960. The accompanying sample plans were made with the aid of enlarged aerial photographs.

Assays of samples taken show that the grade of ore in these deposits is high enough to warrant their consideration as reserves. The tonnage of ore present in each group of deposits and the simplicity of mining methods required must also be taken into account—as well as their proximity to Port Hedland and to the higher grade ore deposit at Mt. Goldsworthy.

The deposits at Pundano (19 miles east-south-east of Port Hedland) and at Trig. F13 (33 miles east of Port Hedland) are the closest to the port.

Other deposits sampled were—

Deposit on Lalla Rookh Station—60 miles south-south-east of Port Hedland.

Deposits on Abydos Station—60 miles, 64 miles and 78 miles respectively, south of Port Hedland.

Deposit at McPhee's Creek—132 miles south-east of Port Hedland.

One sample was taken from a laterite deposit on Indee Station (31 miles south of Port Hedland) and another sample came from a deposit on Marillana Station (170 miles south-south-east of Port Hedland).

References.

Previous reports on limonite deposits near Port Hedland are—

1890—Woodward, H. P.: *Annual General Report of the Government Geologist for the Year 1890, p. 35.*

1908—Maitland, A. G.: The Geological Features and Mineral Resources of the Pilbara Goldfield, *G.S.W.A. Bull. 40, p. 17.*

1959—Veevers, J. J. and Wells, A. T.: Pisolitic Ironstone Deposits, Port Hedland Area, Western Australia, *Bureau of Mineral Resources Records 1959 No. 61.*

Geology.

The limonitic (and hematitic) laterite deposits reveal the Tertiary profile in the Pilbara Goldfield, as in other parts of Western Australia. These ferruginous cappings occur on granites, gneisses, rocks of the Warrawoona System and also on rocks of the Nullagine System. The laterite is usually rather poorly developed on the tops and slopes of the hills and ranges and any limonite cappings in these localities are thin and of low grade. However, some flat-lying deposits low in the topography provide good sources of limonitic ore.

These deposits of good grade limonitic ore occur at plain level in the vicinity of Trig. F13 and low in the valleys in the Wittenoom Range south of Marillana, but they generally appear as caps on buttes rising as much as 100 feet above plain level. Since these deposits are flat-lying and are the lowest remnants of the Tertiary profile visible to-day, it is reasonable to assume that they were formed on the lowest parts of the land surface in Tertiary times. The lakes, rivers and swamps would have formed a suitable environment for the deposition of iron from solution and the marked linearity of the deposits (especially of those at Pundano and Lalla Rookh) indicates their deposition in old drainage channels.

These old local base level deposits now form the caps of the buttes developed by post-Tertiary erosion. Near Pundano the buttes occur in a rather extensive plain but in the valley of the Nullagine River south of Nullagine (upstream) there are long narrow buttes about 70 feet high with thin limonite caps. These caps represent the floor of the valley in Tertiary times and rejuvenation of the river has allowed it to erode below that level. The slopes of the outer valley of the river demonstrate this rejuvenation as they dip towards the tops of the buttes and are cut through by the river and its tributaries.

The kaolin zone visible under these deposits is not necessarily evidence of lateritisation as the organic acids present in swamp water will kaolinise underlying clays. Therefore, despite their apparent continuity with the Tertiary lateritic profile, these deposits are of the "bog-iron" type—formed by deposition from surface water, probably in the colloidal form. Factors supporting this contention are—

(1) The amount of limonite present is more than could be formed in situ by lateritic weathering of underlying granite and sandstone.

(2) There is very little laterite on the highlands which contain abundant iron in the jaspilite beds outcropping there—the iron weathering products having been carried away in solution.

(3) Low-lying flats make ideal loci for deposition of this transported iron.

Some of the buttes near Port Hedland display only a ferruginised capping on sandstone (with pebble bands) which overlies the granite of the plain. They do not contain any limonite ore. Examples of this are Trig. F9 (28 miles east of Port Hedland) and Trig. F12 (Table Hill, 19 miles east-south-east of Port Hedland). This sandstone is flat-dipping and exhibits some kaolinisation under the ferruginous cap, while the underlying granite is rather fresh and hard with rounded outlines (See Figs. 1, 2). On the aerial photographs these buttes look identical with the limonite deposits. Veevers and Wells suggest that this sandstone may be Mesozoic in age but the writer did not find any evidence for believing them younger than the sandstones of the Nullagine System.

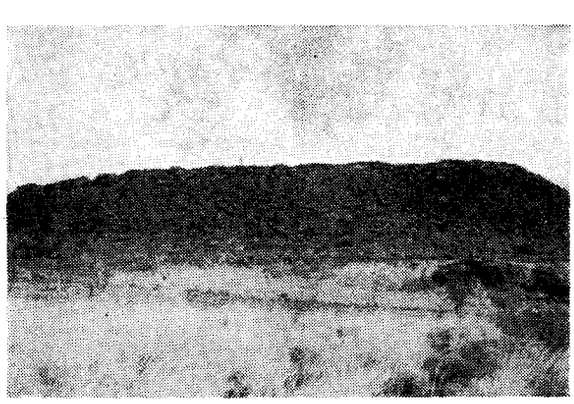


Fig. 1.—Table Hill (Trig. F 12) from north.

[5]—46622

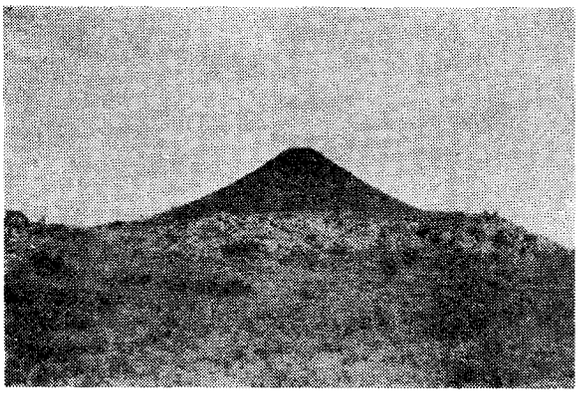


Fig. 2.—Table Hill from west.

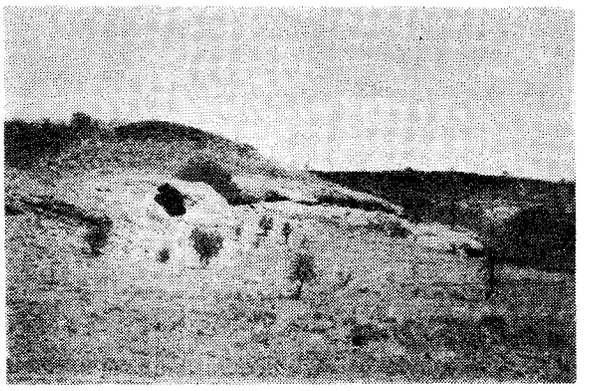


Fig. 3.—Eastern end of Eastern Deposit, Pundano, from north.

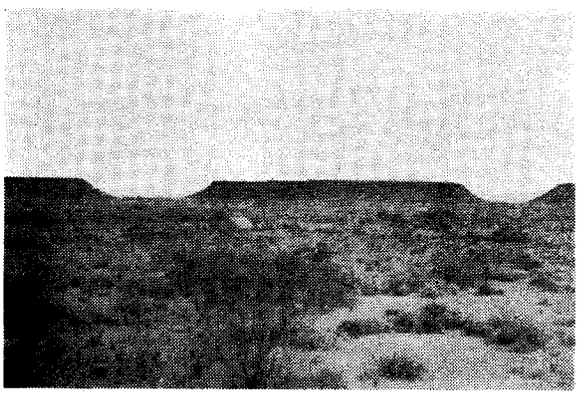


Fig. 4.—Butte No. 3, Central Deposit, Pundano, from north.

The buttes containing deposits of limonite ore overlie kaolinised granite on fresh granite. The ore contains grains of quartz and could have been developed in a sandstone or directly on the granite (See Figs. 3, 4) Veevers and Wells record Casey's description of the most easterly of the Pundano deposits (their deposit "A") as follows:—

20' pisolitic ferruginous sandstone with much small wood—Jurassic

10' sandstone with pipes

40' white decomposed granite with quartz veins, mica, etc.

Woodward also reported the presence of fossil wood in these deposits.

While the writer agrees with Veevers and Wells that these deposits are of the "bog-iron" type, he failed to see any fossil wood fragments.

There is an abundance of pisolites in the ore and many of these have centres of fibrous goethite which is taken to be the "fossil wood" of previous investigators. These pisolites with fibrous centres can be seen also in the valleys and tributaries of the Nullagine River, south of Nullagine, and in creeks in the Hamersley Range south of Marillana. The pisolites are usually about half an inch in diameter and are fairly constant in size. The fibres of iron oxide do not radiate from the centre but are parallel—giving the cellular appearance of fossil wood. Some of the pisolites are elongated along the "grain" but the ends are usually rounded. It seems hard to believe that wood fragments would all be of the same size where they were deposited in swamps and lakes, whereas pisolites tend to have equal development.

All of the deposits are surrounded by patches of limonite scree. Some of this material has been quarried at Pundano for roadmaking. No tonnages have been calculated for the scree material.

Sampling.

A total of sixty samples of limonitic ore were assayed by the Government Chemical Laboratories and most of the samples revealed an acid soluble iron (Fe) content higher than 50 per cent. The loss on ignition (at 1100°C.) was also determined for these samples on a dry basis. These assay results are given in the individual descriptions of the deposits. Many of the samples were of chips taken down the faces of the deposits and the others were surface samples.

Composite samples were made for each deposit by taking equal quantities of the relevant samples and the results of these assays are shown below:

Original Samples used in Composites

Composite No.	Deposit	Original Samples Included
1	McPhee's Creek....	13402–13406
2	Pundano, East	13409–13413
3	Pundano, Central	13415–13420 13422–13425
4	Lalla Rookh	13428–13437
5	Pundano, West	13438, 13439 13441, 13442
6	Trig. F. 13, South	13444–13446, 13448
7	Trig. F. 13, North	13449–13451
8	Abydos, East	13453–13459
9	Abydos Tank Pool	13460–13464
10	Abydos, Pincunah Hill	13465–13468

The iron content (total Fe) of composite samples varies in the range of 52.2-59.4 per cent. Silica ranges 3.45-7.17 per cent., alumina 0.56-6.45 per cent., and the ignition loss varies from 9.42 per cent. to 12.4 per cent. The highest value for titanium is 0.21 per cent., for manganese 0.07 per cent., for sulphur 0.11 per cent and for phosphorus 0.05 per cent.

Assay Results—Composite Samples

Composite Sample No.	Total Iron Fe	Acid-soluble Iron Fe	Titanium Ti	Manganese Mn	Sulphur S	Phosphorus P	Silica SiO_2	Alumina Al_2O_3	Ignition Loss at 1100°C.
	Per cent. on dry basis.								
1	55·9	55·6	0·21	0·04	0·11	0·04	4·51	4·83	10·2
2	53·0	52·3	0·14	0·01	0·06	0·02	6·23	5·16	12·4
3	59·4	58·6	0·07	0·01	0·08	0·05	3·45	0·56	10·3
4	53·7	53·2	0·19	0·07	0·07	0·03	6·23	4·33	12·1
5	52·2	51·7	0·10	Nil	0·06	0·03	7·17	6·45	11·3
6	56·6	56·5	0·06	0·01	0·06	0·04	4·43	2·46	11·8
7	57·4	57·2	0·07	0·02	0·06	0·04	4·80	1·89	10·7
8	54·9	54·9	0·09	0·03	0·05	0·02	5·66	4·35	10·6
9	57·4	57·3	0·10	0·02	0·06	0·03	4·50	3·42	9·42
10	56·1	55·6	0·07	0·07	0·05	0·03	5·14	3·02	10·9

Beneficiation.

The limonitic ore is low-grade but it can be upgraded by ignition. Calculations show that the average ignition loss of approximately 10 per cent. causes an increase of about 6.7 per cent. Fe in the residue. There is a consequent increase in impurities but these are low initially—as shown in the composite samples.

The lowest iron content for the composite samples after ignition is 58.8 per cent., while the best is 66.2 per cent. Fe. Five of the composites give a residue containing more than 63 per cent. Fe, after ignition.

Tonnage.

Veevers and Wells quoted a bulk density for the ore from the eastern deposit at Pundano as 11.84 cubic feet per ton. A factor of 12 cubic feet per ton has been used for all of the tonnage estimates in this report.

Table of Tonnages

Deposit	Distance from Port Hedland Miles	Tonnage Estimate Tons	Grade per cent. Fe
Pundano	19, 24	2,310,000	53
Trig. F. 13	33	1,165,000	57
Lalla Rookh	60	5,000,000	54
Abydos	60, 64, 78	4,720,000	56
McPhee's Ck.	132	4,500,000	56
Total	....	17,695,000	....

This table shows that some 3,475,000 tons of limonite ore above 50 per cent. Fe occur within 35 miles of Port Hedland. While a further 9,720,000 tons of comparable grade occur within 80 miles of the port.

A total of 17,695,000 tons of ore above 50 per cent. Fe has been indicated by this sampling programme.

The Deposits.

Plate (III) shows the location of the deposits and the access roads and tracks, while the sampling plans are on Plates IV, V. The deposits, in order of their distance from Port Hedland are located at Pundano (19 miles), Trig. F13 (33 miles), Lalla Rookh Station (60 miles), Abydos Station (60, 64 and 78 miles respectively), McPhee's Creek (132 miles).

Pundano Deposits.—Pundano was a siding on the old Port Hedland-Marble Bar railway line which has now been pulled up. Only the formation remains. There are three limonite deposits in this vicinity.

The eastern deposit is 13 chains south of the road to Marble Bar and 31 road miles from Port Hedland. It is 7 miles east of the old siding. The central deposit is just east of the siding on the north side of the railway formation and 1½ miles south-west of the main road at Table Hill (F12). The western deposit is 2 miles west of Pundano and 5 miles south of the main road.

Twenty samples were taken from the Pundano deposits and assays were made for acid soluble iron (Fe) content and for ignition loss. The results of these assays are shown below and the results of assays of Composite Samples Nos. 2, 3 and 5 (representative of the eastern, central and western deposits respectively) are given under "Sampling," above.

The total ore available from the eastern, central and western deposits at Pundano is estimated as 2,310,000 tons of better than 53 per cent. Fe.

Assay Results—Pundano Deposits

Sample No.	Description	Acid soluble iron, Fe	Loss on ignition (1100°C.)
		Per cent. on dry basis	
	Eastern Deposit		
13409	0 ft.–8 ft. chip down southern face	50·2	11·7
13410	0 ft.–9 ft. chip down northern face	53·5	12·7
13411	0 ft.–6 ft. chip down northern face	49·0	12·8
13412	0 ft.–10 ft. chip down northern face	52·5	12·8
13413	Surface at southern face	56·3	11·8
	Central deposit		
13415	0 ft.–7 ft. chip down west face	59·0	9·70
13416	0 ft.–10 ft. chip down south face	59·0	10·3
13417	0 ft.–10 ft. chip down north face	58·3	10·1
13418	0 ft.–8 ft. chip down east face	57·6	10·5
13419	0 ft.–8 ft. chip down west face	58·6	9·99
13420	Surface at south face	55·9	12·0
13422	0 ft.–10 ft. chip down west face	57·4	11·1
13423	0 ft.–5 ft. chip down east face	57·0	12·1
13424	Pieces across surface of butte	60·1	9·57
13425	Pieces across surface of butte	59·2	9·31
	Western deposit		
13438	Surface lumps from crest of hill	54·6	9·78
13439	Surface lumps from crest of hill	55·5	9·35
13441	Surface slope north of mesa	50·3	12·7
13442	Surface at west end of butte	46·2	12·8
13443	Grab from gravel pit	38·5	9·10

The Eastern Deposit.—This deposit is 72 chains long and has an average width of about 4 chains with a surface area of nearly 28 acres. Its long axis runs west-north-west, parallel with the main road and it forms the cap of a butte some 60-70 feet above the sand-and spinifex-covered granite plain.

The limonite cap is brown and yellow (without hematite) and varies in thickness from 8 feet to 20 feet—with an average thickness of about 12 feet. Most of the edge of the deposit shows a breakaway face and the limonite talus surrounding the butte is only thin, even though it covers an area much larger than the actual deposit. Some of this talus has been scraped from the northern side for roadmaking.

The ore is pisolitic but is also cemented with limonite. Beneath the solid surface the ore is rather loose in places and patches of yellow powder were observed. Horizontal banding is prominent in the ore and pipes are common. There are several patches containing numerous quartz grains.

A white kaolin zone 20 feet thick (with some mottled patches) underlies the ore and this is underlain in turn by a weathered pegmatitic granite which still contains mica plates and has a rounded outline (Fig. 3). It is possible that some of the sandy limonite patches were originally sandstone but most of the material in the kaolin zone appears to be weathered granite.

The area of the deposit (measured by planimeter) is 1,208,800 square feet—giving a tonnage of some 1,210,000 tons with an approximate iron content of 53 per cent. (determined by Composite Sample No. 2).

The Central Deposit.—The central deposit at Pundano consists of five long thin buttes arranged end-to-end in an east-west line. For convenience of description these buttes have been numbered from east to west. The valleys between the buttes have been eroded to plain level and Fig. 4 shows Butte No. 3 viewed from the north with the ends of Nos. 2 and 4 visible. There is an accordance of level of these deposits which are approximately 80 feet above the plain.

No sandstone was identified in the kaolin zone but some isolated small outcrops were seen within half a mile of the deposit, so it is probable that some sandstone does occur in these buttes. The underlying rock is pegmatitic granite (with quartz reefs) kaolinised in its upper part. Some hematite was seen in these deposits and the grade of ore is good.

Butte No. 1 is 13 chains long and the ore has a surface area of about 10 square chains. The tonnage is only 40,000 tons.

Butte No. 2 is 12 chains long with a surface area of some 12 square chains. There is also a small area of rather massive limonite on the northern lower slope of this butte but this was not included in the estimate. The cap on this butte contains about 50,000 tons of limonite ore.

Butte No. 3 is the second largest of the group—being 19 chains long with a surface area of 43 square chains. The cap has an average thickness of 15 feet and the edges are vertical. The tonnage of ore is 230,000 tons.

Butte No. 4 is the largest with a length of 24 chains and a surface area of 77 square chains. The better ore is 15 feet thick and the underlying low-grade material is 5-10 feet thick (not sampled). The tonnage estimate is 420,000 tons.

Butte No. 5 is 60 chains west of No. 4 and is separated from it by three ridges with negligible amounts of ore. No. 5 is on the east bank of Petermarer Creek just north of Pundano. The limonite cap is 12 chains long with a surface area of 25 square chains and a tonnage of 110,000 tons.

The total tonnage for the central deposit is 850,000 tons and the grade (from Composite Sample No. 3) is about 59 per cent. Fe.

The Western Deposit.—This deposit contains two small mesas which are thin and of low grade (below 50 per cent. Fe) and the better ore occurs on low hill slopes. Roadmaking gravel is being removed from the northern part of the scree and a sample of this material assayed 38.5 per cent. Fe. Sample No. 13438 is from a hillock with some 120,000 tons ore in a cap 5 feet thick and Sample No. 13439 is from a sheet of ore 3 feet thick which extends back to No. 13438. It is probable that a total of 250,000 tons of ore is available from here at a probable grade of 53 per cent. Fe. The western part of the deposit has not been included in this estimate as it is considered to be too low in grade.

Trig. F13 Deposits.—This trig. is 33 miles east of Pt. Hedland and 6 miles east of the Great Northern Highway. It is on a ridge of jaspilite in a granite plain to the south-west of the Ord Ranges.

PLATE III

G.S.W.A.

MAP OF PORTION OF WESTERN AUSTRALIA showing LOCALITIES OF LIMONITIC ORE-BODIES SAMPLED

Scale: 10 miles to 1 inch

L.E. de la Hunty, August 1960

LEGEND

54·9% Fe — Ore-body with total iron content (Fe), determined on dry basis from composite sample.

Roads

Tracks

Mills

Rivers

PORT HEDLAND

Peternarer

North West Coastal Highway

Δ F11

57·4% Fe Δ Mt St GEORGE F7

F9 Δ

F13 Δ

56·6% Fe

Mt GOLDSWORTHY Δ

TABLE HILL F12 Δ

PIPPINGARRA HSTD.

Old Pundano Creek

52·2% Fe

59·4% Fe

53·0% Fe

STRELLEY HSTD.

Great Northern Railway

TABBA TABBA HSTD.

COOKES HILL

WALLAREENYA HSTD.

INDEE HSTD.

LALLA ROOKH HSTD.

Turner River

53·7% Fe

57·4% Fe

The Tank Pool

Δ PINCUNAH B16

56·1% Fe

ABYDOS HSTD.

Well & Mill

54·9% Fe

MARBLE BAR

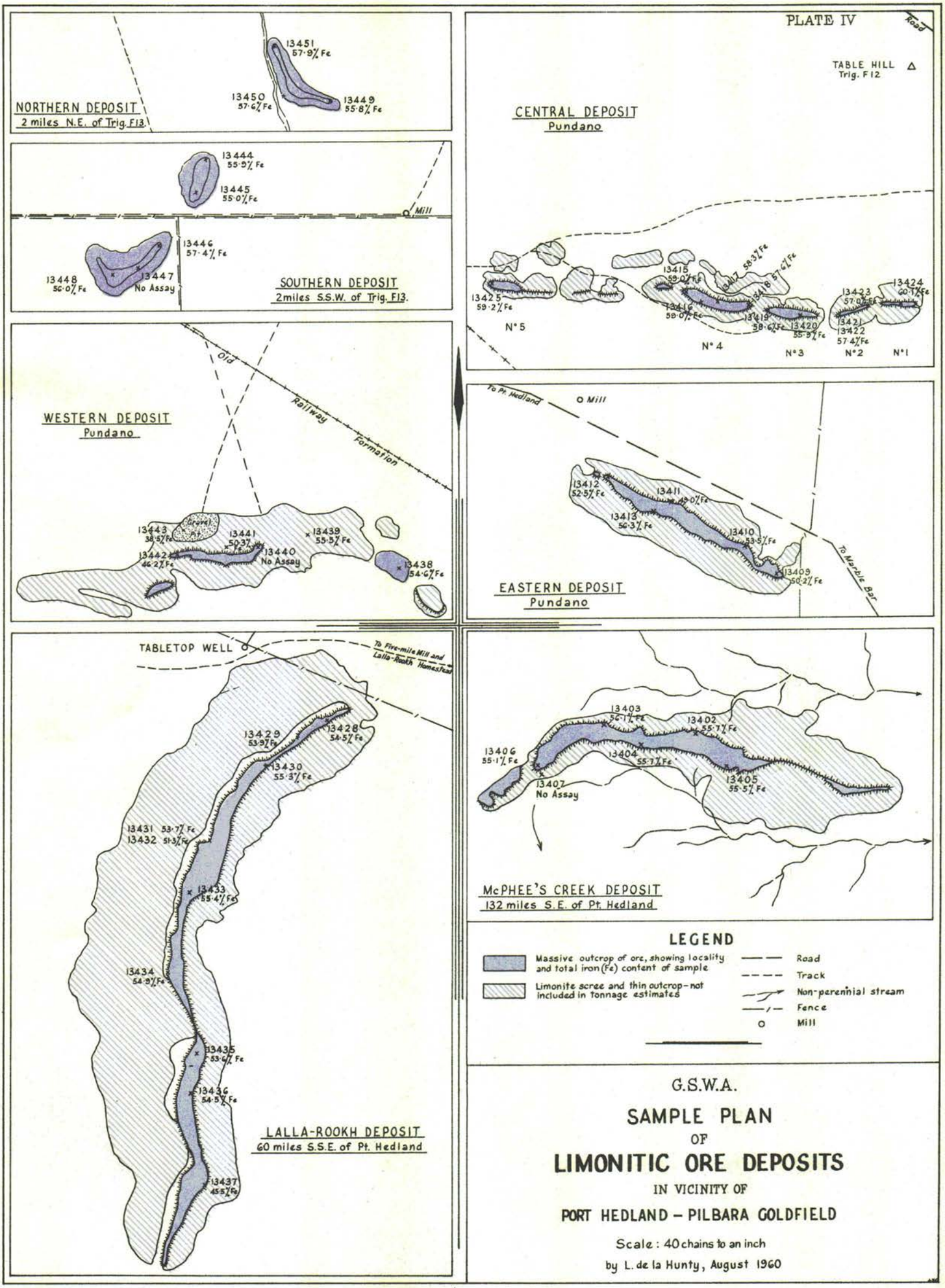
Highway

McPhee Creek

55·9% Fe

Lionel

PLATE IV



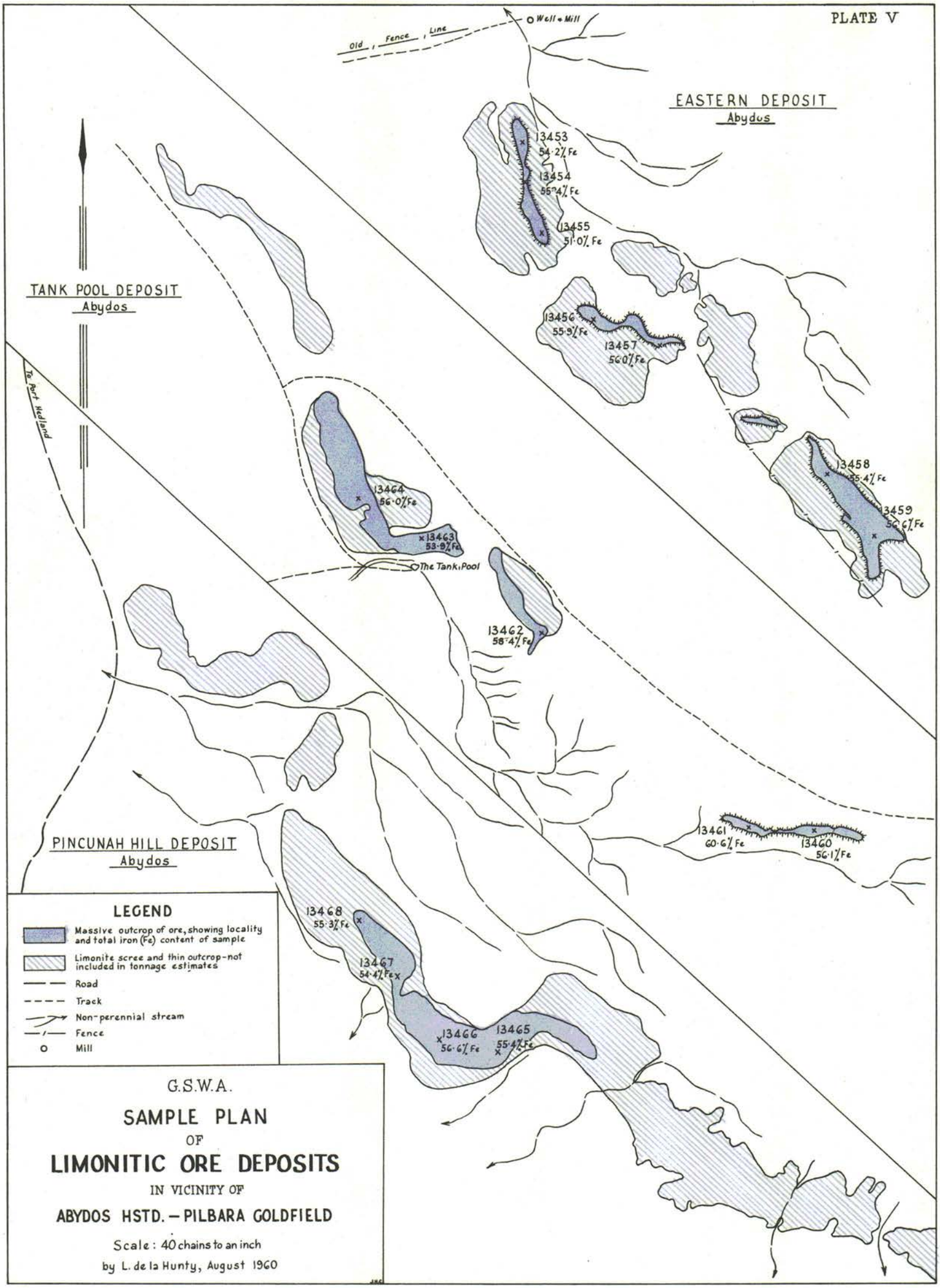
G.S.W.A.

SAMPLE PLAN
OF
LIMONITIC ORE DEPOSITS
IN VICINITY OF
PORT HEDLAND – PILBARA GOLDFIELD

Scale : 40 chains to an inch

by L. de la Hunty, August 1960

PLATE V



G.S.W.A.

SAMPLE PLAN
OF
LIMONITIC ORE DEPOSITS
IN VICINITY OF
ABYDOS HSTD. — PILBARA GOLDFIELD

Scale : 40 chains to an inch

by L. de la Hunty, August 1960

There are two deposits of limonite in this locality and a station track passes both of them. The deposits are 2 miles north-east of the trig. and 2 miles south-south-west of it. There are two mills half a mile north-east and 2 miles south of the trig. respectively.

The tonnage of ore available from this locality is 1,165,000 tons and the grade is about 57 per cent. Fe (from Composite Samples Nos. 6 and 7).

Assay Results—Trig F. 13 Deposits

Sample No.	Description	Acid soluble iron, Fe	Loss on ignition (1100°C.)
		Per cent. on dry basis	
	2 miles S.S.W. of Trig		
13444	Surface at north end of deposit	55·9	12·2
13445	Surface at south end of deposit	55·0	11·7
13446	Surface at north end of deposit	57·4	11·9
13448	Surface near western end of deposit	56·0	12·1
	2 miles N.E. of Trig		
13449	Surface at eastern end	55·8	10·6
13450	0 ft.–10 ft. chip down S.W. face	57·6	11·4
13451	Surface at northern end	57·9	10·1

The Northern Deposit.—This deposit is shaped like a boomerang in plan and occurs at plain level on the east bank of a north-flowing stream. The ore is 30 chains long and 5 chains wide. It is mound-shaped in section with a maximum height of 20 feet and has a vertical face 10 feet high at the south-west corner.

The tonnage estimate for this deposit is 595,000 tons and the grade (from Composite Sample No. 7) is about 57 per cent. Fe.

The Southern Deposit.—There are two outcrops of ore in the southern deposit and the northern outcrop is 20 chains from north to south and has a maximum width of 13 chains. It is dome-shaped on a hill about 50 feet above the plain and most of the ore is rather porous but contains a few pisolites. About 350,000 tons of ore could be won from this outcrop.

The second outcrop is convex to the south and presents a small vertical face at the crest of the deposit. The cap is of rather massive ore (with some pisolites) about 40 feet above the plain. The tonnage is about 220,000 tons.

The total ore available is 570,000 tons and the grade (from Composite Sample No. 6) is nearly 57 per cent. Fe.

Lalla Rookh Deposit.—This deposit is 60 miles south-south-east of Pt. Hedland on Lalla Rookh Station but its distance by present roads and tracks past Lalla Rookh Homestead is 90 miles. It should be possible to make a road west to the Pt. Hedland-Wittenoom road and so reduce the road distance to about 70 miles. Such a road would enable the Lalla Rookh deposit to be considered in conjunction with those on Abydos Station.

The Lalla Rookh deposit is about 200 chains long from north to south and varies in width from a few feet up to 12 chains. It has a surface area of about 916 square chains and varies in thickness from 6 feet to 20 feet, with an average of about 15 feet. The limonite capped butte rises about 80 feet above the sand-covered granite-gneiss plain and forms a prominent landmark. Its northern end is 40 chains east-south-east of Tabletop Well.

Assay Results—Lalla Rookh Deposit

Sample No.	Description	Acid soluble iron, Fe	Loss on ignition (1100°C.)
		Per cent. on dry basis	
13428	0 ft.–10 ft. chip down southern face	54·5	11·9
13429	Surface at western face	53·9	12·8
13430	0 ft.–10 ft. chip down eastern face	55·3	12·6
13431	0 ft.–10 ft. chip down western face	53·7	12·4
13432	10 ft.–16 ft. chip down western face	51·3	11·6
13433	Surface at middle of butte	55·4	11·8
13434	0 ft.–6 ft. chip down western face	54·9	12·1
13435	Surface at middle of butte	53·6	10·2
13436	0 ft.–3 ft. chip down eastern face	54·5	12·4
13437	0 ft.–3 ft. chip down eastern face	45·5	12·3

The ore is rather massive with horizontal banding and some pisolites. Pipe structures are also common in the lower part of the cap (See Fig. 5). Ten samples were taken and only one of these (No. 13437) showed an iron content lower than 50 per cent. The ore at this spot is at least 20 feet thick but the face was too steep to enable a longer sample being taken. Sample No. 13432 from 10-16 feet down the western face showed a drop of 3 per cent. Fe on the average of the remaining samples and on the overlying 10 feet of ore.

About 4 miles south of this deposit there is a possible ore-body 70 chains long from north to south with an average width of about 6 chains. This occurrence, which is in rugged country on Warrawoona rocks, was not visited.

The tonnage estimated for the Lalla Rookh deposit (average depth 15 feet) is 5,000,000 tons and the grade (from Composite Sample No. 4) is nearly 54 per cent. Fe.

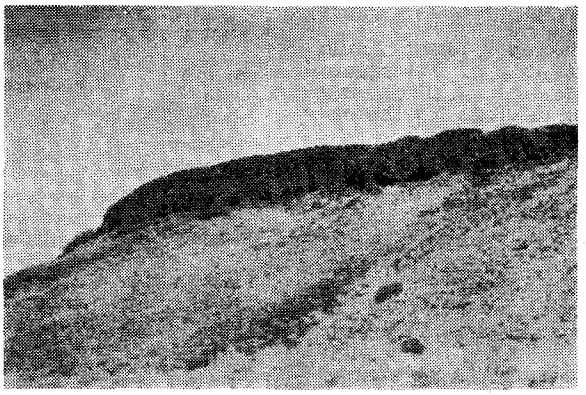


Fig. 5.—Part of Lalla Rookh Deposit, from east.

Abydos Deposits.—There are three limonite deposits on Abydos Station and they are all near the contact of granite with rocks of the Warrawoona System. The deposits are 22 miles north of the homestead (Tank Pool); 18 miles north of the homestead (Pincunah, Trig. B16); 5 miles east of the homestead (Eastern Deposit).

A total tonnage of 4,720,000 tons is available from these three deposits and the grade (from Composite Samples Nos. 8, 9, and 10) is approximately 58 per cent. Fe.

Assay Results—Abydos Deposits

Sample No.	Description	Acid soluble iron, Fe	Loss on ignition (1100°C.)
		Per cent. on dry basis	
	5 miles east of Homestead		
13453	Surface near north end	54·2	9·97
13454	Grab 15 ft. down west face	55·4	12·4
13455	Surface near south end	51·0	12·1
13456	Surface near N.W. end	55·9	9·92
13457	Surface near S.E. end	56·0	10·6
13458	Surface near N.W. end	55·4	8·76
13459	Surface near south end	56·6	9·20
	22 miles north of Homestead		
13460	Surface eastern part of butte	56·1	10·4
13461	Surface western part of butte	60·6	8·16
13462	Surface south end of deposit	58·4	10·0
13463	Surface southern part of deposit	53·9	9·08
13464	Surface central part of deposit	56·0	10·4
	18 miles north of Homestead		
13465	Surface eastern part	55·4	11·0
13466	Surface S.W. part	56·6	10·4
13467	Surface northern part	54·4	11·0
13468	Surface at north end	55·3	11·2

Tank Pool Deposit.—Tank Pool is about 60 miles south of Pt. Hedland and 4 miles east of the road to Wittenoom. The track from the road to the pool is old and hard to find. The ore is on three outcrops, the best of which is the most southerly.

This is a small east-west butte 50 chains long with a surface area of 130 square chains about 80 feet above the plain. The limonite cap is 15 feet thick and the top 5 feet looks better grade than the rest of the cap. The ore is pisolite with limonite cement and it overlies a sandstone containing bands of rather angular pebbles (Nullagine System) which in turn overlies vertical schists with quartz veins and some granite. Since both samples from this deposit were taken from the surface only the top 5 feet is included in the tonnage estimate of 280,000 tons.

The next outcrop is a narrow strip 35 chains long, about 100 chains north-west of the previous outcrop. There is about 5 feet of limonitic ore on 10 feet of low grade limonitic rock about 50 feet above the plain on schists of the Warrawoona System. There are 300,000 tons of ore in this patch.

The most northerly outcrop is about a mile long and has a surface area of 560 square chains. However it is very thin in places and it caps a low ridge. The estimate for the deposit is about 800,000 tons.

The total tonnage for the Tank Pool Deposit is 1,380,000 tons at a grade of 57 per cent. Fe (from Composite Sample No. 9).

Pincunah (Trig. B16) Deposit.—Pincunah is about three miles east of the road to Wittenoom and 64 miles south of Pt. Hedland and the deposit is a mile south-west of the trig. The deposit is in a patch of laterite more than four miles long (east-west) on low-dipping sediments of the Nullagine System, at the contact of the granite with rocks of the Warrawoona System.

Most of the laterite is on a sloping surface where it is thin and has a low iron content. The limonitic ore-body is flat-lying with a length of 100 chains and a surface area of 1,166 square chains. The ground slopes away gradually from the north and west edges of the deposit but there is a sharp drop of 50 feet to the incised lower ground south-east of the deposit.

An estimated average thickness of five feet gives a tonnage for the deposit of 1,750,000 tons of ore at 56 per cent. Fe (from Composite Sample No. 10).

The Eastern Deposit.—This deposit is 5 miles east of Abydos Homestead and 78 miles south of Pt. Hedland. An old windmill track leads from the homestead to a disused mill just north of the deposit. The deposit consists of three butte cappings aligned north-west about 80 feet above plain level on granite. Some quartz pebbles (up to two inches long) were seen on the caps.

The most northerly butte has a cap of cemented pisolites about five feet thick over 20 feet of tubular limonite which falls off in grade. A thickness of 10 feet has been used in calculating the tonnage for this butte which has a length of 45 chains and a surface area of 157 square chains. The tonnage available is 470,000 tons.

The central butte has a cap of cemented pisolitic ore about 10 feet thick at the north end and five feet thick at the south end—with underlying lower grade cavernous limonite. The cap is 39 chains long with a surface area of 126 square chains and the average thickness of the ore is about eight feet. The tonnage estimate is 300,000 tons.

The most southerly butte is 60 chains south-east of the central butte past a small butte with negligible tonnage. The cap of the south butte is 55 chains long and up to 14 chains in width with a surface area of 398 square chains. The top seven feet or more of the cap is of good grade with a further 15 feet of cavernous ore below. The tonnage estimate is 820,000 tons.

The total tonnage available from the Eastern Deposit is 1,590,000 tons of 55 per cent. Fe (from Composite Sample No. 8).

McPhee's Creek Deposit.—This deposit is 132 miles south-east of Pt. Hedland but the road distance is 171 miles—163 miles on the Great Northern Highway then three miles along the Lionel road then five miles north across country.

The deposit overlies vesicular flat-lying basalt of the Nullagine System and could be a direct lateritisation product of the basalt. However it is the lowest remnant visible of the Tertiary land surface in this locality so it could still be of the "bog-iron" type. The basalt in turn overlies rocks of the Warrawoona System which also outcrop above the level of the deposit to the west.

The deposit consists of pisolitic limonite with limonite cement and with vugh linings and lumps of glassy limonite. Vertical pipes of lower grade material occur at the western end of the deposit under the higher grade cap.

Assay Results—McPhee's Creek Deposit

Sample No.	Description	Acid soluble iron, Fe	Loss on ignition (1100°C.)
		Per cent. on dry basis	
13402	0 ft.–10 ft. chip down north face	55·7	10·3
13403	0 ft.–3 ft. chip down north face	56·1	10·3
13404	0 ft.–5 ft. chip down south face	55·7	10·6
13405	0 ft.–10 ft. chip down south face	55·5	10·4
13406	Surface chip (across 20 ft.) at S.W. corner	55·1	9·91

The main ore-body of the deposit is oriented east-west and is 80 chains long with an average width of about 7½ chains and a surface area of 618 square chains. The ore presents a steep vertical face—limiting the sampling length—and the cap is about 100 feet above the plain level. The average thickness of the higher grade ore is about 20 feet and a zone of lower grade material of comparable thickness underneath this cap produces a total face height of 40 feet. A small tonnage of ore could be won from the small deposit to the east of the main body but the outcrop to the south-west is low in grade.

The tonnage of ore available from this deposit is estimated at 4,500,000 tons and the grade (from Composite Sample No. 1) is about 56 per cent. Fe. However its distance from the port should place it outside the economic carting range.

Other Localities.

Nullagine River.—Several low buttes with thin limonitic caps occur in the valley of the Nullagine River south (upstream) from Nullagine township and in the valley of its tributary Bonnie Creek. These deposits were not sampled.

Marillana Station.—Sample No. 13401 from a small limonite deposit 20 miles south-west of Marillana Homestead assayed 58.0 per cent. Fe. The deposit occurs in the valley of a tributary of Yandicoogina Creek. Other small deposits were seen in this valley and there are probably more in the area but the locality is so far from a port that these were not followed up.

Indee Station.—There is a small amount of limonite at Cooke Hill, 32 miles south of Pt. Hedland where the road to Wittenoom crosses the east branch of the Turner River. This is similar in grade to sample No. 13469 (from a very small patch 2 miles west of Cooke Hill), i.e. 51.4 per cent Fe.

L. de la HUNTY,
Geologist.

22/12/60.

REPORT ON A DEPOSIT OF BOG-IRON ORE AT THE SCOTT RIVER, SOUTH-WEST LAND DIVISION, WESTERN AUSTRALIA.

By L. E. de la Hunty, B.Sc.,
Geological Survey of Western Australia.

Introduction.

As a result of claims made by the Griffin Coal Mining Company that it had located some 80,000,000-100,000,000 tons of ferruginous material capable of being used as ore in a sponge-iron industry, the writer visited the deposit on the north bank of the Scott River on October 17th, 1960.

Traverses were made by the writer, in company with the Managing Director, the Superintendent and the Surveyor of the Company, over an area of 2 square miles, and two other localities nearby were also visited. Assays of samples taken by the writer are shown below.

Location and Access.

The deposit occurs on the north and east sides of Sussex locations 2973, 2974, 2975 and on Sussex location 502 on the north side of the Scott River. It is about 3 miles north of the south coast and 4 miles east of the mouth of the Scott River. The Scott River is a swift flowing stream which flows into the head of the Hardy Inlet about a mile east of the mouth of the Blackwood River and about 6 miles north-north-east of Augusta. The deposit is about 8½ miles north-east of Augusta which is at the mouth of Hardy Inlet.

However, access by road to the deposit from Augusta can be had only via Alexandra Bridge—a road distance of some 29 miles. A gravel road runs south from the Brockman Highway (bitumen) 3.6 miles east of the bridge, then a formed dirt road heads east after 2.9 miles then south after 1.3 miles to the Scott River (another 4 miles). The deposit is about a mile east of the road and can be reached by a rough boggy track which leaves the road a mile north of the Scott River.

The dirt road was rough and boggy at the time of inspection. It is a summer road only.

References.

1915—Woodward, H. P.: The Reputed Petroliferous Area of the Warren River District, South-west Division *G.S.W.A. Bull. 65.*

1929—Moore, E. S. and Maynard, J. E.: Solution, Transportation and Precipitation of Iron and Silica. *Economic Geology Vol. XXIV* pp. 272, 365, 506.

1951—Smith, R.: Soils of the Margaret River-Lower Blackwood River Districts, Western Australia, *Commonwealth Scientific and Industrial Research Organisation Bull. 262.*

Geology.

The general geology of this part of the State is given by Woodward as soil overlying Palaeozoic sediments. These sediments contain coal and lignite seams and several wells sunk in the vicinity of the deposit are reputed to have intersected some thin coal and lignite bands.

Smith gives the following description of the "Scott River Suite" of soils:—

> This suite has an extensive distribution on the flat wet plains extending to the Scott River. The parent material is sand probably of estuarine origin.
>
> Typical profiles are described as follows:—
>
> Type 1—
>
> | | | |
> |---|---|---|
> | A^1 | 0–6 in. | Brownish yellow sand with some organic matter, fairly distinct from the A^2. The surface layer, ½ in. deep, is darker in colour and richer in organic matter ; pH 5·3, clay 3%. |
> | A^2 | 6–24 in. | Brownish yellow sand ; pH 5·9 ; clay 4%. |
> | B | 24–51 in. | Iron hardpan layer consisting of large lumps of laterite up to 8 in. diameter and some continuous pan. |
>
> Type 2—
>
> | | | |
> |---|---|---|
> | A^1 | 0–5 in. | Grey sand with small amounts of organic matter, loose and incoherent ; pH 5·1 ; clay 2%. |
> | A^2 | 5–21 in. | Very light grey sand, loose and incoherent ; pH 5·4. |
> | B^1 | 21–39 in. | Light grey, with faint brownish organic stain, sand, slightly incoherent ; pH 5·5. |
> | B^2 | 39 in.+ | Hard and massive laterite layer not penetrated by a crowbar. |
>
> Type 3—
>
> | | | |
> |---|---|---|
> | A^1 | 0–2 in. | Dark brown loamy sand with small amount of organic matter and much iron stain. |
> | A^2 | 2–6 in. | Yellow sand, somewhat ironstained. |
> | B | 6 in.+ | Hard and massive laterite layer not penetrated by a crowbar. |

The writer considers that the term "laterite" has been used rather loosely here in the description of the iron oxide layer. The deposit seems to be of the "bog-iron" type.

The limonite has been deposited on and in a deposit of sand in a low-lying boggy area. The area is characterised by heath-type vegetation with some trees where low sand ridges overlie the ore. Nearby stands of jarrah and marri are growing in thick

sand deposits which could possibly overlie ferruginous material. (This is not considered probable by the writer.)

The Deposit.

Although the ground was wet at the time of inspection, there is some relief in the area containing the ore. A fall of about 50 feet in a mile was noticed and one part of the north bank of the Scott River showed a sloping face of limonite about 50 feet high.

Generally the ore is sandy and friable and rather porous. However all gradations from a ferruginous sandstone to a rock consisting of cemented pisolites (with sand grains) were seen. A skin of pure iron oxide up to ¼ in. thick was seen on some of this latter type. There is a rough horizontal layering in the ore and pockets of loose white silica sand are common. These pockets vary in size from half an inch to about a foot in diameter.

Boring done by the Company has revealed varying thicknesses of ore—ranging from 4 ft. 3 in. to more than 10 ft. 10 in. in nine holes bored in a rough grid pattern. Several holes which did not reach the bottom of the ore were stopped in ore which was reported as "very hard." Some of these holes had been fired—enabling the writer to take a few grab samples of sub-surface material.

SAMPLE RESULTS

Sample No.	Sample Locality	Results of Analysis (Dry basis)		
		Acid Sol. Fe	Acid Insol.	Ignition Loss
		Per cent.	Per cent.	Per cent.
13470	Approx. 1 mile E.N.E. of N. corner of loc. 2973—surface near Hole No. 4	48·2	18·9	8·41
13471	Approx. 27 chns. E.N.E. of N. corner of loc. 2973—Shot Hole No. 3 (0 ft.–2 ft.)	54·6	11·3	8·30
13472	Approx. 7 chns. N.W. of E. corner of loc. 2974—Pit (0 ft.–3 ft.)	38·5	34·4	8·55
13473	Approx. 30 chns. S.S.W. of E. corner of loc. 2975—Shot Hole No. 8 (0 ft.–3 ft.)	49·4	18·6	9·64
	Average	47·7	20·8	8·72

Moore and Maynard (see list of references) conducted considerable research and experimental work on the solution of iron from country rock, its transportation by river waters and its precipitation in deposits. They showed that natural waters, rich in organic matter and of sufficient volume, can take into solution and transport, during a great number of years, sufficient iron to form a large sedimentary iron deposit. They conducted experiments with various waters to test their effect on basic rocks. Carbonated water was found to be the best solvent of iron (and silica) and peat solution was the next most effective. They also showed that contact with sea water causes immediate precipitation of iron from a ferric oxide hydrosol (the form in which most of the iron is transported).

The Scott River and all of the streams in this area carry strong concentrations of organic matter and consequently are able to carry considerable quantities of iron. Initially (in Quaternary times) this iron may have been deposited due to contact with sea water and the salinity of the ground water probably still plays an important part in the precipitation of iron at this deposit. Bacterial action on the surface water is also a highly probable cause of deposition of the iron—as well as direct evaporation as the swamp dries out in the summer months.

The limonite has impregnated a deposit of sand —resulting in ferruginous sandstone and sandy limonite ore.

Other Prospects.

The Company sank a hole 6 ft. 5 ins. deep in similar ore about 40 chains south-south-west of location 4152 (just a few chains west of the road in the old track) and shot the hole. Sample No. 13475 from the resulting pit showed 39.8 per cent. acid sol. Fe, 31.2 per cent. acid insol. and 9.25 per cent ignition loss on analysis. The low ground from which this sample was taken extends for some distance to the south-west and south. (The centre of the main deposit is about 3 miles south-east of this sample hole).

A further hole was bored (No. 2) just a few chains east of where the south road meets Scott River (west corner of location 2973). The borehole showed a thickness of 8 ft. 2 ins. of ore in a small creek bed and the outcrop continued in a swampy area to the north. There is a thick deposit of sand, with tall trees on the south side of this borehole.

Conclusions.

(1) The ore deposit is of the bog-iron type.

(2) In the main deposit the ore outcrops over a minimum area of 2 square miles and 9 holes have disclosed an average thickness of about 6½ feet.

(3) Insufficient work has been done to permit of a tonnage estimate being made.

(4) The ore is unsuitable for blast furnace requirements but may qualify as ore for "sponge-iron" processing.

(5) There are prospects of other ore-bodies in the vicinity.

(6) The ore-bodies are divided by belts of timber on thick sand deposits.

L. de la HUNTY,
Geologist.

30.10.60.

FINAL PROGRESS REPORT ON THE REGIONAL SURVEY OF THE BALFOUR DOWNS 4-MILE SHEET, PILBARA GOLDFIELD, WESTERN AUSTRALIA.

By L. E. de la Hunty, B.Sc., Geological Survey of W.A.

Introduction.

Mapping of this sheet was commenced in 1959 * and the remaining 1,750 square miles were completed by the writer in 1960.

As stated in the previous report,* the work was undertaken in an endeavour to establish the origin and environment of the manganese deposits in the eastern half of the area.

Other general information contained in that report will not be reproduced here.

Field Work.

The 1960 field season was commenced on April 20th and the mapping was completed by August 20th. No base camp was made and the writer, with a survey hand/motor driver "lived off the truck." The vehicle used was a 4-wheel drive 18 cwt. International utility which was equipped with a transceiver for communication with the Royal Flying Doctor wireless network.

Heavy falls of rain during the 1959-1960 summer, together with several winter falls, were responsible for the appearance of quite a lot of non-permanent pools—especially in the bed of the Oakover River. These pools were omitted from the map but they did restrict access to some parts of the area.

A total of 61 specimens of rocks and minerals were collected (Nos. 5842-5900, 13408 and 13426)

* 1960 de la Hunty, L. E.: Progress Report on the Regional Survey of the Balfour Downs 4-Mile Sheet, Pilbara Goldfield, Western Australia. *G.S.W.A. Ann. Prog. Rep.* 1959, p. 11.

Map Compilation.

The Compilation Sheets (on photo scale of 50 chains to an inch) were made available by the Lands Department at the end of 1960. The geology was plotted on these sheets for reduction to a scale of 4 miles to an inch. The 4-mile map is to be published with Explanatory Notes.

General Geology.

The general geology consists of Proterozoic and younger rocks overlying a basement of the Warrawoona System with instrusive granite. The younger rocks include Permian glacial deposits and sandstone, Tertiary sediments, calcrete, laterite and hardpan also Recent sand, alluvium, river gravels and talus.

Some alteration to last year's stratigraphic column was found necessary. The "fine-grained basalt" was proved intrusive—usually in sill form but occasionally in dykes. Therefore it must be called a dolerite and is the youngest of the Proterozoic rocks. Cover rocks are rare on the dolerite but conglomerate is the main type.

The sediments in the south-east part of the area are more sandy than those to the north and a quartzite cap has been developed over the sandy rocks during the Tertiary and Recent erosion cycles. Contrasting with this quartzite is the chert breccia which formed at the unconformity above the chert-shale-mudstone succession in Proterozoic times. This same succession has yielded material for the formation of a chert breccia in Tertiary times and for the present talus mantle. Another siliceous cap occurs on the Oakover Beds. Porous opaline silica up to 20 feet thick caps the buttes at Carawine Gorge north of the area and there is quite a lot of opaline silica associated with the Oakover Beds in the Balfour Downs 4-mile area.

Mining Activity in 1960.

Manganese ore was again mined from M.C.194L on the east bank of the Davis River and trucked to Port Hedland.

J. Clarke continued to produce copper ore from his show near Saddleback Hill. This was carted by road to Meekatharra for onward transport by rail.

Mineral Deposits.

Copper.—Several small outcrops of copper carbonate in the vicinity of Turammunda Rock Hole (20 miles north-north-west Balfour Downs Homestead) were visited this year. The carbonate (malachite) was confined to joints and faults (as seen in other parts of the area) and potholes had been dug on some outcrops. A little cuprite was seen in places.

Gold.—Some old potholes were found in a bed of conglomerate 4 miles south-east of Trig. M48 and 24 miles north-west of Balfour Downs Homestead. (Rooney's alluvial workings were not seen). The conglomerate contained rather poorly rounded boulders of quartz, jaspilite, quartzite and schist. The quartz contained some silver-coloured pyrites. There was no evidence of any gold having been won from the conglomerate.

Diamonds.—The host rock for the diamonds found near Nullagine is the basal conglomerate of the Nullagine System. The only outcrops of this conglomerate in the area mapped are at Sunday Hill, also near Trig. M48 at the head of Brown's Creek (see above) and at the contact of the Warrawoona System with the granite at the north-west corner of the area.

The conglomerate at Trig. M48 is associated with ash beds as is the conglomerate from which the diamonds were recovered. Some tuff also occurs in the M48 locality.

In view of the direction of sedimentation in the area (deep water sediments to the east) it seems probable that the original source rocks for the diamonds occur west (or north-west) of where they were found in the conglomerate near Nullagine.

L. de la HUNTY,
Geologist.

14/3/61.

THE SEARCH FOR OIL IN WESTERN AUSTRALIA IN 1960.

By G. H. Low, B.Sc.,
Geological Survey of W.A.

Drilling.

During the year five bores were completed in the search for oil in Western Australia. Two of these were completed by West Australian Petroleum Pty. Ltd. near Broome in the Canning Basin, two by Exoil (a subsidiary of Oil Drilling and Exploration) in the south of the Eucla Basin, and one by the Commonwealth Bureau of Mineral Resources at Beagle Ridge in the Perth Basin.

The total footage drilled up to 31 December amounted to 16,910 feet. Of this total Thangoo No. 1A and Barlee No. 1 (Wapet) comprised 10,448 feet; Gambanga No. 1 and Eyre No. 1 (Exoil) comprised 1,600 feet; and Buromin Hole No. 10A at Beagle Ridge reached 4,862 feet.

The following is a summary of the holes drilled and the results obtained during 1960:—

Company: West Australian Petroleum Pty. Ltd.
Licence to Prospect: 66H.
Well: Thangoo No. 1A Structure Test.
Location: Latitude, 18° 21′ 52″ S. Longitude 123° 38′ 42″ E. Height of derrick floor above sea level—568 feet.
Spudded in: 28 December, 1959.
Status: Completed at 5,429 feet on 17 February in pre-Cambrian biotite phyllite rocks. There was some slight fluorescence and oil staining in four zones between 3,030 feet and 4,950 feet.

Company: West Australian Petroleum Pty. Ltd.
Licence to Prospect: 67H.
Well: Barlee No. 1 Test.
Location: Latitude 17° 48′ 25″ S. Longitude 122° 42′ 40″ E. Height of derrick floor above sea level—74 feet.
Spudded in: 12 April, 1960.
Status: Completed at 8,101 feet on 29th July in predominantly sandstone rocks of the Upper Carboniferous. There were no hydrocarbon shows.

Company: Exoil Pty Ltd.
Licence to Prospect: 65H.
Well: Gambanga No. 1 Stratigraphic.
Location: Latitude 32° 16′ S. Longitude 124° 15′ E. Height of derrick floor above sea level — ?
Spudded in: 14 February, 1960.
Status: Completed at 1,279 feet on 5 March, 1960 in pre-Cambrian gneissic granite. Marine sequences of Tertiary and Cretaceous rocks were penetrated. There were no showings of oil or gas.

Company: Exoil Pty. Ltd.
License to Prospect: 65H.
Well: Eyre No. 1 Stratigraphic.
Location: Latitude 32° 7′ S. Longitude 126° 58′ E. Height of derrick floor above sea level—52 feet.
Spudded in: 27 November, 1959.
Status: Completed at 1,718 feet on 24 January, 1960 in pre-Cambrian crystalline basement. Marine sequences of Tertiary and Cretaceous rocks were penetrated. There were no showings of oil or gas.

Drilling Authority: Bureau of Mineral Resources.
Permit to Explore: 27H.
Well: B.M.R. No. 10A Beagle Ridge Stratigraphic.
Location: Latitude 29° 49′ 38″ S. Longitude 114° 58′ 30″ E. Height of derrick floor above sea level—26 feet.
Spudded in: 2 May, 1960.
Status: Completed at 4,862 feet on 10 July, 1960 in pre-Cambrian basement rocks. The rocks penetrated included sequences of Pleistocene, Jurassic, Triassic and Permian sediments.

LIST OF PERMITS TO EXPLORE.

The following Permits to Explore were current on 31st December, 1960:—

Company or Syndicate	Number of Permit to Explore	Date of Approval	Area Sq. miles approx.
West Australian Petroleum Pty. Ltd.	27H	23/10/52	52,000
	28H	23/10/52	51,000
	29H	23/10/52	31,100
	30H	23/10/52	151,600
Westralian Oil Ltd.	106H	29/3/55	11,250
Gulf Oil Syndicate	127H	29/3/55	13,000
Jackson Explorations	133H	3/9/57	15,800
Exoil Pty. Ltd.	134H	10/12/58	13,000
	135H	10/12/58	13,000
	136H	10/12/58	13,000
	137H	10/12/58	13,000
	138H	10/12/58	13,000
	139H	10/12/58	13,000
	140H	10/12/58	13,240
	143H	28/7/59	13,000
Hawkstone Oil Co. Pty. Ltd.	142H	9/4/59	5,500
Frome-Broken Hill Pty. Ltd.	144H	17/8/59	16,400
	145H	17/8/59	13,000
	146H	17/8/59	13,000
	147H	17/8/59	13,000
	148H	17/8/59	13,000
Hackathorn Oils Pty. Ltd.	151H	8/2/60	14,200
	152H	8/2/60	11,650
	153H	8/2/60	13,050
Davis, (Mr. D. L.)	154H	9/2/60	17,800
	155H	9/2/60	13,800
Hunt Oil Coy. and Placid Oil Coy.	156H	11/7/60	12,450
	157H	11/7/60	12,600
	158H	11/7/60	12,800
	159H	11/7/60	12,800
	161H	25/8/60	12,900
Australian Oil Industries Pty. Ltd.	162H	21/10/60	11,300
	163H	21/10/60	18,000
	164H	21/10/60	12,950

LIST OF LICENCES TO PROSPECT.

The following Licenses to Prospect were current on 31st December, 1960:—

Company or Syndicate	Number of Licence to Prospect	Date of Approval	Area Sq. miles approx.
West Australian Petroleum Pty. Ltd.	51H	20/6/57	191
	52H	7/10/57	190
	53H	17/12/57	195
	54H	8/5/58	195
	55H	15/7/58	197
	56H	9/2/59	200
	63H	6/8/59	120
	66H	2/12/59	200
	67H	3/3/60	199
	68H	11/5/60	195
	69H	11/5/60	175
	70H	11/5/60	193
	71H	11/5/60	187
	72H	11/5/60	195
	73H	11/5/60	189
	74H	11/5/60	186
	75H	11/5/60	191
	76H	11/5/60	193
	77H	11/5/60	196
	78H	11/5/60	190
	79H	11/5/60	199
	80H	11/5/60	189
	81H	11/5/60	193
	82H	11/5/60	198
	83H	11/5/60	193
	84H	11/5/60	187
	85H	11/5/60	187
	86H	11/5/60	189
Westralian Oil Pty. Ltd.	57H	22/7/59	200
Associated Freney Oil Fields N.L.	58H	28/10/59	120
	59H	28/10/59	112
	60H	28/10/59	112
	61H	28/10/59	112
	62H	28/10/59	112
Exoil Pty. Ltd.	64H	22/9/59	200
	65H	22/9/59	199

Other Activities.

West Australian Petroleum continued seismographic operations on the Jurgarra Terrace area in the Fitzroy Basin until April, and then the seismic crew moved to the Perth Basin and continued operations in the area west of Carnamah.

Other companies have been concerned with geologic assessment of their respective areas, much of which has been an extension of basic geologic and geophysical work done by the Bureau of Mineral Resources.

A mission from the French Institute of Petroleum visited this State in May during the course of an Australian wide study of petroleum possibilities instigated by the Commonwealth Government. Their preliminary report indicated that they considered, on their present knowledge, the Fitzroy and Carnarvon Basins as being the two best prospects in Australia, and further that the Perth and Bonaparte Gulf Basins are relatively high in oil potential.

G. H. LOW,
Geologist.

27/1/61.

REPORT ON THE COPPER MINE ON M.C. 14, WARRIEDAR CENTRE, YALGOO GOLDFIELD.

By G. H. LOW, B. Sc.,
Geological Survey of W.A.

CONTENTS

Introduction.

The examination was made at the request of Messrs. F. J. and F. G. O'Callaghan, and K. B. Howlett, holders of Mineral Claim 14 for copper. It was undertaken primarily for the purpose of advising on the location of a new shaft and to evaluate the prospects of the property.

Location and Access.

The mineral claim is located in the southern part of the Yalgoo Goldfield on Warriedar Station property. When travelling from Perth, probably the best access is along the Great Northern Highway via Miling and Wubin to the 236 mile peg, thence 20.8 miles by graded tracks to Warriedar Station, thence 6.5 miles by graded track via the abandoned Long's Find (there is still some machinery and treatment plant remaining on the "Rose Marie" Lease, May, 1960) to the Mine.

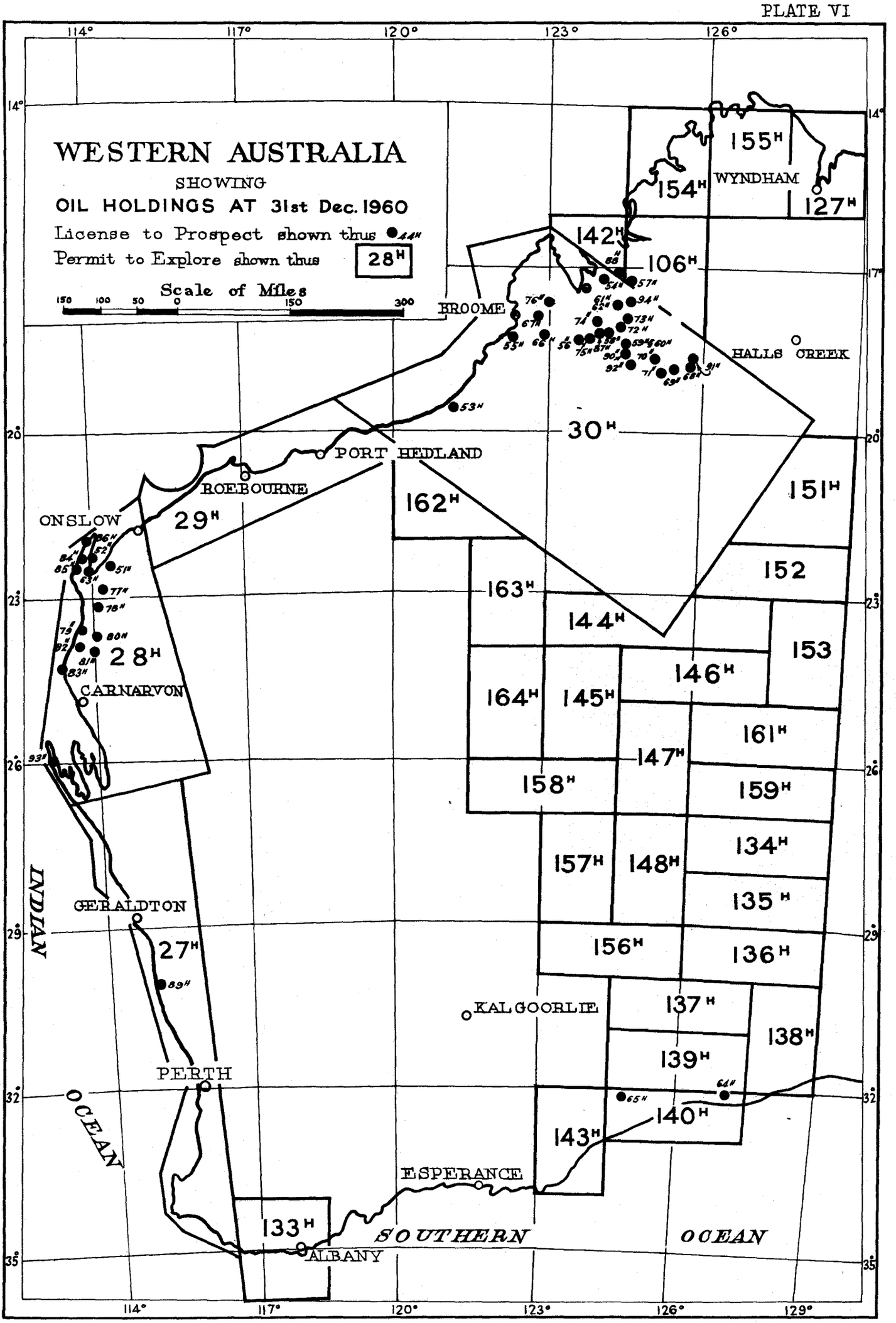
Distance to rail is approximately 70 miles northwards to Yalgoo along the Paynes Find—Yalgoo road, or 74 miles south-westwards to Perenjori via the old mining centre of Rothsay. The latter road however is in poor condition at the present and cannot be used for ore cartage.

Approximate geographical co-ordinates are:
Latitude: 29° 10′ S.
Longitude: 117° 5′ E.

Reference may be made to the following maps:—
(1) Lands Department Lithograph No. 41/300;
(2) Lands Department 10-mile Topographic Series Sheet 4 (Perth);
(3) Geological Sketch Map of W.A., G.S.W.A. 1957, Scale 1" equals 40 miles.

Physical Features and Water Supply.

M.C. 14 lies in the South-west Land Division between the 10 inch and 15 inch isohyets, the bulk of the rainfall falling between May to October. The average yearly temperature lies between 65 to 70 degrees.


WESTERN AUSTRALIA
SHOWING
OIL HOLDINGS AT 31st Dec. 1960
License to Prospect shown thus ●44H
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°
155H
154H
WYNDHAM
127H
142H
106H
BROOME
HALLS CREEK
30H
PORT HEDLAND
ROEBOURNE
151H
162H
ONSLOW
29H
152
163H
144H
153
146H
164H
145H
28H
CARNARVON
161H
147H
158H
159H
134H
157H
148H
135H
GERALDTON
156H
136H
27H
KALGOORLIE
137H
138H
139H
PERTH
140H
143H
ESPERANCE
133H
ALBANY
INDIAN
OCEAN
SOUTHERN
OCEAN

As shown on the "Vegetation Map of W.A." prepared for the Forests Department by O.L. Gardiner in 1928, the Claim lies in the belt of country classified as bearing "Low rainfall temperate forests and woodlands with belts of sand heaths and mallees." (Vernacular; salmon gum forest and sand plain).

Jutson[1] classifies the area as part of his Saltlake and Salinaland Physiographic Division. He describes the Division as a "new plateau of arid erosion on which stands remnants of an old plateau", the remnants consisting of flat topped mesas and buttes, the rocks of which include granite-gneiss, greenstones and meta-sediments.

The height of the old plateau above the new varies considerably in different places. Many of the hills have weathered into rounded elongated prominences, one of which is Mt. Warriedar, about 2 miles south-east of M.C. 14, which rises to over 500 feet above the general level of the plain (new plateau). Mt. Warriedar forms the southern end of a long range, which with few breaks extends north-north-west to almost Yalgoo.

The greenstone hills carry jam, wattle and some of the smaller types of mulga. There are also some quandong, and a few kurrajong. Drainage is not well developed.

Water is obtained from wells and shafts located on sandy flat areas. The water is generally potable but contains much mineral matter, and is unpleasant to drink if it has been standing undisturbed in the wells for any considerable time (local information). Water is held in the creeks only intermittently.

History and Production.

The first recorded production from this Mineral Claim was in 1958, and by 16 March, 1960, the production total had reached 231.95 long tons of 10.53 per cent copper. The details are as follows:—

Production of Cupreous Ore and Concentrates from M.C. 14, Warriedar Centre, Yalgoo Goldfield

Year	Quantity Long Tons	Assay Per cent. Copper	Copper Units	Value £A
1958	43·09	9·13	....	636·70
1959	112·10	11·10	1,232·09	2,220·95
Up to 16th March, 1960	76·30	11·37	921·11	1,637·59
Total	231·95	10·53	2,153·20	4,495·24

The mine is not worked continuously (May, 1960) and there is usually only two men engaged at one time.

Geology.

(a) *General.*—Reference to the general geology can be found in G.S.W.S. Bulletin 81[2].

The rocks of the general area consist of various types of greenstones, and associated meta-sediments, granitic rocks, and younger acid and basic intrusives. There are interbedded jaspilitic horizons. The nearest granite outcrop to M.C. 14 is an intrusive mass of acid type containing essentially quartz, microcline and muscovite. Molybdenite has been reported in places. Feldtmann (op. cit) regards this Mulgine Granite as an acid marginal facies of the more normal granite to the south.

In the vicinity of Mt. Warriedar, and comprising the line of hills which extends some 30 miles to the north-north-west and south-south-east is a sequence of sedimentary beds composed of shales, sandstones, quartzites and conglomerates. The dip of these beds is steep to the south-west.

M.C. 14 lies approximately 2 miles north 65 degrees east of Warriedar Trig. in the greenstones on the eastern side of the belt of meta-sediments.

(b) *The Mine.*—The copper on M.C. 14 occurs in a quartz vein in a strongly fractured though texturally massive fine-grained basaltic dolerite.

The vein, which varies in width from 1 foot to 4 feet, strikes 25 degrees west of north, and dips at angles from 35° to 40° to the south-west. It crops out poorly, indicated only by a few scattered quartz boulders, on the northern flank of a low rise comprised of blocky dolerite rubble and reddish-brown decomposition products, and can be traced on the surface with any degree of certainty for only about 4 chains.

There are several pronounced directions of fracturing in the massive dolerite rock, namely:

Strike 330°, dip practically vertical;
Strike 300°, dip 75° north-east;
Strike 235°, dip 85° north-west.

The copper bearing quartz vein in the workings strikes close enough to the 330° line of fracturing to be regarded as probably co-incident with it, but the vein dip is about one-half of the latter.

About one hundred yards south-west of the mine shaft, scattered outcroppings of copper-bearing quartz can be seen. These seem to occur in two or more narrow quartz veins, the strike of which, as far as could be judged from the poor exposures, coincide with the 235° line of fractures. The dips could not be measured.

The vein has been worked down dip to about 140 feet and to a maximum length of 50 feet. It is subject to pinching and swelling, but there is an overall increase in the thickness from about 1 foot at the north-western end of the workings to about four feet at the other end.

The workings are still within the oxidised zone and the copper bearing minerals are azurite, malachite, chrysocolla, some chalcocite, and also the rather rare (in Western Australia at least) pseudomalachite. Gangue minerals include quartz, with limonite, calcite, and chalcedony. Near the surface copper mineralization tends to be disseminated throughout the gangue and also in the weathered material of the walls, whereas in the deeper parts of the workings it is more usually concentrated in seams or kidneys throughout the quartz.

The workings are open stoped down dip for about 140 feet and over an average length of 35 feet. The back and floor conditions are good, and three pillars have been left. The senior partner stated his intention of sinking a new shaft in ore to the south-south-east of the present workings, and driving along the bottom level, thus blocking out a quantity of ore where the vein is thickest. This seems as sound a plan as any at the present stage of development and with the present knowledge of the mineralization.

There is no apparent structural reason why the ore carrying vein should not continue at depth, unless its weak outcrop be considered derogatory, but the grade beneath the secondary sulphide zone (and perhaps also in this) can be expected to be lower than the average grade in the oxidised material.

Grade.

To 16 March, 1960, 231.95 long tons have been treated at an average grade of 10.53 per cent Copper, worth £A4,495.24.

Two samples were taken from the mine by the writer, and submitted to the Government Chemical Laboratories for examination. The results are given at the end of this report.

Summary.

A copper bearing quartz vein varying in thickness from 1 foot to 4 feet, and with an observable outcrop length of about 4 chains occurs in a strongly fractured, texturally massive fine-grained basaltic dolerite on M.C. 14, 6.5 miles northwards of Warriedar Station Homestead in the Yalgoo Goldfield.

The workings are still within the oxidised zone, dips at angles from 35° to 40° to the south-west. It has been stoped down dip to a vertical depth of about 90 feet.

The workings are still within the oxodised zone, and the ore minerals are azurite, malachite, chrysocolla, and some chalcocite.

231.95 long tons have been produced at an average grade of 10.53 per cent Cu.

[1] 1948 Jutson, J. T. The Physiography (Geo-morphology) of Western Australia. G.S.W.A. Bull. No. 95 p. 9 et seq. Third edition 1948.

[2] 1921. Feldtmann, F. R.: The Geology and Mineral Resources of the Yalgoo Goldfield, Pt. 1, p. 8 et seq. 1918.

The observable structure is not strong and it is doubtful whether this prospect will develop into a big producer. While the present grade is maintained it is sound planning to develop this mine in ore.

There are some other copper bearing quartz veins in the vicinity, and the general area should be prospected for stronger developments of these.

G. H. LOW,
GEOLOGIST.

20th May, 1960.

GOVERNMENT CHEMICAL LABORATORIES

Report on Two Specimens from M.C. 14,

Warriedar Centre, Yalgoo Goldfield.

Received 6th April, 1960.

Lab. No: 4976/60.

Marks: GS/YG/1.—Taken 30 ft. down-dip from wall of shaft.

Result of Examination: This sample was composed of two distinct types of rock.

(a) A fraction which contained the basic copper phosphate mineral pseudomalachite in a matrix of opaline material, sericite, quartz, a little chlorite and some clay. Limonite stains were also present.

(b) This fraction was composed chiefly of limonite with malachite, and some clay, quartz and chlorite. Neither gold nor silver was present.

Lab. No: 4977/60.

Marks: GS/YG/2.—Taken 135 ft. down dip from bottom face of shaft.

Result of Examination: The sample consisted chiefly of quartz and limonite with malachite, a little azurite and clay. The greenish-yellow patches are clay stained by iron and copper.

The sample assayed 2.6 dwt. of gold and approximately 8 oz. of silver per ton.

G. H. PAYNE,
Deputy Government Mineralogist.

REPORT ON THE EXPLORATORY DIAMOND DRILLING OF PART OF THE MT. GOLDSWORTHY (ELLERINE HILLS) HEMATITE IRON ORE DEPOSITS, PILBARA GOLDFIELD, WESTERN AUSTRALIA.

By G. H. LOW, B.Sc.

CONTENTS

MAPS, PLANS AND SECTIONS

Summary.

During the year 1960 the Western Australian Government conducted a test exploratory diamond drilling programme into the Mt. Goldsworthy (Ellerine Hills) hematite iron ore deposits. Four holes were completed, involving 3,593 feet of core recovery drilling. A fifth hole in progress at the end of the year was still in hanging wall rock at 478 feet borehole depth. The holes penetrated hanging wall and footwall country rock, which consists of slightly metamorphosed argillaceous and jaspilite (banded silica and iron formation) types and showed that the iron ore persists in hematite form (both powdery and massive) to at least 940 feet downdip on the footwall side of the main lens. This is equivalent to 900 feet vertical depth at that point.

There are considered to be three main lenses, apparently discontinuous, extending in an east-west direction over a distance of approximately 100 chains. Only the middle, and apparently the biggest, lens was drilled.

This main lens, called the No. 1 lens, is almost 2,000 feet in overall length, averages about 190 feet in width, dips northerly at about 85 degrees, and forms the backbone of a ridge or hill, which rises to an average height of about 200 feet above the general plain level on its northern side. The boreholes were drilled in a southerly direction into the northern face of the ore body at a depressed angle of 55 degrees, and to the medial points of the borehole intersections, show an average down dip depth of backs of 716 feet. There are some thin lenses of argillaceous material in this ore body.

Based on the results of these boreholes and his surface mapping, and using the tonnage factor of 10 (ten) cubic feet to the ton, and using all available assay data, the author estimates that down to the average down dip depth of 716 feet there is a possible* ore reserve of 24,718,000 (say 25 million) tons of 60%+grade hematite iron ore contained in the No. 1 lens, approximately one-third of this, that is about eight million tons, lies above the general level of the northern plain.

There is a thin lens averaging about 40 feet in thickness on the footwall side of the No. 1 Lens. It has about the same length as the No. 1 Lens, and is separated from it by up to 70 feet of country rock. It is of generally lower grade, assaying in core recovered, approximately 50 per cent iron, and showing a **possible** reserve of approximately six million tons. The SiO_2 content, calculated from the three intersections, is approximately 32 per cent.

The other two main lenses have not been sampled or drilled, but cover a smaller area in outcrop and are considered to be of lower grade than the No. 1 Lens. There are some other areas in the Ellerine Hills which may provide further reserves of Hematite iron ore, but none of these are as impressing or as exploitable, judged by outcrop conditions, as the ore in the main lenses.

Introduction.

In pursuance of its policy of testing by diamond drilling known deposits of iron ore, the Western Australian Government instructed the Mines Department late in 1959 to conduct a drilling programme on the Mt. Goldsworthy deposits. In October, 1959, the author was instructed by the Government Geologist to compile a contoured geological map of the three main lenses known to exist in this area and to lay out a programme of drill holes.

This work was completed in November, eight borehole sites having been marked on the ground; five in the No. 1 Lens, two in the No. 2 Lens in the west, and one in the No. 3 Lens in the east.

Tenders were called for a core recovery drilling programme and subsequently contracts were let to drillers Messrs. L. C. Honey and A. Horsham operating independently two Mindrill A2000 drilling rigs. Because of heavy seasonal rains during January and February which made the roads unusable, drilling did not commence until late in March. By the end of the year four holes had been completed and one was in progress, the total footage drilled amounting to 4,071 feet. Of the four completed holes one of them, Hole B, was abandoned in iron ore at a depth of 826 feet due to extremely bad

* See page 84 for definition of "possible" ore.

drilling conditions. The contract rates were £3 per foot, with provision for an optional penalty for non-recovery of core, and a bonus for recovery of casing used.

The author joined the drillers in the field at the end of April and provided close geological supervision until the end of the year, as well as conducting a reconnaissance geological survey of the surrounding area.

On the completion of his second hole in November, Mr. Horsham left the area to commence a drilling programme on the Wilgie Mia iron deposits, while Mr. Honey returned to Perth for annual leave in Mid-December.

At this stage the programme was reviewed by the Government and a decision was made to abandon the programme on completion or abandonment of the fifth hole which was then in progress.

In view of the Commonwealth Government's decision announced in December, 1960, to permit limited export of iron ore from approved deposits, and despite the fact that the fore-shortened programme is not yet completed, the Government Geologist instructed the author to complete a report on results obtained as at the end of 1960. These results are presented hereunder, together with the author's views on some aspects beyond immediate geologic considerations.

At this point the author would like to express his appreciation of the drillers and their helpers who were at all times co-operative and hospitable under very trying climatic and "bush" conditions, and who maintained a tenacious attitude to the job under tough drilling conditions.

Situation and Access.

The Mt. Goldsworthy iron ore deposits are situated in the Ellerine Hills, located 62.5 miles east of Port Hedland in the Pilbara Goldfield, in the North-west of Western Australia.

Approximate geographical co-ordinates are:

Latitude, South 20° 21′.
Longitude, East 119° 32′.

Reference may be made to the following maps:—

(1) Lands Department Lithograph No. 114/300.
(2) Lands Department 4-mile Series, Port Hedland Sheet.
(3) Geological Sketch Map of Western Australia, G.S.W.A. 1950.

Stereographic Aerial Photographic pairs and photo mosaics at a scale of approximately 1 inch equals 1 mile are also available from the Lands and Surveys Mapping Branch.

The deposit is most easily reached by travelling along the Great Northern Highway (which is an unsurfaced road—Jan. 1961) for 60 miles eastwards from Port Hedland to the sign-posted Mulyie Station turn-off, then following the graded Mulyie Station track southwards to the Ellerine Well, which is shown on the Port Hedland Sheet, then travelling east-south-eastwards for 6 miles along a newly-graded track which crosses the Pardoo Creek at the same ford as the old, but now rarely used, Marble Bar-Broome Road.

For most months of the year these roads and tracks can be traversed by light two wheel drive motor vehicles, but during and after seasonal rains from December to April the several creeks and rivers which are crossed by fords on the Great Northern Highway, and the clay pan areas on the Mulyie Station tracks which are subject to sheet flooding, can become unusable by even heavy four-wheel drive vehicles.

The closest aeroplane landing ground is at Mulyie Station and this is a private aerodrome licensed by the Commonwealth Department of Civil Aviation. This is about 9 miles by indifferent station tracks from Mt. Goldsworthy. There are some flat areas in the vicinity of the deposit which in emergencies during the dry season might possibly be used by light aircraft.

The Goldsworthy area comes under the Port Hedland Divisional Control of the Flying Doctor Service Radio Communications Scheme, and an outpost station in contact with Port Hedland was maintained at the drilling camp during the period of operations.

Physical Features.

Topographically the area is a low level plain consisting of level sand areas with some semi fixed sand dunes, and interspersed areas of clayey soil which are subject to shallow flooding after rain storms. This plain is broken by the isolated Ellerine Hills and Ord Ranges.

Vegetation consists of spinifex plains with areas of light scrub. Heavy timber for mining purposes or for fuel is very scarce, what there is being restricted to a variety of white barked gum which grows rather indifferently along the various water courses. If extensive timber were required for mining purposes it is probable that this would have to be carted into the area.

During 1960, water for drilling purposes was drawn from the Goldsworthy Well (shown on the Port Hedland 1 inch equals 4 miles map as being 2.5 miles north-west of Mt. Goldsworthy). This well is 64 feet deep and the water stands at about 50 feet below the collar. Up to 6,000 gallons a day were drawn from the well for drilling purposes and the water level showed no appreciable drop. The actual potential yield is not known at present. The water was used for drinking purposes for a while with no apparent ill effect but arrangements were later made to draw drinking water from the Port Hedland supply. Other wells sunk on this flat should prove to be equally good producers of a comparable quality.

During the construction of access tracks to the various drill sites road surfacing material was bulldozed from the scree slopes of some of the hills and was found to be quite adequate for the purpose. But these access tracks would be subject to considerable scouring effect in places during seasonal rain storms.

The nearest established harbour facilities are at Port Hedland but the wharf and harbour entrances are not capable of handling large tonnage ore carriers at present. Independent expert investigations on the cost and practicability of establishing adequate harbour facilities have been made and persons concerned with this aspect of the problem should contact the Under Secretary for Mines at the Western Australian Mines Department. In the public press a figure in excess of £3,500,000 has been mentioned as the possible cost involved.

As an alternative to road cartage of ore from Goldsworthy to Hedland, the establishment of a railway line seems to be worthy of serious consideration.

The Drilling Programme.

The drilling was done by contract, the two contractors hiring the drilling plant and equipment from the Mines Department. The primary contractor was Mr. L. C. Honey who later agreed that two of the originally planned 8 holes be drilled by Mr. A. Horsham. When the programme was revised in December, 1960, the number of holes to be completed was reduced to five, three of which were drilled by Mr. Honey.

Of the four holes drilled as at the end of the year, three of the holes were drilled to the depth intended, the remaining one being abandoned short of the target due to caving ground.

All of the holes were cased for some depth, NX, BX, and AX casing being used in some cases in the same hole. The maximum cased depth of hole was in Hole C1 in which the AX casing was seated at 150 feet.

Ground water was reported by the drillers at borehole depths varying from 165 to 180 feet. This level however did not persist and after the iron ore had been entered many thousands of gallons of water were lost on occasions due to non return. Drilling bit wear was severe in most of the ore body, and also in sections of the country rock, particularly where lenses of argillaceous and siliceous rock were finely interfingered. In some sections of the ore body it was found more practicable to use tungsten tipped coring bits than diamond bits, but these could be ruined by inches of penetration where the soft micaceous hematite gave way to the rubbly massive variety.

Maximum length of penetration in any one run was 10 feet, a stationary inner tube core recovery barrel being used at all times. However, in ore, the complete 10 feet of penetration was seldom achieved.

The location of the drilling sites was governed by the slope of the ground, by the desired vertical depth of entry into the ore (between 400 and 500 feet) and the length and variability of the main ore lenses. The boreholes were so directed that the points of entry into the hanging wall of the ore body would be about 400 feet apart.

The object of the drilling was not to *prove* any specific quantity or grade of ore, but to test as far as is possible in such a limited programme the attitude of the beds, the lateral and vertical extent of the ore in hematite form, variation of grade in depth, and generally to establish some facts on which to base computations of possible tonnage and grade.

Drilling Results.

The drilling has shown that the ore persists in hematite form down to a vertical depth of at least 900 feet below the outcrop. The drilling sections together with assay data are shown on Plates VIII-XI.

A further set of sections showing the percentage core recovery over the various assay lengths are shown on Plates XII, XIII.

The borehole sections as shown show little correlation with the lenses of massive and banded hematite, and the supposedly argillaceous rich bands shown on the surface plan. The surface plan was prepared from surface indications only, there was no pitting, trenching or sampling done, and the areas shown as being occupied by massive and banded iron, stand out on the surface as appearing to be darker, heavier and more massive than the other areas which may occupy slight depressions and have a slaggy, dusty or irregularly bedded appearance.

Some of these so-called argillaceous areas can perhaps be correlated by projection downdip with the areas of poor core recovery as shown in the borehole sections showing percentage core recovery over the assay sections. The true nature of the material which was not recovered in the core is not known to the author. Attempts were made in places to take sludge samples or samples from the fluid return but it was found that it was not possible to accurately fix the depths from which these came. This was largely due to the run-in of fine material from the sides of the uncased hole above the core barrel. On many occasions the packing of these fines of iron ore around the barrel and drilling rods caused extreme difficulty during the withdrawal of the drilling string, and on other occasions when re-entering the hole it was found necessary to drill through several feet of this material before the bottom of the hole could be reached, since in some instances the accumulation of the fines became too solidly packed to be flushed out by fluid circulation alone.

Again, it was found that on one or two occasions sludge and cuttings which had packed the bottom of the hole at the end of a day's drilling were not present in the hole on the following morning. This suggests that some of the sections which yielded poor or no core recovery were in fact cavities in the ore.

Consideration of these factors makes obvious the limitations to be placed on the reliability of interpretations to be made from the borehole data.

The average grade of samples taken from the boreholes agrees remarkably well with those taken at the surface, but the author personally holds some reservations about the degree of enrichment through weathering agencies which may have taken place at the surface and thus upgraded these samples. It is suggested that the most practicable method of providing an intermediate check on these results is by adits, or by shafts and crosscuts, designed to penetrate the ore at about 200 feet below outcrop. Apart from giving a check on grade, these would at the same time provide the mining engineers with vital information about the holding or standing qualities of the country rock and ore. It is thought that in some sections of these, in the ore, extensive timbering would be necessary.

The results of the drilling can be summarised as follows:—

(a) Ore penetrated in the boreholes consists of variably massive, cellular, finely banded grey crystalline hematite, some purplish coloured ochreous ore, some shaley liver coloured ore, and some brown to brownish-black argillaceous hematite showing gradational increase or decrease in argillaceous content;

(b) Overall averaged grade of core taken from the borehole penetrations agrees very closely with averaged grade of surface samples taken by officers of the Commonwealth Government,* and the author during the course of the drilling programme in 1960. An average of 60%+ is accepted on a possible basis.

(c) No traces of magnetism which could be attributed to the mineral magnetite were detected in any of the core recovered from the ore body.

(d) The four completed boreholes showed that the ore body continues in the form indicated above to the average down dip depth of 716 feet.

(e) The four boreholes penetrated the main or No. 1 Lens over a length of 1,260 feet along the strike entering the ore body on the hanging wall side at vertical depths of between 420 and 500 feet and leaving it on the footwall side at vertical depths of between 700 and 860 feet.

(f) The principal foreign material in the recovered core is silica. The precentage of SiO_2 in the No. 1 Lens from group assays by the Government Chemical Laboratories on a moisture free basis being for each hole; Hole A1, 10.9%; Hole B1, 0.83%; Hole C1, 4.05%; and Hole D1, 6.38%.

(g) The wall rocks consist of slightly metamorphosed argillaceous and jaspilitic (banded silica and iron formation) types.

(h) The four borehole intersections showed the following approximate true widths of No. 1 Lens; Hole A1, 220 feet; Hole B1, 190 feet plus (this hole was not completed); Hole C1, 200 feet; Hole D1, 186 feet.

Core Logs, Core Recovery, Sampling, Assay Data and Mineral Determinations.

Core logs with detailed descriptions describing the nature of the material penetrated, the length of penetration of each pull, the amount of core recovered for each pull, and a core recovery analysis for each hole are reproduced below. Samples were taken from all the iron ore recovered in the lenses penetrated, the length of hole penetrated which each sample represents being determined by the amount of core recovered. The samples were taken by splitting the core transversely into one inch pieces, and including every alternate piece in the sample sent for assay. Thus half of the core of each sample length was assayed, and the remaining one-half is retained at the Geological Survey and is available for examination to interested persons.

The iron ore samples from each hole were grouped over suitable lengths, and determinations made in each group for Fe (total), Fe (acid soluble), SiO_2, S, P, Ti, Mn, MgO, CaO, Al_2O_3 and of the ignition loss. These details are included under the heading "Group Assays" and are also shown on the borehole sections at a scale of 1 inch equals 100 feet.

A table showing the calculated weighted average of the results of the group assays for the four penetrations of the No. 1 Lens, and the three penetrations of the hanging wall lens, is given at the end of this chapter.

All assays were made by the Mineral Section, Government Chemical Laboratories, Perth.

* 1939. Finucane, K. J. and Telford, R. J.: The Ellerine Hills and Andover Iron Deposits, Pilbara Goldfield. The Aerial, Geological and Geophysical Survey of Northern Australia. Report W. A. No. 56, 1939.

DIAMOND DRILL HOLE DETAILS

Information concerning each hole is supplied under the following headings:—

(1) Summarised and Detailed Core Logs with Core Recovery, and showing:
- Position of hole
- Azimuth
- Angle of depression
- Total depth
- Date commenced
- Date completed or abandoned
- By whom logged
- Drilling contractor
- Type of drilling machine used
- Core size
- Casing used
- Core recovered.

(2) Sample List showing:
- Sample number
- Borehole section from which sample was taken
- Length of core recovered in this section
- Assay results as percentage acid soluble on a dry basis.

(3) Group Assay List:
- Group assays for Fe. (total), Fe. (acid soluble), SiO_2, S., P., Ti., Mn., MgO., CaO., Al_2O_3 and ignition loss.

(4) Borehole Section. Scale 1 inch equals 100 feet.

Diamond Drill Hole No. A1, Site A.

Location: 1,080 ft. plan distance bearing 290° from Mt. Goldsworthy Trig. Stn.
Azimuth: 164° Mag.
Angle of Depression: 55°.
Total Depth: 941 ft.
Date Commenced: 5 June, 1960.
Date Completed: 11 November, 1960.
Logged by: G. H. Low
Contractor: A. Horsham.
Machine used: Mindrill A3000.
Core Size: AXT.
Casing Used: AX 191 ft., NX 15 ft.
Core Recovery: Total 73.3%. In iron ore: 499 ft. to 860 ft. = 85%, 860 ft. to 941 ft. = 69%.

Diamond Drill Hole No. A1
Summarised Core Log

Section From	Section To	Summarised Description
ft. in.	ft. in.	
0 0	128 0	Red brown argillaceous sediment and dark grey cherty jaspilite.
128 0	263 0	Grey and green argillaceous siltstone with some slightly argillaceous quartzite.
263 0	465 0	Mainly dark grey cherty jaspilite with some bands of brown argillaceous sediment.
465 0	499 0	Red brown massive mudstone.
499 0	941 0	HEMATITE IRON ORE, with some thin bands of argillaceous material and becoming more siliceous towards bottom. Lenses of country rock between 560 ft. to 572 ft. and 890 ft. to 906 ft.
		END OF HOLE.

Diamond Drill Hole No. A1
Detailed Core Log

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	15 0	15 0	3 0	Hematite iron and argillaceous hematite rubble.
15 0	17 0	2 0	1 2	Dark grey cherty jaspilite and argillaceous sediment. Broken.
17 0	21 6	4 6	2 6	As above.
21 6	27 0	5 6	1 5	As above.
27 0	29 6	2 6	0 10	Brown argillaceous rubble.
29 6	34 6	5 0	0 6	White and brown argillaceous sediment.
34 6	46 0	11 6	0 5	As above.
46 0	53 0	7 0	0 5	White and grey green intrusive quartz.
53 0	54 6	1 6	0 10	As above.
54 6	63 0	8 6	0 3	Dark grey cherty jaspilite.
63 0	70 0	7 0	0 3	As above.
70 0	80 0	10 0	2 0	As above.
80 0	89 6	9 6	6 0	Brown mudstone.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
89 6	99 0	9 6	0 3	Dark grey cherty jaspilite.
99 0	108 0	9 0	0 3	As above.
....	....	....	0 6	Grey siltstone.
108 0	120 0	2 0	0 6	Grey cherty jaspilite.
120 0	127 0	7 0	0 2	As above.
127 0	128 0	1 0	0 3	As above.
128 0	133 6	5 6	1 0	Grey siltstone—metamorphosed.
133 6	134 0	0 6	0 6	As above.
134 0	135 0	1 0	1 0	As above.
135 0	140 0	5 0	0 6	As above.
140 0	141 0	1 0	0 4	Light grey to brown silty mudstone, slightly metamorphosed.
141 0	150 0	9 0	4 0	As above.
150 0	154 0	4 0	2 9	As above.
154 0	160 0	6 0	3 6	As above.
160 0	165 0	5 0	2 9	As above.
165 0	170 0	5 0	5 0	As above.
170 0	174 0	4 0	2 6	As above.
174 0	180 0	6 0	3 9	As above.
180 0	189 0	9 0	5 0	As above.
189 0	190 0	1 0	0 6	As above.
190 0	194 0	4 0	3 0	As above.
194 0	204 0	10 0	9 0	As above.
204 0	207 0	3 0	2 9	Grey green chloritic quartzite.
207 0	210 0	3 0	2 9	As above.
210 0	211 0	1 0	0 4	Brown shale.
211 0	216 0	5 0	4 0	Grey to dark grey argillaceous quartzite.
216 0	222 0	6 0	5 0	As above.
222 0	229 0	7 0	6 6	As above.
229 0	230 0	1 0	1 0	As above.
230 0	232 0	2 0	2 0	As above.
232 0	242 0	10 0	10 0	As above.
242 0	251 0	9 0	9 0	As above.
251 0	259 0	8 0	8 0	As above.
259 0	262 0	3 0	3 0	As above.
262 0	263 0	1 0	1 0	As above.
263 0	267 0	4 0	3 0	Dark grey cherty jaspilite-brecciated with some argillaceous bands.
267 0	270 0	3 0	3 0	As above.
270 0	278 0	8 0	3 0	As above.
278 0	285 0	7 0	4 0	As above.
285 0	292 0	7 0	7 0	As above.
292 0	297 0	5 0	5 0	As above.
297 0	299 6	2 6	1 10	As above.
299 6	302 6	3 0	3 0	As above.
302 6	305 0	2 6	2 6	As above.
305 0	313 0	8 0	8 0	As above.
313 0	316 0	3 0	3 0	Black and dark grey cherty jaspilite.
316 0	324 0	8 0	7 6	Brecciated jaspilite in argillaceous material.
324 0	326 6	2 6	2 6	As above.
326 6	327 6	1 0	0 10	As above.
327 6	331 0	3 6	3 6	As above.
331 0	336 0	5 0	5 0	As above.
336 0	340 0	4 0	4 0	As above.
340 0	346 0	6 0	5 0	As above.
346 0	351 6	5 6	5 0	Dark grey cherty jaspilite, with a little argillaceous material.
351 6	357 6	6 0	6 0	As above.
357 6	358 6	1 0	1 0	As above.
358 6	361 6	3 0	2 6	As above.
361 6	367 0	6 6	3 0	As above.
367 0	371 0	4 0	3 0	As above.
371 0	372 6	1 6	1 6	Grey siliceous jaspilite, with drusy quartz.
372 6	378 0	5 6	3 3	Dark brown hematitic meta-mudstone.
378 0	381 0	3 0	2 6	Grey siliceous jaspilite.
381 0	382 0	1 0	1 0	As above.
382 0	383 0	1 0	0 10	As above.
383 0	384 0	1 0	0 10	As above.
384 0	385 0	1 0	1 0	As above.
385 0	386 6	1 6	1 4	As above.
386 6	387 6	1 0	1 0	As above.
387 6	388 8	1 2	0 8	As above.
388 8	392 0	3 4	2 0	As above.
392 0	394 0	2 0	1 6	As above.
394 0	397 0	3 0	2 6	As above.
397 0	398 0	1 0	0 8	As above.
398 0	399 0	1 0	0 6	Grey siliceous jaspilite with drusy quartz.
399 0	409 0	10 0	2 0	As above.
....	....	....	5 0	Dark brown meta-mudstone.
409 0	413 0	4 0	2 6	As above.
....	....	....	1 0	Dark grey cherty jaspilite.
413 0	415 0	2 0	2 0	As above.
415 0	417 0	2 0	2 0	As above.
417 0	419 6	2 6	2 0	As above.
419 6	423 0	3 6	3 0	As above.
423 0	430 6	7 6	7 0	As above.
430 6	433 0	2 6	2 6	As above.
433 0	440 0	7 0	5 0	As above.
440 0	450 0	10 0	9 0	As above.
450 0	455 0	5 0	4 11	As above.
455 0	456 0	1 0	1 0	As above.
456 0	458 0	2 0	2 0	As above.
458 0	459 6	1 6	1 6	As above.
459 6	469 6	10 0	5 0	As above.
....	....	....	2 3	Red brown massive mudstone.
469 6	479 6	10 0	10 0	As above.
479 6	489 0	9 6	9 0	As above.
489 0	499 0	10 0	10 0	As above, hematitic towardsend
499 0	505 0	6 0	5 0	HEMATITIC IRON ORE.
505 0	514 0	9 0	7 0	As above.
514 0	515 0	1 0	0 5	As above.
515 0	524 0	9 0	8 4	As above.
524 0	531 0	7 0	4 7	As above.
531 0	536 6	5 6	2 0	As above.
536 6	541 6	5 0	1 4	As above.
541 6	544 0	3 6	1 6	As above.
544 0	546 0	2 0	1 2	As above.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
546 0	547 6	1 6	1 6	HEMATITIC IRON ORE.
547 6	554 0	6 6	6 6	As above.
554 0	557 0	3 0	1 6	As above.
557 0	563 6	5 6	3 0	As above.
....	....	....	2 6	White and grey argillaceous sediment.
563 6	569 6	6 0	6 0	Brown meta-mudstone.
569 6	574 0	4 6	1 10	As above.
....	....	....	2 0	HEMATITE IRON ORE.
574 0	574 6	0 6	0 6	As above.
574 6	575 0	0 6	0 3	As above.
575 0	575 2	0 2	0 2	As above.
575 2	576 0	....	0 3	As above.
576 0	577 0	1 0	0 4	As above.
577 0	578 0	1 0	0 7	As above.
578 0	584 6	6 6	5 10	As above.
584 6	589 6	5 0	4 3	As above.
589 6	595 0	5 6	5 3	As above.
595 0	603 0	8 0	7 8	HEMATITIC IRON ORE—somewhat siliceous in places.
603 0	605 6	2 6	2 6	As above.
605 6	614 0	8 6	8 0	As above.
614 0	620 6	6 6	6 6	As above.
620 6	622 0	2 6	1 5	As above.
622 0	632 0	10 0	10 0	As above.
632 0	642 0	10 0	10 0	As above.
642 0	652 6	10 6	10 0	As above.
652 6	659 6	7 0	5 0	As above.
659 6	669 6	10 0	10 0	As above.
669 6	679 6	10 0	10 0	As above.
679 6	682 6	3 0	2 10	As above.
682 6	692 6	10 0	10 0	As above.
692 6	702 6	10 0	10 0	As above.
702 6	712 6	10 0	10 0	As above.
712 6	723 0	10 6	10 0	As above.
723 0	725 0	2 0	2 0	As above.
725 0	728 0	3 0	3 0	As above.
728 0	731 0	3 0	2 6	As above.
731 0	736 0	5 0	4 4	As above.
736 0	743 6	7 6	7 2	As above.
743 6	753 6	10 0	10 0	As above.
753 6	761 0	7 6	7 6	As above.
761 0	771 0	10 0	8 0	As above.
771 0	776 0	5 0	4 6	As above.
776 0	785 0	9 0	9 0	As above.
785 0	786 0	1 0	0 9	As above.
786 0	794 6	8 6	8 6	As above.
794 6	801 6	7 0	5 6	As above.
801 6	803 6	2 0	2 0	As above.
803 6	806 0	2 6	2 0	As above.
806 0	807 6	1 6	0 7	As above.
807 6	809 6	2 0	2 0	As above.
809 6	811 0	1 6	1 6	As above.
811 0	813 0	2 0	1 6	As above.
813 0	816 0	3 0	3 0	As above.
816 0	817 6	1 6	1 2	As above.
817 6	822 0	4 6	4 6	As above.
822 0	823 0	1 0	0 10	As above.
823 0	824 0	1 0	0 11	As above.
824 0	826 6	2 6	2 0	As above.
826 6	831 0	4 6	0 5	As above.
831 0	833 0	2 0	2 0	As above.
833 0	839 0	6 0	2 0	As above.
839 0	841 0	2 0	0 8	As above.
841 0	842 0	1 0	0 9	As above.
842 0	843 0	1 0	0 4	As above.
843 0	845 6	2 6	2 0	As above.
845 6	851 0	5 6	3 0	As above.
851 0	854 0	3 0	1 2	As above.
854 0	859 0	5 0	3 8	As above.
859 0	863 6	4 6	2 6	As above.
863 6	866 6	3 0	2 1	As above.
866 6	874 0	7 6	4 2	As above.
874 0	875 6	1 6	0 8	As above.
875 6	882 0	6 6	6 6	As above.
882 0	890 0	8 0	6 0	As above.
890 0	897 6	7 6	4 1	Brown mudstone with a little hematite.
....	....	....	0 9	Siliceous jaspilite with a few iron bands.
897 6	900 6	3 0	3 0	As above.
900 6	906 6	6 0	5 6	Banded argillaceous and siliceous sediments with some iron.
906 6	913 0	6 6	6 0	HEMATITE IRON ORE with siliceous bands.
913 0	918 6	5 0	5 0	As above.
918 6	929 6	11 0	4 6	As above.
929 6	933 6	4 0	1 2	As above.
933 6	934 0	0 6	0 9	As above.
934 0	937 0	3 0	2 9	As above.
937 0	941 0	4 0	4 0	As above.
				END OF HOLE.

Diamond Drill Hole No. A1

Assay Data

Sample No.	From	To	Length of Core Recovered	Per cent. Fe, Acid Soluble on a dry basis
	ft. in.	ft. in.	ft. in.	
G.A. 1	499 0	505 0	5 0	66·8
G.A. 2	505 0	510 0	4 0	68·0
G.A. 3	510 0	515 0	3 5	68·3
G.A. 4	515 0	520 0	5 0	68·5
G.A. 5	520 0	525 0	4 0	68·6
G.A. 6	525 0	530 0	3 4	68·1
G.A. 7	530 0	535 0	2 7	68·6
G.A. 8	535 0	545 0	4 0	68·7
G.A. 9	545 0	550 0	3 10	68·7
G.A. 10	550 0	555 0	4 0	69·0
G.A. 11	555 0	560 0	4 6	67·8
G.A. 12	572 0	577 0	3 8	69·1
G.A. 13	577 0	582 0	3 11	68·9
G.A. 14	582 0	587 0	4 6	68·8
G.A. 15	587 0	592 0	4 10	66·5
G.A. 16	592 0	595 0	2 8	65·0
G.A. 17	595 0	600 0	5 0	45·2
G.A. 18	600 0	605 0	4 8	51·0
G.A. 19	605 0	610 0	4 6	54·4
G.A. 20	610 0	615 0	5 0	59·7
G.A. 21	615 0	620 0	5 0	61·3
G.A. 22	620 0	625 0	4 11	58·3
G.A. 23	625 0	630 0	5 0	63·7
G.A. 24	630 0	635 0	5 0	66·9
G.A. 25	635 0	640 0	5 0	63·3
G.A. 26	640 0	645 0	5 0	64·7
G.A. 27	645 0	650 0	5 0	65·5
G.A. 28	650 0	655 0	4 6	63·4
G.A. 29	655 0	660 0	3 6	64·3
G.A. 30	660 0	665 0	5 0	63·2
G.A. 31	665 0	670 0	4 6	65·7
G.A. 32	670 0	675 0	5 0	63·6
G.A. 33	675 0	680 0	5 0	56·0
G.A. 34	680 0	685 0	4 10	56·0
G.A. 35	685 0	690 0	5 0	57·0
G.A. 36	690 0	695 0	5 0	57·5
G.A. 37	695 0	700 0	5 0	57·5
G.A. 38	700 0	705 0	5 0	55·2
G.A. 39	705 0	710 0	5 0	56·2
G.A. 40	710 0	715 0	5 0	58·6
G.A. 41	715 0	720 0	5 0	63·5
G.A. 42	720 0	725 0	4 6	59·2
G.A. 43	725 0	730 0	4 6	54·8
G.A. 44	730 0	735 0	4 4	58·3
G.A. 45	735 0	740 0	5 0	62·1
G.A. 46	740 0	745 0	4 8	60·1
G.A. 47	745 0	750 0	5 0	61·6
G.A. 48	750 0	755 0	5 0	55·4
G.A. 49	755 0	760 0	5 0	60·2
G.A. 50	760 0	765 0	4 0	60·8
G.A. 51	765 0	770 0	4 0	61·0
G.A. 52	770 0	775 0	4 0	59·6
G.A. 53	775 0	780 0	5 0	58·4
G.A. 54	780 0	785 0	5 0	58·2
G.A. 55	785 0	790 0	4 6	54·2
G.A. 56	790 0	795 0	5 0	63·5
G.A. 57	795 0	800 0	4 0	64·4
G.A. 58	800 0	805 0	4 0	57·5
G.A. 59	805 0	810 0	4 1	53·9
G.A. 60	810 0	815 0	4 6	48·7
G.A. 61	815 0	820 0	4 8	56·2
G.A. 62	820 0	825 0	4 9	62·9
G.A. 63	825 0	835 0	4 1	62·4
G.A. 64	835 0	845 0	5 1	63·1
G.A. 65	845 0	855 0	4 8	64·6
G.A. 66	855 0	860 0	4 2	60·7
G.A. 67	860 0	865 0	3 7	48·5
G.A. 68	865 0	875 0	4 10	25·4
G.A. 69	875 0	880 0	5 0	33·2
G.A. 70	880 0	885 0	3 6	32·5
G.A. 71	885 0	890 0	4 0	45·9
G.A. 72	906 0	911 0	4 0	39·6
G.A. 73	911 0	916 0	5 0	29·7
G.A. 74	916 0	921 0	3 6	25·9
G.A. 75	921 0	931 0	4 2	46·2
G.A. 76	931 0	941 0	7 0	45·6

Average Fe content of penetration from 499 ft. to 860 ft. = 61·5%.

Excluding band of country rock between 560 ft. and 572 ft. per cent. of core recovery over this length = 85·3.

Average Fe content of penetration from 860 ft. to 941 ft. = 37·25%.

Excluding band of country rock between 890 ft. and 906 ft. per cent. recovery over this length = 68·6.

Diamond Drill Hole No. A1

Group Assays

% on Moisture Free Basis

Sample Length	Fe (Total)	Fe (Acid Soluble)	SiO_2	S.	P.	Ti.	Mn.	MgO.	CaO.	Al_2O_3	Ignition Loss
499 ft. to 860 ft.	61·9	61·6	10·9	*Nil*	0·03	0·01	0·14	0·02	0·02	0·21	0·21
860 ft. to 941 ft.	37·8	37·3	45·1	0·01	0·05	0·01	0·01	*Nil*	*Nil*	Tr.	0·46

Assays by Mineral Section, W.A. Government Chemical Laboratories
Ground sample remnants retained.

Diamond Drill Hole No. B1, Site B.

Location: 773 ft. plan distance bearing 301° from Mt. Goldsworthy Trig. Stn.

Azimuth: 167° Mag.

Angle of Depression: 55°.

Total Depth: 826 ft.

Date Commenced: 25th March, 1960.

Date Completed: 24th June, 1960.

Logged by: G. H. Low.

Contractor: A. Horsham.

Machine Used: Mindrill A3000.

Core Size: AXT.

Casing Used: AX 134 ft., BX 98 ft., NX 10 ft.

Core Recovery: Total 56.8% in iron ore: 528 to 826 ft. = 32%.

Summarised Core Log.

Diamond Drill Hole No. B1.

Section From	Section To	Summarised description
ft. in.	ft. in.	
0 0	152 0	Mainly dark grey or brown argillaceous sediment (mudstone) with some minor bands of grey siliceous sediment. Shows slump structures: Bedding generally at about 50° to core axis.
152 0	201 0	Mainly dark grey jaspilitic sediment with some minor argillaceous bands.
201 0	217 0	Brown argillaceous sediment with some cherty bands. Some syngenetic pyrite.
217 0	425 0	Mainly dark grey jaspilite, with some argillaceous bands.
425 0	497 0	Mainly dark grey jaspilite.
497 0	528 0	Dark brown mudstone, with some thin cherty bands. The mudstone carries some hematite towards bottom.
528 0	826 0	HEMATITE IRON ORE. Argillaceous in places. END OF HOLE.

Diamond Drill Hole No. B1.

Detailed Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	22 0	22 0	0 10	Red-brown argillaceous sedimenmentary rubble.
22 0	45 0	23 0	0 4	As above.
45 0	62 0	17 0	0 6	As above.
62 0	79 0	17 0	0 6	Dark grey argillaceous and quartz rubble.
79 0	85 0	6 0	1 3	Light grey silty sediment.
85 0	91 0	6 0	0 8	Red brown sedimentary rubble.
91 0	98 0	7 0	1 0	As above.
98 0	100 0	2 0	0 6	Dark grey argillaceous sediment.
100 0	108 6	8 6	1 0	As above.
108 6	111 6	3 0	0 6	Light grey siliceous and argillaceous sediment.
111 6	118 0	6 6	0 6	Dark grey argillaceous sediment.
118 0	120 0	2 0	0 8	As above.
120 0	130 0	10 0	0 8	As above.
130 0	134 6	4 6	0 8	As above.
134 6	135 0	0 6	0 6	As above.
135 0	137 6	2 6	1 4	Grey siliceous and argillaceous sediment.
137 6	142 6	5 0	1 0	As above.
142 6	145 6	3 0	1 2	As above, showing slumping.
145 6	149 6	4 0	1 5	As above, showing slumping.
149 6	152 0	2 6	2 3	As above, showing slumping.
152 0	154 6	2 6	2 0	Grey jaspilite with some argillaceous sediment.
154 6	160 0	5 6	4 8	Grey jaspilite.
160 0	166 0	6 0	6 0	Mainly grey jaspilite with some argillaceous bands.
166 0	170 0	4 0	4 0	As above.
170 0	170 6	0 6	0 6	As above.
170 6	175 0	4 6	4 0	As above.
175 0	179 0	4 0	4 0	Mainly grey jaspilite with some argillaceous bands.
179 0	186 6	7 6	7 0	As above.
186 6	192 0	5 6	5 6	As above.
192 0	195 0	3 0	3 0	As above.
195 0	201 6	6 6	6 0	As above.
201 6	210 6	9 0	8 0	Brown argillaceous sediment with some jaspilite bands.
210 6	215 6	5 0	4 0	As above, with a little syngenetic pyrite.
215 6	217 6	2 0	1 0	Brown argillaceous sediment.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
217 6	222 6	5 0	5 0	Dark grey jaspilite. Brecciated, with some brown argillaceous bands. Some syngenetic pyrite.
222 6	230 0	7 6	7 0	As above.
230 0	233 6	3 6	3 0	As above.
233 6	237 0	3 6	3 0	As above.
237 0	241 6	4 6	4 0	As above.
241 6	245 6	4 0	4 0	As above.
245 6	249 0	3 6	3 6	As above.
249 0	254 0	5 0	4 0	As above.
254 0	257 6	3 6	3 0	As above.
257 6	267 6	10 0	10 0	As above.
267 6	277 6	10 0	10 0	As above.
277 6	287 0	9 6	9 6	Grey jaspilite, with argillaceous bands—brecciated. Some pyrite rich bands.
287 0	297 0	10 0	10 0	Dark grey jaspilite, with some argillaceous bands. Brecciated. Occasional specks of pyrite.
297 0	303 0	6 0	6 0	As above.
303 0	304 0	1 0	1 0	As above.
304 0	309 0	5 0	5 0	As above.
309 0	316 6	7 6	6 8	As above.
316 6	323 6	7 0	6 8	As above.
323 6	331 6	8 0	7 6	As above, (bedding at 45° to core axis).
331 6	342 0	10 6	10 0	Dark grey jaspilite, with some argillaceous bands. Brecciated Occasional specks of pyrite.
342 0	352 0	10 0	10 0	As above.
352 0	362 0	10 0	10 0	As above.
362 0	372 6	10 6	10 0	As above.
372 6	382 6	10 0	10 0	As above.
382 6	392 6	10 0	10 0	As above.
392 6	398 0	5 6	5 6	As above.
398 0	408 0	10 0	9 1	As above.
408 0	412 0	4 0	3 0	Dark grey jaspilite and brown argillaceous bands.
412 0	413 6	1 6	1 6	Brown and white argillaceous and silty bands.
413 6	423 6	10 0	10 0	As above.
423 6	427 0	3 6	3 6	As above.
427 0	433 6	5 6	5 2	Dark grey jaspilite, with some brown argillaceous bands.
433 6	438 0	4 6	4 6	Black cherty jaspilite.
438 0	441 6	3 6	3 6	As above.
441 6	443 6	2 0	2 0	White and black cherty jaspilite.
433 6	449 0	5 6	5 3	As above.
449 0	452 0	3 0	3 0	Dark grey to black jaspilite. Some clayey bands.
452 0	455 0	3 0	3 0	As above.
455 0	458 0	3 0	3 0	As above.
458 0	459 6	1 6	1 0	As above.
459 6	461 6	2 0	2 0	As above.
461 6	464 0	2 6	2 6	As above.
464 0	469 0	5 0	5 0	As above.
469 0	470 0	1 0	1 0	As above.
470 0	476 0	6 0	6 0	As above.
476 0	479 0	3 0	3 0	As above.
479 0	480 6	1 6	1 6	Blue-grey jaspilite. Some thin argillaceous bands.
480 6	490 0	9 6	9 6	Blue-grey jaspilite. Some thin argillaceous bands.
490 0	497 0	7 0	7 0	As above.
497 0	497 6	0 6	0 4	As above.
497 6	500 0	2 6	2 0	Brown and white argillaceous sediment, with some thin cherty bands. Bedding at 55° to core axis.
500 0	502 6	2 6	2 6	As above.
502 6	508 0	7 6	5 2	As above.
508 0	518 0	10 0	9 0	Brown mudstone with some white mudstone "balls".
....	....	....	1 0	Brown mudstone bearing low percentage of hematite.
518 0	525 6	7 6	7 6	As above.
525 6	528 0	2 6	0 4	Brown mudstone with hematite. Broken core.
528 0	529 0	1 0	1 0	HEMATITE IRON ORE.
528 0	531 6	2 6	1 9	As above.
531 6	536 6	5 0	4 8	As above.
536 6	540 0	3 6	2 3	As above.
540 0	544 6	4 6	1 10	As above.
544 6	548 6	4 0	2 0	As above.
548 6	553 0	5 0	0 10	As above.
553 0	553 6	0 6	0 2	As above.
553 6	557 0	3 6	3 0	As above.
557 0	559 8	1 8	1 4	As above.
559 8	562 6	2 10	2 10	As above.
562 6	568 0	5 6	4 0	As above.
568 0	572 0	4 0	1 5	As above.
572 0	577 6	5 6	0 8	As above.
577 6	582 6	5 0	0 8	As above.
582 6	584 0	1 6	0 8	As above.
584 0	589 0	5 0	3 10	As above.
589 0	593 0	4 0	1 3	As above.
593 0	596 0	3 0	0 6	As above.
596 0	598 0	2 0	0 3	As above.
598 0	599 6	1 6	0 7	As above.
599 6	601 0	1 6	0 7	As above.
601 0	602 0	1 0	0 8	As above.
602 0	603 6	1 6	0 4	As above.
603 6	604 0	0 6	0 3	As above.
604 0	605 0	1 0	0 9	As above.
605 0	614 0	9 0	5 0	As above.
614 0	616 0	2 0	0 2	As above.
616 0	621 0	5 0	0 4	As above.
621 0	625 0	4 0	0 4	As above.
625 0	631 0	6 0	1 5	As above.
631 0	633 6	2 6	2 2	As above.
633 6	640 0	6 6	0 0	No Core.
640 0	649 0	9 0	0 1	As above.
649 0	652 0	3 0	1 4	As above.
652 0	657 0	5 0	0 6	As above.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
657 0	661 6	4 6	0 9	HEMATITE IRON ORE As above.
661 6	664 6	3 0	1 8	As above.
664 6	673 0	8 6	4 2	As above.
673 0	680 0	7 0	3 10	As above.
680 0	680 6	0 6	0 2	As above.
680 6	687 0	6 6	3 8	As above.
687 0	696 0	9 0	4 2	As above.
696 0	701 0	5 0	1 10	As above.
701 0	705 0	4 0	1 8	As above.
705 0	710 0	5 0	0 10	As above.
710 0	716 0	6 0	2 0	As above.
716 0	720 0	4 0	1 3	As above.
720 0	724 6	4 6	0 11	As above.
724 6	729 6	5 0	0 9	As above.
729 6	730 6	1 0	0 10	As above.
730 6	735 0	4 6	2 8	As above.
735 0	744 6	8 6	3 0	As above.
744 6	746 6	2 0	0 2	As above.
746 6	754 6	8 0	1 4	As above.
754 6	756 6	2 0	0 7	As above.
756 6	759 0	2 6	0 6	As above.
759 0	768 6	9 6	0 10	As above.
768 6	772 0	3 6	0 4	As above.
772 0	780 0	8 0	2 0	As above.
780 0	782 6	2 6	0 6	As above.
782 6	787 6	5 0	0 11	As above.
787 6	791 6	4 0	0 2	As above.
791 6	802 0	10 6	0 6	As above.
802 0	809 6	7 6	0 6	As above.
809 6	818 0	8 6	1 1	As above.
818 0	824 0	6 0	1 7	As above.
824 0	826 6	2 6	1 0	As above. END OF HOLE.

Diamond Drill Hole No. B1.
Assay Data.

Sample No.	From	To	Length of Core Recovered	% Fe—acid soluble on a dry basis
	ft. in.	ft. in.	ft. in.	
G.B. 1	528 0	533 0	5 0	62·6
G.B. 2	533 0	538 0	4 0	62·6
G.B. 3	538 0	543 0	3 0	66·8
G.B. 4	543 0	553 0	2 10	67·9
G.B. 5	553 0	558 0	4 2	67·5
G.B. 6	558 0	563 0	3 2	68·2
G.B. 7	563 0	568 0	4 0	68·0
G.B. 8	568 0	578 0	2 1	68·1
G.B. 9	578 0	588 0	3 6	67·8
G.B. 10	588 0	598 0	2 7	68·2
G.B. 11	598 0	603 0	2 2	69·0
G.B. 12	603 0	608 0	4 0	69·7
G.B. 13	608 0	613 0	2 2	68·0
G.B. 14	613 0	633 0	4 3	67·7
G.B. 15	633 0	663 0	3 4	68·1
G.B. 16	663 0	668 0	3 0	68·0
G.B. 17	668 0	678 0	5 0	68·1
G.B. 18	678 0	688 0	4 10	68·1
G.B. 19	688 0	698 0	4 10	68·2
G.B. 20	698 0	708 0	4 2	68·8
G.B. 21	708 0	718 0	3 3	68·6
G.B. 22	718 0	738 0	5 2	68·8
G.B. 23	738 0	748 0	3 2	68·7
G.B. 24	748 0	768 0	3 3	68·8
G.B. 25	768 0	788 0	3 11	68·0
G.B. 26	788 0	818 0	2 1	68·6
G.B. 27	818 0	826 0	2 7	68·5

Average Fe content of penetration from 528 ft. to 826 ft. = 67·8%.
% Core Recovery over this length = 32%.

Diamond Drill Hole No. B1.
Group Assay.
% on Moisture Free Basis.

Sample Length	Fe Total	Fe Acid Soluble	SiO_2	S.	P.	Ti.	Mn.	MgO	CaO	Al_2O_3	Ignition Loss
528 ft. to 826 ft. (298 ft.)	67·9	67·7	0·83	Tr.	0·01	0·01	0·78	0·04	*Nil*	0·95	0·21

Assay by Mineral Section, W.A. Government Chemical Laboratories
Ground sample remnants retained.

Diamond Drill Hole No. C1, Site C.

Location: 550 ft. plan distance bearing 327° from Mt. Goldsworthy Trig. Stn.
Azimuth: 158° Mag.
Angle of Depression: 55°.
Total Depth: 895 ft.
Date commenced: 26 March, 1960.
Date Completed: 31 May, 1960.
Logged by: G. H. Low.
Contractor: L. C. Honey.
Machine Used: Mindrill A2000.
Core Size: AXT.
Casing Used: AX 150 ft., BX 75 ft., NX 10 ft.
Core Recovery: Total 70%. In iron ore: 506 ft. to 797 ft. = 55%, 832 ft. to 869 ft. = 92%.

Summarised Core Log.
Diamond Drill Hole No. C1.

Section		Summarised Description
From	To	
ft. in.	ft. in.	
0 0	160 0	Mainly brown argillaceous sediment, not very well bedded. Some inferior siliceous bands. The top few feet consists of hematite, argillaceous sediment, and quartz rubble in soil.
160 0	258 0	Mainly white and grey jaspilitic sediment. Some argillaceous bands. Shows deep-water-sediment structure. Standing water level at approximately 180 ft. (May, 1960).
258 0	415 0	Mainly brown argillaceous sediment. Some siliceous bands. HEMATITE IRON ORE at 300 ft. (3 ft. 6 in.), and at 371 ft. 6 in. (7 ft. 0 in.).
415 0	467 0	Mainly siliceous sediment as above.
467 0	505 6	Mainly argillaceous sediment as above.
505 6	797 0	HEMATITE IRON ORE. Crystalline, powdery, and argillaceous.
797 0	832 0	Mainly brown bedded argillaceous sediment, with some siliceous and argillaceous hematite bands.
832 0	869 0	HEMATITE IRON ORE. Crystalline, powdery, and argillaceous.
869 0	895 0	Grey siliceous sediment, with inferior hematite and argillaceous hematite bands (Banded iron formation). END OF HOLE.

Diamond Drill Hole No. C1.
Detailed Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	23 0	23 0	0 0	No core. Surface soil with ironstone rubble.
23 0	63 10	40 10	14 0	White-yellow-red ironstained "shaley" argillaceous sediments.
63 10	73 1	9 3	4 0	Red-brown fairly massive argillaceous sediment (mudstone ?).
73 1	75 0	1 11	0 6	3 inches as above, 3 inches greenish-brown quartz.
75 0	81 3	6 3	1 3	Red-brown "shaley" argillaceous sediment.
81 3	84 1	2 10	0 5	Quartz and argillaceous sediment rubble.
84 1	89 6	5 5	0 5	As above.
89 6	90 0	0 6	0 4	As above.
90 0	93 6	3 6	0 8	Red-brown shaley sediment.
93 6	97 6	4 0	1 9	As above.
97 6	101 8	4 2	0 10	Grey shaley sediment rubble.
101 8	106 0	4 4	3 0	As above.
106 0	107 8	1 8	1 4	As above.
107 8	109 4	1 8	1 0	As above.
109 4	115 9	6 5	2 6	As above.
115 9	119 9	4 0	1 2	As above.
119 9	127 4	7 7	1 1	3 inches amber quartz, 10 inches grey shaley sediment.
127 4	133 10	6 6	2 9	Gray shaley sediment.
133 10	135 6	1 8	1 2	As above.
135 6	137 10	2 4	0 5	As above.
137 10	141 0	3 2	0 6	As above.
141 0	151 0	10 0	0 4	As above.
151 0	156 6	5 6	0 6	As above.
156 6	160 2	3 8	2 10	Grey and brown shaley sediment.
160 2	161 7	1 5	1 2	As above.
161 7	171 3	9 8	9 6	Brown massive argillaceous sediment (mudstone ?). Some irregular quartz stringers. Last few inches slightly graphitic. Bedding at 50 degrees to core axis.
171 3	178 8	7 5	7 3	As above. Brecciated in places.
178 8	185 11	7 3	6 10	As above, with some bedding.
185 11	195 8	9 9	9 9	Grey-brown massive argillaceous sediment (mudstone ?).
195 8	205 3	9 7	9 0	As above, with some bedding at 30 degrees to core axis.
205 3	215 3	10 0	10 0	As above, some hematite iron in last 10 inches.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
215 3	225 3	10 0	10 0	Grey-brown argillaceous sediment. Bedding at 50 degrees to core axis.
225 3	231 3	6 0	6 0	As above, some quartz stringers.
231 3	241 0	9 9	9 9	As above.
241 0	251 0	10 0	10 0	Grey argillaceous sediment silty in places—shows varving and deep water slumping.
251 0	260 6	9 6	8 6	As above.
260 6	261 6	1 0	1 0	As above.
261 6	267 6	6 0	5 0	As above.
267 6	275 1	7 7	7 0	As above.
275 1	279 1	4 0	4 0	Brown argillaceous sediment. Slatey. Sheared.
279 1	289 2	10 1	9 2	Brown massive hard mudstone.
289 2	299 0	9 10	9 10	As above.
299 0	309 0	10 0	9 7	12 inches as above, 43 inches HEMATITE IRON ORE, 60 inches brown massive mudstone.
309 0	319 0	10 0	9 5	Brown massive mudstone.
319 0	329 0	10 0	10 0	As above.
329 0	333 0	4 0	3 9	As above. Sheared (slatey) in places. Shows some slump ball structure.
333 0	342 3	9 3	9 2	As above.
342 3	352 3	10 0	10 0	White and brown mudstone. Silty in places.
352 3	362 0	9 9	9 7	As above.
362 0	370 3	8 3	7 6	As above.
370 3	380 3	10 0	8 4	16 inches as above, 84 inches HEMATITE IRON ORE.
380 3	390 0	9 9	9 9	Brown mudstone, with some silica, and poor quality iron bands.
390 0	400 0	10 0	10 0	As above.
400 0	404 11	4 11	4 10	Brown mudstone and siltstone, a little hematite in places (argillaceous hematite).
404 11	415 0	10 0	10 0	As above.
415 0	424 9	9 9	9 8	30 inches as above, 86 inches silica and hematite bands.
424 9	434 9	10 0	9 2	White to grey brecciated siliceous sediment.
434 9	440 3	5 6	5 6	As above.
440 3	450 3	10 0	10 0	As above.
450 3	457 4	7 1	7 0	Brown mudstone, some siliceous bands.
457 4	467 4	10 0	10 0	As above.
467 4	477 4	10 0	10 0	White, brown and dark grey argillaceous sediment. Some argillaceous hematite.
477 4	486 0	8 8	8 0	As above.
486 0	495 9	9 9	9 2	As above.
495 9	505 6	9 9	9 6	Brown mudstone. Some banding. Some argillaceous hematite.
505 6	508 9	3 3	3 0	HEMATITE IRON ORE.
508 9	512 1	3 4	2 6	As above.
512 1	514 0	1 11	1 4	As above.
514 0	516 1	2 1	1 3	As above.
516 1	520 0	3 11	2 1	19 inches HEMATITE IRON ORE, 5 inches mudstone, 1 inch HEMATITE IRON ORE.
520 0	523 0	3 0	3 0	HEMATITE IRON ORE.
523 0	529 1	6 1	4 2	As above.
529 1	539 0	9 11	7 0	As above.
539 0	543 5	4 5	1 5	As above.
543 5	552 11	9 6	9 0	As above.
552 11	559 8	6 9	6 6	As above.
559 8	569 8	10 0	10 0	As above.
569 8	574 4	4 8	3 0	As above.
574 4	578 9	4 5	3 4	As above.
578 9	588 9	10 0	10 0	As above.
588 9	590 3	1 6	0 6	As above.
590 3	593 0	2 9	0 5	As above.
593 0	594 0	1 0	0 6	As above.
594 0	604 0	10 0	10 0	As above.
604 0	609 9	5 9	4 0	As above.
609 9	613 3	3 6	1 4	As above.
613 3	623 3	10 0	10 0	HEMATITE IRON ORE, with thin clayey bands.
623 3	627 9	4 6	4 0	HEMATITE IRON ORE.
627 9	630 2	2 5	0 6	As above.
630 2	635 1	4 11	1 3	As above.
635 1	639 9	4 8	0 9	As above.
639 9	642 0	2 3	1 6	HEMATITE IRON ORE, with thin clayey bands.
642 0	646 3	4 3	3 10	HEMATITE IRON ORE.
646 3	650 9	4 6	4 3	As above.
650 9	660 9	10 0	9 0	As above.
660 9	670 9	10 0	3 9	As above.
670 9	676 9	6 0	3 9	As above.
676 9	682 9	6 0	1 4	As above.
682 9	684 9	2 0	1 0	As above.
684 9	690 4	5 7	3 7	As above.
690 4	698 6	8 2	2 0	As above.
698 6	703 10	5 4	1 0	As above.
703 10	708 8	4 10	3 3	As above.
708 8	712 2	3 6	0 11	As above.
712 2	717 2	5 0	2 3	As above.
717 2	726 0	8 10	0 9	As above.
726 0	731 0	5 0	1 1	As above.
731 0	731 9	0 9	0 0	
731 9	737 0	5 3	0 3	HEMATITE IRON ORE.
737 0	739 6	2 6	0 9	As above.
739 6	740 0	0 6	0 4	As above.
740 6	743 11	3 5	0 7	As above.
743 11	750 0	6 1	0 0	
750 0	755 6	5 6	0 0	
755 6	759 8	4 2	0 0	
759 8	764 2	4 6	0 4	HEMATITE IRON ORE.
764 2	765 4	1 2	1 0	As above.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
765 4	774 3	8 11	8 6	HEMATITE IRON ORE
774 3	784 3	10 0	4 0	As above.
784 3	785 6	1 3	0 8	As above.
785 6	787 3	1 9	1 2	HEMATITE IRON ORE, with brown clayey bands.
787 3	796 0	8 9	0 5	As above.
796 0	797 3	1 3	0 11	As above.
797 3	807 0	9 9	9 2	22 inches argillaceous hematite, 88 inches banded mudstone and siltstone.
807 0	817 4	10 4	8 0	Brown mudstone and hematite bands.
817 4	825 0	7 8	7 0	Red-brown argillaceous sediment, hematite and silica bands.
825 0	830 5	5 5	5 0	As above.
830 5	832 0	1 7	2 0	As above.
832 0	839 0	7 0	7 0	HEMATITE IRON ORE. Argillaceous, and with some silica bands.
839 0	849 0	10 0	9 6	22 inches HEMATITE IRON ORE with some silica bands. 58 inches HEMATITE IRON ORE, clay content increasing towards end. 34 inches Banded argillaceous sediment and silica. Some slight hematite.
849 0	855 6	6 6	6 4	Banded argillaceous sediment, silica and hematite.
855 6	863 10	8 4	8 4	66 inches brown mudstone, 34 inches mudstone and hematite.
863 10	869 0	5 2	2 10	Banded silica and hematite.
869 0	873 0	4 0	4 0	Banded silica and argillaceous sediment.
873 0	876 9	3 9	3 6	Brown argillaceous hematite and grey silica. Banded.
876 9	886 0	9 3	9 0	Brown argillaceous hematite and argillaceous sediment. Banded.
886 0	895 0	9 0	8 7	Grey silica and brown argillaceous hematite. Banded. END OF HOLE.

Diamond Drill Hole No. C1.
Assay Data.

Sample No.	From	To	Length of Core Recovered	% Fe—acid soluble on a dry basis
	ft. in.	ft. in.	ft. in.	
G.C. 1	300 0	303 7	3 7	57·1
G.C. 2	371 7	378 7	7 0	58·2
G.C. 3	505 6	510 6	3 9	64·8
G.C. 4	510 6	515 6	3 3	65·1
G.C. 5	515 6	520 6	3 2	62·8
G.C. 6	520 6	525 6	4 0	67·4
G.C. 7	525 6	530 6	4 0	67·0
G.C. 8	530 6	535 6	3 2	68·7
G.C. 9	535 6	540 6	2 9	67·2
G.C. 10	540 6	545 6	2 10	69·2
G.C. 11	545 6	550 6	4 6	68·7
G.C. 12	550 6	555 6	5 0	67·9
G.C. 13	555 6	560 6	4 0	66·2
G.C. 14	560 6	565 6	5 0	65·6
G.C. 15	565 6	570 6	4 10	66·7
G.C. 16	570 6	575 6	3 0	67·2
G.C. 17	575 6	580 6	4 4	68·2
G.C. 18	580 6	585 6	5 0	65·2
G.C. 19	585 6	590 6	3 9	64·8
G.C. 20	590 6	595 6	1 11	65·9
G.C. 21	595 6	600 6	5 0	66·0
G.C. 22	600 6	605 6	4 10	67·6
G.C. 23	605 6	610 6	3 0	67·4
G.C. 24	610 6	615 6	3 4	65·4
G.C. 25	615 6	620 6	5 0	63·8
G.C. 26	620 6	625 6	4 5	65·9
G.C. 27	625 6	630 6	2 10	66·3
G.C. 28	630 6	640 0	2 0	68·3
G.C. 29	640 0	645 0	4 0	66·9
G.C. 30	645 0	650 0	4 10	67·6
G.C. 31	650 0	655 0	4 5	68·6
G.C. 32	655 0	660 0	4 6	67·0
G.C. 33	660 0	670 0	3 9	63·5
G.C. 34	670 0	675 0	3 6	67·1
G.C. 35	675 0	680 0	2 0	67·5
G.C. 36	680 0	690 0	4 7	66·7
G.C. 37	690 0	700 0	2 6	67·4
G.C. 38	700 0	710 0	4 9	68·0
G.C. 39	710 0	730 0	4 6	68·6
G.C. 40	730 0	765 0	3 1	64·9
G.C. 41	765 0	770 0	5 0	59·7
G.C. 42	770 0	775 0	3 6	61·3
G.C. 43	775 0	785 0	4 8	63·1
G.C. 44	785 0	797 0	2 3	53·2
G.C. 45				
G.C. 46	797 0	832 0	Band of barren country rock not assayed.	
G.C. 47				
G.C. 48				
G.C. 49	832 0	837 0	5 0	54·1
G.C. 50	837 0	842 0	5 0	46·2
G.C. 51	842 0	847 0	5 0	49·4
G.C. 52	847 0	852 0	4 4	36·9
G.C. 53	852 0	857 0	5 0	43·0
G.C. 54	857 0	862 0	5 0	48·6
G.C. 55	862 0	869 0	4 8	46·5

Average Fe content of main penetration from 505 ft. 6 in. to 797 ft. = 65·9%.
% Core Recovery over this length = 55·1%.
Average Fe content of second orebed from 832 ft. to 869 ft. = 46·4%.
% Core recovery over this length = 92%.

Diamond Drill Hole No. C1.
Group Assays.
Per Cent. on Moisture Free Basis.

Sample Length	Fe Total	Fe Acid Soluble	SiO_2	S.	P.	Ti.	Mn.	MgO.	CaO.	Al_2O_3	Ignition Loss
505 ft. to 797 ft. (292 ft.)	66·0	65·9	4·05	*L0·01	0·01	0·05	0·53	0·01	0·05	0·28	0·51
832 ft. to 869 ft. (37 ft.)	47·9	47·1	29·7	0·04	0·02	0·07	0·40	*Nil*	*Nil*	0·89	0·72

*L = less than
Assays by Mineral Section, W.A. Government Chemical Laboratories
Ground sample remnants retained

Diamond Drill Hole D1.

Location: 585 ft. plan distance bearing 5° from Mt. Goldsworthy Trig. Stn.
Azimuth: 146°.
Angle of Depression: 55°
Total Depth: 931 ft.
Date Commenced: 11 June, 1960.
Date Completed: 1 October, 1960.
Logged by: G. H. Low.
Contractor: L. C. Honey.
Machine Used: Mindrill A2000.
Core Size: AXT.
Casing Used: BX 32 ft., NX 16 ft.
Core Recovery: Total 77.1 per cent. in iron ore: 454 ft. to 722 ft. = 61 per cent., 790 ft. to 866 ft. = 53 per cent.

Diamond Drill Hole No. D1.
Summarised Core Log.

From	To	Description
ft. 0	ft. 297	Dark grey cherty jaspilite with some red-brown mudstone. Some thin quartz veinlets below 190 feet, and some disseminated pyrite.
297	454	Mostly slightly metamorphosed red-brown mudstone with some interbedded siliceous jaspilite.
454	722	Massive, vesicular, and finely specular HEMATITE IRON ORE.
722	790	Red brown slightly metamorphosed mudstone showing slumping structure, carrying some hematite.
790	866	Massive, vesicular and finely specular HEMATITE IRON ORE.
866	931	Dark grey cherty jaspilite with a little hematite and argillaceous sediment. END OF HOLE.

Diamond Drill Hole No. D1.
Detailed Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	37 0	37 0	3 6	Brown-grey cherty jaspilite, broken with some soil and sand.
37 0	39 0	2 0	1 8	Grey cherty jaspilite. Broken.
39 0	40 6	1 6	1 3	As above.
40 6	42 7	2 1	0 6	As above.
42 7	44 3	1 8	1 0	As above.
44 3	45 5	1 2	0 6	As above.
45 5	48 4	2 11	2 0	As above.
48 4	51 3	2 11	1 0	As above.
51 3	52 10	1 7	0 10	As above.
52 10	56 0	3 2	1 10	As above.
56 0	57 9	1 9	0 8	As above.
57 9	58 7	0 10	0 6	As above.
58 7	58 10	0 3	0 3	As above.
58 10	63 2	4 4	3 0	As above.
63 2	64 10	1 8	1 6	As above.
64 10	66 9	1 11	1 3	As above.
66 9	68 2	1 5	1 2	As above.
68 2	73 5	5 3	3 0	As above.
73 5	75 4	1 11	0 8	As above.
75 4	78 10	3 6	0 9	Red brown mudstone and grey jaspilite.
78 10	81 6	2 8	1 6	As above.
81 6	84 11	3 5	1 0	As above.
84 11	87 9	2 10	1 6	As above.
87 9	89 1	1 4	0 8	As above.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
89 1	94 0	4 11	1 6	White mudstone and fine-grained sandstone.
94 0	97 3	3 3	0 8	Red brown mudstone.
97 3	100 5	3 2	0 6	Grey jaspilite and mudstone.
100 5	104 4	3 11	3 0	As above.
104 4	106 7	2 3	1 0	Grey jaspilite.
106 7	108 5	1 10	1 2	White quartz vein.
108 5	109 2	1 9	0 6	Grey jaspilite.
109 2	110 2	1 0	0 4	As above.
110 2	111 11	1 9	1 4	Grey jaspilite with argillaceous bands.
111 11	112 7	0 8	0 7	As above.
112 7	114 0	1 5	0 10	As above.
114 0	117 7	3 7	3 0	Grey chert breccia in mudstone
117 7	120 5	2 10	0 10	Red brown mudstone and grey siltstone.
120 5	121 5	1 0	0 10	Grey chert and brown mudstone.
121 5	124 1	2 8	0 10	Red brown mudstone, some grey chert.
124 1	125 0	0 11	0 6	Red brown mudstone.
125 0	126 9	1 9	0 4	As above.
126 9	128 5	1 8	1 0	Grey chert and brown mudstone.
128 5	129 7	1 2	0 6	Dark grey chert.
129 7	131 7	2 0	1 0	As above.
131 7	133 8	2 1	0 10	Dark grey jaspilite with brown argillaceous bands.
133 8	134 6	1 10	0 0	No core.
134 6	134 11	0 5	0 3	Dark grey chert.
134 11	135 6	0 7	0 4	As above.
135 6	136 3	0 9	0 4	As above.
136 3	137 0	0 9	0 4	As above.
137 0	137 9	0 9	0 6	As above.
137 9	139 9	2 0	0 5	As above.
139 9	140 3	0 6	0 4	As above.
140 3	141 3	1 0	0 9	Dark grey to black cherty jaspilite.
141 3	142 5	1 2	0 6	As above.
142 5	143 5	1 0	0 10	As above.
143 5	145 0	1 7	1 4	As above.
145 0	146 5	1 5	1 0	As above.
146 5	151 3	4 10	2 9	As above.
151 3	153 2	1 11	1 0	As above.
153 2	155 5	2 3	1 2	As above.
155 5	158 4	2 11	0 5	Dark grey to black cherty jaspilite.
158 4	159 0	0 8	0 8	Dark grey dense fine grained metamorphosed mudstone.
159 0	162 0	3 0	2 6	Dark grey cherty jaspilite breccia.
162 0	164 0	2 0	1 6	As above.
164 0	173 11	9 11	4 0	Dark brown metamorphosed mudstone.
....	....	....	3 6	Dark grey brecciated jaspilite.
173 11	183 8	9 9	8 0	Dark grey cherty jaspilite with some intrusive quartz veinlets.
183 8	188 3	4 7	4 0	Dark grey cherty jaspilite.
188 3	198 3	10 0	1 0	Red brown mudstone.
....	....	....	8 0	Light grey metamorphosed siltstone.
198 3	200 3	2 0	2 0	Dark grey cherty jaspilite.
200 3	202 1	1 10	1 4	As above.
202 1	209 5	7 4	7 4	As above with some quartz veinlets.
209 5	214 8	5 3	5 0	Light and dark grey jaspilite carrying some disseminated pyrite.
214 8	221 7	6 11	6 0	As above.
221 7	227 7	6 0	6 0	As above.
227 7	230 2	2 7	2 0	As above.
230 2	234 3	4 1	3 6	As above.
234 3	235 6	1 3	1 2	As above.
235 6	241 7	6 1	6 0	As above.
241 7	249 3	7 8	7 8	As above.
249 3	258 10	9 7	9 0	As above.
258 10	261 0	3 10	2 0	As above.
261 0	271 0	10 0	10 0	Dark grey brecciated jaspilite in red brown mudstone.
271 0	277 0	6 0	6 0	As above.
277 0	278 9	1 9	1 6	Dark grey cherty jaspilite.
278 9	281 9	3 0	2 6	As above.
281 9	285 3	3 6	3 0	As above with some quartz veinlets.
285 3	291 2	5 11	4 6	Dark grey cherty jaspilite.
291 2	301 0	9 10	5 6	As above.
....	....	....	4 0	Dark brown mudstone, with some cherty patches, carrying some hematitic iron.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
301 0	311 0	10 0	10 0	Dark brown mudstone carrying a little iron. Some white patches.
311 0	321 0	10 0	10 0	As above.
321 0	331 0	10 0	10 0	As above, some quartz veinlets.
331 0	341 0	10 0	10 0	As above.
341 0	350 7	9 7	9 6	Dark grey-green metamorphosed argillaceous sediment. Bedding at 30° to core axis. Some thin quartz veinlets.
350 7	360 7	10 0	10 0	As above.
360 7	362 7	2 0	1 6	As above.
362 7	364 5	1 10	1 5	As above.
364 5	373 5	9 0	9 0	Dark grey brecciated jaspilite with mudstone.
373 5	374 0	0 7	0 7	As above.
374 0	379 10	5 10	4 6	Red brown massive mudstone, with a little hematitic iron.
379 10	389 5	9 7	9 7	As above.
389 5	399 5	10 0	10 0	As above.
399 5	408 0	8 7	8 7	As above.
408 0	418 0	10 0	9 0	As above.
418 0	428 0	10 0	10 0	As above.
428 0	438 0	10 0	10 0	As above.
438 0	448 0	10 0	10 0	As above.
448 0	458 0	10 0	4 0	IRON ORE. Hematitic, argillaceous.
458 0	464 3	6 3	1 0	As above.
464 3	474 3	10 0	9 6	IRON ORE. Hematitic, massive.
474 3	484 3	10 0	3 0	As above.
484 3	486 9	2 6	0 6	As above.
486 9	488 8	1 11	1 0	As above.
488 8	489 9	1 1	0 9	As above.
489 9	496 2	6 5	6 0	As above.
496 2	501 8	5 6	2 9	IRON ORE. Hematitic, massive.
501 8	511 0	9 4	9 0	As above.
511 0	518 9	7 9	2 9	IRON ORE, hematitic, somewhat cellular.
518 9	528 9	10 0	9 6	As above.
528 9	538 9	10 0	9 6	As above.
538 9	548 9	10 0	9 0	As above.
548 9	558 9	10 0	9 0	As above.
558 9	561 0	2 3	1 9	As above.
561 0	565 2	4 2	3 4	As above.
565 2	575 2	10 0	9 6	As above.
575 2	585 2	10 0	9 0	As above.
585 2	588 5	3 3	0 9	As above.
588 5	595 10	7 5	1 0	As above.
595 10	604 2	8 4	3 6	As above.
604 2	611 0	6 10	2 0	As above.
611 0	613 5	2 5	0 9	As above.
613 5	623 5	10 0	8 9	As above, massive.
623 5	629 3	5 10	4 10	As above.
629 3	636 6	7 3	6 0	As above.
636 6	646 6	10 0	9 6	As above.
646 6	653 3	6 9	3 4	As above.
653 3	659 1	5 10	2 6	As above.
659 1	665 3	6 2	1 0	IRON ORE, hematitic cellular, with some very small chips of argillaceous sediment.
665 3	669 8	4 5	1 6	IRON ORE, hematitic, cellular.
669 8	679 2	9 6	8 0	As above.
679 2	684 2	5 0	3 0	As above.
684 2	694 2	10 0	5 0	As above.
694 2	704 2	10 0	9 0	As above, slightly siliceous.
704 2	706 4	2 2	2 0	IRON ORE, hematitic massive.
706 4	716 4	10 0	9 6	As above, becoming argillaceous.
716 4	722 1	5 9	3 6	As above.
722 1	732 0	9 11	8 4	Brown mudstone, somewhat hematitic.
732 0	742 0	10 0	9 0	Brown mudstone showing slumping features.
742 0	752 0	10 0	10 0	As above.
752 0	753 1	1 1	1 1	As above.
753 1	763 0	9 11	9 6	As above.
763 0	773 0	10 0	10 0	As above.
773 0	783 0	10 0	8 0	As above.
783 0	793 0	10 0	7 0	As above.
....	....	....	3 0	IRON ORE, hematitic, argillaceous.
793 0	803 3	10 3	10 0	As above.
803 3	813 3	10 0	8 9	As above.
813 3	823 3	10 0	9 4	As above.
823 3	831 7	8 4	8 0	As above.
831 7	837 3	5 8	5 0	IRON ORE, argillaceous, siliceous.
837 3	842 3	5 0	5 0	As above.
842 3	848 11	6 8	6 6	As above.
848 11	855 10	6 11	6 1	As above.
855 10	866 3	10 5	9 6	As above.
866 3	875 0	8 9	8 6	Red brown argillaceous metamorphosed sediment. Sandy in places.

Detailed Core Log—*continued.*

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
875 0	882 10	7 10	7 0	Dark grey cherty jaspilite with a few hematitic bands.
882 10	885 5	2 7	2 5	As above.
885 5	891 0	5 7	3 0	As above.
891 0	900 0	9 0	9 0	Grey siliceous metasediment.
900 0	908 0	8 0	8 0	As above.
908 0	918 0	10 0	10 0	Banded grey siliceous sediment, and hematite. Some disseminated pyrite.
918 0	919 6	1 6	1 6	As above.
919 6	922 0	2 6	2 6	As above.
922 0	929 0	7 0	7 0	As above.
929 0	931 0	2 0	1 8	As above. END OF HOLE.

Diamond Drill Hole No. D1.
Assay Data.

Sample No.	From	To	Length of Core Recovered	Per cent. Fe, Acid Soluble, on a Dry Basis
	ft. in.	ft. in.	ft. in.	
G.D. 1	454 0	459 0	4 0	60·9
G.D. 2	459 0	469 0	5 6	68·1
G.D. 3	469 0	474 0	5 0	63·2
G.D. 4	474 0	484 0	3 0	63·4
G.D. 5	484 0	494 0	6 3	59·0
G.D. 6	494 0	499 0	4 0	62·6
G.D. 7	499 0	504 0	4 9	58·2
G.D. 8	504 0	509 0	5 0	61·6
G.D. 9	509 0	519 0	2 9	62·8
G.D. 10	519 0	524 0	5 0	62·7
G.D. 11	524 0	529 0	4 6	64·1
G.D. 12	529 0	534 0	5 0	62·0
G.D. 13	534 0	539 0	4 6	63·2
G.D. 14	539 0	544 0	4 6	64·1
G.D. 15	544 0	549 0	4 6	64·8
G.D. 16	549 0	554 0	4 6	60·8
G.D. 17	554 0	559 0	4 6	62·1
G.D. 18	559 0	565 0	5 1	64·5
G.D. 19	565 0	570 0	4 6	59·5
G.D. 20	570 0	575 0	5 0	58·2
G.D. 21	575 0	580 0	4 6	63·2
G.D. 22	580 0	585 0	4 6	64·7
G.D. 23	585 0	595 0	1 11	60·6
G.D. 24	595 0	605 0	3 6	60·4
G.D. 25	605 0	615 0	3 9	66·5
G.D. 26	615 0	620 0	5 0	64·4
G.D. 27	620 0	625 0	4 4	66·3
G.D. 28	625 0	630 0	3 11	66·6
G.D. 29	630 0	635 0	5 0	66·0
G.D. 30	635 0	640 0	5 0	66·3
G.D. 31	640 0	645 0	5 0	66·1
G.D. 32	645 0	655 0	4 4	66·5
G.D. 33	655 0	670 0	4 0	65·1
G.D. 34	670 0	675 0	5 0	63·3
G.D. 35	675 0	680 0	3 10	64·5
G.D. 36	680 0	685 0	3 0	60·6
G.D. 37	685 0	690 0	2 6	62·7
G.D. 38	690 0	695 0	3 6	61·4
G.D. 39	695 0	700 0	5 0	56·7
G.D. 40	700 0	705 0	3 10	60·0
G.D. 41	705 0	710 0	4 10	61·3
G.D. 42	710 0	715 0	5 0	61·6
G.D. 43	715 0	722 0	4 4	60·0
G.D.X. 53	790 0	795 0	3 6	63·2
G.D.X. 54	795 0	800 0	5 0	62·9
G.D.X. 55	800 0	805 0	4 9	62·2
G.D.X. 56	805 0	810 0	4 6	63·9
G.D.X. 57	810 0	815 0	4 6	63·0
G.D.X. 58	815 0	820 0	4 4	59·7
G.D. 44	820 0	825 0	5 0	63·1
G.D. 45	825 0	830 0	5 0	62·3
G.D. 46	830 0	835 0	4 3	53·5
G.D. 47	835 0	840 0	5 0	41·2
G.D. 48	840 0	845 0	5 0	39·0
G.D. 49	845 0	850 0	4 10	36·3
G.D. 50	850 0	855 0	5 0	46·1
G.D. 51	855 0	860 0	3 6	45·1
G.D. 52	860 0	866 0	6 0	49·3

	%
Average Fe content of penetration from 454 feet to 722 feet (268 feet) .... =	62·7
Percentage Core Recovery over this length .... =	61·0
Average Fe content of penetration from 790 feet to 866 feet (76 feet) .... =	54
Percentage Core Recovery over this length .... =	92·1

Diamond Drill Hole No. D1.
Group Assays.
Per Cent. on Moisture Free Basis.

Sample Length	Fe (Total)	Fe (Acid Soluble)	SiO_2	S.	P.	Ti.	Mn.	MgO	CaO	Al_2O_3	Ignition Loss
454 ft. to 722 ft. (268 ft.)	62·7	62·3	6·38	0·02	0·14	0·05	0·63	0·65	*Nil*	1·30	0·69
790 ft. to 866 ft. (76 ft.)	53·7	53·3	21·1	*Nil*	0·02	0·04	0·23	0·38	0·03	0·96	0·54

Assays by Mineral Section, W.A. Government Chemical Laboratories. Ground sample remnants retained.

TABLE 1.

Calculation of Weighted Average of Results of Group Assays.

No. 1 Lens.

Drill Hole	Core Length	Fe (Total)	Fe (Acid Soluble)	SiO_2	S.	P.	Ti.	Mn.	MgO	CaO	Al_2O_3	Ignition Loss
	ft.											
A1 499 ft. to 860 ft. (excluding 560 ft. to 572 ft.)	349	61·9	61·6	10·9	*Nil*	0·03	0·01	0·14	0·02	0·02	0·21	0·21
B1 528 ft. to 826 ft.	298	67·9	67·7	0·83	Trace	0·01	0·01	0·78	0·04	*Nil*	0·95	0·21
C1 505 ft. to 797 ft.	292	66·0	65·9	4·05	<0·01	0·01	0·05	0·53	0·01	0·05	0·28	0·51
D1 454 ft. to 722 ft.	268	62·7	62·3	6·38	0·02	0·14	0·05	0·63	0·65	*Nil*	1·30	0·69
Weighted Average per cent. for the four holes	....	64·5	64·3	5·75	0·02	0·02	0·03	0·50	0·16	0·03	0·65	0·39

Footwall Lens.

Drill Hole	Core Length	Fe (Total)	Fe (Acid Soluble)	SiO_2	S.	P.	Ti.	Mn.	MgO	CaO	Al_2O_3	Ignition Loss
	ft.											
A1 860 ft. to 941 ft. (excluding 890 ft. to 906 ft.)	65	37·8	37·3	45·1	0·01	0·05	0·01	0·01	*Nil*	*Nil*	Trace	0·46
C1 832 ft. to 869 ft.	37	47·9	47·1	29·7	0·04	0·02	0·07	0·40	*Nil*	*Nil*	0·89	0·72
D1 790 ft. to 866 ft.	76	53·7	53·3	21·1	*Nil*	0·02	0·04	0·23	0·38	0·03	0·96	0·54
Weighted Average per cent. for the three holes	....	47·2	46·2	31·6	0·02	0·19	0·03	0·18	0·38	0·03	0·94	0·55

Geological Consideration and Further Ore Prospects.

The iron ore bodies at Mt. Goldsworthy occur as apparently discontinuous lenses in a bedded sequence of argillaceous, banded silica and iron (jaspilitic), arenaceous types and siltstones with irregular transgressive and conformable siliceous intrusives generally of limited thickness and length in outcrop. The hanging wall and footwall rocks of the iron ore lenses are principally argillaceous types.

These beds have been tilted and folded, to form a major synclinal structure, suffering only a slight degree of metamorphism in the process. The whole structure comprises the so-called Ellerine Hills.

The major structure is a syncline plunging at about 80 degrees to the east-north-east. Mt. Goldsworthy is on the southern limb of this structure, the beds there striking approximately east-west and dipping northwards at angles between 80 and 85 degrees. The Goldsworthy beds have been invaded from the south by granite and a transition zone of para-gneiss can be seen from about 2 to 3 miles south-east of Mt. Goldsworthy Trigonometrical Station, and, beyond this, for example, in the vicinity of Granite Well, (see the Port Hedland 4 mile sheet) massive granite crops out. Granite and granitised remnants of the Goldsworthy beds may also be seen westwards of Mt. Grant beyond the Shaw and Strelley Rivers. The rocks comprising the Ord Ranges are considered to be comparable in lithology and age to the Goldsworthy beds, as are also those comprising the hills 8 miles north-east of Nimingarra Station (about 30 miles slightly south of east from Mt. Goldsworthy), and those comprising the hills immediatetly south of the Marble Bar-Port Hedland Road westwards of Doolena Gap.

The only other undoubted igneous rocks seen in the vicinity of the Ellerine Hills, other than those mentioned above, were small basic intrusives 2 miles south-east of Mt. Goldsworthy Trigonometrical Station, and on the east side of the Ord Ranges near the junction of the Strelley and Shaw Rivers. Both of these are apparently concordant. Northwards and eastwards the beds of the Ellerine Hills, reducing in height, plunge beneath a cover of Mesozoic and Recent sediments.

In some sections of the hanging wall core, structures which are attributed to deep water slumping were recorded, as also were gradational changes from hematite rich to argillaceous rich core. No conditions suggesting hydrothermal emplacement of the hematite were seen and no trace of magnetite was observed in core taken from a vertical depth of 900 feet. From the present available information, and until other facts are presented to the contrary, the author holds the opinion that the iron ore in the Mt. Goldsworthy locality is of syngenetic origin and (subject to some hypothetical qualification) that the iron ore will persist in its hematite form to the extent of limits defined by the original sedimentary conditions. The hypothetical qualifications are —subsequent disruption due to earth movements, and conversion to another mineral form by some unknown form of metamorphism at depth.

If the author's opinion is correct, the possibility exists that those sections along the strike (of the same beds as the three main lenses) which appear poor in iron where they crop out may, in fact, be the upper limits of ore lenses, the rich portions of which are down dip from the outcrop. (The opposite of course may also be true, that is, that these sections are the bottoms of such lenses.) One such section that the author believes should definitely be tested (by drilling down dip) by anyone mining iron ore in this locality is the length of outcrop between the mapped limits of the No. 1 Lens and the No. 2 Lens. Other prospects may be found on the extension of these beds around the nose of the syncline in the Ellerine Hills, and in some beds in the Ord Ranges.

An idealized block section and plan were used for the computations of ore reserves. These are shown as Plate XIV. The limitations on accuracy are apparent when it is realised that the bore-hole intersections are, on an average, 700 feet down-dip, and that the average core recovery of the 4 holes in iron ore is only 58%. There is no information on the nature or behaviour of the ore bodies between the surface and the bore-hole intersections.

There are about 6.8 cubic feet of pure hematite to the long ton. The figure of 10 cubic feet per long ton used in these computations allows a safe margin for a percentage of powder ore, cavities, and possible argillaceous lenses which may be present in the mass of the body.

The qualification of *"possible"* ore as used in this report is defined as follows: Possible ore is a class the existence of which is a reasonable possibility, as based primarily upon the strength and continuity of geologic-mineralogic relationships based

NOTE:- The N°1 and N°2 Lens are not immediately adjoining, but have been connected only by base line contour, and bearing and distance from plane table station A on the N°1 Lens to station B on the N° 2 Lens

D.D.H. A1
Azimuth 164°
Depression 55°
RL 0 feet.

D.D.H. B1
Azimuth 167°
Depression 55°
RL 8 feet.

D.D.H. C1
Azimuth 158°
Depression 55°
RL 9 feet.

D.D.H. D1
Azimuth 146°
Depression 55°
RL 3 feet.

D.D.H. E1
Azimuth 155°
Depression 55°
RL 0 feet.

SITE "E"

Mt GOLDSWORTHY

Bearing 287° 15' 2574 feet A to B (N°2 Lens)

Interfingering Lenses of Siliceous and Argillaceous Sediments

Joins X–Y on Sheet 3

N° 1 LENS

SHEET 1

LEGEND

Fe	Hematite Iron-Ore
A-Fe	Argillaceous Hematite doubtful Iron Ore
A	Mainly Argillaceous sediments, may be some Siliceous Beds
S	Argillaceous sediment enriched at surface with Hematite
J	Mainly Siliceous sediment, may be some Argillaceous Bands
Q-Fe	Mainly Siliceous with some Iron-Banding.

REFERENCE TO SIGNS

- Contours at 10' Intervals
- Strike and dip of Bedding
- Strike and plunge of minor Dragfold.
- Strike of vertical Bedding

G.S.W.A.

PLAN

OF

Mt GOLDSWORTHY IRON DEPOSITS

(ELLARINE HILLS)

PILBARA GOLDFIELD W.A.

SHOWING PROPOSED BOREHOLE SITES A—H

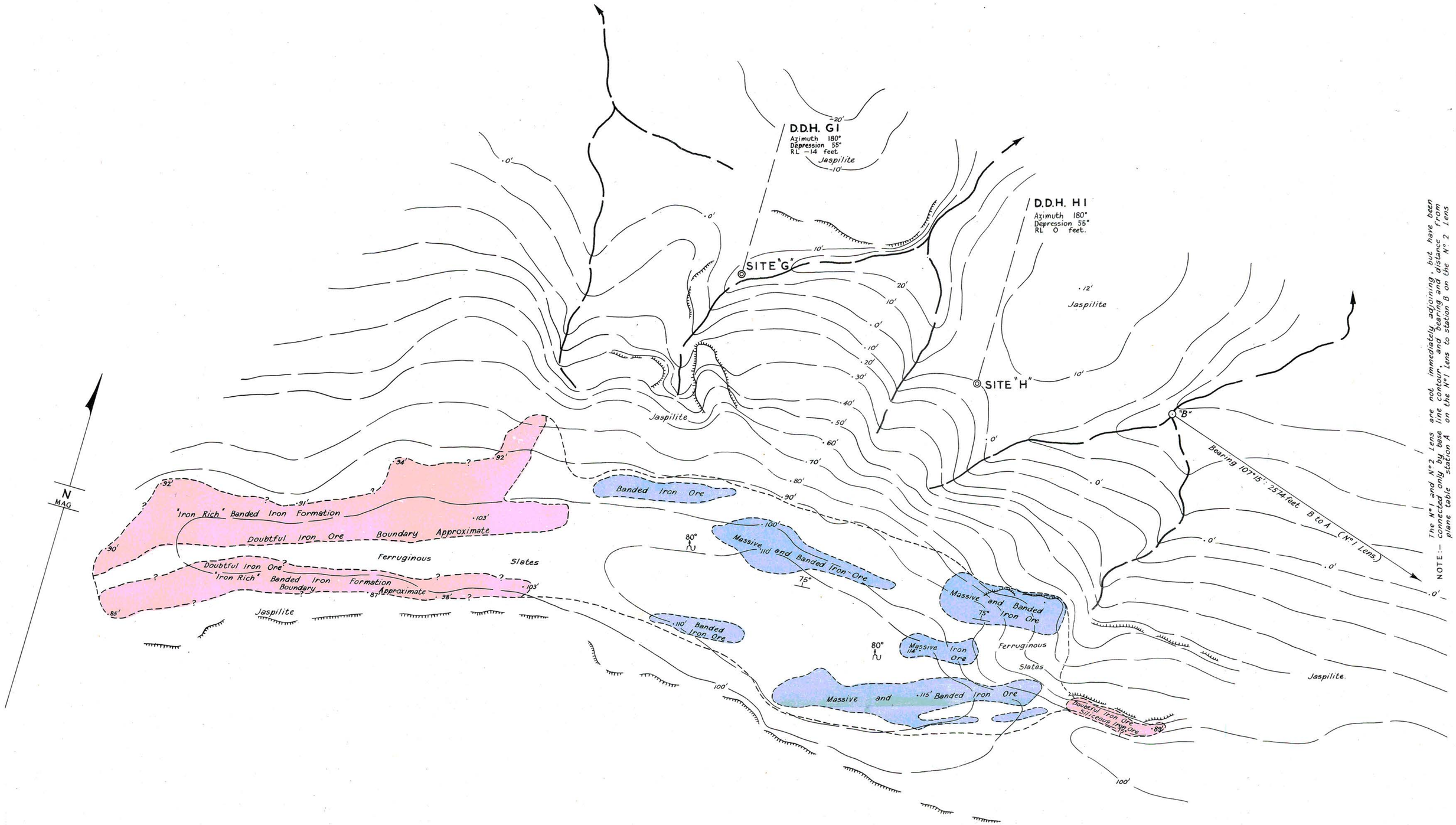
ONLY SITES A1, B1, C1, D1, DRILLED UP TO 31.12.1960.

Scale : 100 ft. to an Inch

Base line Levels by Microptic Level
Profile Heights by Abney Level and staff
Plan by Plane Table and Alidade.
Survey by G.H. Low and B.B. Owens
October 1959.

—NOTE—

Geology: (Based on surface indications only
No trenching, pitting or sampling.)
By: G.H. Low. October 1959 & July 1960.



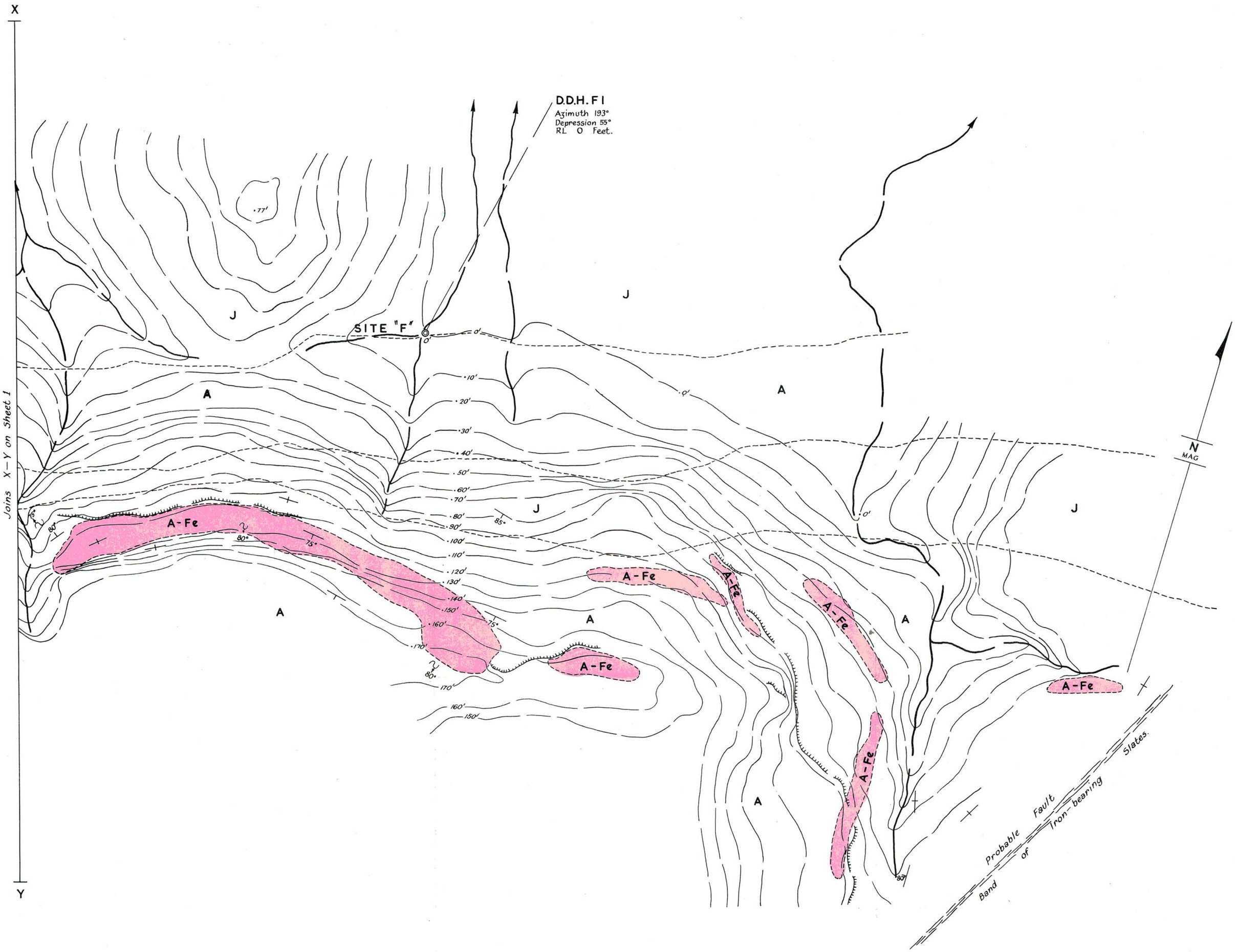
NOTE:- The N°1 and N°2 Lens are not immediately adjoining, but have been connected only by base line contour, and bearing and distance from plane table station A on the N°1 lens to station B on the N° 2 Lens

N° 2 LENS

Mt GOLDSWORTHY

FOR TITLE, REFERENCE AND LEGEND, SEE SHEET N°1

SHEET 2



N° 3 LENS

Mt GOLDSWORTHY

FOR TITLE, REFERENCE AND LEGEND, SEE SHEET N°1

SHEET 3

G. S.W.A.

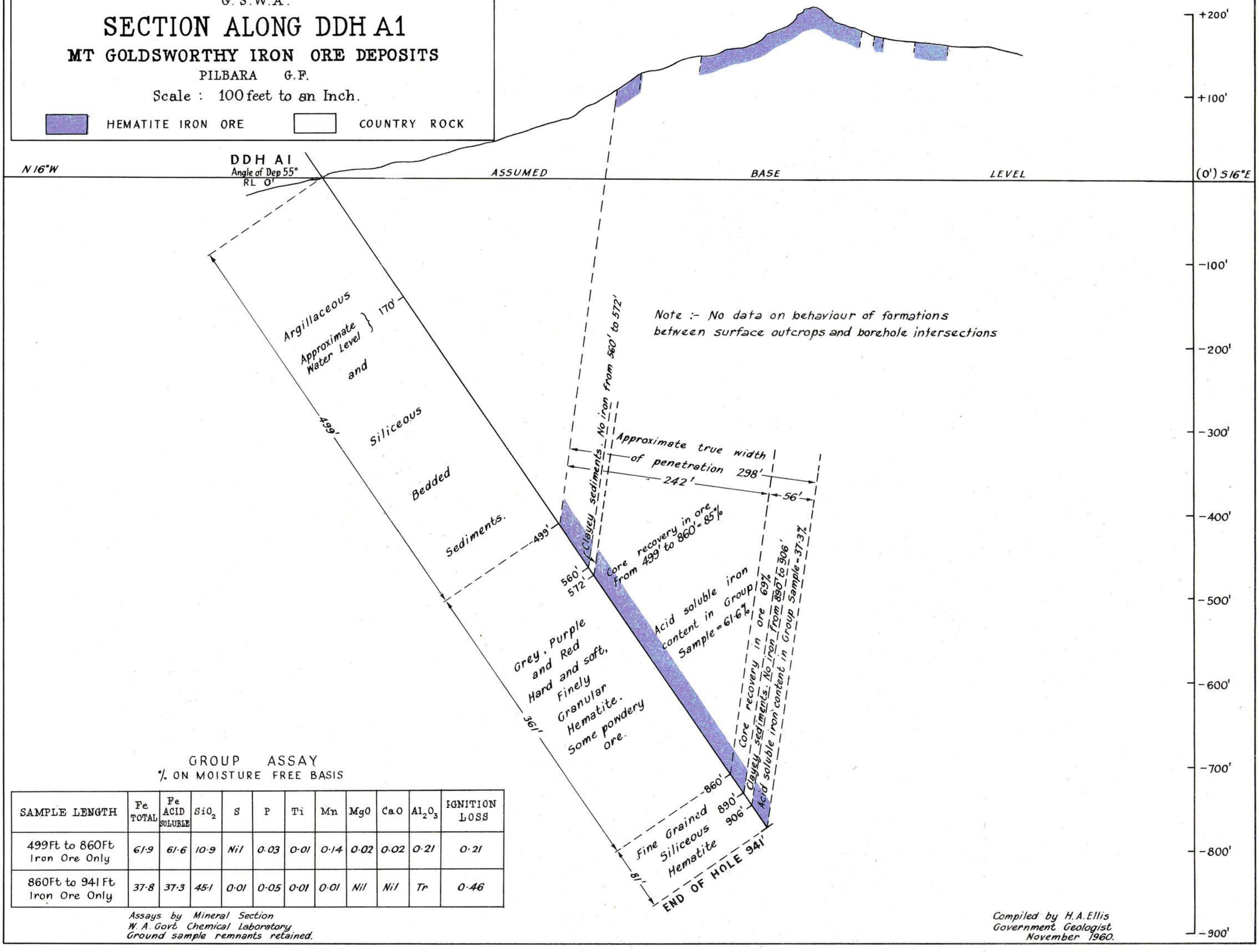
SECTION ALONG DDH A1

MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale : 100 feet to an Inch.

HEMATITE IRON ORE — COUNTRY ROCK



GROUP ASSAY

% ON MOISTURE FREE BASIS

SAMPLE LENGTH	Fe TOTAL	Fe ACID SOLUBLE	SiO_2	S	P	Ti	Mn	MgO	CaO	Al_2O_3	IGNITION LOSS
499Ft to 860Ft Iron Ore Only	61·9	61·6	10·9	Nil	0·03	0·01	0·14	0·02	0·02	0·21	0·21
860Ft to 941Ft Iron Ore Only	37·8	37·3	45·1	0·01	0·05	0·01	0·01	Nil	Nil	Tr	0·46

Assays by Mineral Section
W. A. Govt Chemical Laboratory
Ground sample remnants retained.

Compiled by H. A. Ellis
Government Geologist
November 1960.

PLATE IX

G. S. W. A.

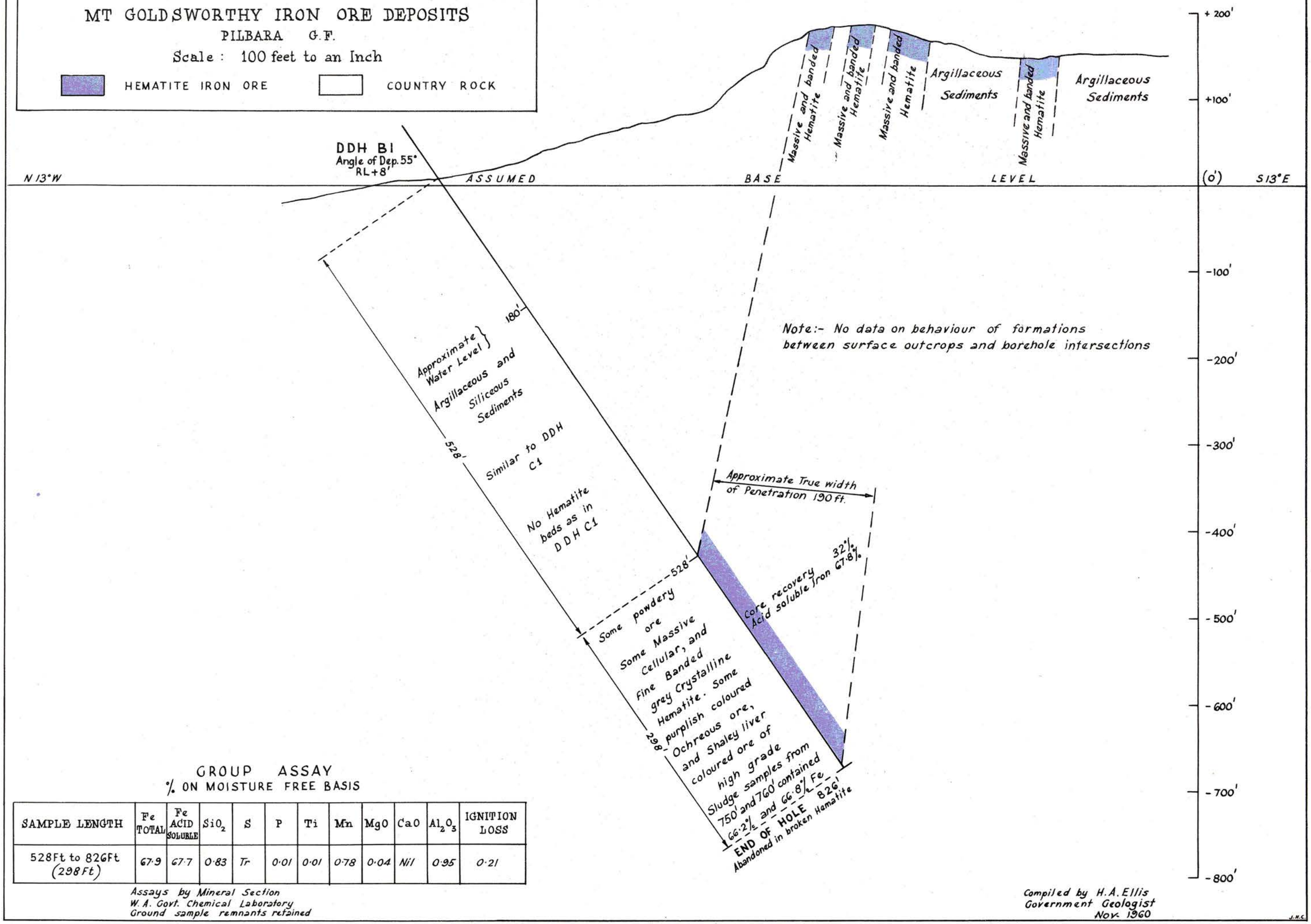
SECTION ALONG DDH B1

MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale : 100 feet to an Inch

HEMATITE IRON ORE COUNTRY ROCK



GROUP ASSAY

% ON MOISTURE FREE BASIS

SAMPLE LENGTH	Fe TOTAL	Fe ACID SOLUBLE	SiO_2	S	P	Ti	Mn	MgO	CaO	Al_2O_3	IGNITION LOSS
528Ft to 826Ft (298Ft)	67·9	67·7	0·83	Tr	0·01	0·01	0·78	0·04	Nil	0·95	0·21

Assays by Mineral Section
W. A. Govt. Chemical Laboratory
Ground sample remnants retained

Compiled by H. A. Ellis
Government Geologist
Nov. 1960

J.H.C.

PLATE X

G.S.W.A

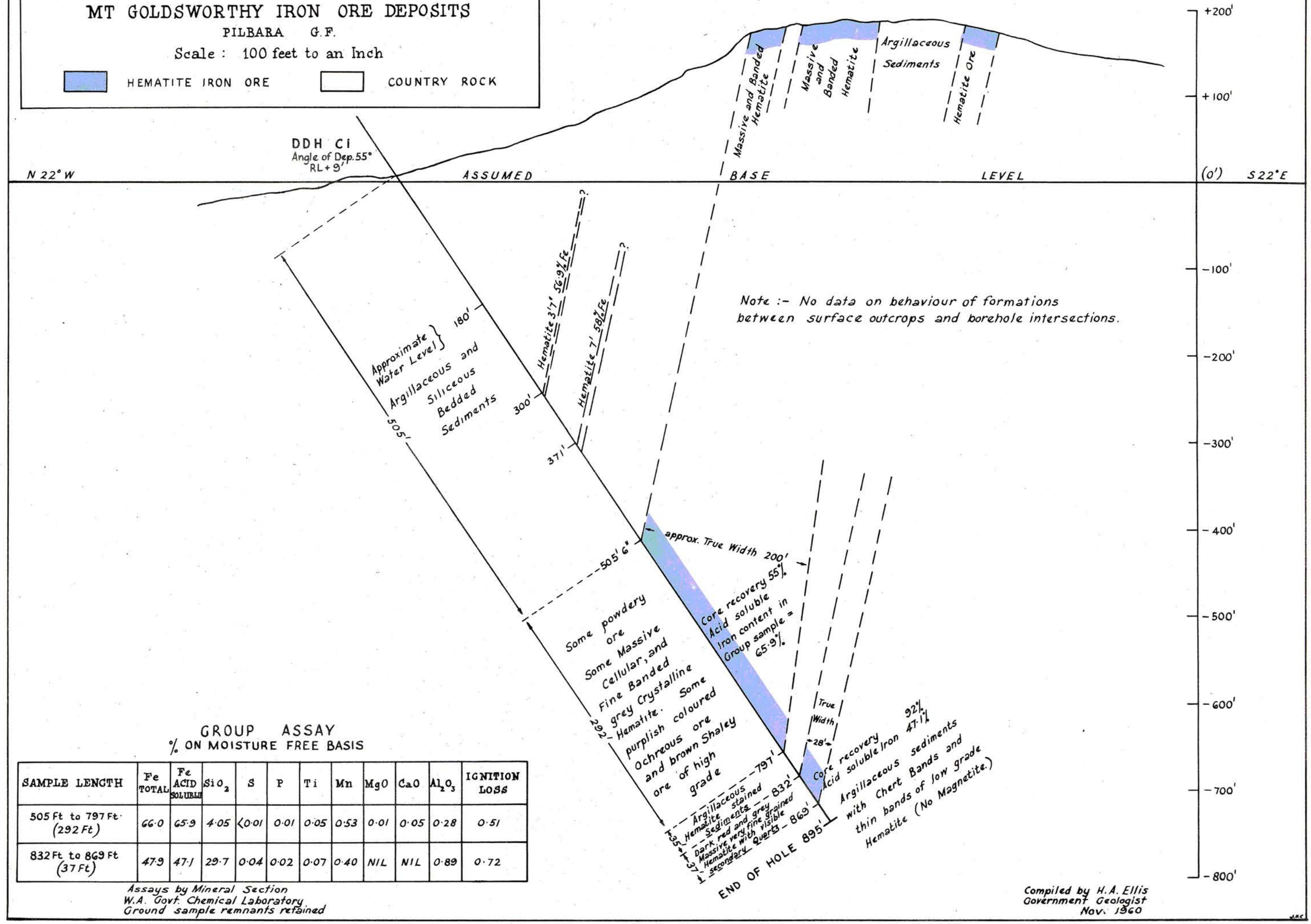
SECTION ALONG DDH C1

MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale : 100 feet to an Inch

HEMATITE IRON ORE COUNTRY ROCK



GROUP ASSAY
% ON MOISTURE FREE BASIS

SAMPLE LENGTH	Fe TOTAL	Fe ACID SOLUBLE	SiO_2	S	P	Ti	Mn	MgO	CaO	Al_2O_3	IGNITION LOSS
505 Ft to 797 Ft (292 Ft)	66·0	65·9	4·05	<0·01	0·01	0·05	0·53	0·01	0·05	0·28	0·51
832 Ft to 869 Ft (37 Ft)	47·9	47·1	29·7	0·04	0·02	0·07	0·40	NIL	NIL	0·89	0·72

Assays by Mineral Section
W.A. Govt. Chemical Laboratory
Ground sample remnants retained

Compiled by H.A. Ellis
Government Geologist
Nov. 1960

PLATE XI

G. S. W. A.

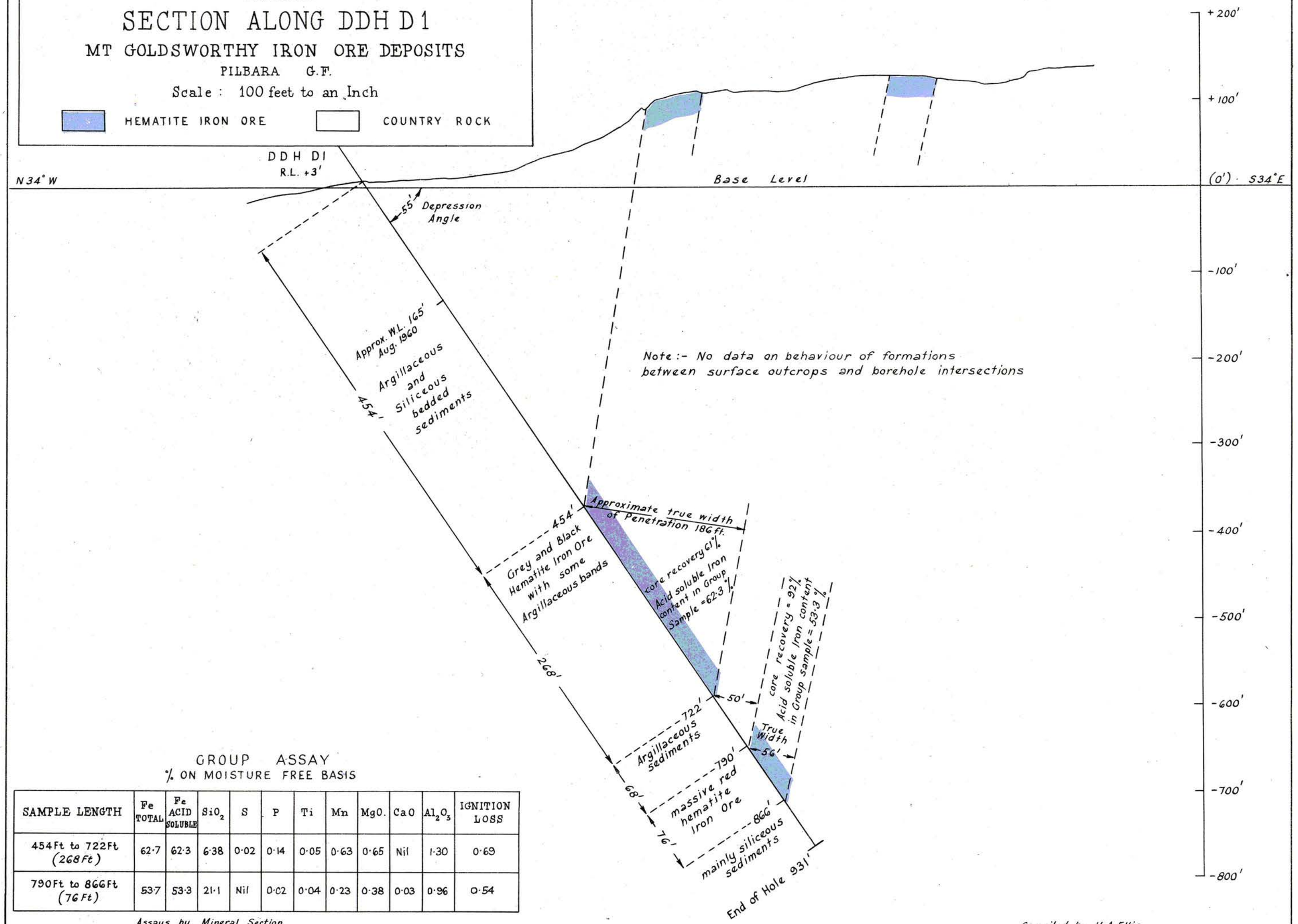
SECTION ALONG DDH D1

MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale : 100 feet to an Inch

HEMATITE IRON ORE — COUNTRY ROCK



GROUP ASSAY

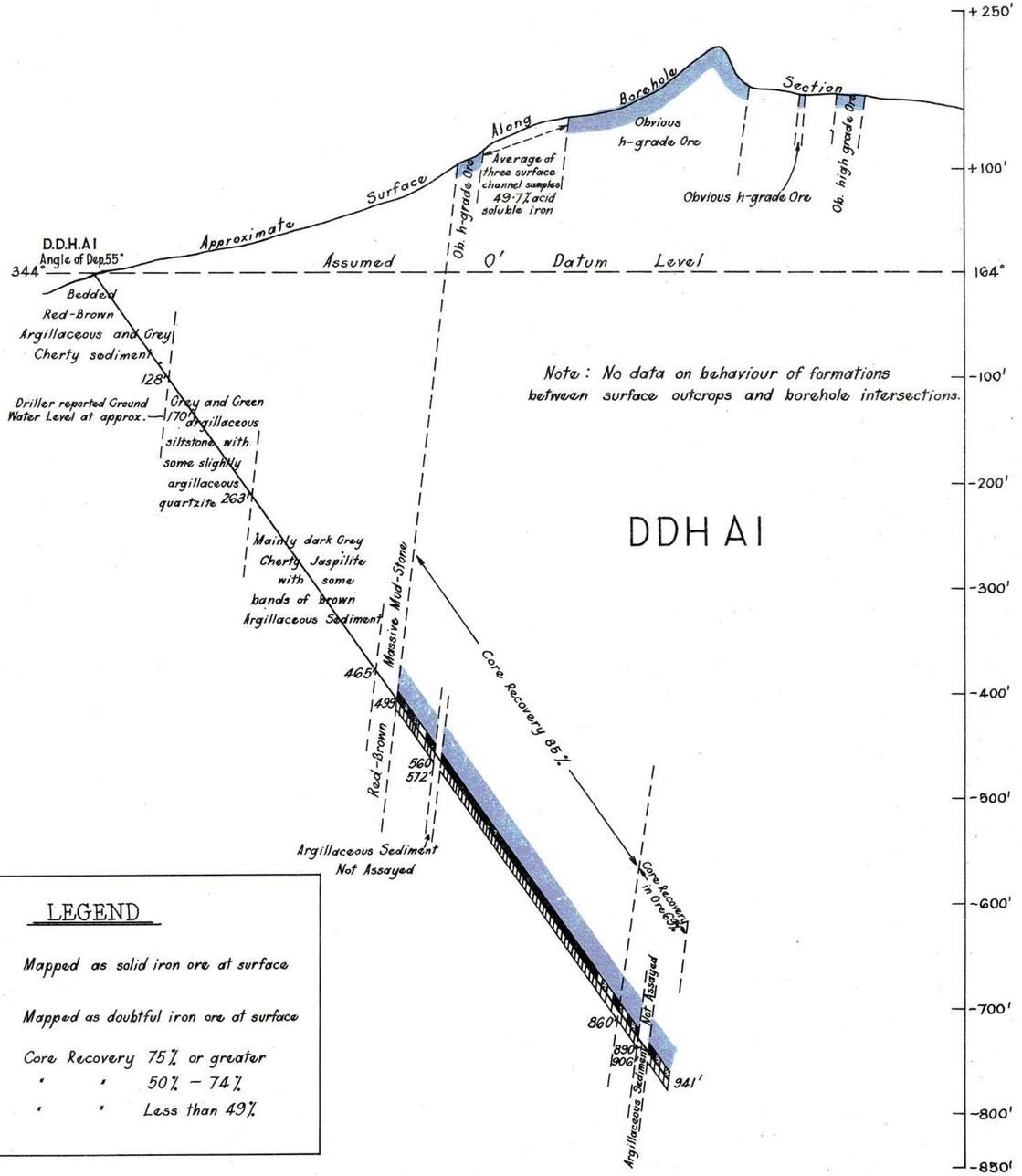
% ON MOISTURE FREE BASIS

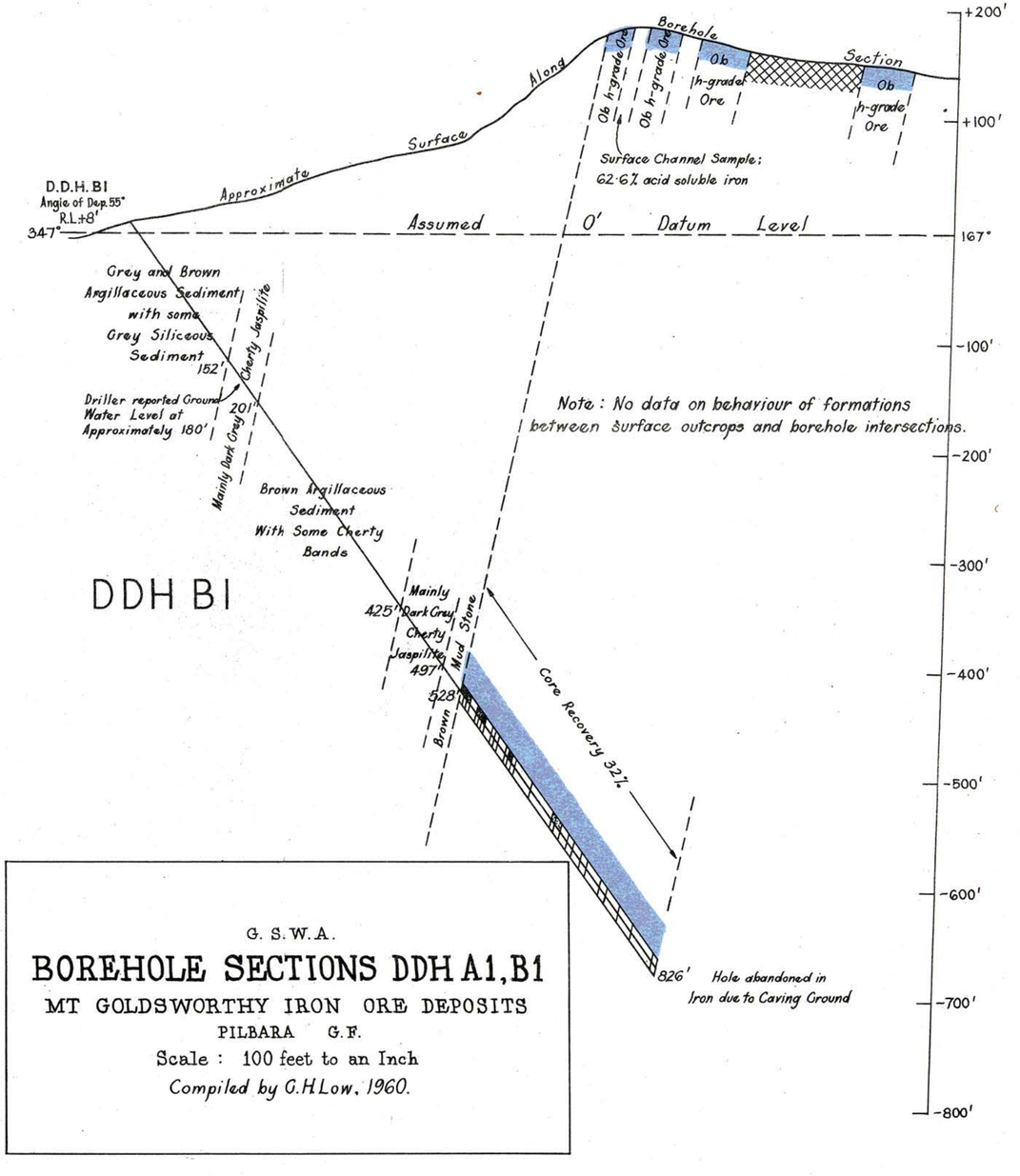
SAMPLE LENGTH	Fe TOTAL	Fe ACID SOLUBLE	SiO_2	S	P	Ti	Mn	MgO.	CaO	Al_2O_3	IGNITION LOSS
454Ft to 722Ft (268Ft)	62·7	62·3	6·38	0·02	0·14	0·05	0·63	0·65	Nil	1·30	0·69
790Ft to 866Ft (76Ft)	53·7	53·3	21·1	Nil	0·02	0·04	0·23	0·38	0·03	0·96	0·54

Assays by Mineral Section
W. A. Govt. Chemical Laboratory
Ground sample remnants retained.

Compiled by H. A. Ellis
Government Geologist
Nov. 1960.

PLATE XII





LEGEND

- Mapped as solid iron ore at surface
- Mapped as doubtful iron ore at surface
- Core Recovery 75% or greater
- " " 50% – 74%
- " " Less than 49%

G. S. W. A.

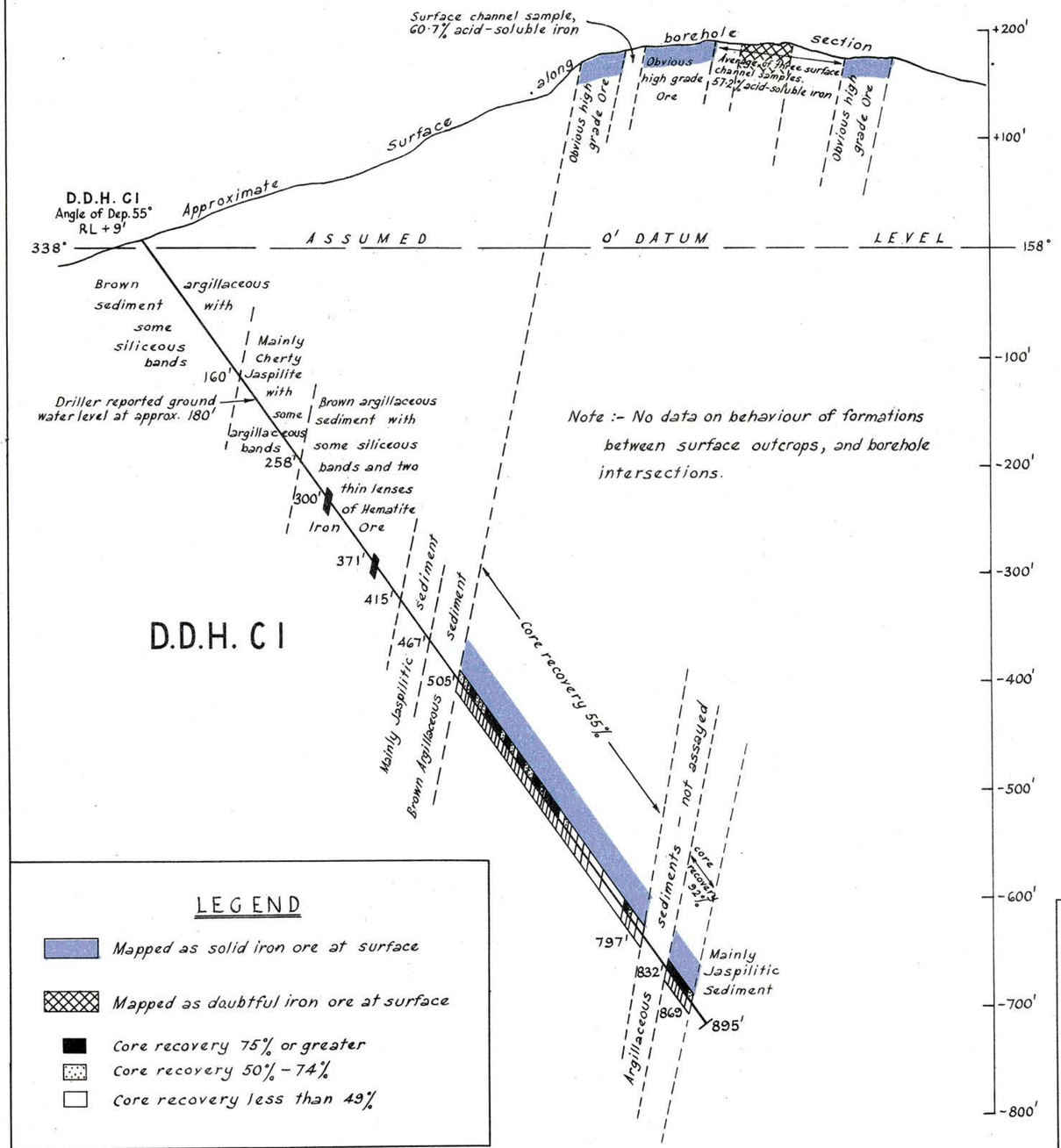
BOREHOLE SECTIONS DDH A1, B1

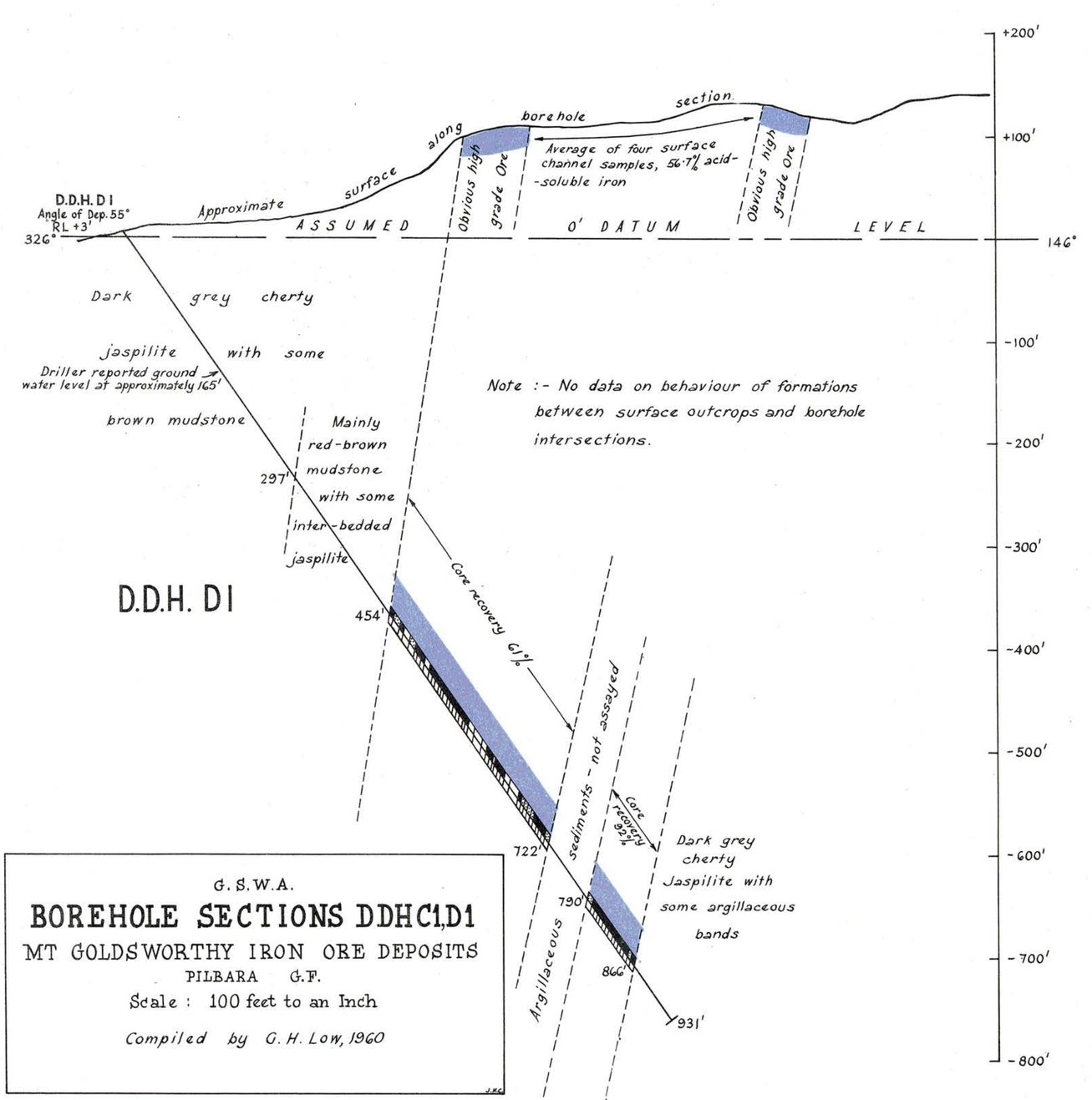
MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale: 100 feet to an Inch

Compiled by G.H Low, 1960.





G.S.W.A.

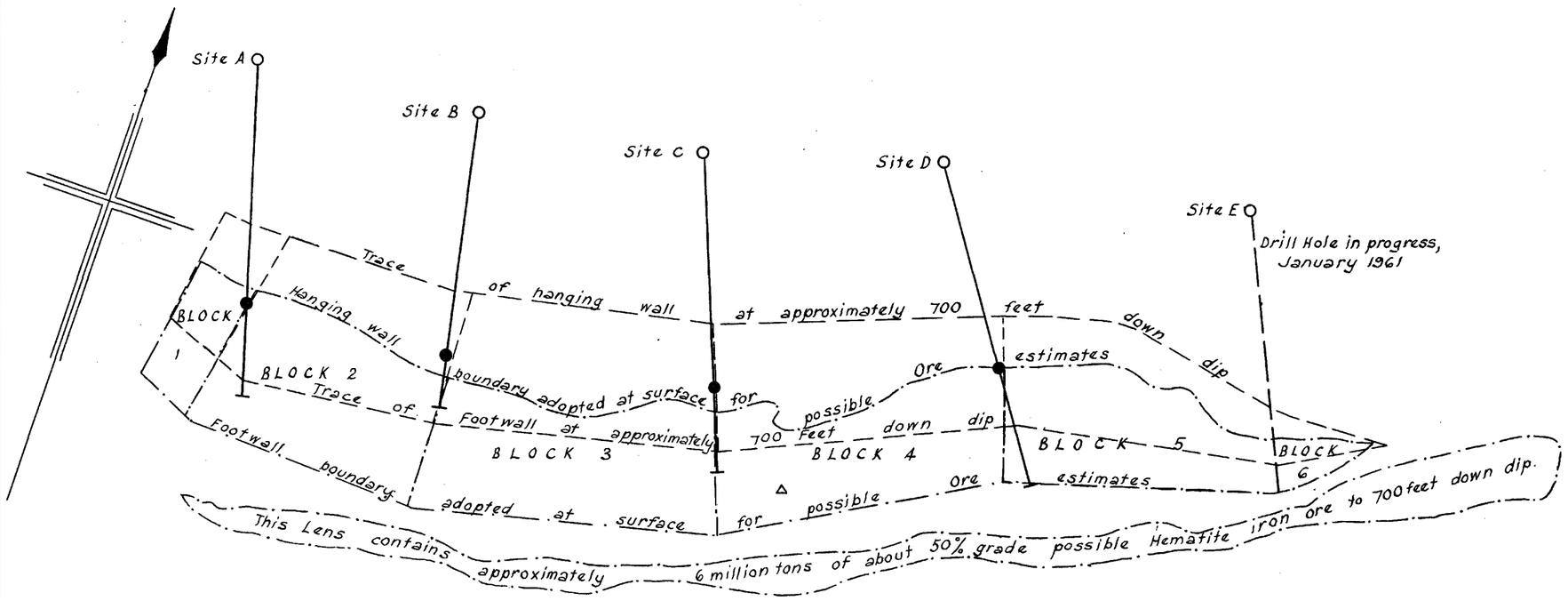
BOREHOLE SECTIONS DDHC1,D1

MT GOLDSWORTHY IRON ORE DEPOSITS

PILBARA G.F.

Scale : 100 feet to an Inch

Compiled by G. H. Low, 1960



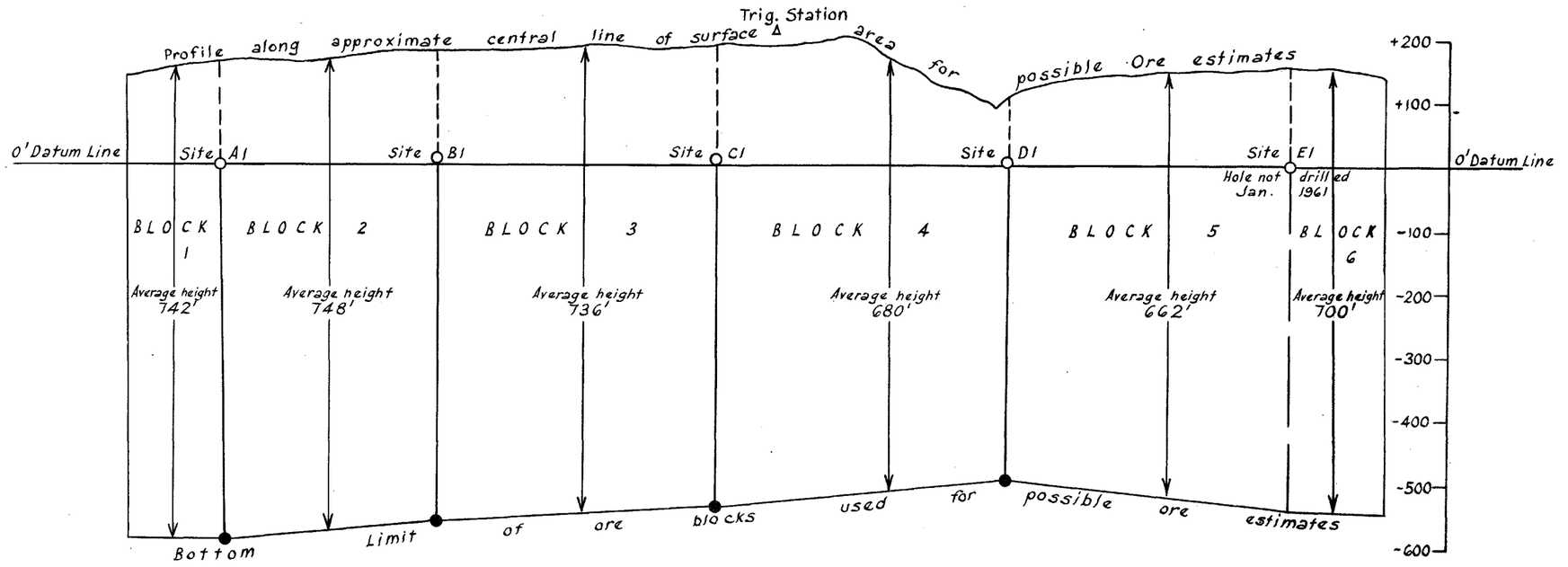
PLAN

ESTIMATE OF RESERVES IN N°1 LENS

POSSIBLE TONNAGE

BLOCK 1	–	1,510,000
BLOCK 2	–	5,963,000
BLOCK 3	–	6,403,000
BLOCK 4	–	5,736,000
BLOCK 5	–	4,581,000
BLOCK 6	–	525,000
TOTAL		24,718,000 Long Tons

Based on 10 cubic feet equivalent to one long ton
Accepted possible grade 60% + Hematite Iron Ore.



LONGITUDINAL SECTION

G.S.W.A.

IDEALISED

PLAN AND LONGITUDINAL SECTION

OF

N° 1 IRON ORE LENS Mt GOLDSWORTHY

PILBARA G.F.

Scale : 1inch = 200feet

Compiled by G.H. Low. 1960

J.H.C

● *Medial points of intersections of boreholes in N°1 Lens.*

upon surface geological mapping, sampling and drilling, and by comparison with comparable deposits which have been mined in other areas. Possible ore cannot be assigned a grade over its estimated extent with any practicable certainty.

G. H. LOW,
Geologist.

18/1/61.

SUMMARY REPORT ON THE "CORONATION" G.M.L. 1137, WYMANS WELL CENTRE, PILBARA GOLDFIELD.

By G. H. Low, B.Sc.,
Geological Survey of W.A.

On November 14, 1960, the writer made a reconnaissance examination of the adit on the Coronation G.M.L. 1137, Wymans Well, and of the country surrounding this lease. G.M.L. 1137 is one of a series of five leases located approximately 1 mile south of Wymans Well, and about 10 miles southwards of Marble Bar. Access is by the old Warrawoona Road to Wymans Well, and thence by poor bush track to the lease.

At the time of the inspection the lease was held in the name of Mr. H. Hansen of Marble Bar, who pegged it on 16 November, 1954.

G.M.L. 1137 is the centre one of the five leases the others being, from north-west to south-east, 1026, 986, (1137), 987, and 1027. They are located on a belt of metamorphosed lava and sedimentary rocks of the Warrawoona Series, the general strike of the country in this area being north-north-west and south-south-east. Reference may be made to the 4 Mile Geological Series Sheet, Marble Bar, issued by the Geological Survey of Western Australia in 1959.

The only recorded production from these leases was in 1938 from G.M.L. 986 "Coronation West" which returned 1.98 (REPEAT 1.98) fine ounces of gold from 52.00 tons of ore treated.

An adit 90 feet long and to a maximum depth of about 40 feet below the crest of the hill, has been driven south-westwards to intersect the downward continuation of the banded-iron-formation which forms the hill along which the leases have been pegged. The hill crest is about 150 feet above the general level and the portal of the adit is about three-quarters of the way up this on the north-eastern slope.

The footwall of the banded-iron-formation is about three feet from the face of the adit, which shows that at that spot the formation is between 7 and 8 feet wide and dips northwards at about 80 to 85 degrees. In the adit the strike measures 285 degrees.

The banded-iron-formation has been mineralized by intrusive quartz carrying pyrite. The occurrence of the intrusive quartz appears erratic but reasonably strong.

The banded-iron-formation is strongly developed at the surface over a length of at least one-half mile, and there is an apparent structural plunge to the east-south-east.

Mr. R. Johnston of Moolyella advised the writer that two samples he took from the banded-iron-formation at the crest of the ridge assayed 10 dwts. and 7 dwts., and a chip sample taken across the body in the adit assayed 14 dwts. The strike distance covered by these samples is about 200 yards.

A chip sample taken by the writer across 6 feet of the formation in the adit and submitted to the Government Chemical Laboratories in Perth assayed 19 (nineteen) grains of gold per long ton (Govt. Chem. Lab. No. 11192/1960).

In view of this result and despite the strength of the host formation, it appears that the gold mineralization is erratic and from the indications the prospect is a poor one. It is felt that a recommendation for development is not justified.

G. H. LOW,
Geologist.

1/12/60.

SUMMARISED REPORT ON AN OCCURRENCE OF LATERITIC IRON ORE, APPROXIMATELY FIVE MILES NORTH-EAST OF COLLIE, SOUTH-WEST DIVISION.

By G. H. Low, B.Sc., Geological Survey of W.A.

Introduction.

In accordance with instructions the writer travelled to Collie on Wednesday, 17th February, 1960, to examine the above deposits. Mr. K. Davies Superintendent of Griffin Collieries and Mr. W. Latter, President of the Collie Miners' Union were contacted and both of these gentlemen accompanied the writer on Wednesday afternoon on a general examination of the deposits. The writer returned alone on the following day and again on Friday, 19th February when the examination was concluded at midday.

Location and Access.

The area is best reached by proceeding 5.1 miles north-east from the Collie Post Office along the Williams Road. From this point a graded track runs to the south-west and eventually contacts with the Collie-Darkan Road just south of Buckingham. The first iron ore shown to the writer occurs 8 chains along this track from the Williams Road, on Wellington Location 793, and then other isolated occurrences were indicated over an elongated area extending about four miles to the south-east on either side of the east branch of the Collie River. There are numerous timber cutters' tracks throughout the area, and some passable bull-dozed tracks alongside fence lines.

The Nature of the Occurrence.

This part of the State consists of a portion of the peneplained pre-Cambrian Shield which has been subject to renewed erosional activity by the intermittent waters of the Collie River drainage system. The rocks of the Shield are generally described as a granite-gneiss complex, derived from pre-existing greenstones and sediments by granitisation and metamorphism, intruded by younger basic (doleritic) and acid (granitic, or more siliceous) dykes. Grantitisation has not been complete throughout and remnant "patches" of the ancient greenstones and sediments can be observed in places.

Except where it has been exposed by water erosion, mostly on the more acute slopes, the granite-gneiss complex is covered over by residual and transported soils and laterite.

In the area under consideration the laterite cover is by far the most extensive. It occupies mostly the flat tops of hills and high level ground. It is formed by the weathering of the underlying rock in-situ and its composition varies according to the nature of the underlying rocks; when these are basic (greenstones, dolerites, etc.), the laterite is richer in iron, but when they are acidic (granite, gneiss, etc.), the laterite is poorer in iron and proportionally richer in alumina.

The iron rich parts owe their origin to the concentration of hydroxides of iron resulting *entirely* from the surface decomposition of rocks rich in iron; nowhere do they attain any great thickness and in fact, except under exceptional conditions rarely extend to 10 feet depth. The laterite, therefore, may vary from a ferruginous bauxite to an almost pure limonite and in places it may contain some hematite and some residual magnetism may be detected.

It may be opportune to observe that the lateritic iron ores are a very different occurrence from the banded quartz-hematite (magnetite) ores associated with pre-Cambrian "banded iron" formations found in many parts of the world including Koolyanobbing, Tallering Range and Mt. Goldsworthy. These are derived by metamorphism and oxidation of chemically precipitated iron carbonate and iron silicate minerals deposited in marine deposits.

Under the conditions existing in the Collie district the areal extent of the iron ore will to all extents and purposes, be that which is observable on the surface, and the thickness may average about five feet.

In the area examined by the writer most of the laterite could be classified as pisolitic ferruginous bauxitic laterite. The patches of high grade limonitic iron ore do not exceed one quarter acre in area and they are not contiguous. In the writer's opinion from the surface evidence observed in the area examined, there would not be more than 100,000 tons of 30 per cent. grade iron ore in scattered patches, and for the reasons stated above there is no basis for hoping that any significant quantities are obscured from view.

Grade of the Ore.

Fourteen representative samples were collected from various parts of the area and submitted to the Government Chemical Laboratories for assay and analysis. These samples represent the average grade in the vicinity from which they were taken. The results of the determinations are as follows:—

GOVERNMENT CHEMICAL LABORATORIES.

Report on Fourteen Lateritic Iron Ore Samples from the Collie District, received 23rd February, 1960.

Lab. No. (1960)	G.S.W.A. Sample No.	Acid-soluble iron, Fe Per cent. on dry basis
2412	CFE 1	45·7
2413	CFE 2	29·9
2414	CFE 3	40·5
2415	CFE 4	28·2
2416	CFE 5	34·9
2417	CFE 6	27·7
2418	CFE 7	40·3
2419	CFE 8	43·7
2420	CFE 9	17·2
2421	CFE 10	42·3
2422	CFE 11	17·7
2423	CFE 12	29·7
2424	CFE 13	22·9
2425	CFE 14	25·1
Calculated average		31·8

Conclusion.

The field evidence and the assay results indicate that there is neither the quantity nor quality of iron ore in the area examined to constitute an economic deposit under present marketing conditions.

G. H. LOW,
Geologist.

8th March, 1960.

NOTES ON THE COOPER (W.A.) AND MANN (S.A.) 4-MILE SHEETS ON THE WEST AUSTRALIA-SOUTH AUSTRALIA BORDER.

by A. J. Noldart, B.Sc.,
Geological Survey of W.A.

General.

Acting on instructions received I departed Perth by air on Sunday, 29th May to join a South Australian Mines Department geological field party operating at Mt. Davies in South Australia. The object of the trip was to carry out an aerial reconnaissance of the general geology of the area, and to make localised surface inspections of the nickeliferous deposits in the Blackstone Range-Hinkley Range-Tomkinson Range districts on the West Australian-South Australian border.

I was met at Adelaide by Mr. B. Thomson, Senior Geologist (Geochemistry) South Australian Geological Survey, and in his company departed the following morning for Mt. Davies via Leigh Creek and Oodnadatta (S.A.), and Kulgera (N.T.). The trip was made in a charted "Auster" type aircraft necessitating two days' air travel from Adelaide.

Field reconnaissance commenced on 1st July, the field party then comprising Mr. Thomson, Geologist R. Mirams, myself, a motor driver, and a "prospector." Two 4-wheeled drive vehicles equipped with short range radio intercommunication were available. All external radio communication was carried out through Flying Doctor Services at Alice Springs (N.T.), and Port Augusta (S.A.), by means of a portable "Traeger" transceiver set carried in the "master" vehicle.

Field Operations.

Operations on the first day consisted of familiarisation flights over the known nickeliferous zones in the Blackstone Range-Hinkley Range-Tomkinson Range area, and a generalised reconnaissance of the southern portions of the Cooper (W.A.) and Mann (S.A.) 4-Mile Sheets. Subsequent morning flights were entirely spent in traversing the granite/gneiss areas of the Mann 4-Mile Sheet. Shorter localised reconnaissance flights over the basic and ultrabasic belts along the northern section of the sheets were carried out during the afternoons.

Traverse flying was carried out on an E-W basis at approximately 5 mile intervals with individual traverses coinciding with the overlap zone between adjoining air-photo runs. Visibility was unlimited throughout and excellent outcrop coverage was possible, particularly in areas of low relief and sand dune cover where outcrop was not readily determinable from air-photo studies.

The aircraft altimeter was effectively used to obtain relative heights of known trig. stations and the surrounding plains, and to obtain spot heights on the more prominent unsurveyed hills.

Surface inspections were made of the "Scarface" and "Claude Hills" laterite zones in S.A., and of the "Wingelinna" laterite zone in W.A. A brief inspection was made of the accessible sections of the "No. 1" Shaft at the "Wingelinna" deposit.

Geology.

The geology of the area is complex and beyond the scope of this report but the following broad generalisations can be made.

Topographically the country is flat to gently undulating with occasional ranges and hills rising abruptly from the plains. Blackstone, Bell Rock, Hinkley, Mann and Tomkinson Ranges form the main relief occurring as a series of approx. E.-W. trending ridges throughout the north sections of the sheets. Prominences in the southern sections are of comparatively small areal extent taking the form of short ridges, "pinnacles," and monadnocks, rising from sand dunes and clay pan flats.

As far as could be ascertained from the aircraft the southern areas are occupied by granitic rocks overlain by innumerable N.W. trending sand dunes. Northerly towards the main ranges the rock types appear to become progressively more gneissic and surface inspections show the bulk of the ranges to be composed of gneissose meta-sediments and granulites.

The meta-sediments have been subject to extensive intrusion by basic dyke swarms of a doleritic-gabbroidal nature, and several massive ultrabasic bodies such as Blackstone Range and "Gosses' Pile" in the Hinkley Ranges. The ultrabasics are not composed of the same rock types from mass to mass, nor are individual masses homogenous within themselves. Olivine norites, picrites, peridotites, pyroxenites, harzburgites, and related rocks have been identified and mapped by previous investigators within the ultrabasic suites. The metamorphic grade of the intrusives is generally fairly low but shearing and folding has taken place and serpentization is a feature of the more steeply dipping strata.

The nature of the ultrabasic intrusives was not apparent where seen but previous investigators suggest a multi-sill origin.

Mineralisation.

Two types of mineralisation were seen; nickel stained chalcedonic silica (Chrysoprase) veinlets occurring in a hard dark brown "jasperoidal" laterite associated with ultrabasic rocks in the "Scarface" laterite zone (S.A.), and disseminated garnierite mineralisation in a yellowish ochreous laterite in the "Wingelinna" locality (W.A.). A further outcrop of the latter type laterite was inspected at Claude Hills (S.A.) but no mineralisation was observed.

Thin veinlets of garnierite have been reported from the 150 feet level in the "No. 1" shaft sunk in the "Wingelinna" laterite but this section of

the shaft was not accessible at the time of inspection. Thin stringers of chromatic and graphitic material were noted in the drives at the 80 feet level from this shaft.

Conclusion.

No estimates of the grades, tonnages, or potential, of the respective deposits can be made from the superficial inspections made in the field and any attempt to obtain the necessary data to allow such estimates to be made, independently of the private interests currently investigating the deposits, would necessitate costly large scale field operations of several years' duration, involving considerable manpower and equipment problems.

The use of light aircraft for broad reconnaissance in this locality proved a useful adjunct to air-photo interpretation. Its main application was the pinpointing of non "photogenic" outcrops, the superficial identification of significant rock suites, and the location and planning of critical traverses in country where access difficulties are a major factor.

A. J. NOLDART,
Geologist.

24/6/60.

REPORT ON EXPLORATORY DIAMOND DRILL HOLE NO. PF1, SITE A, PADDY'S FLAT, MEEKATHARRA, MURCHISON GOLDFIELD.

By A. J. Noldart, B.Sc.,
Geological Survey of W.A.

General.

Paddy's Flat comprises a north-easterly trending mineralised belt centred approximately 1½ miles south-east of Meekatharra. The main mining activity was centred on the "Marmont"-"Fenian"-"Ingliston Consols" ore body and the drill hole was designed to test for any northerly extension of that ore body.

Subsurface plans and sections of the mines available from the Mines Department Drafting Office and G.S.W.A. Bulletin No. 68 (E. de C. Clarke) were utilised and further composite sections were constructed to obtain as much information as possible on the now inaccessible ore body.

The main ore channel was never considered to be a promising drilling target and equal emphasis was placed on an extensive penetration of the hitherto unexplored footwall rocks.

The hole was collared at a point 145 feet on a bearing of 25° true from the south-easterly corner of Tailings Area 26N. The hole was drilled on a bearing of 299° true at a depressed angle of 70°. Drilling was abandoned at a depth of 1,820 feet down the hole due to breakdown of the walls of the hole above 1,600 feet.

Geology.

The geology of the ore body and its environs is given in G.S.W.A. Bulletin No. 68. Briefly the ore channel is a mineralised shear zone striking north-north-east and dipping easterly. The lode formation consists of numerous quartz veins in a matrix of highly sheared greenstones of varying composition. The lode is closely associated with a hard, discontinuous, fine grained quartz albite porphyry dyke containing erratic auriferous quartz veinlets and often forms part of the dyke. Both lode and porphyry are heavily mineralised with pyrite (mostly pyritohedra), arsenopyrite and some pyrrhotite.

The lower limits of the ore body appear to have been controlled to a large extent by a strong transverse fault, the trace of which with the ore channel having an apparent plunge of approximately 50° to the north east. Strong spur veins containing economic mineralisation occur at intervals along the trace of the fault plane. The spur veins persist to considerable depths but normally do not attain any great lateral extent.

The rock types encountered in the drill hole are representative of those mapped on the surface by Clarke consisting for the most part of interbedded amygdaloidal lavas, fine fragmental beds, meta sediments and talc schists. Silica impregnations and small quartz veins and veinlets were common throughout.

A summarised core log and cross section of the drill hole accompany this report.

Mineralisation.

A greyish-green quartz albite porphyry dyke was encountered between 1,659 feet and 1,722 feet down the hole. The upper 27 feet was predominantly quartz with occasional remnants of the hanging wall rocks. A similar but narrower zone of quartzose material occurred on the footwall of the dyke. Arsenopyrite and pyrite mineralisation was generally regular throughout the unaltered porphyry with a decrease in pyrite and the addition of pyrrhotite occurring in the quartzose portions and throughout the wall rocks.

The hanging wall quartz impregnations have been tentatively correlated with the main ore channel.

Quartz "stringers" and veinlets, and pyritic mineralisation were common throughout the hole and sample assays were taken at several horizons but no significant assays were obtained.

Conclusions.

(1) The mineralisation encountered at a drill depth of 1,659 feet is consistent with the reported ore body from the "Marmont"-"Fenian"-"Ingliston Consuls" ore channel and has been tentatively classified as such.

(2) The depth of penetration at the cessation of drilling was insufficient to adequately test the footwall rocks.

(3) The low grade of the ore channel encountered does not warrant further expenditure on this target, particularly at this depth, and the intended penetration of the footwall rocks is not sufficient cause in itself to warrant further drilling.

A. J. NOLDART,
Geologist.

25/5/60.

MEEKATHARRA DRILLING.
D.D.H. No. PF1, Paddy's Flat.

Hole No.: PF1, Site A.
Position of Collar: 145 feet on a true bearing of 25° from the southern corner peg of Tailings Area, T.A. 26N.
Angle of Depression: 70°. Machined Used: Mindrill A2000.
Azimuth: 299°T. Core Size: AXT.
Date commenced: 22/11/59. Contractor: O. Koski.
Object: To test the possibility of a repetition of the "Fenian-Ingliston Consuls" ore body northerly of the main working.
Logged by: A. J. Noldart. Completed depth: 1,820 feet.
Assays by: Government Chemical Laboratories, Perth.
Date of completion: 1/4/60.

Summarised Core Log.

From		To		Description of Core
ft.	in.	ft.	in.	
0	0	20	0	Nil.
20	0	116	0	Kaolin and very highly oxided greenstone.
116	0	125	0	Weathered actinolitic lava.
125	0	169	0	Amygdaloidal and andesitic lavas, zoisite and amphibole amygdules, oxidation on joint faces.
169	0	248	0	Fine grained amygdaloidal lavas, amphibole amygdules less numerous, some oxidisation on joint faces.
248	0	386	0	Mainly coarse amygdaloidal lavas grading into finely amygdaloidal in a series of flows, flows appear to be right side up, 2 inch quartz/rhodonite (?) vein at 257 feet, 2 inch quartz vein at 321 feet, possible flow tops at 313 feet and 358½ feet coarse grained below fine grained above contact.
386	0	387	6	Coarse grained tuff, top and bottom contacts very sharp at 70 degrees to core axis.
387	6	403	0	Coarsely amygdaloidal lavas as above.
403	0	407	6	Porphyritic andesite.
407	6	413	6	Coarsely amygdaloidal lavas, 6 inch shear zone with quartz stringers at 413½ feet.
413	6	465	0	Meta-sediments, chloritic, talcose schists highly sheared and contorted throughout, mottled with quartz and/or silica below 450 feet.

Summarised Core Log—*continued.*

From		To		Description of Core
ft.	in.	ft.	in.	
465	0	468	0	Probable tuffaceous bed.
468	0	472	0	Meta-sediments as above.
472	0	513	0	Coarsely amygdaloidal lavas, highly sheared and mottled with silica blebs and bands, structure often masked by shearing and/or brecciation.
513	0	551	6	Meta-sediments as above, highly sheared and epidotised with some quartz and carbonate stringers, pug zone at 526 feet.
551	6	566	0	Sheared amygdaloidal or andesitic lavas.
566	0	604	0	Meta-sediments as above, chloritic and talcose sheared in places with pug zones at 589 feet, 597 feet, 600 feet.
604	0	608	6	Porphyritic andesite.
608	6	625	0	Meta-sediments, chloritic schists sheared and mottled with silica, becoming carbonated, pug zone at 620 feet.
625	0	763	0	Meta-sediments, highly sheared and contorted carbonated chlorite schists mottled in part with silica blebs. Pug zones at 705 feet, 738 feet, 745 feet, 750 feet, 753 feet, 756 feet, 757 feet, pug zones fracturing generally acute to core axis.
763	0	806	0	Meta-sediments, chloritic schist with strong silica impregnations, pug zones 775 feet, 796 feet.
806	0	828	0	As above—core jumbled in transit and not in correct order, some carbonates present.
828	0	917	0	Meta-sediments, carbonated chloritic schist with quartz and silica bands and blebs, broken from 846–850 feet. Occasional talc bands, grading to a talc-chlorite schist with silica impregnations. Kaolinised pug zone 909 feet.
917	0	925	0	Chloritic schist with silica stringers and fine to medium sized pyrite cubes. Probable igneous origin.
925	0	976	0	Fragmental rock becoming hard, fine grained and silicified. Probable tuff band with slate-like fragments.
976	0	1,015	0	Becoming chloritic with more numerous inclusions. Grain size increasing and partly carbonated.
1,015	0	1,025	0	Hard fine grained silicified rock. Alteration of above rock (?).
1,025	0	1,036	0	Carbonatised speckled chloritic schist.
1,036	0	1,043	0	Highly sheared and contorted sericite schist with 2 inches quartz at 1,036 feet.
1,043	0	1,062	0	Hard silicified mottled schist.
1,062	0	1,066	0	Speckled chloritic schist as above.
1,066	0	1,088	0	Hard mottled chert like rock, probably silicified agglomerate or tuff.
1,088	0	1,111	0	Silicified agglomeratic rock with coarse fragments, finely disseminated pyrite throughout. Quartz vein oblique to core axis between 1,094 and 1,096½ feet.
1,111	0	1,111	6	Quartz vein with fine pyrite mineralisation.
1,111	6	1,127	0	Hard silicified fragmental rock, probably tuffaceous.
1,127	0	1,152	0	Carbonatised chloritic schist with quartz and silica impregnations from 1,131 to 1,140 feet. Grading into a talc sericite schist.
1,152	0	1,169	0	Coarsely mottled sericite talc schist.
1,169	0	1,173	0	Medium grained sheared grey meta-sediments.
1,173	0	1,206	0	Dark grey and green chloritic schists—probably meta-igneous and amygdaloidal in part. Fault pug zone 1,190 feet.
1,206	0	1,253	0	Blebby, coarse grained sericite talc schist as above.
1,253	0	1,279	0	Very dark green chloritic schists. Probably meta-sediments with shaley inclusions and some felspar laths.
1,279	0	1,310	0	Medium grained greyish tuffaceous rock.
1,310	0	1,324	0	Dark, blebby sericite chlorite schists with occasional small talc bands.
1,324	0	1,331	0	Grey tuffaceous rock with sericite and a few talc bands.
1,331	0	1,344	0	Silicified rock with quartz stringers lightly mineralised with pyrite.
1,344	0	1,440	0	Very dark chloritic schists with occasional quartz stringers. Fault zones 1,359 feet, 1,363 feet, 1,407 feet, 1,413 feet, 1,426–1,428 feet, 1,436–1,438 feet. Rock type grades into a grey sericite blebby r ock probably of fragmental origin.
1,440	0	1,450	0	Meta-tuffaceous rocks.
1,450	0	1,470	0	Dark chloritic schists with porphyro–blasts of felspars—probable meta-lavas.
1,470	0	1,484	0	Meta-fragmental rock dark green chloritic schist with black inclusions.
1,484	0	1,510	0	Silicified meta-fragmental rock.
1,510	0	1,535	0	Highly silicified rock—probably meta-igneous.
1,535	0	1,640	0	Coarsely blebby sericite chlorite schists. Fault zone 1,571 feet, 1,580 feet, 1,603 feet, 1,619 feet.
1,640	0	1,659	0	Altered greyish brown schistose rock with quartz impregnations, lightly mineralised with pyrite.
1,659	0	1,686	0	White quartzitic felspar porphyry with remnants of country rock. Lightly mineralised with pyrite, arsenopyrite and pyrrhotite (?). Heavily impregnated with quartz throughout.
1,686	0	1,722	0	Grey/green felspar porphyry grading to quartzitic material as above with white cloudy felspars. Bottom contact very sharp and mineralised.
1,722	0	1,736	0	Grey-brown highly sheared rock with fine augen of quartz and quartz stringers, lightly mineralised throughout.
1,736	0	1,756	0	Mottled green chloritic-fuchsitic (?) rock with quartz stringers.
1,756	0	1,782	0	Grey-brown mottled rock as above.
1,782	0	1,786	0	Mottled green rock as above.
1,786	0	1,820	0	Grey-brown mottled schist as above—meta-fragmental (?).
				HOLE ABANDONED.

TABLE I.
Assay Results.

Lab. No.	Sample No.	Depth From	Depth To	Results Core	Results Au. (dwts.) per ton of 2,240 lb.
D.D.H., PF 1, Site 1.		ft. in.	ft. in.	in.	
1960/5126	PF 1	452 0	457 0	60	Trace
5127	PF 2	457 0	462 0	60	Trace
5128	PF 3	462 0	467 0	60	Trace
5129	PF 4	467 0	472 0	60	Trace
5130	PF 5	472 0	477 0	60	Trace
5131	PF 6	477 0	482 0	60	Trace
5132	PF 7	482 0	487 0	60	*Nil*
5133	PF 8	487 0	492 0	60	*Nil*
5134	PF 9	907 0	912 0	60	Trace
5135	PF 10	912 0	917 0	60	Trace
5136	PF 11	986 0	991 0	60	Trace
5137	PF 12	991 0	996 0	60	0·1
5138	PF 13	1,035 0	1,039 0	48	Trace
5139	PF 14	1,039 0	1,043 0	48	0·1
5140	PF 15	1,108 0	1,111 0	36	0·2
5141	PF 16	1,111 0	1,111 6	6	0·3
5142	PF 17	1,111 6	1,114 6	36	0·1
5143	PF 18	1,131 0	1,136 0	60	0·1
5144	PF 19	1,136 0	1,141 0	60	Trace
5145	PF 20	1,330 0	1,335 0	60	0·1
5146	PF 21	1,335 0	1,340 0	60	0·2
5147	PF 22	1,340 0	1,345 0	60	0·1
5148	PF 23	1,345 0	1,350 0	60	Trace
5149	PF 24	1,350 0	1,355 0	60	Trace
5150	PF 25	1,355 0	1,360 0	60	Trace
5151	PF 26	1,360 0	1,365 0	60	Trace
5152	PF 27	1,365 0	1,370 0	60	Trace
5153	PF 28	1,640 0	1,645 0	60	Trace
5154	PF 29	1,645 0	1,650 0	60	Trace
5155	PF 30	1,650 0	1,655 0	60	Trace
5156	PF 31	1,655 0	1,659 0	48	0·1
5157	PF 32	1,659 0	1,664 0	60	0·1
5158	PF 33	1,664 0	1,669 0	60	0·4
5159	PF 34	1,669 0	1,674 0	60	0·8
5160	PF 35	1,674 0	1,679 0	60	0·1
5161	PF 36	1,679 0	1,684 0	60	0·5
5162	PF 37	1,684 0	1,689 0	60	0·1
5163	PF 38	1,689 0	1,694 0	60	0·1
5164	PF 39	1,694 0	1,699 0	60	0·1
5165	PF 40	1,699 0	1,704 0	60	0·1
5166	PF 41	1,704 0	1,709 0	60	0·1
5167	PF 42	1,709 0	1,714 0	60	0·1
5168	PF 43	1,714 0	1,719 0	60	0·1
5169	PF 44	1,719 0	1,722 0	36	0·2
5170	PF 45	1,722 0	1,727 0	60	Trace
5171	PF 46	1,727 0	1,732 0	60	Trace
5172	PF 47	1,732 0	1,737 0	60	Trace
5173	PF 48	1,737 0	1,742 0	60	Trace
5174	PF 49	1,742 0	1,747 0	60	0·1
5175	PF 50	1,747 0	1,752 0	60	Trace
5176	PF 51	1,752 0	1,757 0	60	Trace

NOTES ON "WAROONGA EXTENDED SOUTH" G.M., G.M.L. 1356, AGNEW, EAST MURCHISON G.F.

By A. J. Noldart, B.Sc.,
Geological Survey of W.A.

General.

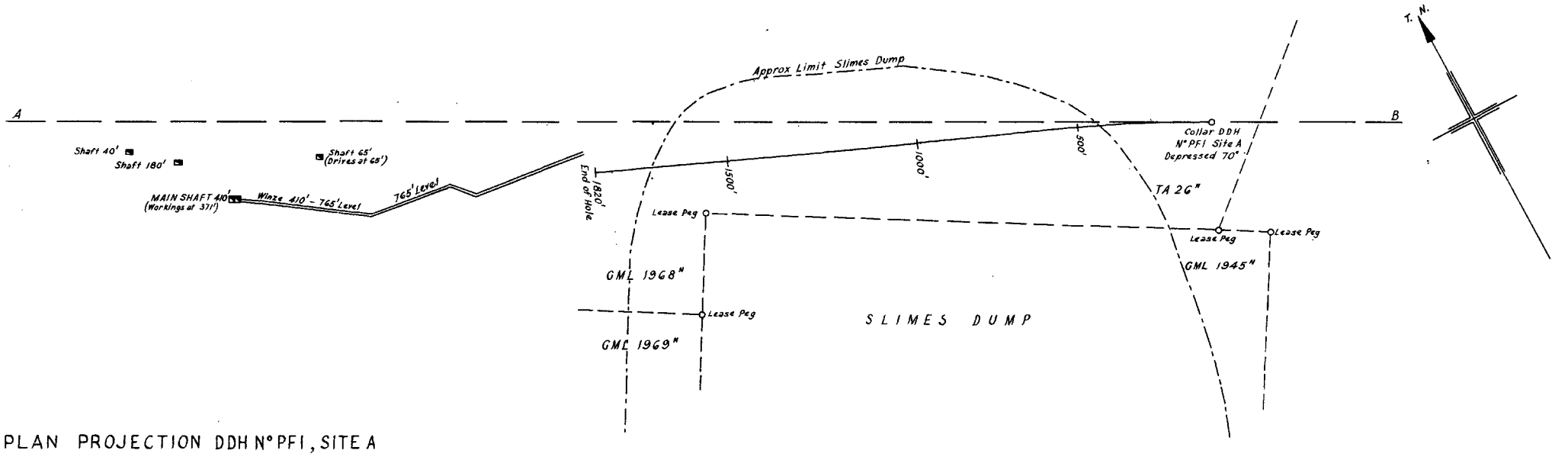
In July-August, 1957, a series of exploratory diamond drill holes were drilled on G.M.L. 1356 by the Mines Department of W.A. in conjunction with the lease-holders. The object of the drilling was to test for possible extensions of the now inaccessible "Emu" Goldmine ore body to the north on the shallower horizons. Four holes were completed disclosing low grade mineralisation throughout. Some high grade intersections were made and, on the most promising of these, shallow mining operations were recommended.

Subsequently shaft sinking, cross cutting, and driving has been carried out, but difficulties in identification and assessment of the ore body arose and the writer was instructed to assess the effectiveness of the operations to date, and advise on future operations.

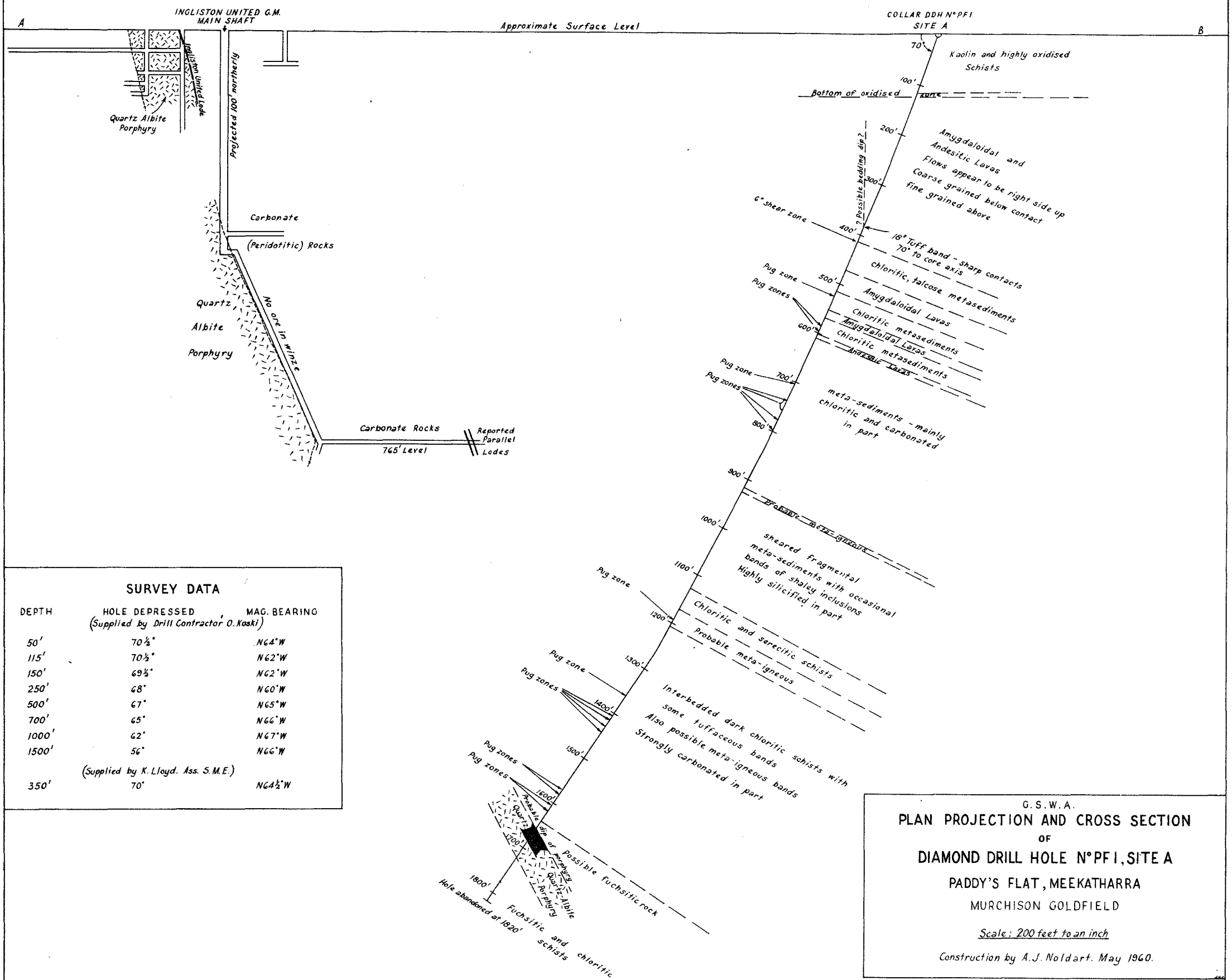
Full information on the diamond drilling results, and notes on the subsurface geology of the "Emu" ore body, are contained in the following reports:—

1950—Ward, H. J.: Notes on Emu Gold Mine, Agnew, East Murchison Goldfield. *G.S.W.A. Ann. Prog. Rep. 1948*, p. 60.

1957—de la Hunty, L. E.: Report on Diamond Drilling on G.M.L. 1356, "Waroonga Extended South," Agnew, East Murchison Goldfields, W.A. *G.S.W.A. Bull. No. 114*, p. 50.



PLAN PROJECTION DDH N°PF1, SITE A



SURVEY DATA

DEPTH	HOLE DEPRESSED (Supplied by Drill Contractor O. Kaski)	MAG. BEARING
50'	70½°	N64°W
115'	70½°	N62°W
150'	69½°	N62°W
250'	68°	N60°W
500'	67°	N65°W
700'	65°	N66°W
1000'	62°	N67°W
1500'	56°	N66°W
	(Supplied by K. Lloyd. Ass. S.M.E.)	
350'	70°	N64½°W

G.S.W.A.

PLAN PROJECTION AND CROSS SECTION OF DIAMOND DRILL HOLE N°PF1, SITE A

PADDY'S FLAT, MEEKATHARRA

MURCHISON GOLDFIELD

Scale: 200 feet to an inch

Construction by A.J. Noldart. May 1960.

CROSS SECTION ALONG A-B

PLATE XVI

G.S.W.A

PLAN and CROSS SECTION

SHOWING

NEW MINE WORKINGS and DDH N°2, Site A2

GML 1356 "WAROONGA EXTENDED SOUTH"

AGNEW

EAST MURCHISON G.F.

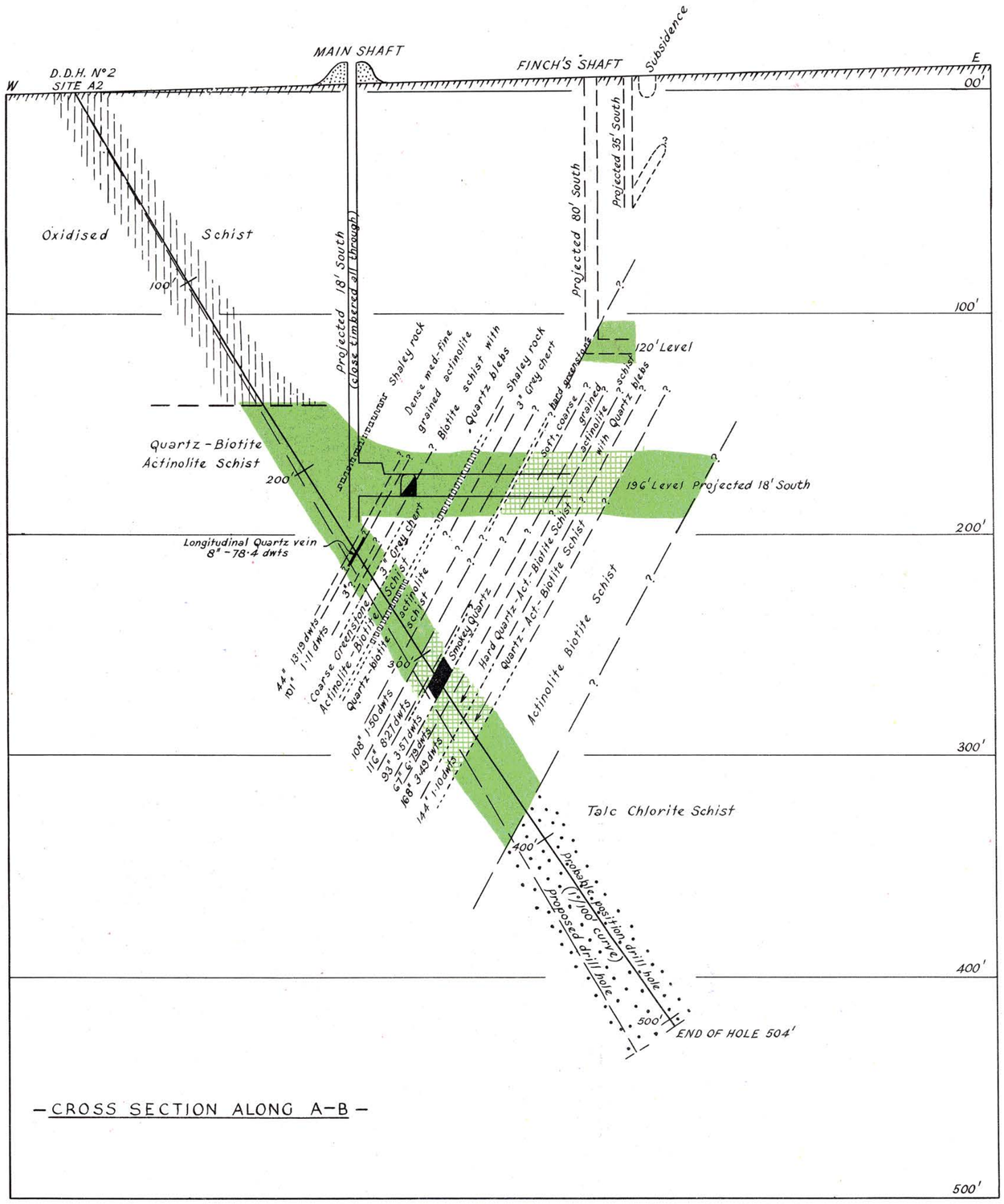
Scale: 40 feet to an inch

Drill Hole Geology : after L. De la Hunty , September 1957
Mine Survey : after F. Sweet , April 1960
Mine Geology and Compilation : A.J. Noldart , April 1960
Mine Grid after mine plans EMU GOLD MINES Ltd
Survey pegs shown thus .... o

J.H.C.

LEGEND

- Coarse grained Actinolite Biotite Schist with Quartz blebs.
- Dense fine-medium grained Actinolite Biotite Schist.
- Oxidised Schist
- Talc chlorite Schist
- Quartz reefs — Shaley rock
- Schistosity (surface) 65°
- Joint
- Fault 20
- Geological boundary 65
- Mullion Structures, Slickensiding etc.. 50
- Shaft
- Drive



— CROSS SECTION ALONG A–B —

— PLAN —

The most promising intersections were made in D.D.H. No. 2, Site A2, and a shaft was sited to intersect the mineralisation encountered at a drill depth of 243½ feet. Cross-cutting easterly from the shaft would then test the lower grade zone of mineralisation encountered between 290 feet and 348 feet down the hole.

The investigation was carried out on 21st-22nd April, 1960, and developmental recommendations were made accordingly. A plan and cross section of the workings accompany this report.

Mining Operations.

A two compartment shaft, close-timbered to 173 feet, was sunk to a depth of 207 feet. Cross-cutting commenced at the 196 feet level. At the time of inspection the cross-cut had attained a length of 96 feet. Short drives (37 feet) to the north and south had been completed on an apparent hanging wall encountered in the cross-cut 18 feet from the shaft. No stoping had been attempted.

Geology.

Only the subsurface geology was mapped. A brief examination of the surface outcrops and open cuts was made in an endeavour to determine the probable direction of drift and curvature of the (unsurveyed) drillhole.

The untimbered lower section of the shaft, the drives, and the western 68 feet of the cross-cut, were found to be in a dense, fairly hard, medium to fine grained, gneissose or banded biotite actinolite schist. This rock type showed little variation throughout. The eastern 26 feet of the cross-cut was in a very coarse grained actinolite biotite schist with characteristic radiating actinolite crystal structures. The two rock types were separated by a 2 ft. wide band of hard, medium grained greenstone of possible igneous origin.

The sedimentary nature of the fine grained actinolite biotite schist is indicated by a 2 feet wide bed of black shaley rock occurring 26 feet westerly of the coarse grained actinolite biotite schist contact. A second narrow band of the shaley material was noted in the shaft 17 feet above the cross-cut.

The general strike of the contacts is N.5°E. (true), with dips of 60° to 65° to the west. A correlation based on attitudes and lithological descriptions has been made between the shale bed in the cross-cut and a similarly described rock type encountered in the drill hole at a depth of 272½ feet down the hole.

Small quartz veinlets and blebs of quartz occurred at random throughout the cross-cut, the blebby quartz content increasing towards the eastern end of the cross-cut. Several cross veins and veinlets up to 8 inches in width occur in the drives, particularly to the north, but do not appear to be associated with any enrichment in mineralisation.

Examinations of uncrushed lode material from the "Emu" ore body shows it to be identical in composition with the coarse grained actinolite biotite schist in the cross-cut of the current workings. Ward's report also suggests a correlation between the two rock types and a correlation between the gneissose rocks on the hanging walls of the coarse grained material.

Conclusions.

A study of the sections shows the shaft to be too shallow to intersect the mineralised zone encountered in the drill hole from 241½ feet to 253½ feet down the hole, unless excessive deflection of the hole has occurred; and this is not considered likely. Projections, based on the shale horizon and observed dips in the cross-cut, suggest that this zone would be in the immediate hanging wall of the present drives.

The high grade quartz veinlet encountered in the drill hole at a drill depth of 243½ feet is believed to be located approximately 22 feet below the present cross-cut, and some 18 feet south of the projection of the shaft.

The second (lower grade) zone of mineralisation encountered in the drill hole corresponds on projection with the coarse grained actinolite biotite schist mapped in the cross-cut. This schist has been correlated with the lode material from the "Emu" ore body. The foot wall of the schist has not been reached in the cross-cut.

It is unlikely that the payable sections of the ore bodies will be readily delineated and constant sampling will be necessary to outline the lodes.

Gold mineralisation appears to be closely associated with quartz veinlets and blebs, although not necessarily confined to the quartz.

Recommendations.

The following recommendations are given; each recommendation is to a large extent dependent on the preceding one:—

(1) Extend the cross-cut easterly until past the footwall of the coarse grained actinolite biotite schist.

(2) Prior to further developmental work crush the stone "at grass" endeavouring to make separate crushings of the two rock types. The bulk assays thus obtained will be a reliable guide to the respective values of the two "ore bodies."

(3) Carry out a full sampling programme (channel samples 3 feet long) along the extended cross-cut and plan further developmental drives on the results obtained. Any driving carried out to the north should eventually be connected through to "Finch's" shaft.

(4) Bore hole sample the hanging walls of the present drives at 5 feet intervals. The holes should be 10 feet deep.

(5) Deepen the main shaft and drive south on the 218 feet level to intersect the rich quartz reef located in the diamond drill hole. Should the assays obtained from the present workings warrant further development the deepening of the shaft would be a matter of normal developmental procedure and this latter recommendation would be done in the normal course of development.

(6) Deepen the main shaft and cross-cut east on the 296 feet level to intersect the lower mineralised zone encountered in the drill hole.

(7) (i) From the east end of the extended crosscut a diamond drill hole approximately 180-200 feet in length to test for possible parallel lodes in the footwall.

(ii) From the ends of the present drives short (100 feet) diamond drill holes depressed at 45° to the east to test the ore body at an intermediate level.

The drilling may be done at any time a plant becomes available.

A. J. NOLDART,
Geologist.

PRELIMINARY REPORT ON THE DIAMOND DRILL EXPLORATION OF THE ORD RIVER No. 2 MAIN DAMSITE, ORD RIVER, EAST KIMBERLEY DIVISION.

Approximate Latitude: 16°7′ S.

Approximate Longitude: 128°15′ E.

By J. D. Wyatt, Geologist.

Introduction.

Following the drilling programme which was initiated by the Mines Department at the Bandicoot Bar Diversion Dam in 1959, a further request was made by the Hydraulics Branch of the Public Works Department for a similar drill coverage at the Ord River Main Dam No. 2 site.

This site is situated on the Ord River, some 25 miles upstream from Bandicoot Bar. Access is along the main Wyndham-Nicholson road for a

distance of 90 miles, thence W.S.W. by way of a rough bush track for an additional 30 miles, in all a total of 120 miles from Wyndham.

The programme consisted of 11 holes, one on each spillway, and nine others spaced along the centre line of the wall. The maximum depth being 270′ and the minimum 95′.

The drilling, which was carried out by Ausdrill Ltd., Darwin, on a contract basis, was commenced on the 21st June, 1960, and completed on the 13th October, 1960, eighteen days under the contract time for the job.

Three drilling rigs were used, all petrol driven, two Mindrill E1000 screw feed machines and one Mindrill hydraulic rig.

A total of 1,881′6″ of drilling was completed with an overall core recovery of 94.5%.

Geology.

The general geology of the Main Damsite consists of a series of interbedded massive to thin bedded quartzites and phyllites which have been subjected to strong faulting, folding and shearing, with accompanying quartz vein intrusion.

These metasediments of undifferentiated Pre-Cambrian age either overlie porphyritic granites and gneisses of the Lamboo complex or are inliers within these granites.

This granitic complex outcrops some 3 to 4 miles to the north-east of the damsite occurring as a relatively flat sandy plain, with occasional weathered granite boulders and ridges of intrusive quartz and basic dykes.

Remnants of the Halls Creek metamorphics occur within the main granitic mass.

In the immediate vicinity of the damsite the geology is confined only to the quartzite and phyllite rock types.

The quartzites vary from massive to thin bedded medium grained rocks, strongly jointed and intruded by abundant quartz veinlets. These quartzites are brown in colour being strongly oxidized and weathered on the surface. At depth, however, they give way to a massive dense white rock. Cross bedding and ripple marking are common.

The phyllites vary from a massive, sparsely jointed rock exhibiting large flat tabular surfaces (main outcrops on the NE side of the river, faulted against the quartzite), to a highly contorted, quartz intruded, thin bedded rock of entirely dissimilar character which outcrops exclusively on the SW side of the Ord River.

These phyllites are red in colour, but at depth black (unoxidised ?) sections were exposed.

Associated with the more intense silicification was evidence of pyrite.

Both these rock types are conformable and right side up, except in one instance where overturning of the quartzite is probable along a fold or fault, they strike in a general E.-W. direction and their dips vary from 5°-40° N.-N.W., except along the margins of faults where dragging and steepening is common.

Jointing.

Both the quartzite and the phyllite are strongly jointed, this jointing being most evident in the quartzite, the more competent rock of the two. Under conditions of extreme stress the less competent phyllite gives way to intricate fold patterns rather than complex jointing.

This jointing can be roughly divided into three sets although there are abundant additional fractures which do not conform to these three:—

(1) *N. 10° W.—N. 20° W.:* This set of joints is most evident in the vicinity of the south-west abutment, where numerous slickensided surfaces and small brecciated zones can be observed paralleling the jointing, which dips from 45°-65° to the west.

(2) *N. 40° W.—N. 80° W.:* These joints are usually steeply dipping a few degrees off vertical either east or west and generally parallel to the bedding strike.

(3) *N. 60° E.-N. 80° E.:* This set is usually vertically dipping and roughly parallel to the numerous quartz veinlets which occur throughout the area probably utilizing the joints as zones of weakness.

On the surface the joints are visibly open especially on the vertical cliff faces, some of which show cavities one foot to two feet in width, closer to the river the cracks are filled with silt.

During the pressure testing of the drill holes it was shown that the joint system has a considerable lateral extent, as water pumped into one hole would, in some cases, bubble out of another several hundred feet away.

However, at depth the drill core showed the rocks to be massive and tight jointed and only rarely decomposed by the percolation of water.

Shearing and Faulting.

Throughout geological time, the area in the vicinity of the Damsite has been subjected to a great deal of earth movement. Abundant evidence being visible of old faults, shear lines and indeed even evidence of present day earth movements.

During the 1960 field season the writer recorded three earth tremors, each of some 30 seconds duration and having an intensity of about four on the Rossi Forel scale, that is "a tremor felt by several people, causing disturbance of movable objects, creaking of doors and rattling of windows."

In all surface observations of brecciated zones or slickensided surfaces, recementing was evident and it is most probable that these zones are now fairly tight.

The accompanying diagrammatic sketch plan outlines the only faulting which need be considered in the construction of the dam and associated structures in its immediate vicinity.

The NE quartzite outcrop appears to have been block faulted in two steps, apparently north side up, south side down.

The most northern of the two faults causes the phyllite to be in an unconformable contact with quartzite, but rubble strewn slopes obscure any chance of measuring the movement.

The southern fault is shown up as a strong flexure in the quartzite beds which causes a gradual increase of the dip of these beds from 5° to vertical and in some instances complete overturning.

As no break is evident on the surface which is unfortunately either obscured by river deposits or completely under water, it is probably that this structure is merely a strong flexure.

DDH No. 1OM was drilled to test for this flexuring and an intersection of steeply dipping, thin bedded and sheared quartzite was made below the river gravels.

Diamond Drilling.

In the 1960 field season the diamond drilling was carried out under private contract by Ausdrill Pty Ltd., Darwin.

An initial programme of eleven holes was laid out, the drilling commenced on the 21st June and was completed on the 13th October, 1960, eighteen days under the contract time for the job.

Three machines were used, all petrol driven, two E1000 Mindrill screw feed drills and one E1000 hydraulic rig. One of the screw feed drills was equipped with an EX head and the other with AX size.

Core was limited in the contract specifications to a minimum of AX and whilst most holes were commenced in either NX or BX, by far the greatest proportion of the drilling was carried out in AX size.

The percentages of each are as follows:—

NX—0.5 per cent.
BX—6.7 per cent.
AX—92.8 per cent.

The roughness of the terrain was, as experienced in the 1959 drilling of Bandicoot Bar Diversion Dam, again the cause of lengthy delays, whilst rigs were manhandled into position.

G. S. W. A.

GEOLOGICAL PLAN
Nº 2 MAIN DAMSITE — ORD RIVER

SHOWING

COMPLETED AND PROPOSED 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

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.
- Proposed drill holes

Phyllite Rubble

Scattered Phyllite Outcrops in Drift Sand

Abundant Quartz Veinlets

Quartz Veins

Abundant Quartz Veins

ORD RIVER

Phyllite

Massive Jointed Quartzite

Rubble Covered

Massive Jointed Quartzite

Slickensiding

Rubble

Interbedded Massive and Platy Quartzite

Possible Spillway
800 foot Entry R.L. 290'
Grade 1 in 60
Ungated Crest

Platy Quartzite with Phyllite Bands

D.D.H. 9 M (Spillway)
Depression 75
Bearing 253 Mag.

Interbedded, Massive, and Platy Quartzite

Quartzite Rubble

Blocky Massive Quartzite

Massive Quartzite

Platy Quartzite Rubble

Massive Quartzite

Shear Zone
Brecciated and Ferruginous Quartzite

Rubble

Phyllite

Massive Quartzite

Quartzite Rubble

Quartzite Rubble

Underground Power Station
R.L 150'

Joint or Shear Direction

Rubble and Alluvium

Quartzite Rubble

Massive Quartzite

Outlet Tower, Gates, Screens and Accessway

Alluvium

Alluvium

D.D.H. Nº 11 (Spillway)

Possible Spillway
500 foot Entry R.L. 290'
Grade 1 in 100
Ungated Crest

Quartzite Rubble

Quartzite Rubble

Very Laminated Quartzite

Alluvium

D.D.H. Nº 8

D.D.H. Nº 7

D.D.H. Nº 4

D.D.H. Nº 10

D.D.H.'s 1 and 2

D.D.H. Nº 6

D.D.H. Nº 3

D.D.H. Nº 5

Main Dam
550 foot Spillway
30 Tainter Gates

Axis Of Acute Fold Or Shear

Alluvium

Alluvium

Alluvium

F ?

At one stage whilst shifting to the site for DDH No. 9M, on the Northern Spillway, a machine was taken apart and carried piece by piece to the new site and it is to the credit of the crews that such a task was accomplished, considering the equipment available. That the machine seized up after drilling only a few feet is beside the point.

Core Recovery.

Under the terms of the contract any hole with an overall recovery of below 80 per cent was to be considered lost and if deemed necessary redrilled. Fortunately recoveries were, except in one instance, all well above this figure the average for all drilling being 94.5 per cent.

The figures for individual holes are as follows:—

DDH	Drilled NX	Recovered NX	Per cent.	Drilled BX	Recovered BX	Per cent.	Drilled AX	Recovered AX	Per cent.	Drilled Total	Recovered Total	Per cent.
	ft. in.	ft. in.		ft. in.	ft. in.		ft. in.	ft. in.		ft. in.	ft. in.	
1	3 6	3 6	100	31 6	31 3	99·2	214 7	208 2	97·0	249 7	242 11	97·4
2	....	....	....	1 7	1 7	100	171 5	160 6	93·5	173 0	162 1	93·6
3	....	....	....	10 5	5 4	50·7	140 7	137 10	98·1	151 0	143 2	94·8
4	....	....	....	6 6	6 6	100	263 6	259 2	98·3	270 0	265 8	98·4
5	....	....	....	15 0	14 4	95·5	231 8	229 5	99·2	246 8	243 9	98·8
6	....	....	....	10 1	9 6	95·0	130 11	128 0	97·7	141 0	137 6	97·5
7	....	....	....	10 1	10 1	100	102 11	100 8	97·7	113 0	110 9	98·0
8	....	....	....	9 6	9 3	98·2	86 0	83 5	97·0	95 6	92 8	97·3
9	....	....	....	19 0	7 8	40·3	127 6	90 8	71·2	146 6	98 4	66·3
10	5 6	5 6	100	4 0	4 0	100	134 9	126 11	94·2	144 3	136 5	94·6
11	....	....	....	10 0	7 7	75·0	141 0	137 4	97·4	151 0	144 11	96·0
Total	9 0	9 0	100	127 8	107 1	83·9	1,744 10	1,662 1	95·2	1,881 6	1,778 2	94·5

In direct contrast to the 1959 results at Bandicoot Bar, drilling of the phyllite proved to be most difficult, both the individual runs and the core recoveries being usually poorer than those obtained when drilling quartzite.

The average footage obtained from each bit was also less than that obtained in the 1959 drilling. Using approximately 3½ carats, each bit averaged 4.7 feet, and during the course of the season many bits were completely ruined. The 1959 figure was 5.7 feet per bit, the carat value was correspondingly higher with no bits being lost.

The programme of eleven holes, which was completed during the season, can be considered an initial step in the proving of this site as suitable for the construction of a dam.

So far, the results have been encouraging and a brief examination of each hole as to its purpose and the results achieved is as follows:—

D.D.H. No. 1M.

This hole was drilled at -45° to a depth of 249′ 7″ in quartzite.

The purpose of the hole was to test for the possible occurrence of a fault passing through the centre of the dam.

After a close examination of the core, no evidence of faulting, in the way of brecciation, or fault gouge was found.

The quartzite below a depth of 70 ft. was massive tight jointed and in every way apparently sound. Some of the joints were iron stained, showing the passage of water but no decomposition was evident.

The initial 70 ft. was drilled through an oxidized zone which caused the slightly ferruginous quartzite to be strongly stained, the rock was soft in places and crumbled fairly easily.

The jointing was more open and all joints heavily iron stained.

Caving in the hole was common and casing was continued down to 35 ft. Later pressure testing revealed a connection between joints in this hole and those of DDH 4M, as water pumped down one bubbled out of the other.

Complete water loss was noted twice, firstly at 32 ft. and then when casing was continued to 35 ft. and the water recovered, again at 51 ft. Pressure testing confirmed these observations, as in the initial 63 ft. loss of water in excess of 10 gpm was recorded.

D.D.H. No. 2M.

This hole was drilled along the axis of the dam wall at right angles to the river and below the foundations, at an angle of -45° and to a depth of 173 feet. At this depth the rods jammed due to the hole caving, and after numerous attempts to remove the rods and continue to the target depth of 200 feet the hole was abandoned.

The first 60 feet was again drilled in oxidized ferruginous quartzite, open jointed and fragmentary.

Water losses were recorded at 20 feet and 33 feet with bad caving at 55 feet. Pressure tests revealed a loss in excess of 11 gpm down to 48 feet, where the hole was so badly caved as to prevent further testing.

Below 60 feet the quartzite became tighter jointed and more massive and remained this way until the hole was abandoned at 173 feet.

D.D.H. No. 3M.

This was a vertical hole drilled along the centre line of the wall to a depth of 151 feet.

Again the rock was ferruginous and open jointed to a depth of about 96 feet, when the transition into tighter jointed, non-ferruginous rock was made and the hole finished in excellent white, massive quartzite.

Throughout this hole no appreciable water loss was recorded and pressure testing revealed a slight almost constant loss of between 5-6 gpm throughout the complete length of the hole.

D.D.H. No. 4M.

This hole was drilled at an angle of -40° under the river bed to a depth of 270 feet. It was laid out to test for any faulting underneath and parallel to the river direction.

No faulting was discovered, but in the 1961 season an additional 4 holes will be drilled at intervals across the river as a further precaution against any undisclosed weaknesses.

Intersection with the quartzite/phyllite contact was made at a drill depth of 183 feet.

Water losses were recorded by the drillers at 57 feet and 183 feet, but these losses were not confirmed by pressure testing except in the intial 40 feet of the hole.

D.D.H. No. 5M.

This was one of the most important holes drilled during the season. It was angled to intersect the underground power station chamber.

After the initial 30 feet of slightly decomposed ferruginous quartzite, the hole continued in more silicified compact ferruginous, jointed rock, until at a depth of 190 feet massive non-ferruginous quartzite was encountered.

Whilst the rock was not as sound as that drilled in DDH's 3M and 6M, it is considered suitable for the excavation of a tunnel and power station.

In all events a further series of holes will be drilled along the line of the tunnel in the 1961 season.

Water losses were recorded at 3 feet and 33 feet but pressure tests revealed only a small constant loss over the entire 143 feet tested. This result may be due to the abundant grease used as a prevention against caving.

D.D.H. No. 6M.

The hole was laid out along the centre line of the Dam wall in the same relative position as DDH 3M and half way between 3M and 1M. The results were similar to those encountered in DDH 3M as to the rock type and depth of oxidation.

It was at this depth, namely 73 feet that a 100 per cent. water loss was recorded by the drillers but results do not tally with pressure testing.

An interesting result of this testing was the observation on a connection underground between DDH 6M and 4M, when water pumped into 6M leaked out of the collar of 4M some 350 feet away.

D.D.H. No. 7M.

This hole was drilled to test for the quartzite/phyllite contact on the southern side of the river at a depression of 52° for 113 feet.

The contact was made at 95 feet 6 inches exactly as projected from the contact made in DDH 4M.

Ferruginous open jointed quartzite was evident until 63 feet when the more massive, tight jointed white variety was encountered.

Water loss of 100 per cent. was recorded at 23 feet and this was borne out by pressure tests.

D.D.H. No. 8M.

This hole was drilled to further test the quartzite-phyllite contact on the southern abutment of the dam.

The contact was made at the unexpectedly shallow depth of 61 feet 9 inches. The position of the phyllite at this depth can only be explained by a series of small slip faults or by folding.

There is abundant surface evidence of small brecciated zones parallel to the main shear direction and it is likely that a little of both have accounted for the change of position of the phyllite.

A second possibility is that a low angle fault between DDH's 7M and 4M has caused this anomaly, this likelihood will be tested by an additional vertical hole from DDH 7M in the 1961 season.

A 100 per cent. water loss at 14 feet was recorded but pressure testing revealed no losses greater than about 2 gpm.

D.D.H. No. 9M.

This hole was drilled vertically to a depth of 146 feet 6 inches, in the centre of the northern spillway to test for possible suitable concrete aggregate.

This hole was drilled in thin bedded, interbedded quartzite and sandy phyllite—very ferruginous and oxidized.

The ground would not be suitable as a source of concrete aggregate.

D.D.H. No. 10M.

This hole was drilled to intersect a possible fault zone or strong fold which extends across the river some 200 feet upstream from the proposed dam.

This folding was intersected at approximately 127 feet, as steeply bedded, sheared quartzite.

This result provides additional evidence to the theory that the quartizite is block faulted both up and downstream from the dam and at right angles to the river.

One point of interest is that this hole was the only one to be surveyed, using a primitive gelatine and glass tube method to test for dip. It was found that the hole had steepened approximately 11° in 113 feet of drilling.

D.D.H. No. 11M.

This was another spillway hole, drilled vertically to a depth of 151 feet, in the southern spillway, again as a test for suitable concrete aggregate.

The hole was drilled in oxidized, red, highly folded phyllite and is not suitable aggregate material.

Water Pressure Tests.

The following table of results of pressure tests as applied to each drill hole was provided by the Hydraulics Branch of the Public Works Department:—

D.D.H. No. 4M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./sq. in.)	(ft. head)	(gal./min.)	
15	23	53	50	13·4	
30	23	53	52	13·4	
15	43	58	53	10·1	No surface loss.
30	43	58	53	10·3	No loss around packer.
45	43	60	55	10·2	
15	63	65	55	8·2	
30	63	65	56	8·1	
15	83	60	55	6·7	
30	83	60	55	6·7	
15	103	65	58	6·2	
30	103	66	59	6·2	
15	123	68	60	5·5	
30	123	68	60	5·5	No surface leak.
15	143	68	52	4·7	0·5 g/m. loss around packer.
30	143	68	52	4·7	
45	143	68	52	4·7	
1 hr.	143	68	52	4·7	

D.D.H. No. 7M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./sq. in.)	(ft. head)	(gal./min.)	
15	23	62	50	12·2	Surface to 23 ft. unable to seal—losing 1 g/m. round packer.
30	23	62	55	12·1	
15	38	61	52	7·9	43 ft. losing over 2 gal./min. round packer. Pulled up 5 ft. to 38 ft.. 38 ft. losing only 1 g/m. round packer.
30	38	61	52	8·4	
15	63	62	52	4·8	Leak around packer seemed to increase slightly—no way of testing accurately if so. Loss water around packer 1·5 g/m.
30	63	62	52	5·3	
45	63	62	53	5·3	
1 hr.	63	62	53	5·3	

Loss around packer as in remarks.
No surface loss apparent.

D.D.H. No. 8M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./sq. in.)	(ft. head)	(gal./min.)	
15	23	63	58	2·0	
30	23	63	58	1·9	
45	23	63	58	1·9	No surface leak.
1 hr.	23	63	58	1·8	

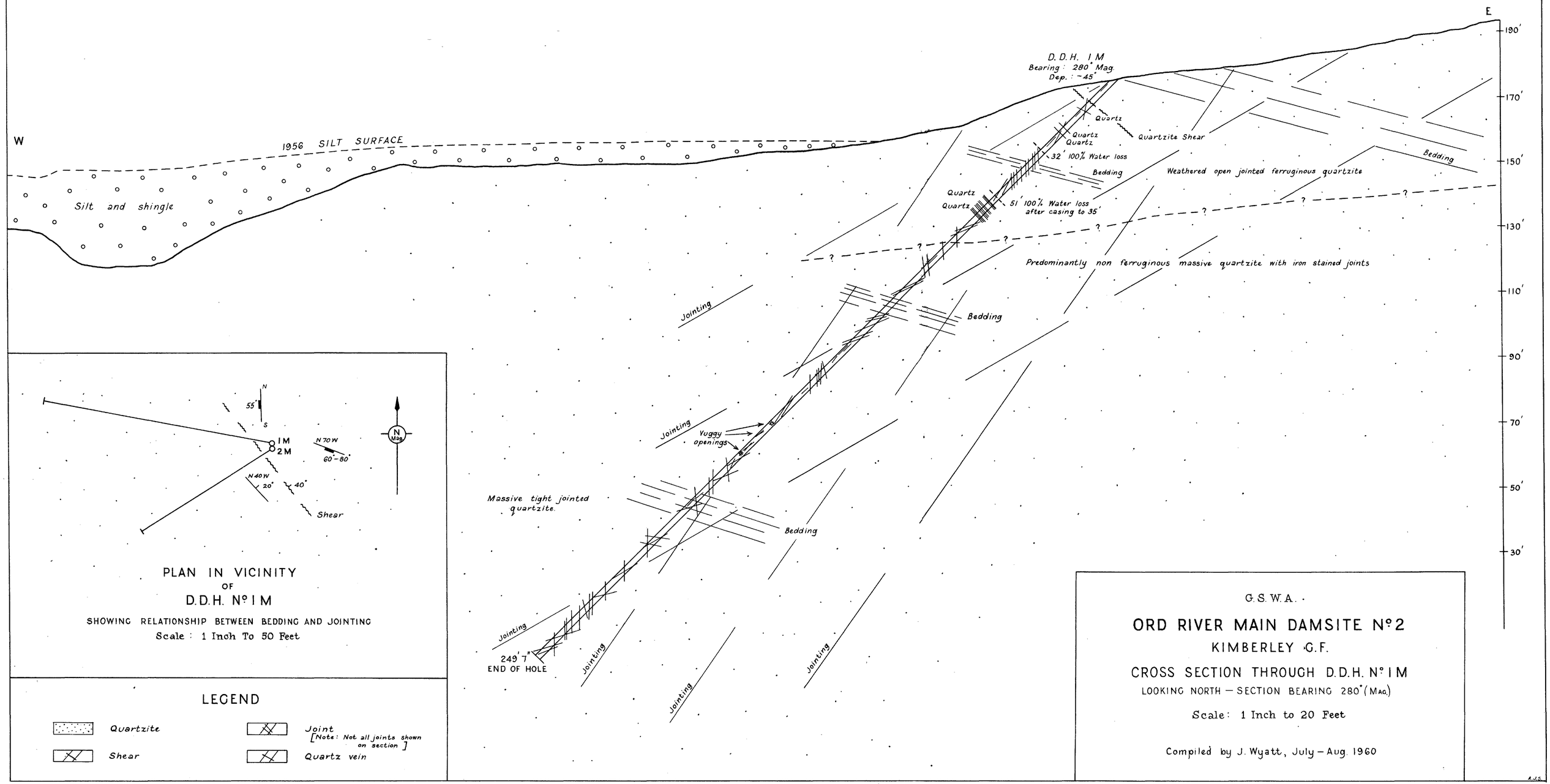
Hole heavy with grease. Test Pipe had to be tied down.
13 ft.–14 ft. leaking badly. 38 ft. head, water loss = 14 g/m.
Bad surface leak after about 5–10 mins.

D.D.H. No. 2M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./sq. in.)	(ft. head)	(gal./min.)	
15	23	60	32	13·2	No surface loss.
15	43	60	55	11·9	No leak around packer.
30	43	60	55	11·9	Hole caved in at approx. 48 ft.

D.D.H. No. 1M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./sq. in.)	(ft. head)	(gal./min.)	
15	23	55	35	13·5	
30	23	55	35	13·5	No surface loss.
15	43	56	58	12·1	No loss around packer.
30	43	56	58	12·1	
15	63	57	66	10·8	No surface loss.
30	63	57	66	10·5	No loss around packer.
15	83	39	60	8·4	No surface loss, but losing water from D.D.H. 4M.
30	83	39	60	8·4	
15	103	40	55	7·5	
30	103	39	56	7·4	No loss around packer.
15	123	42	60	7·0	No surface loss, but losing water from D.D.H. 4M.
30	123	41	50	6·4	
15	143	41	53	6·1	
30	143	41	53	6·1	
15	163	42	54	5·7	
30	163	42	54	5·7	



PLAN IN VICINITY
OF
D.D.H. Nº 1 M

SHOWING RELATIONSHIP BETWEEN BEDDING AND JOINTING
Scale: 1 Inch To 50 Feet

LEGEND

- Quartzite
- Shear
- Joint [Note: Not all joints shown on section]
- Quartz vein

G.S.W.A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

CROSS SECTION THROUGH D.D.H. Nº 1 M

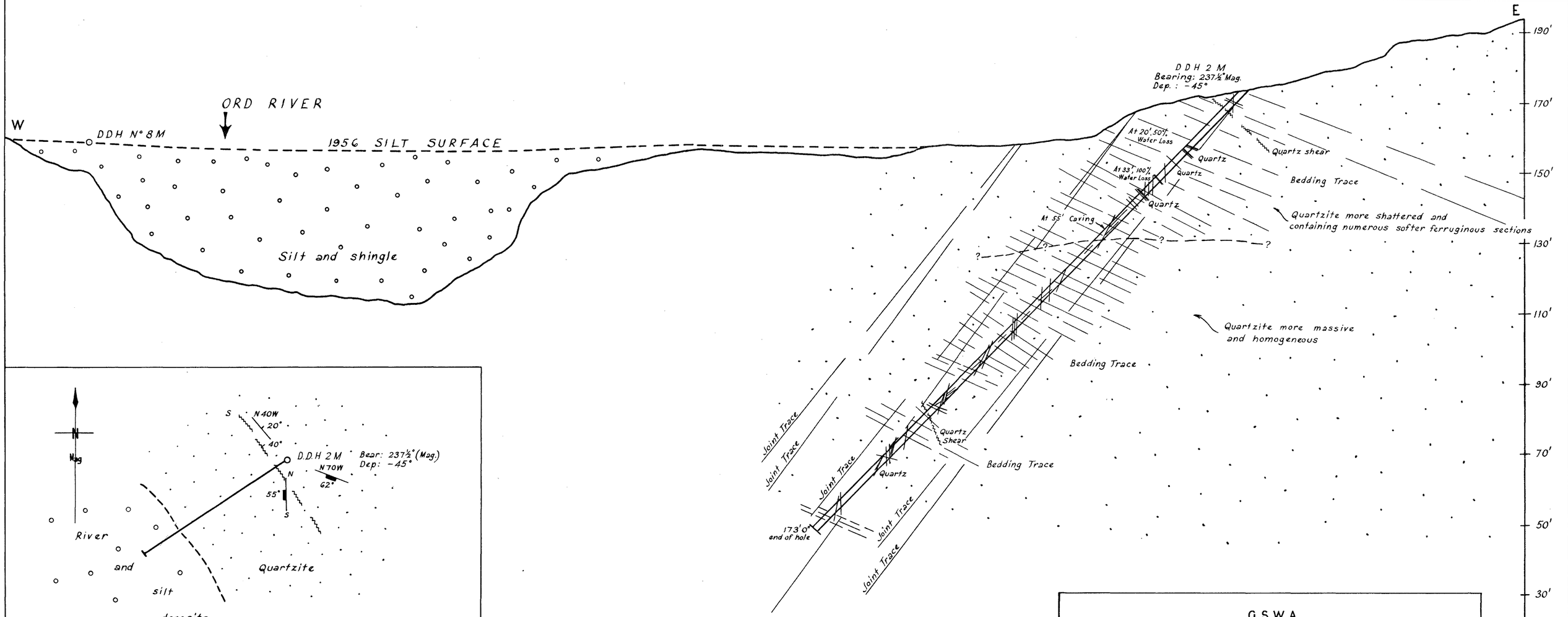
LOOKING NORTH — SECTION BEARING 280° (MAG.)

Scale: 1 Inch to 20 Feet

Compiled by J. Wyatt, July — Aug. 1960

A.J.S.

PLATE XIX



PLAN IN VICINITY
OF
DDH N°2M
showing relationship between bedding and jointing
Scale: 1 inch to 50 feet.

LEGEND

- Quartzite
- Joint
- Shear
- Quartz veinlet

G.S.W.A

CROSS SECTION THROUGH DDH N°2M

LOOKING N.W. — SECTION BEARING S57½°W

ORD RIVER MAIN DAMSITE N°2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. Wyatt, June-July 1960

J.H.C. Del.

SW

NE

Trace of D.D.H. N° 8M

F?

Ferruginous Quartzite

Quartzite / Phyllite contact projected from D.D.H. 8M

Red and cream oxidized and faulted phyllite

Probable fault dip along line of strongest surface shearing

Slip joint direction

Prominent slip joint direction

Prominent fault and slip joint direction

Phyllite

Ferruginous open jointed quartzite

Non ferruginous tight jointed quartzite

Grey phyllite

Black phyllite

Grey phyllite

Bedding and cleavage

Bedding and cleavage

Bedding and cleavage

270' 0" END OF HOLE

Well bedded strongly cleaved phyllite

ORD RIVER

D.D.H. 7M
Bearing 260° Mag.
Angle of dep. - 52°

1956 SILT SURFACE

Silt and shingle

Quartzite / Phyllite contact projected onto section

D.D.H. 4M
Bearing 243° Mag.
Angle of dep. - 40

Bedding

Ferruginous and non ferruginous more open jointed quartzite

Non ferruginous tight jointed quartzite

Joint trace

173' 0"
END OF HOLE

D.D.H. 2M
Bearing 237½° Mag.
Angle of dep. - 45°

At 20' 50% Water loss

At 35' 100% Water loss

At 55' Caving

Quartz

Quartz shear

Bedding trace

Quartzite more shattered and containing numerous softer ferruginous sections

Quartzite more massive and homogeneous

190'
170'
150'
130'
110'
90'
70'
50'

G.S.W.A.

CROSS SECTION THROUGH D.D.H. N°s 2M, 4M. AND SIGHTS OF D.D.H. N°'s 7M, 8M.

LOOKING NORTH WEST — SECTION BEARS S 57½° W

ORD RIVER MAIN DAMSITE N° 2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. D. Wyatt — Aug. 1960.

LEGEND

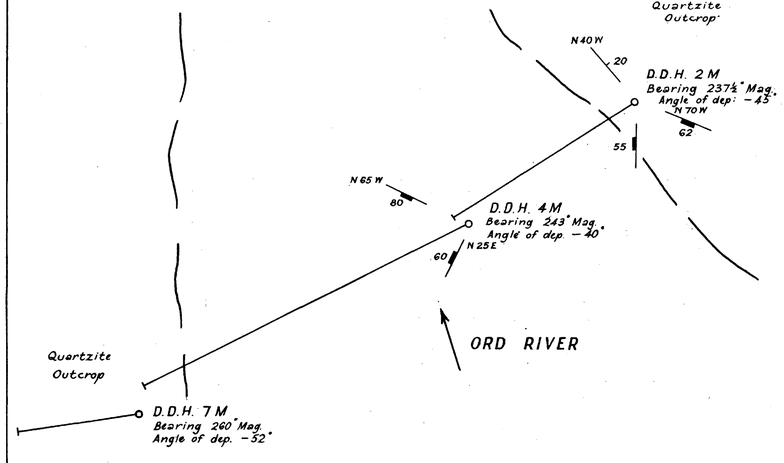
- Quartzite
- Phyllite
- Shearing
- Quartz veinlet
- Fault zone
- Joint (w - Water bearing)

[Note: Only representative jointing shown on drill section.]

PLAN IN VICINITY OF D.D.H. N°'s 2M, 4M AND 7M

Showing relationship between bedding and jointing

Scale: 1 inch to 50 feet



S

N

ORD RIVER

D.D.H. 6 M
Vertical

DDH 3 M
Vertical

Mainly ferruginous quartzite with iron stained joints.

Jointing Trace

Bedding Trace

Bedding

100' W.L.

101' Temporary W.L.

Non ferruginous tight jointed quartzite

Mainly ferruginous quartzite with reasonably tight non stained jointing

Quartz Injection

141'0"

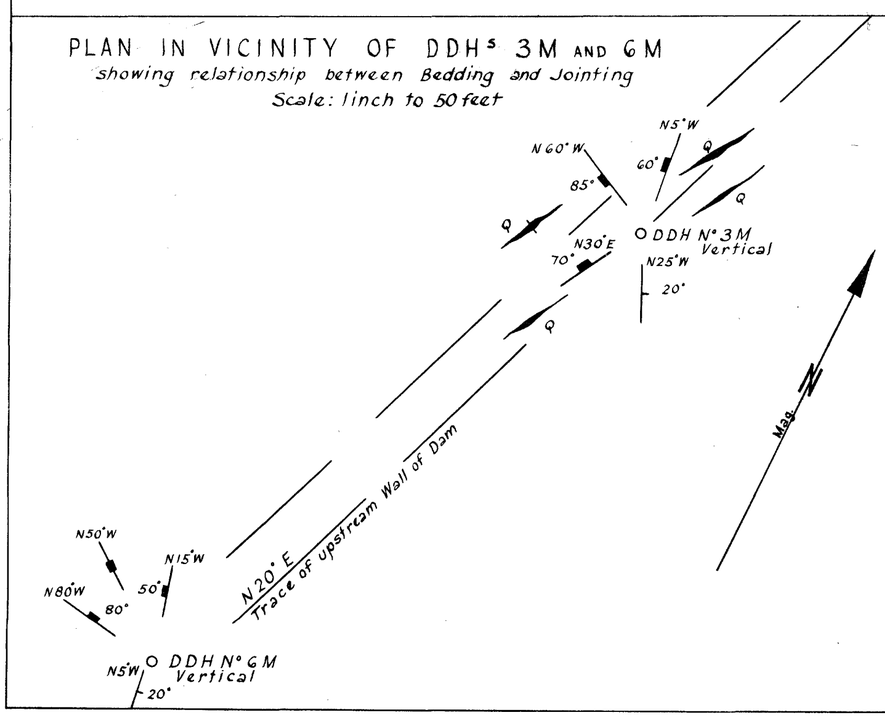
151'0"

240'
220'
200'
180'
160'
140'
120'
100'
80'
60'
40'
20'

PLAN IN VICINITY OF DDHs 3M AND 6M

showing relationship between Bedding and Jointing

Scale: 1inch to 50 feet



LEGEND

- Quartzite
- Joint (w- water bearing)
- Quartz vein
- W.L. Water Loss

Note: Representative jointing only shown

G.S.W.A

CROSS SECTION THROUGH DDHs Nos 3M, 6M

SECTION BEARING N 20° E

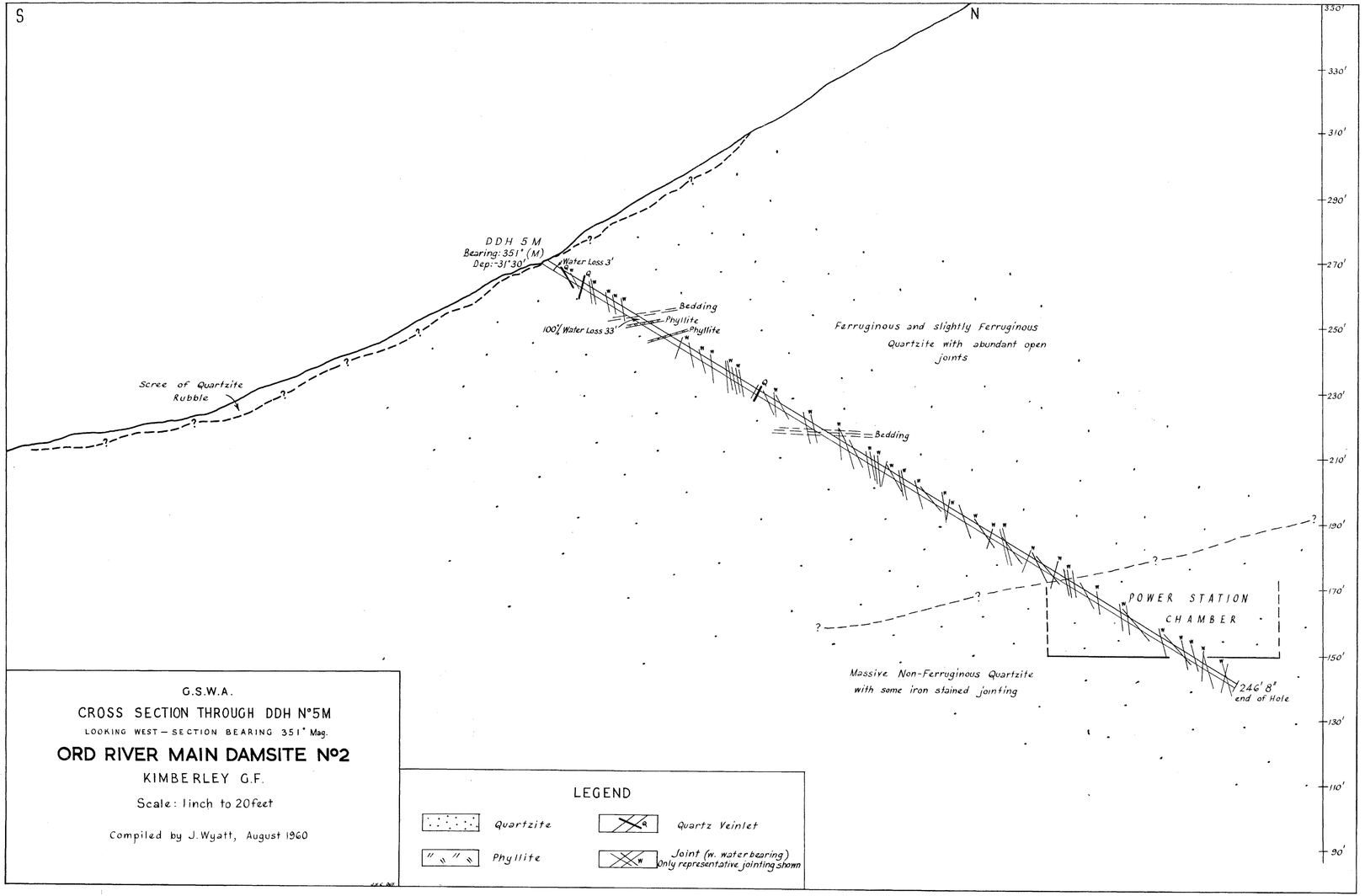
ORD RIVER MAIN DAMSITE No2

KIMBERLEY G.F.

Scale: 1inch to 20feet

Prepared by J.Wyatt, September 1960

PLATE XXII



G.S.W.A.

CROSS SECTION THROUGH DDH N°5M

LOOKING WEST — SECTION BEARING 351° Mag.

ORD RIVER MAIN DAMSITE N°2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. Wyatt, August 1960

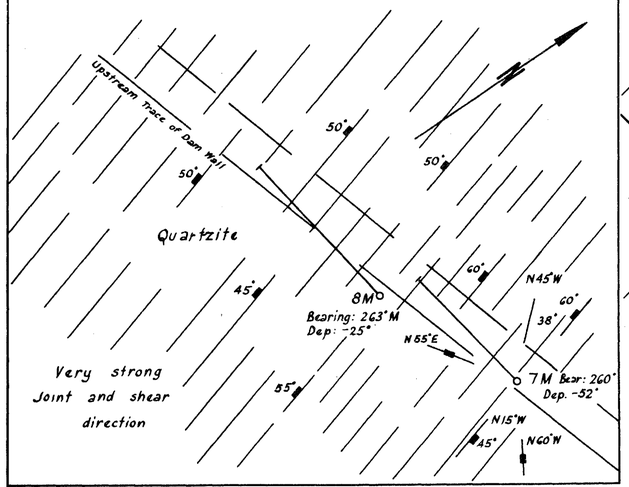
LEGEND

- Quartzite
- Phyllite
- Quartz Veinlet
- Joint (w. water bearing) Only representative jointing shown

PLAN IN VICINITY OF D.D.H's 7M & 8M

showing relationship between Bedding and Jointing

Scale: 1inch to 50 feet



W — E

Top Level of Dam Wall

Very prominent Joint and shear pattern

DDH 8M [Proj. 8' onto section]
Bearing: 263° M
Dep: -25°

100% W.L. 14'

Grey/Cream/Red Phyllite (Oxidised)

Ferruginous open jointed Quartzite

DDH 7M
Bearing: 260° M
Dep: -52°

95'6" End of Hole

90% W.L. 23'

Bedding

1956 SILT LEVEL

Silt and Shingle

ORD RIVER

Ferruginous open jointed Quartzite

Bedding trace

Massive fairly tight jointed non ferruginous quartzite

Water Recovered

Grey phyllite

Quartz and disseminated pyrite

113' End of Hole

Strongest fracture joint

Strongest fracture joint

Jointing trace

Jointing trace

Jointing trace

Jointing trace

Black Phyllite contorted, strongly cleaved and injected with quartz veinlets

300 280 260 240 220 200 180 160 140 120 100 80 60 40 20

LEGEND

- Quartzite
- Phyllite
- Shear
- Fault Zone
- Joint (w-water bearing)
- Quartz vein
- W.L. Water Loss

Note: Only representative jointing shown on D.D.H's.

G.S.W.A

CROSS SECTION THROUGH DDH's Nos 7M, 8M

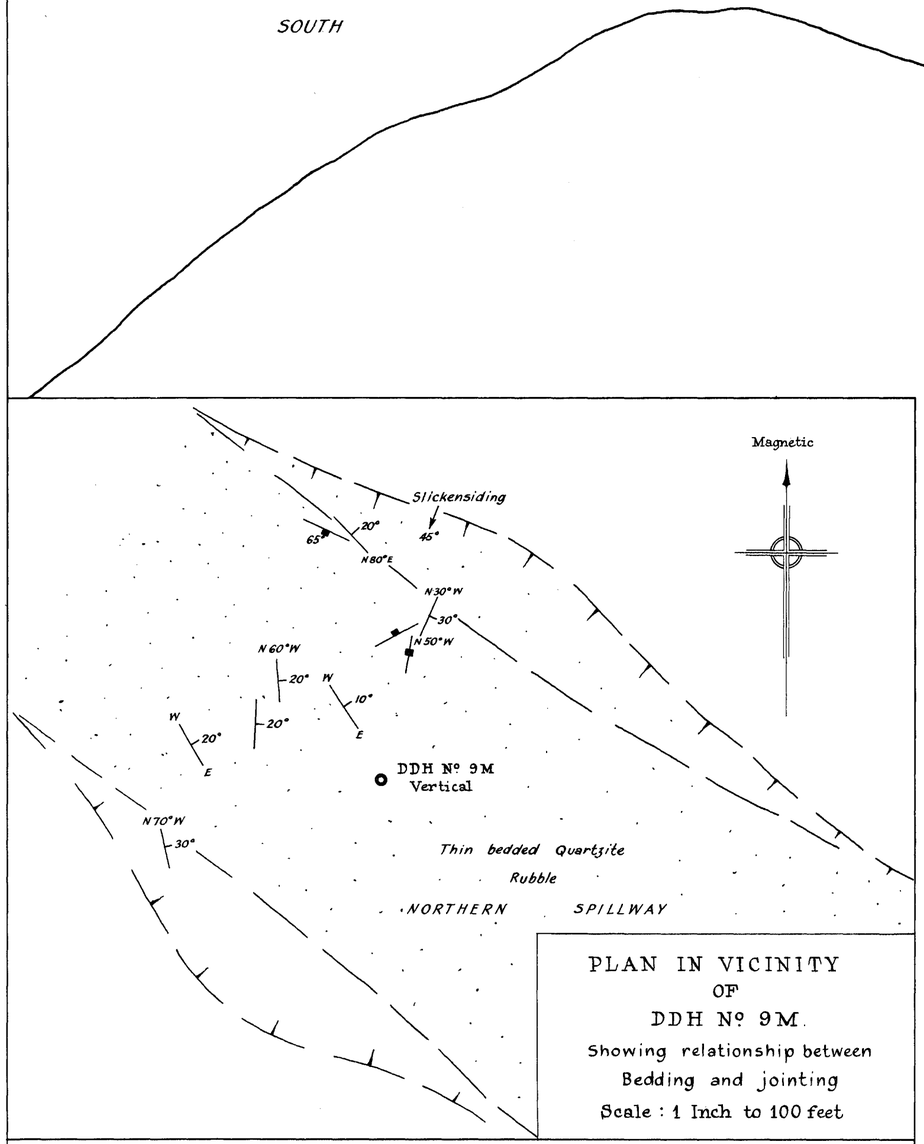
LOOKING NORTH — SECTION BEARING 260° Mag.

ORD RIVER MAIN DAMSITE No2

KIMBERLEY G.F.

Scale: 1inch to 20feet

Prepared by J.Wyatt, September 1960



PLAN IN VICINITY
OF
DDH Nº 9M.
Showing relationship between
Bedding and jointing
Scale : 1 Inch to 100 feet

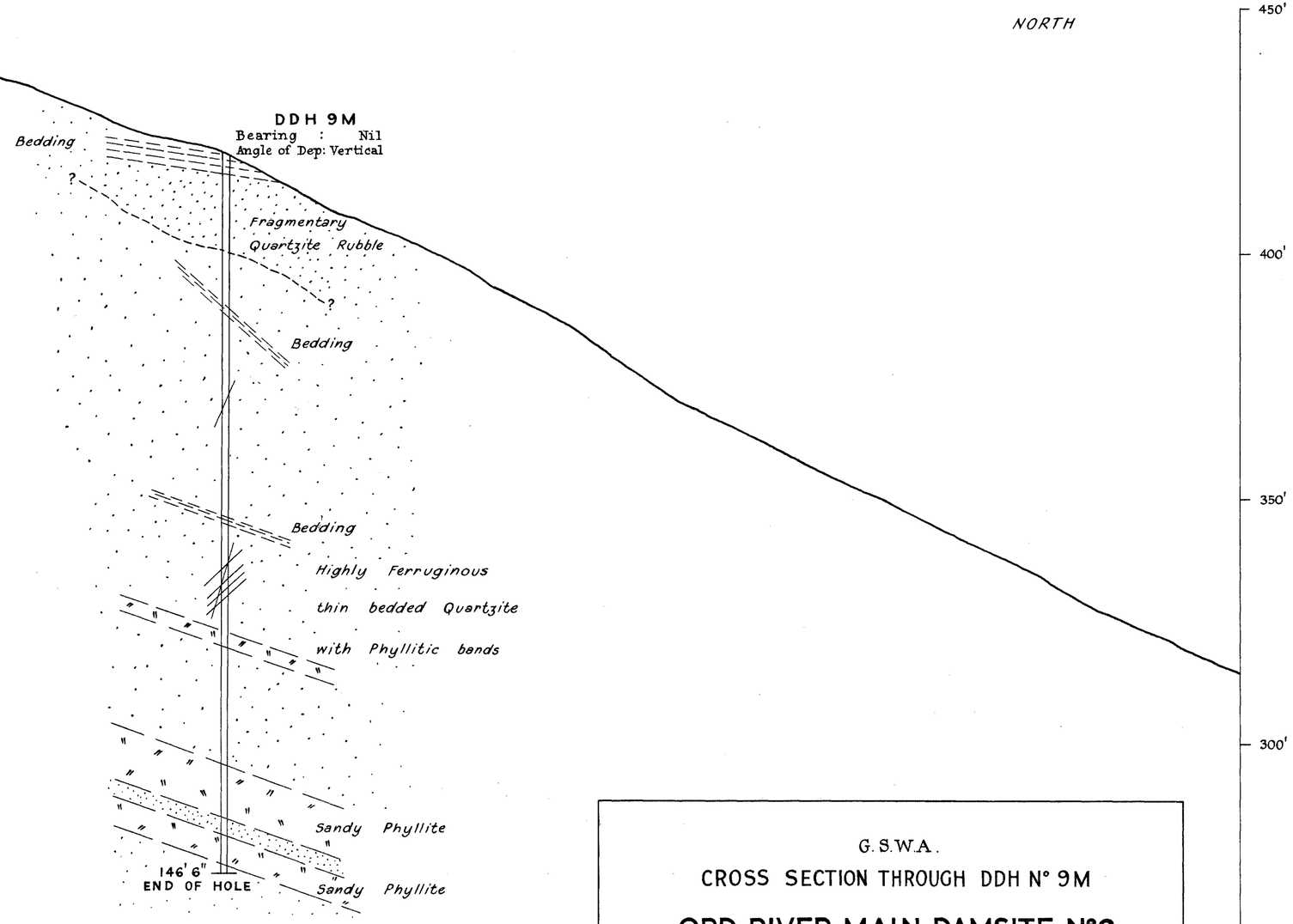
—LEGEND—

Quartzite

Phyllite

Joint

Quartz veinlet



G.S.W.A.

CROSS SECTION THROUGH DDH N° 9M

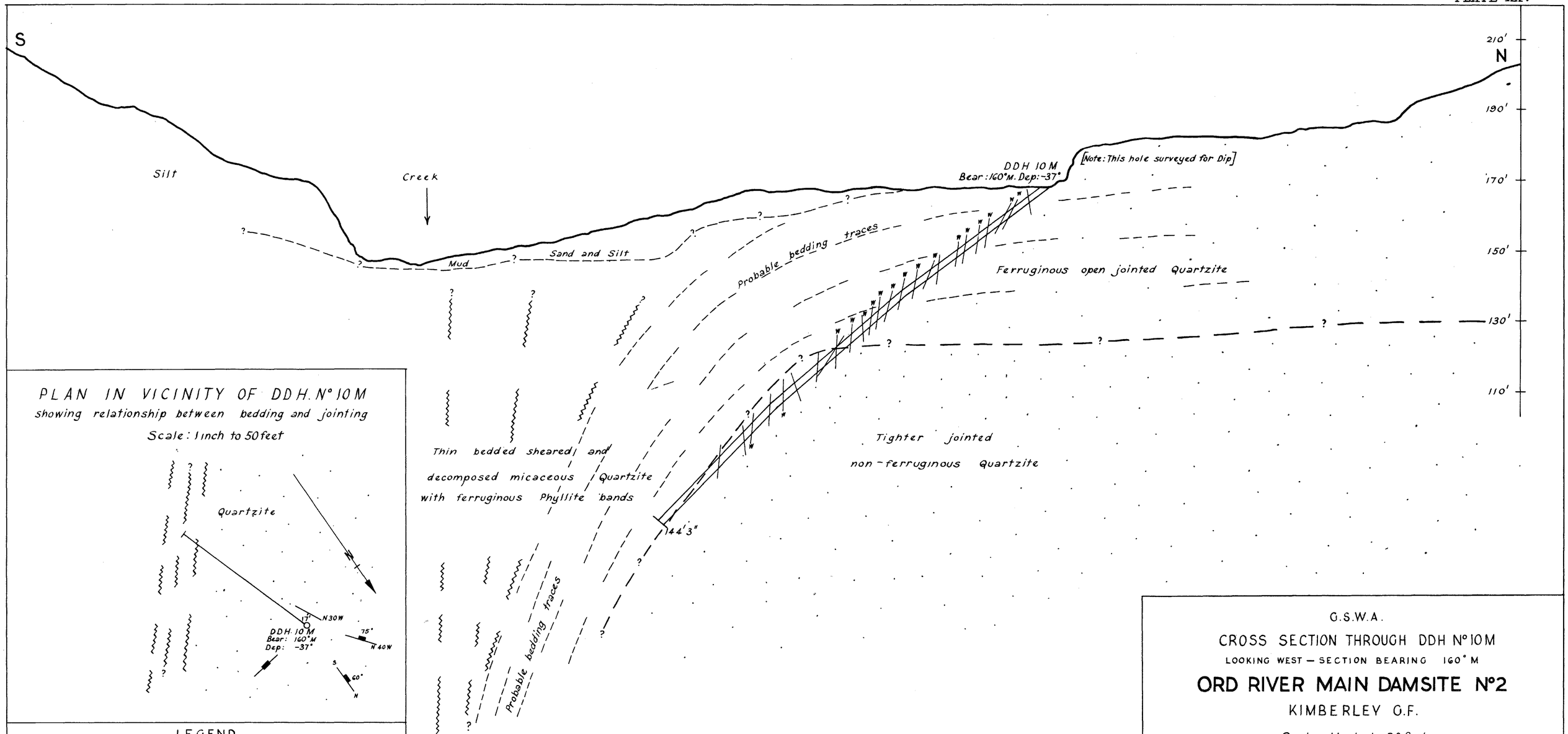
ORD RIVER MAIN DAMSITE N°2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. Wyatt. Sept–Oct 1960.

PLATE XXV



PLAN IN VICINITY OF DDH. N° 10M

showing relationship between bedding and jointing

Scale: 1 inch to 50 feet

LEGEND

- Quartzite
- Shear
- Joint (W - water bearing)

G.S.W.A.

CROSS SECTION THROUGH DDH N° 10M

LOOKING WEST — SECTION BEARING 160° M

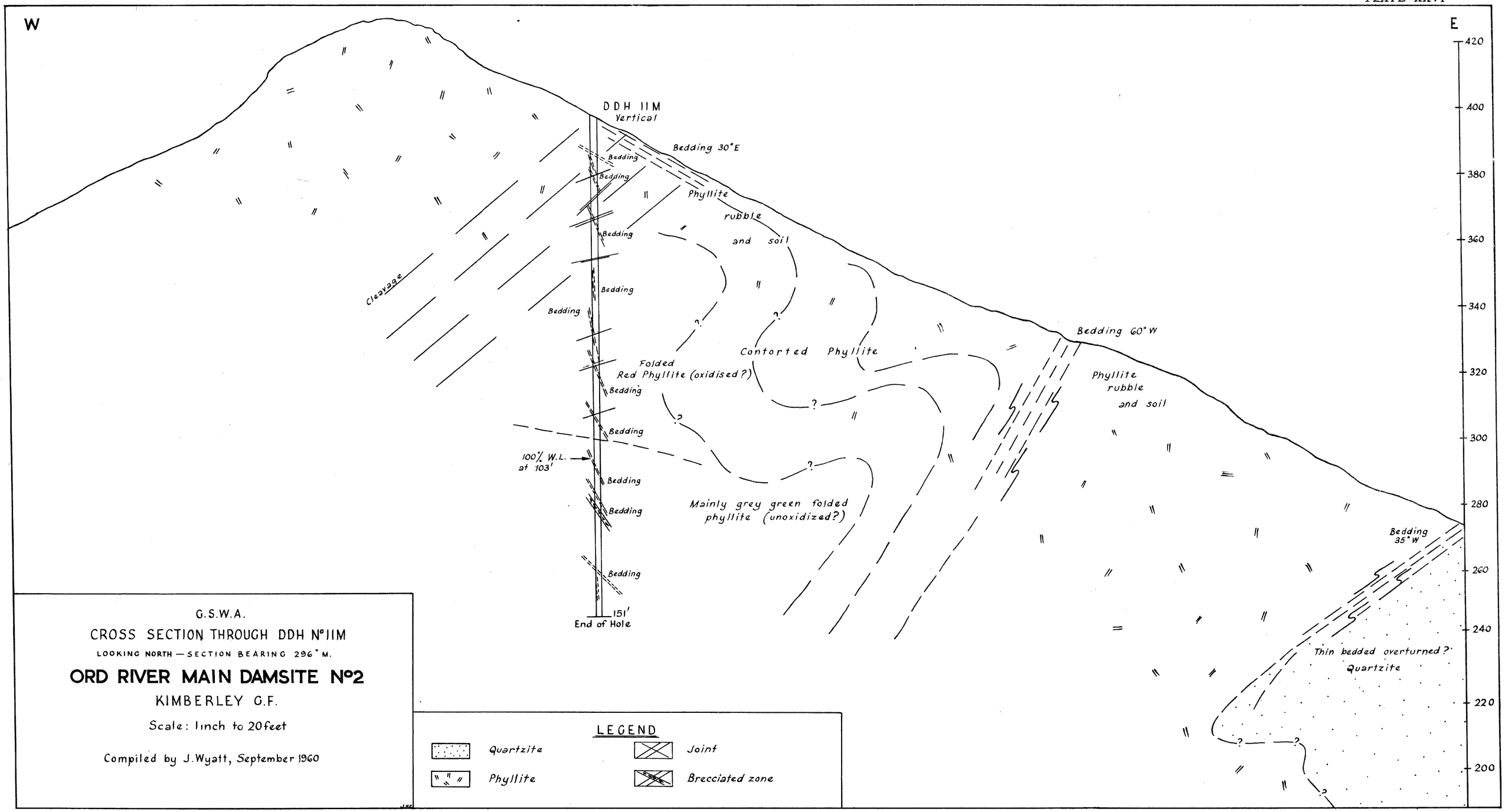
ORD RIVER MAIN DAMSITE N°2

KIMBERLEY G.F.

Scale: 1 inch to 20 feet

Compiled by J. Wyatt, September 1960

J.H.C. Delt



G.S.W.A.

CROSS SECTION THROUGH DDH N°IIM

LOOKING NORTH — SECTION BEARING 296° M.

ORD RIVER MAIN DAMSITE N°2

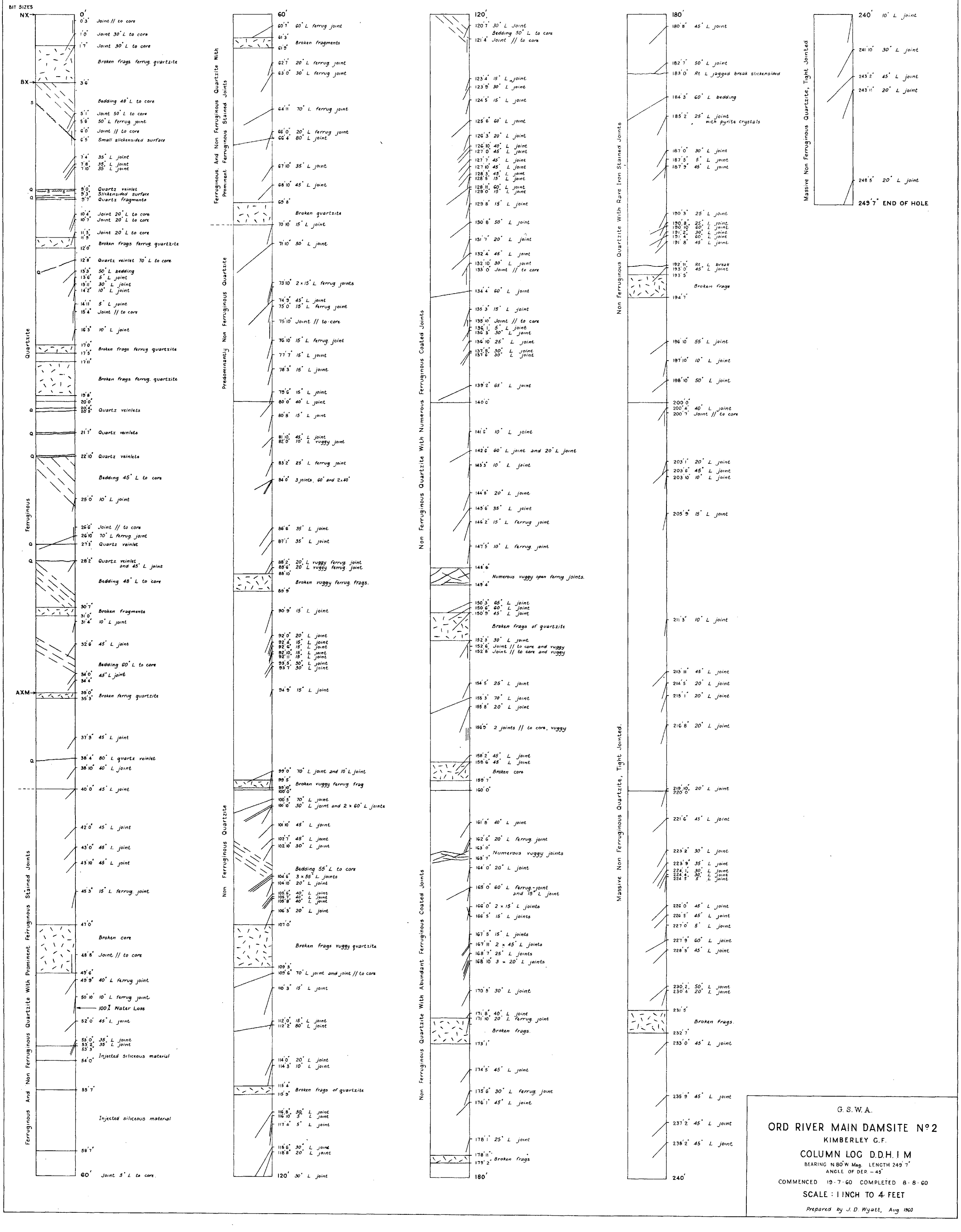
KIMBERLEY G.F.

Scale: 1inch to 20feet

Compiled by J.Wyatt, September 1960

LEGEND

- Quartzite
- Phyllite
- Joint
- Brecciated zone



G. S. W. A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

COLUMN LOG D.D.H. 1 M

BEARING N 80° W Mag. LENGTH 249' 7"
ANGLE OF DEP. – 45°

COMMENCED 19·7·60 COMPLETED 8·8·60

SCALE : 1 INCH TO 4 FEET

Prepared by J. D. Wyatt, Aug 1960

G. S. W. A.

ORD RIVER MAIN DAMSITE N° 2

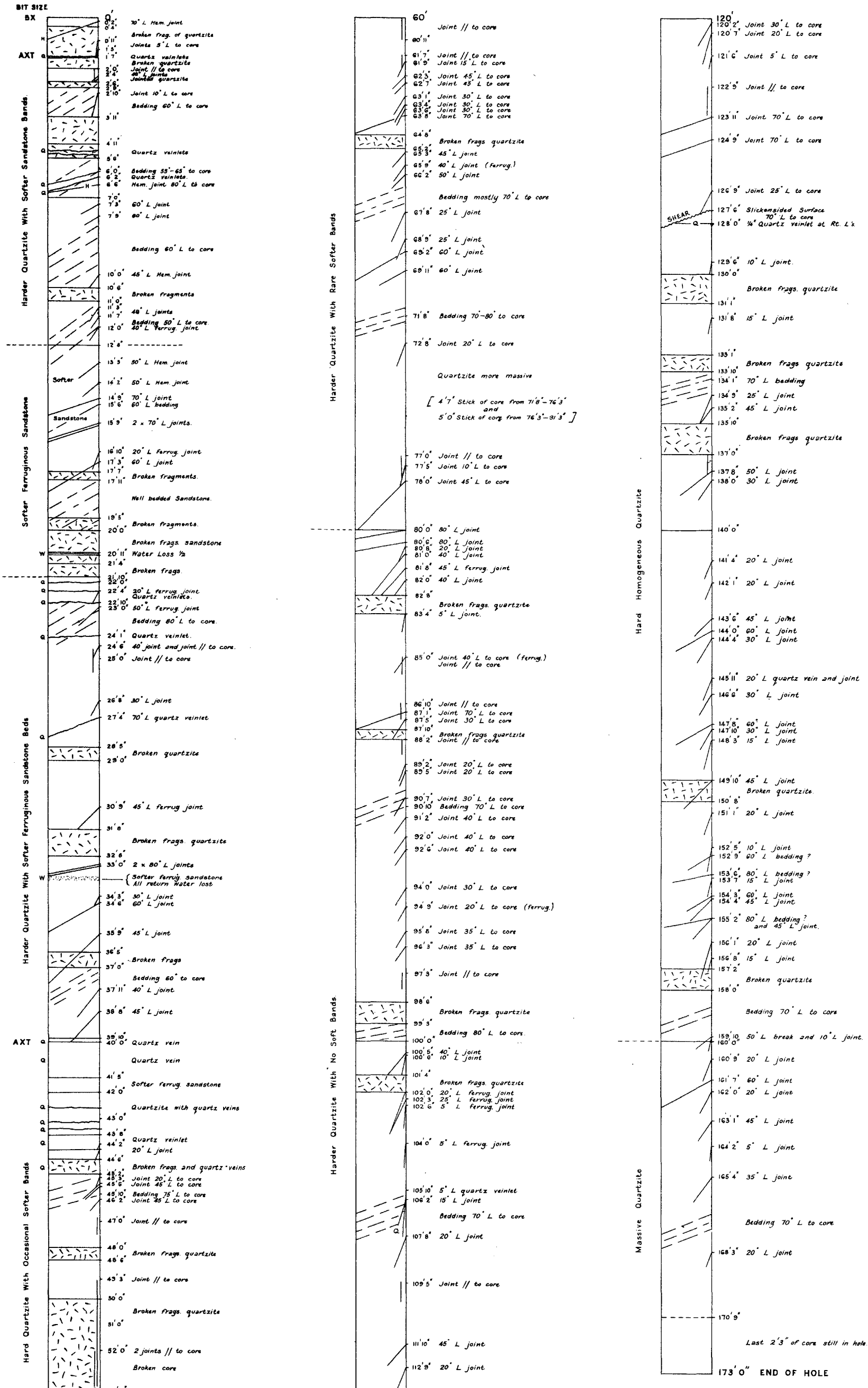
KIMBERLEY G.F.

COLUMN LOG D.D.H. 2 M

BEARING S 57½° W Mag LENGTH 173' 0"
ANGLE OF DEP. −45°

COMMENCED 21·6·60 COMPLETED 13·7·60

SCALE : 1 INCH TO 4 FEET



REMARKS

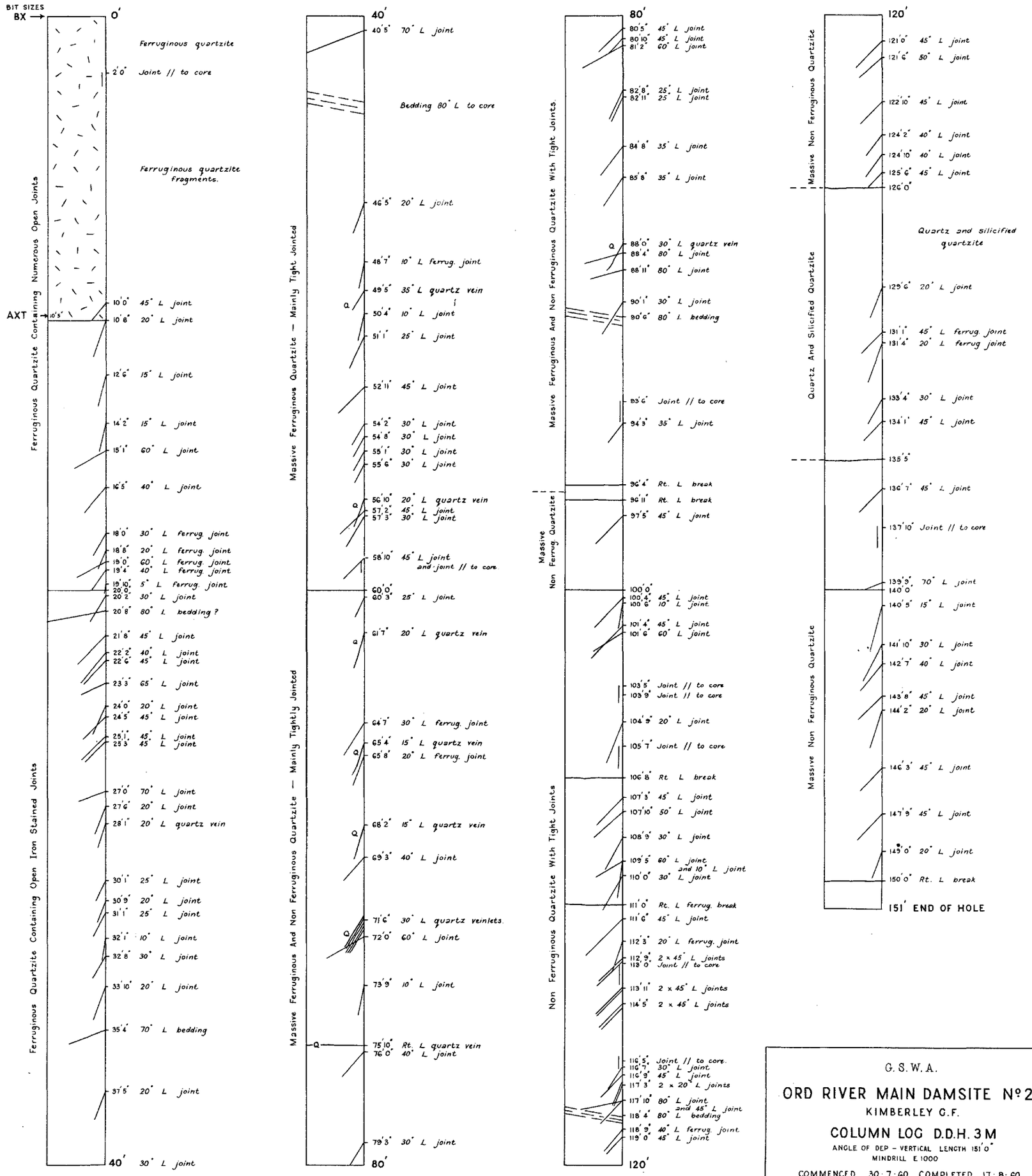
Quartzite encountered in the drillhole between 0−75' considerably shattered and jointed, iron stained and susceptible to caving. All caving in this hole is considered to come from 0−60'. The quartzite is not homogeneous containing numerous ferruginous beds, pale pinkish in colour and quite soft especially where decomposed by water, carried in joints

From 65' to the end of the hole at 173' the quartzite becomes increasingly more massive, (solid sticks of core up to 4'6" being common). The hole was abandoned at 173'0" due to successive caving from higher levels. It was considered that the quartzite between 173'0" and 200' (target depth) would be equally massive

It was not considered warranted that the hole be cemented, in order to drill an additional 27', especially as water testing is yet to follow

J. D Wyatt, Geologist. 13·7·60

PLATE XXIX



G. S. W. A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

COLUMN LOG D.D.H. 3M

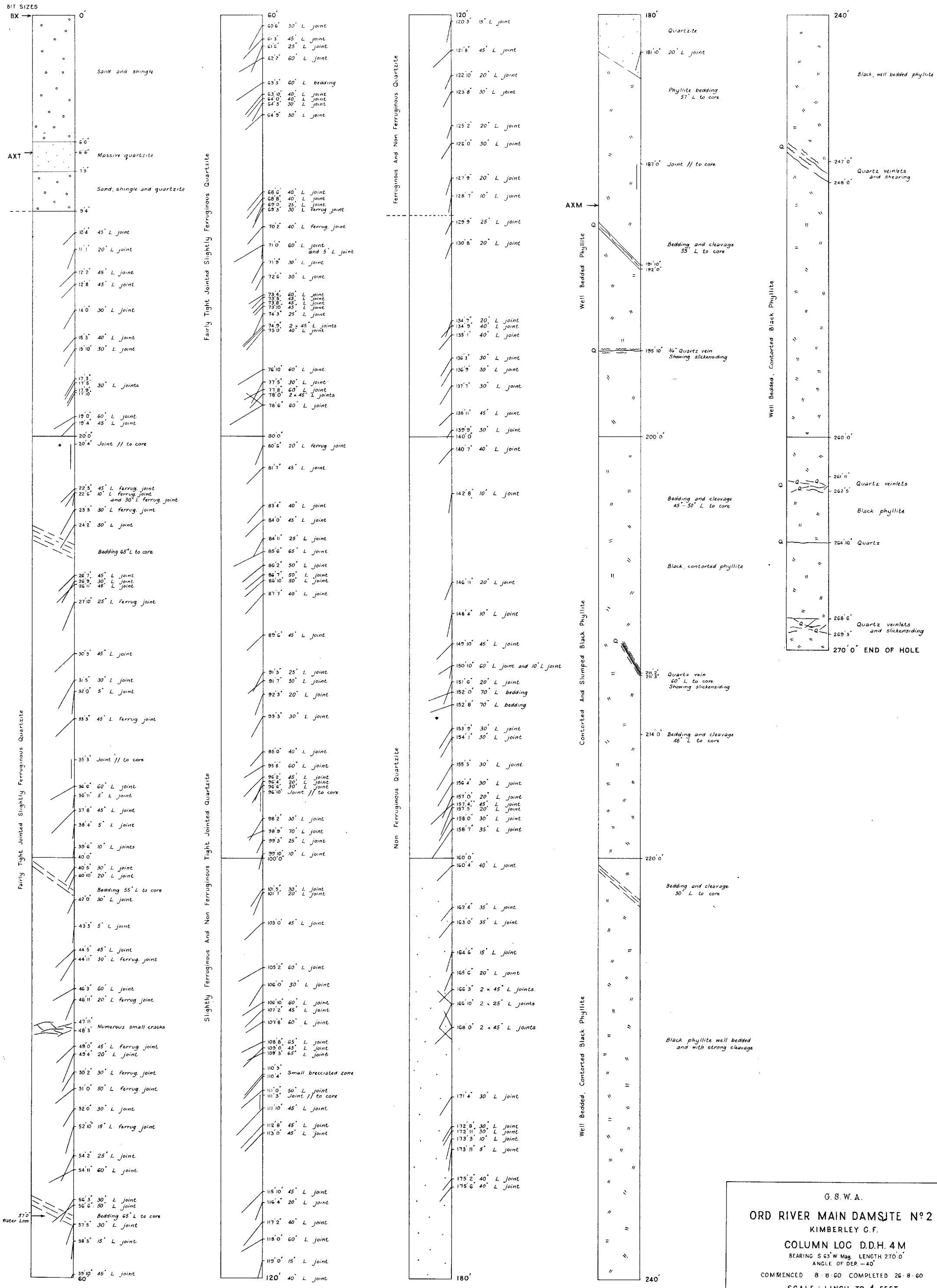
ANGLE OF DEP – VERTICAL LENGTH 151'0"

MINDRILL E 1000

COMMENCED 30·7·60 COMPLETED 17·8·60

SCALE : 1 INCH TO 4 FEET

Prepared by J.D. Wyatt. Aug 1960.



G. S. W. A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

COLUMN LOG D.D.H. 4M

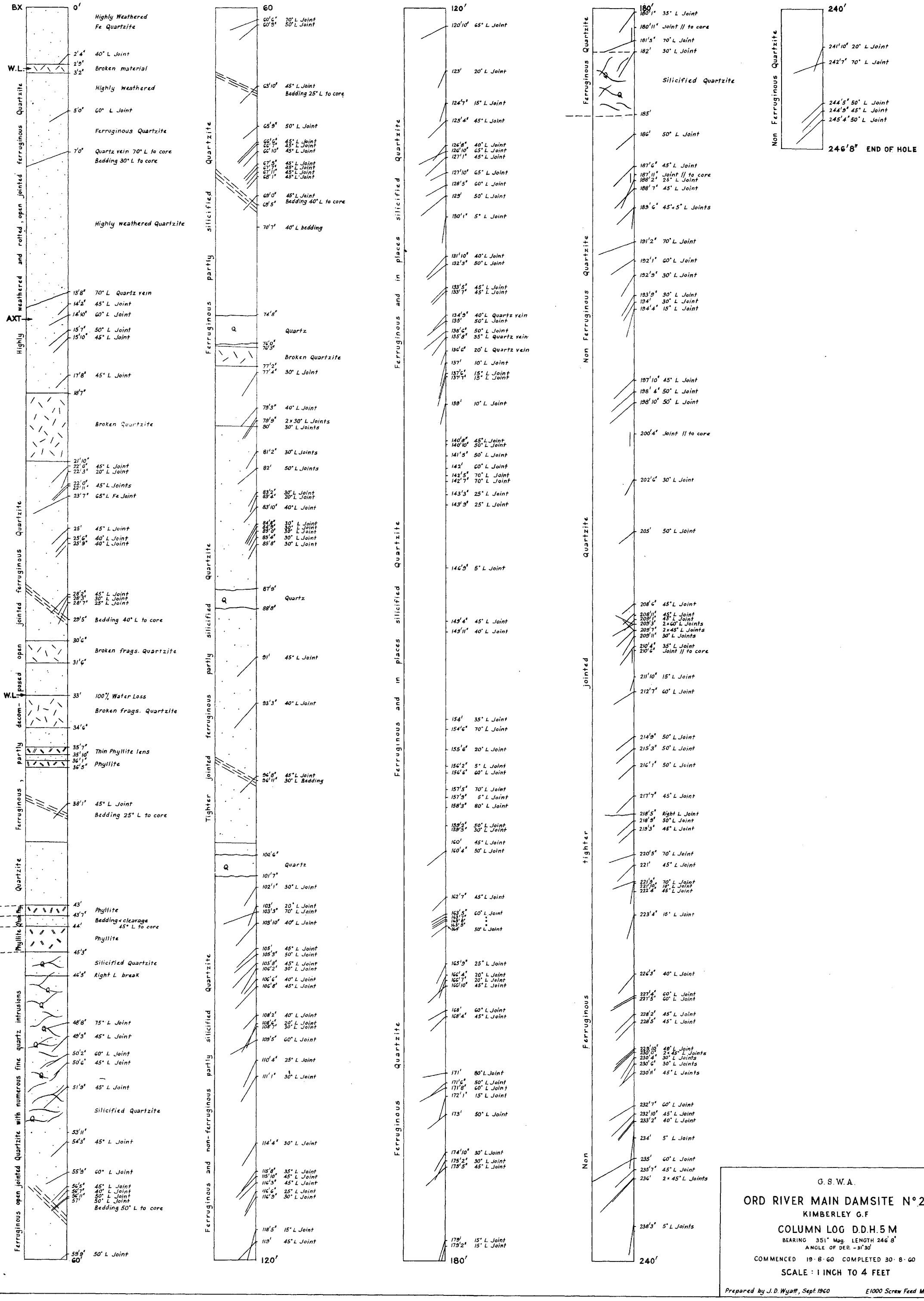
BEARING S 63° W Mag. LENGTH 270'0"
ANGLE OF DEP. – 40°

COMMENCED 8·8·60 COMPLETED 26·8·60

SCALE : 1 INCH TO 4 FEET

Prepared by J D Wyatt, Aug 1960

PLATE XXXI



G.S.W.A.

ORD RIVER MAIN DAMSITE N°2

KIMBERLEY G.F

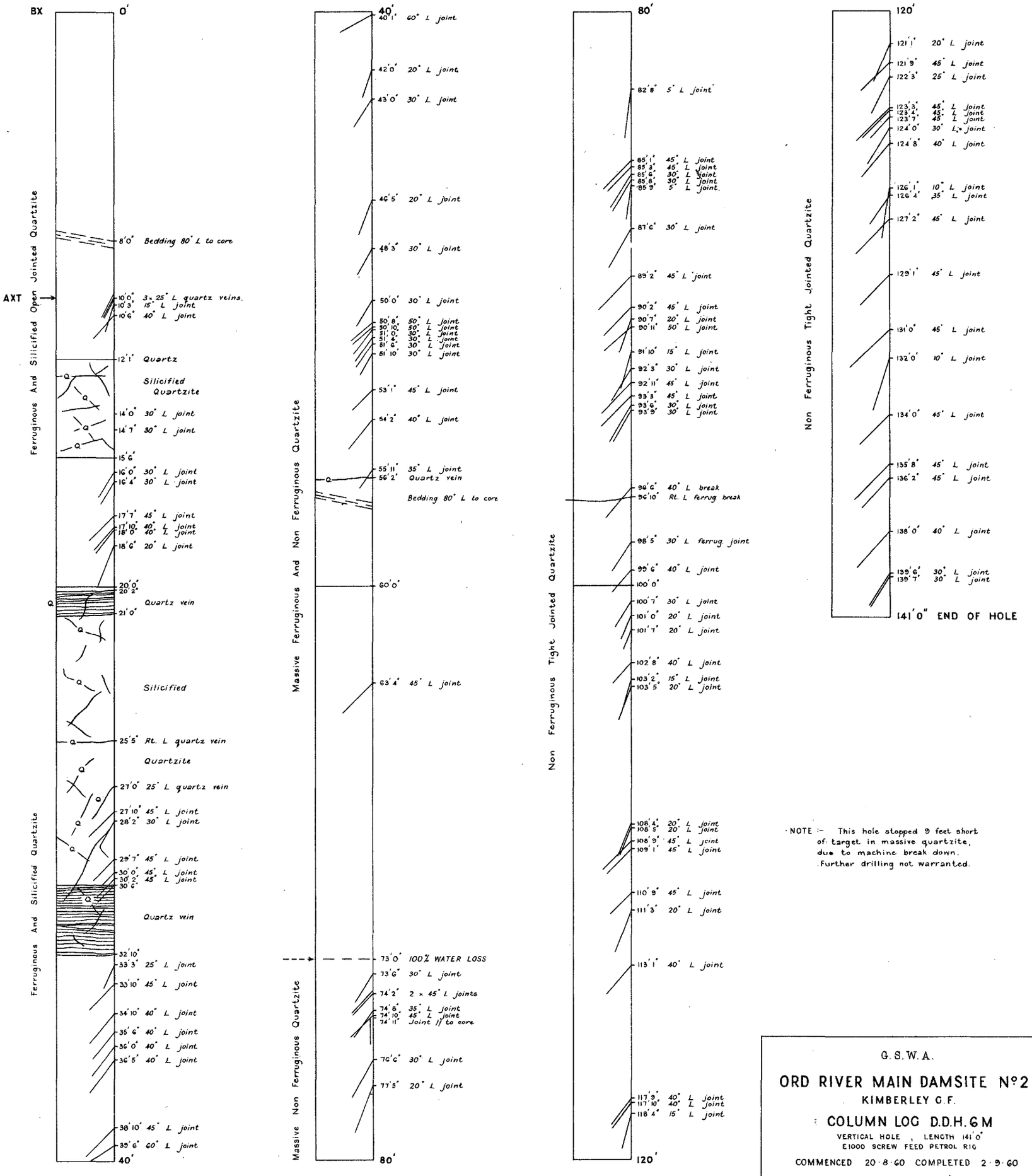
COLUMN LOG D.D.H.5 M

BEARING 351° Mag. LENGTH 246' 8"
ANGLE OF DEP. -31°30'

COMMENCED 19·8·60 COMPLETED 30·8·60

SCALE : 1 INCH TO 4 FEET

Prepared by J.D. Wyatt, Sept. 1960 — E1000 Screw Feed Machine



NOTE :- This hole stopped 9 feet short of target in massive quartzite, due to machine break down. Further drilling not warranted.

G. S. W. A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

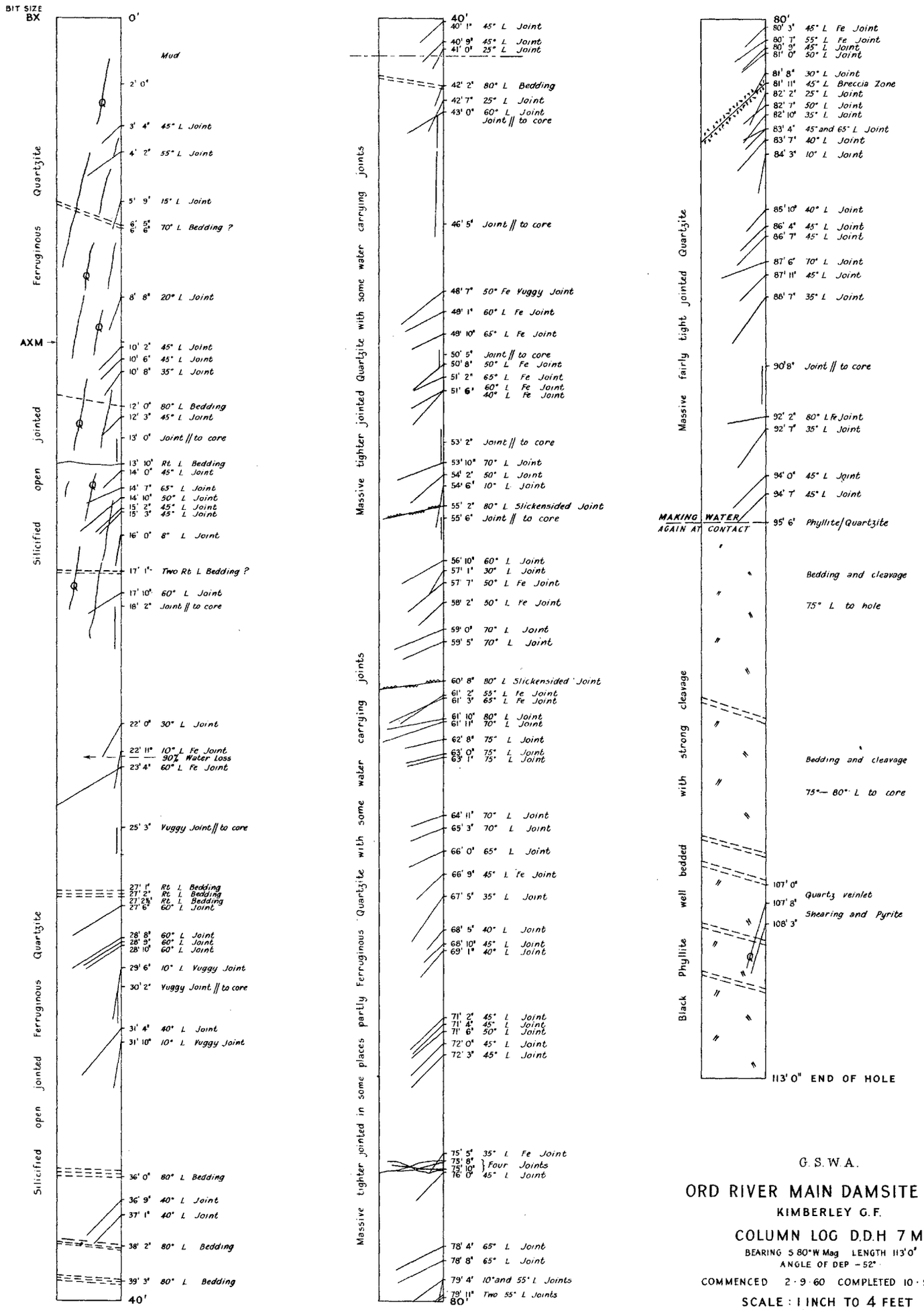
COLUMN LOG D.D.H. 6 M

VERTICAL HOLE , LENGTH 141'0"
E1000 SCREW FEED PETROL RIG

COMMENCED 20·8·60 COMPLETED 2·9·60

SCALE : 1 INCH TO 4 FEET

Prepared by J.D. Wyatt, Sept. 1960.



G. S. W. A.

ORD RIVER MAIN DAMSITE N° 2.

KIMBERLEY G.F.

COLUMN LOG D.D.H 7 M

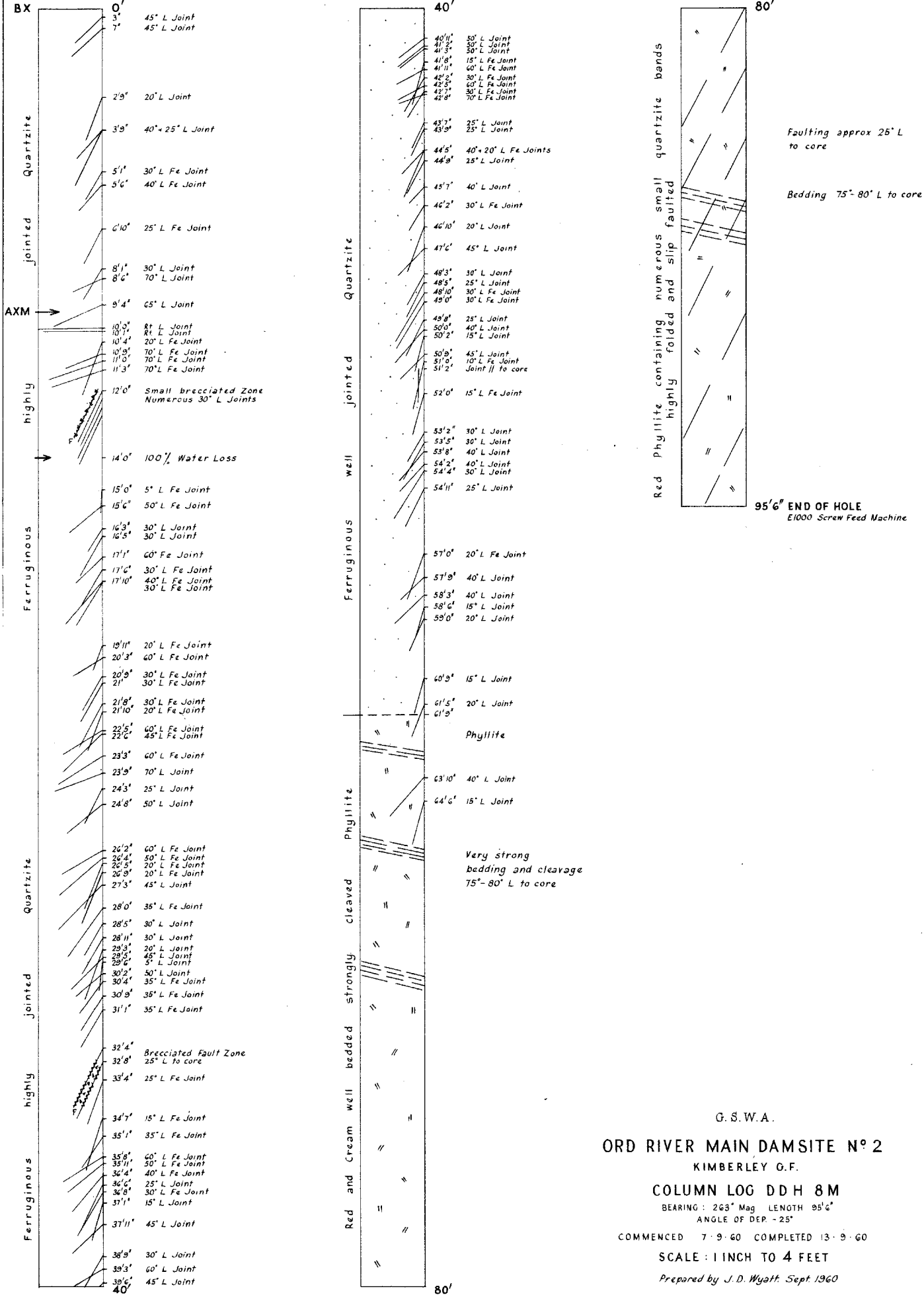
BEARING S 80°W Mag LENGTH 113'0"
ANGLE OF DEP – 52°

COMMENCED 2·9·60 COMPLETED 10·9·60

SCALE : 1 INCH TO 4 FEET

Prepared by :- J.D. Wyatt. Sept 1960.

PLATE XXXIV



G.S.W.A.

ORD RIVER MAIN DAMSITE N° 2

KIMBERLEY G.F.

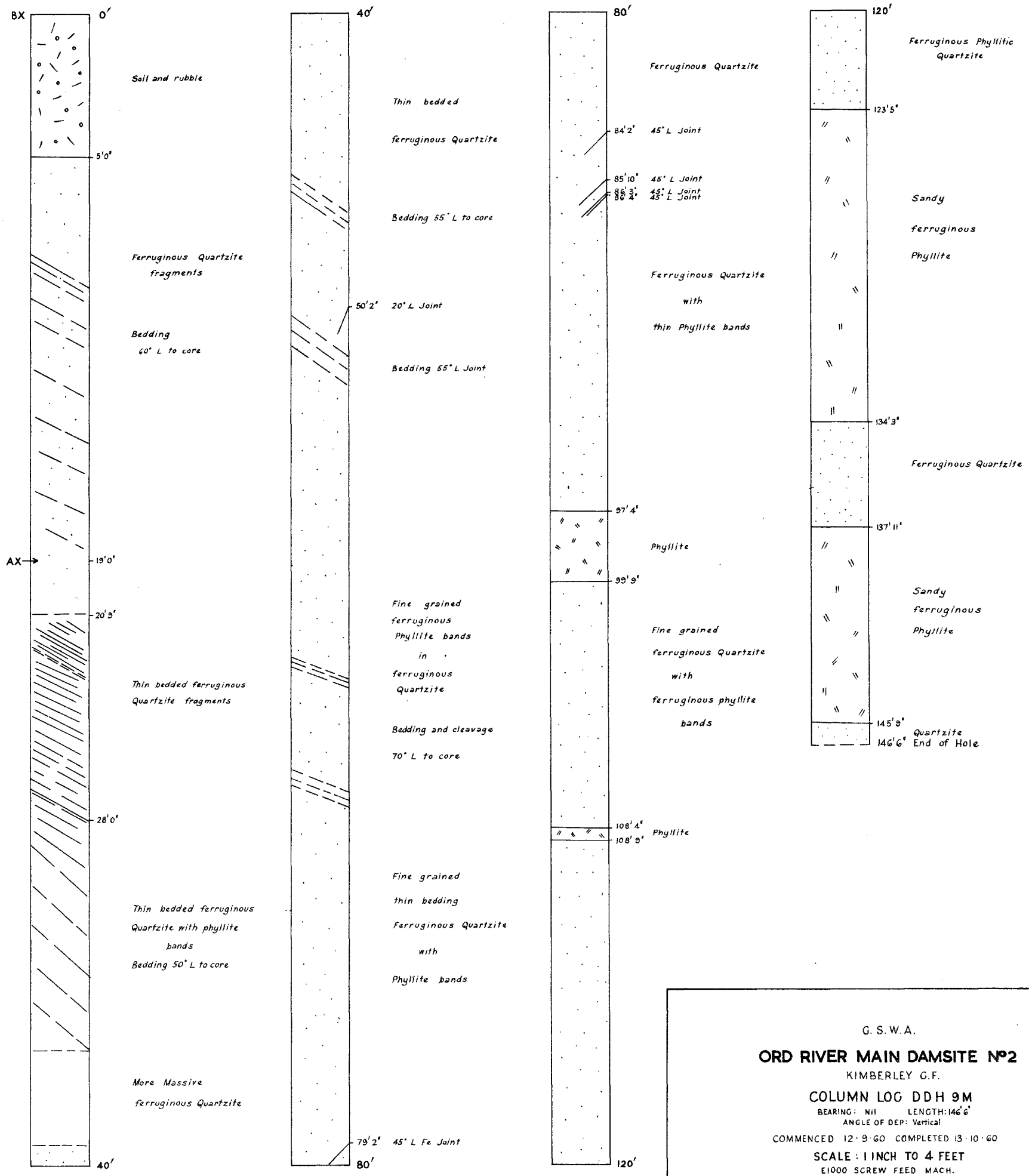
COLUMN LOG DDH 8M

BEARING : 263° Mag LENGTH 95'6"
ANGLE OF DEP. - 25°

COMMENCED 7·9·60 COMPLETED 13·9·60

SCALE : 1 INCH TO 4 FEET

Prepared by J.D. Wyatt. Sept 1960



G. S. W. A.

ORD RIVER MAIN DAMSITE Nº2

KIMBERLEY G.F.

COLUMN LOG DDH 9M

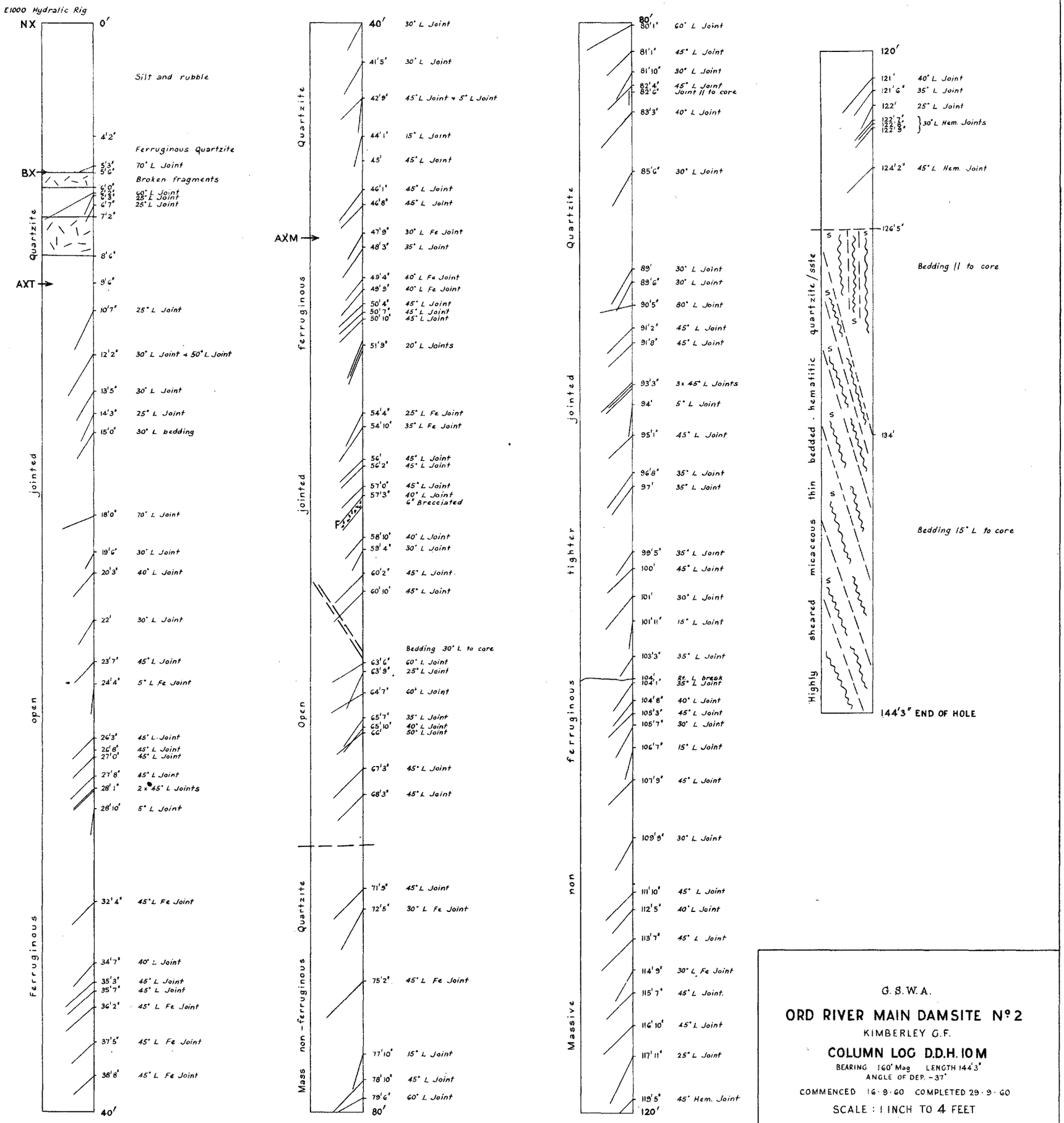
BEARING: Nil LENGTH: 146'6"
ANGLE OF DEP: Vertical

COMMENCED 12·9·60 COMPLETED 13·10·60

SCALE: 1 INCH TO 4 FEET

E1000 SCREW FEED MACH.

Prepared by J. D. Wyatt Sept.-Oct. 1960



G.S.W.A.

ORD RIVER MAIN DAMSITE Nº 2

KIMBERLEY G.F.

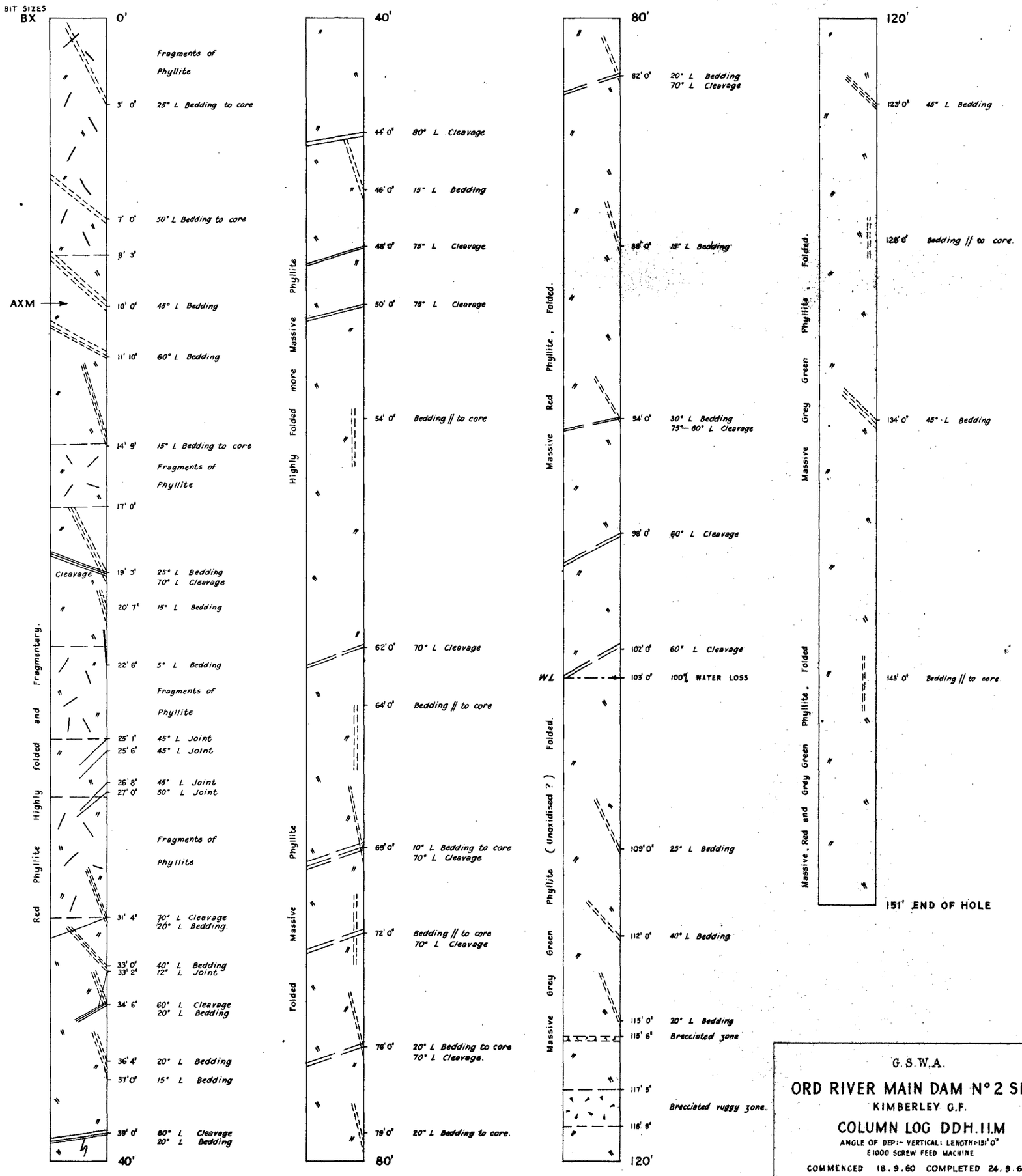
COLUMN LOG D.D.H. 10M

BEARING 160° Mag LENGTH 144'3"
ANGLE OF DEP. - 37°

COMMENCED 16·9·60 COMPLETED 29·9·60

SCALE : 1 INCH TO 4 FEET

Compiled by J. D. Wyatt, September 1960



G.S.W.A.

ORD RIVER MAIN DAM N° 2 SITE

KIMBERLEY G.F.

COLUMN LOG DDH.11M

ANGLE OF DEP:- VERTICAL: LENGTH-151'0"
E1000 SCREW FEED MACHINE

COMMENCED 18.9.60 COMPLETED 24.9.60

SCALE : 1 INCH TO 4 FEET

Prepared by J.D.Wyatt. Sept. 1960.

D.D.H. No. 6M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./ sq. in.)	(ft. head)	(gal./ min.)	
15	23	51	7	10·7	
15	43	51	20	10·2	
30	43	51	20	10·2	No leak on surface except water leaking out of D.D.H. 4.
15	63	50	34	9·8	
30	63	50	33	9·7	
15	83	50	44	8·9	No leak around packing.
30	83	50	46	9·0	Hole caved in at approx. 132 ft.
15	103	50	52	8·5	
30	103	50	52	8·5	
15	123	52	58	8·0	
30	123	51	59	8·1	

D.D.H. No. 3M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./ sq. in.)	(ft. head)	(gal./ min.)	
15	23	52	20	5·3	
30	23	52	25	5·9	
45	23	52	25	5·9	
60	23	52	18	5·6	
15	43	54	20	5·8	
30	43	54	20	5·8	
45	43	54	20	5·8	No surface leaks.
60	43	54	20	5·8	No leaking around packer.
15	63	55	21	6·3	
30	63	55	21	6·4	
15	83	56	28	6·0	
30	83	56	29	6·0	
15	103	55	40	6·2	
30	103	55	42	6·3	
15	123	53	46	6·0	
30	123	53	46	6·0	

D.D.H. No. 5M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./ sq. in.)	(ft. head)	(gal./ min.)	
15	23	50	0	8·0	
15	43	51	10	7·2	
30	43	51	14	7·1	
15	63	40	13	7·1	
30	63	40	15	7·1	
15	83	40	16	6·6	
30	83	40	20	6·5	No surface loss.
15	103	43	23	5·9	No loss around packer.
30	103	44	23	6·0	
15	123	46	30	5·6	
30	123	46	30	5·6	
15	143	56	30	5·4	
30	143	56	30	5·4	
45	143	56	30	5·4	
1 hr.	143	56	30	5·4	

D.D.H. No. 10M.

Time	Depth	Oxygen	Water	Water loss	Remarks
(mins.)	(ft.)	(lb./ sq. in.)	(ft. head)	(gal./ min.)	
15	23	61	54	5·0	
30	23	61	54	5·0	
45	23	61	54	5·0	
1 hr.	23	61	54	5·0	No surface loss.
15	43	68	64	3·4	No loss around packer.
30	43	68	64	3·4	
45	43	68	64	3·4	
1 hr.	43	68	63	3·5	

Photographs.

A photographic record was kept of all core recovered during the season as a precautionary measure for future reference.

Conclusions.

In conclusion it can be stated that the various aims of the diamond drilling programme have been successfully reached and that surface indications have been confirmed.

The two spillway holes have shown that it is unlikely that any useful concrete aggregate will be forthcoming from these localities.

Also the holes laid out along the centre line of the wall on the northern side, namely 4M, 1M, 2M, 3M and 6M have proved the soundness of the ground on this abutment.

The hole designed to intersect the underground power station, D.D.H. 5M, gives every indication that the tunnel will be driven in good non ferruginous massive quartzite, and the additional 6 holes laid out for the 1961 season will no doubt confirm this.

The holes testing the southern abutment namely 7M and 8M have done little to allay the suspicions regarding this area. The thickness of the quartzite cover in two places has been established but the anomalous position of the phyllite in D.D.H. 8M has complicated the underground geological picture.

Additional drilling in 1961 will help to clear up this problem.

Pressure testing has revealed that the ground is open jointed particularly in the first 30-40 feet, as expected from the drill core examined, but in some cases the drill core has revealed an openness not confirmed by pressure test.

However, indications are that the ground is more open than that drilled at Bandicoot Bar and additional grouting will no doubt be needed.

At depths in excess of between 60-80 feet the quartzite was in excellent condition, being both tight jointed and fresh.

Therefore drilling results obtained from the 1960 season give every indication that the construction of the main dam can be accomplished without additional major construction problems and this conclusion should be further supported by the 1961 drilling results.

John D. WYATT,
Geologist.

23rd November, 1960.

RECONNAISSANCE SURVEY OF COMMERCIAL LIME DEPOSITS WITHIN A 15 MILE RADIUS OF ALBANY, S.W. DIVISION.

J. D. Wyatt, Geologist.

Introduction.

Following a request for an investigation into the occurrence of commercial lime deposits in the Albany district, the writer was instructed to visit the area and carry out a sampling programme of all limestone occurrences within a 15 mile radius of Albany.

Albany is situated on the south coast of Western Australia some 252 miles by road from Perth.

Nine days were spent in the locality and with aerial photographs supplied by the Lands and Surveys Photogrammetry Section, a distance of 800 miles was travelled along all visible roads and tracks.

A total of 32 samples were collected, 31 of these being considered sufficiently high in CaO to warrant analysis.

All the deposits of limestone or lime sand were found to be restricted to a narrow coastal strip extending approximately three miles inland.

Geology.

The geology of the area consists of granites and gneisses of the Pre Cambrian basement complex, which are overlain, in the immediate vicinity of the coast by a thin veneer of Tertiary sandy limestones, sandstones, and siliceous or calcareous sand dunes.

Further inland, a siliceous sand cover overlies pisolitic laterite, with local outcrops or granite/gneiss occurring as isolated hills.

The overlying limestones vary in thickness from a few feet along their northern edge to about 200 feet thick along the coastal cliffs, although this thickness is variable.

Generally, these sediments strike E.-W. and dip gently to the north; cross bedding and minor folding were also noted.

Near the coast numerous south west trending sand dunes overlie the older rock types, these dunes are predominantly siliceous but some were partially calcareous and therefore sampled.

Sampling Methods.

Using aerial photographs every visible track and road was investigated, and grab samples of limestone or lime sand, weighing approximately 5 lb. were taken at all likely deposits.

In many cases these surface samples were indurated and possibly enriched, however, in all quarry sampling, the sample was taken from as far below the surface as possible.

Eight samples were submitted from calcareous sand dunes but the analyses show these to be low in CaO and overwhelmingly high in acid insolubles (silica).

Two samples of shell deposits were taken, one on the western side of Princess Royal Harbour and one on the north-western side of Oyster Harbour, both of these were disappointing.

A locality plan is provided showing the positions of the 31 samples collected and a table of analyses carried out by the Government Chemical Laboratories is below.

Lab. No. (1960)	G.S.W.A. No.	Acid-soluble Lime, CaO	Acid-soluble magnesia, MgO	Acid-insoluble material
		per cent. on dry basis	per cent. on dry basis	per cent. on dry basis
11758	13001	38·3	0·80	27·3
11759	13002	50·6	0·60	6·44
11760	13003	53·0	0·37	2·35
11761	13004	46·0	1·09	12·9
11762	13005	42·4	0·56	20·6
11763	13006	47·7	0·86	10·3
11764	13007	8·59	0·75	82·1
11765	13008	5·47	0·27	87·7
11766	13009	50·0	0·74	5·33
11767	13010	42·5	0·92	19·0
11768	13011	12·7	0·07	74·7
11769	13012	5·65	0·09	88·3
11770	13013	52·2	0·68	1·72
11771	13014	36·6	0·04	33·9
11772	13015	43·3	1·30	16·5
11773	13016	23·2	0·04	56·7
11774	13017	46·3	1·10	12·4
11775	13018	45·5	0·91	13·8
11776	13019	31·1	0·52	41·3
11777	13020	35·6	1·73	30·8
11778	13021	47·0	2·26	9·58
11779	13022	50·8	1·11	3·85
11780	13023	26·1	0·81	47·8
11781	13025	6·30	0·46	85·9
11782	13024	52·2	1·36	0·77
11783	13026	46·4	1·06	12·0
11784	13027	7·50	0·43	84·3
11785	13028	6·55	0·34	85·8
11786	13030	8·24	0·28	82·4
11787	13031	6·34	0·54	86·8
11788	13032	53·0	0·54	1·42

Limiting factors controlling Lime for Industrial uses:

(1) Lime for Iron Smelting—
  (a) must contain not more than 6% SiO_2.
  (b) must contain not more than 3% Magnesia.
  (c) must have sufficient crushing strength to support ore in furnace.
  (d) must contain not less than 50% CaO.

It is not considered that the limestones exposed in the vicinity of Albany would have sufficient strength to qualify under clause (c) above.

(2) Cement Industry requirements (most undesirable constituents)—
  (a) free quartz as coarse sand or pebbles;
  (b) gypsum or pyrite;
  (c) not more than 5% Magnesia;
  (d) not more than 4%-5% Fe_2O_3;
  (e) not less than 42% CaO.

Bearing in mind the above analyses and the limiting factors controlling commercial lime, it is possible to disregard 25 out of the 31 samples submitted. Firstly on the basis of CaO content, 42% being the approximate lower limit acceptable and secondly on the basis of acid insolubles, 6% being the upper limit allowable for industry.

However, several of the samples are borderline and would probably be of value, especially where they occur in reasonably close proximity to high grade limestones.

Bearing this in mind the number of samples which can be considered is increased to sixteen, namely samples—

13002- 6 inclusive.
13009-10 inclusive.
13013.
13015.
13017-18 inclusive.
13021-22 inclusive.
13025-26 inclusive.
13032.

From an examination of the sample location map it can be seen that the most promising area for a detailed sampling programme and investigation would be along the south west and southern side of Princess Royal Harbour where four good quality and four borderline grade limestones occur.

It should be noted that in this area all samples were taken from surface outcrops, which could possibly be enriched cappings giving misleading analyses, however, a detailed sampling programme below this capping would confirm the Chemical Laboratories figures.

A second locality in the vicinity of Elleker, south of Lake Powell, has one excellent limestone and two of borderline quality, the mixture of these two could produce a commercial limestone. It should again be noted that all samples were from surface outcrops and furthermore access is rather difficult at the present time.

A third locality, in the Torbay district, contains three deposits of interest, one of high grade and two of low grade limestone. However, all are from surface outcrop and access is poor. Out of the remaining two deposits one (13026) is already being worked, and the other (13024) is in rather inaccessible coastal country at Herald Point.

Of the two shell deposit samples, both were taken from the Harbours themselves, and both were very poor quality. The only good source of shell would appear to be that reported by Woodward in 1913 at the mouth of the Kalgan River, analysis of which is as follows:—

	CaO	$CaCO_3$	Insol.	NaCl	MgO	$(FeAl)_2O_3$
Gastropod bank average	38·58	68·84	25·85	0·10	....	....

Conclusions.

Surface sampling within a 15 mile radius of Albany has indicated:

(1) That detailed investigations for commercial limestone can be confined to a 3 mile strip along the coast;
(2) That detailed sampling be confined to four localities in the following order of importance:—
  (a) south and south west side of Princess Royal Harbour;
  (b) Elleker area south of Lake Powell;
  (c) Torbay area south of the railway line between Tennessee and Kronkup and through to the coast;
  (d) possible in the immediate vicinity of Herald Point, but access is not good.
(3) That any detailed sampling programme be made below the indurated surface capping.

J. D. WYATT,
27/2/61. Geologist.

REPORT ON M.C. 720H FOR BUILDING STONE NEAR WATHEROO, S.W. LAND DIVISION.

Introduction.

M.C. 720H encloses an area of approximately 150 acres comprising part of each of Melbourne Locations 2133 and 2132. The first working pit on the claim is reached from Namban Siding via the homestead occupied by Mr. Mulroy, a total distance of 2.3 miles along existing road and farm tracks.


G.S.W.A.
PLAN OF
LIMESTONE DEPOSITS
ALBANY DISTRICT
showing Location of samples
Scale: 1mile to an inch
To accompany report by J. D. Wyatt, 1961.
Approx. limit of commercial Limestone Deposits, within a 15 mile radius of Albany.
TORBAY
KING GEORGE
SOUND
SOUTHERN
OCEAN
OYSTER
SHELL
HARBOUR
DEPOSITS
SHELL DEPOSITS
PRINCESS ROYAL
HARBOUR
Limestone
MIDDLETON BAY
FRENCHMAN BAY
ISTHMUS BAY
Flinders Peninsula
ALBANY
See Enlarged Plans
SHEET 1
SHEET 2
SHEET 3
SHEET 4
GLEDHOW
ELLEKER
MARBELLUP
LAKE POWELL
INLET
FORT HUGHES
PORT HARDING
Forsyth Bluff
GARDNER LAKE
MOATES LAKE
TWO PEOPLE BAY
MT MARTIN
Common
National Park
Recreation
Quarantine
13001 CaO. 38·3 MgO. 0·80 Insol. 27·3
13002 CaO. 50·6 MgO. 0·60 Insol. 6·44
13003 CaO. 53·0 MgO. 0·37 Insol. 2·35
13004 CaO. 46·0 MgO. 1·09 Insol. 12·9
13005 CaO. 42·4 MgO. 0·56 Insol. 20·6
13006 CaO. 47·7 MgO. 0·86 Insol. 10·3
13007 CaO. 8·59 MgO. 0·75 Insol. 82·1
13008 CaO. 5·47 MgO. 0·27 Insol. 87·7
13009 CaO. 50·0 MgO. 0·74 Insol. 5·33
13010 CaO. 42·5 MgO. 0·92 Insol. 19·0
13011 CaO. 12·7 MgO. 0·70 Insol. 74·7
13012 CaO. 5·65 MgO. 0·09 Insol. 88·3
13013 CaO. 52·2 MgO. 0·68 Insol. 1·72
13014 CaO. 36·6 MgO. 0·04 Insol. 33·9
13015 CaO. 43·3 MgO. 1·30 Insol. 16·5
13016 CaO. 23·2 MgO. 0·04 Insol. 54·7
13017 CaO. 46·3 MgO. 1·10 Insol. 12·4
13018 CaO. 45·5 MgO. 0·91 Insol. 13·8
13019 CaO. 31·1 MgO. 0·52 Insol. 41·3
13020 CaO. 35·6 MgO. 1·73 Insol. 30·8
13021 CaO. 47·0 MgO. 2·26 Insol. 9·58
13022 CaO. 50·8 MgO. 1·11 Insol. 3·85
13023 CaO. 26·1 MgO. 0·81 Insol. 47·8
13024 CaO. 52·2 MgO. 1·36 Insol. 0·77
13025 CaO. 6·30 MgO. 0·46 Insol. 85·9
13026 CaO. 46·4 MgO. 1·06 Insol. 12·0
13027 CaO. 7·50 MgO. 0·43 Insol. 84·3
13028 CaO. 6·55 MgO. 0·34 Insol. 85·8
13030 CaO. 8·24 MgO. 0·28 Insol. 82·4
13031 CaO. 6·34 MgO. 0·54 Insol. 86·3
13032 CaO. 53·0 MgO. 0·54 Insol. 1·42

Inspection.

The writer was directed to the claim by Mr. Mulroy on 29th August, 1960, and a specimen of the stone taken from a trial pit of maximum dimensions 15 feet by 12 feet by 5 feet deep put down by the claimants. The rock is a porphyritic granite with flesh colored feldspar phenocrysts up to 1½ inches maximum dimensions, pale green subhedral crystals of feldspar up to ⅜ inch maximum dimension, quartz and biotite in descending order of abundance in the rock. A little fluorite was seen close to joint planes in the rock. When cut and polished to a plane surface the rock presents an attractive mottled pale green/pale pink color of sufficiently subdued hue to be used in large areas.

Within the claim there are large areas of this stone exposed together with some thin soil covered areas on a north trending low hill which terminates near the northern boundary of the claim. Two reasonably well developed joint planes were observed, one striking north and dipping 80° E, the other striking E.N.E. and vertical. A third possible horizontal jointing was not directly observed. Occasional remnants of a dark green fine grained rock were seen but these were small (less than 6 inch cube) and could be avoided in quarrying.

The ideal quarrying approach would be from the north working south when an increased height of face would result from each cut to a horizontal floor. At the date of inspection a mobile compressor and crane truck had exposed fresh rock at three places on the northern tip of the ridge and approximately 5 cubic yards of stone were lying on the surface.

Of the 150 acres comprising the claim approximately one-eighth at the northern end has been cleared and cultivated. The remainder is comprised of the rocky, north trending low hill previously mentioned with some poor natural pasture and scattered timber.

Conclusions.

On part of Melbourne Locations 2133 and 2132 comprising M.C. 720H there occurs an attractive porphyritic granite suitable for decorative stonework. The mineral claim also covers some 20 acres of cleared and cultivated land.

R. R. CONNOLLY,
Geologist.

1/9/60.

APPENDIX.

Report on Specimen of Facing Stone from M.C. 720H by the Deputy Government Mineralogist.

Lab. No.: 8907/60.

Marks: G.S.W.A. No. 5309.

Result of Examination:

(a) *Mineral Composition.*—The specimen contains microcline and microperthite in slight excess over oligoclase, with quartz, chlorite (after biotite) and accessory minerals magnetite-ilmenite, sphene (leucoxenised in part), fluorite, zircon and apatite.

The plagioclase shows a marked turbidity due to alteration while the potash feldspar shows only minor alteration.

(b) *Colour.*—It is difficult to match exactly the colours of the feldspars with Ridgway standards, but the following are close approximations:—

Potash Feldspar—Ridgway, Plate XXXIX, 5". OO-R. f, "pale brownish vinaceous".

Plagioclase—Ridgway, Plate XXXII, 33". GY-G. f, "pale fluorite green".

(c) *Potential Alkali Reactivity.*—As stone of this nature could find use as an exposed concrete-aggregate as well as a facing stone, it was tested for its possible reaction with the alkalis of cement.

The test was carried out as described in A.S.T.M. Spec. C289-57T. In this test, 25 g. of rock, crushed to — 52 + 100 mesh, is treated in a closed container with 25 ml. of a normal solution of sodium hydroxide for 24 hrs. at 80°C.

The following factors are then measured:—

(i) Reduction in alkalinity (Rc) of the extracting solution expressed as millimoles per litre of solution, and

(ii) Concentration of silica (Sc) in the solution, expressed in the same units.

From the results, the potential reactivity of the material is evaluated as follows:—

If Rc exceeds 70, the aggregate is considered potentially reactive if Sc is greater than Rc.

If Rc is less than 70, the aggregate is considered potentially reactive if Sc is greater than 35 + ½ Rc.

The sample under test gave the following figures:—

Reduction in alkalinity, Rc = 9

Dissolved silica, Sc = 12

and would therefore be classified as not potentially reactive towards cement alkalis.

(Signed) G. H. PAYNE,
Deputy Government Mineralogist.

REPORT ON M.C. 719H FOR BUILDING STONE NEAR WATHEROO, S.W. LAND DIVISION.

Introduction.

M.C. 719H encloses an area of approximately 40 acres lying wholly within the boundaries of Melbourne Location 1174. The claim is reached from Namban railway siding by existing road and track, a total distance of 3.9 miles.

Inspection:

The claim was examined on 30th August, 1960, and a specimen of the stone taken from a small pit broken out by the claimants. The rock is a porphyritic granite with red feldspar phenocrysts of maximum dimension 1½ inches in a dark green ground-mass of quartz and dark green mineral (s). The feldspar constitutes approximately 85% of the rock. The rock when cut and polished to a plane surface presents a very attractive deep red color with flecks of dark green. The color however is so striking that it is unlikely that large areas would be faced with this stone. It would be eminently suitable for feature panels in a lighter or neutral environment.

The main outcrop on the claim, from whence the specimen was taken, is less than 20 yards square but numerous smaller outcrops close by suggest a fairly large lateral extent of granite beneath a thin soil cover. Stone of the deep red color however could be of limited extent if the depth of color is the result of slight alteration due to weathering. Some variations in color were noticed even within the main outcrop area.

Of the 40 acres comprising the mineral claim approximately one quarter has been cleared and pastured. The remainder is virgin bush from which some timber has been taken for fencing purposes. The claim is located on high and in places rocky ground which would normally be excluded from intensive cultivation.

In the granite two observed weakly developed directions of jointing more or less at right angles and in vertical planes will assist quarrying of the stone. A third horizontal joint plane may exist but the flat nature of the outcrop prevented direct observation of this possible joint plane.

Conclusions:

On M.C. 719H within Melbourne Location 1174 there occurs a particularly attractive red porphyritic granite suitable for decorative stone facing work. The mineral claim area is three fourths virgin land largely unsuitable for agricultural purposes and one fourth cleared land in pasture.

R. R. CONNOLLY,
Geologist.

1/9/60.

APPENDIX.

Report on Specimen of Facing Stone from M.C. 719H by the Deputy Government Mineralogist.
Lab. No.: 8908/60.

Marks: G.S.W.A. No. 5210.

Result of Examination:

(a) *Mineral Composition*—Sample contains microcline and microperthite in excess of oligoclase. The plagioclase is in general fairly clear while the potash feldspar shows a slight turbidity and a marked red colour even in thin sections.

Other minerals are quartz, chlorite and iron oxides, with accessory zircon and apatite. No sphene or fluorite were seen.

(b) *Colour.*—The Ridgway colour of the feldspar was found to be a slight variation of "dark mineral red" or "mineral red" (Plate XXVII, 1". RED, K or m).

(c) *Potential Alkali Reactivity.*—Tests gave Rc =10, Sc = 11, so this rock would also be innocuous if used as a concrete aggregate.

(Signed) G. H. PAYNE,
Deputy Government Mineralogist.

REPORT ON DIAMOND DRILLING OF ABANDONED GOLD SHOWS D.D.H. NO. C4, SITE B2, "FOREST KING" G.M., LATE G.M.L. 284, COOLGARDIE.

By R. R. Connolly,
Geological Survey of W.A.

Introduction.

This drill hole is the second of a two hole programme designed to test at depth the Forest King Gold Mine. Details of the mine regarding location and access, production, the ore body and the purpose of the drilling programme have been published previously[1] and will not be repeated here. In brief, the conclusions arrived at on completion of the first hole were that the downward extension of the "Forest King" reef had been intersected but at that point contained no gold.

Hole No. C4 was drilled from site B2 which was located 828 feet on a bearing S 86° E from the main shaft, the azimuth of the drill hole being 292° and the angle of depression 60°. Based on the results of the first hole it was estimated that the ore channel would be cut at 950 feet and that the hole would be continued for at least 100 feet into the footwall rocks.

Mineralisation and Assay.

A total of five samples were submitted for assay to the Government Chemical Laboratories, the results of these assays being shown in the appended table.

Between 964 feet and 973 feet in the drillhole quartz-carbonate veins with some accessory pyrite occurred in greater number and size than elsewhere in the hole. It is considered that this zone represents the downward continuation of the Forest King reef which at this point is very weak and barren of gold mineralisation.

The two other samples from a greater depth were of veins of no more than 12 inches true width and these also were devoid of gold.

Surveying.

The drill hole was surveyed at intervals of 200 feet by an officer of the State Mining Engineer's Branch and the results of the survey shown in the appended table show that the hole followed a steady course with little deflection.

[1]Report on Diamond drilling of abandoned Gold Shows D.D.H. No. C3, Site B1, "Forest King Gold Mine," late G.M.L. 284 Coolgardie. Annual Progress Report Geological Survey of W.A. 1959.

Core Recovery.

An analysis of the core recovery is as follows:—

Depth From	Depth To	Core Recovered	Per cent. Recovered
ft.	ft.	in.	
0	200	810	33·7
200	1,112	10,773	98·4
0	1,112	11,583	86·8

Conclusions.

In the second and final drill hole of a programme designed to test the possible depth extension of the "Forest King" G.M. a poorly developed quartz-calcite zone was intersected in the target area but it carried no gold. Two separate footwall veins were similarly barren.

R. R. Connolly,
2nd August, 1960. Geologist.

"FOREST KING" G.M.
Late G.M.L. 284.
Temporary Reserve 1636H.
Crown Diamond Drilling.
D.D.H. No. C4, Site No. B2.
Sample List.

G.S.W.A. Sample No.	Drill Hole depth From	Drill Hole depth To	Core Length	Assay	Remarks
	ft. n.	ft. in.	in.	dwts/long ton	
GS/C/39	964 0	967 0	36	Less than 0·1	Quartz-carbonate representing the ore channel.
GS/C/40	967 0	970 0	36	Less than 0·1	
GS/C/41	970 0	973 0	36	Less than 0·1	
GS/C/42	1,049 0	1,052 0	36	Less than 0·1	
GS/C/43	1,072 0	1,075 0	36	*Nil*	

Survey Results.

Depth	Angle of Depression	Azimuth	Remarks
ft.			
200	58°	N 67° W	Hole cased to 120 feet
400	58°	N 65° W	
600	57°	N 65° W	
800	55°	N 64° W	
1,100	53°	N 64° W	

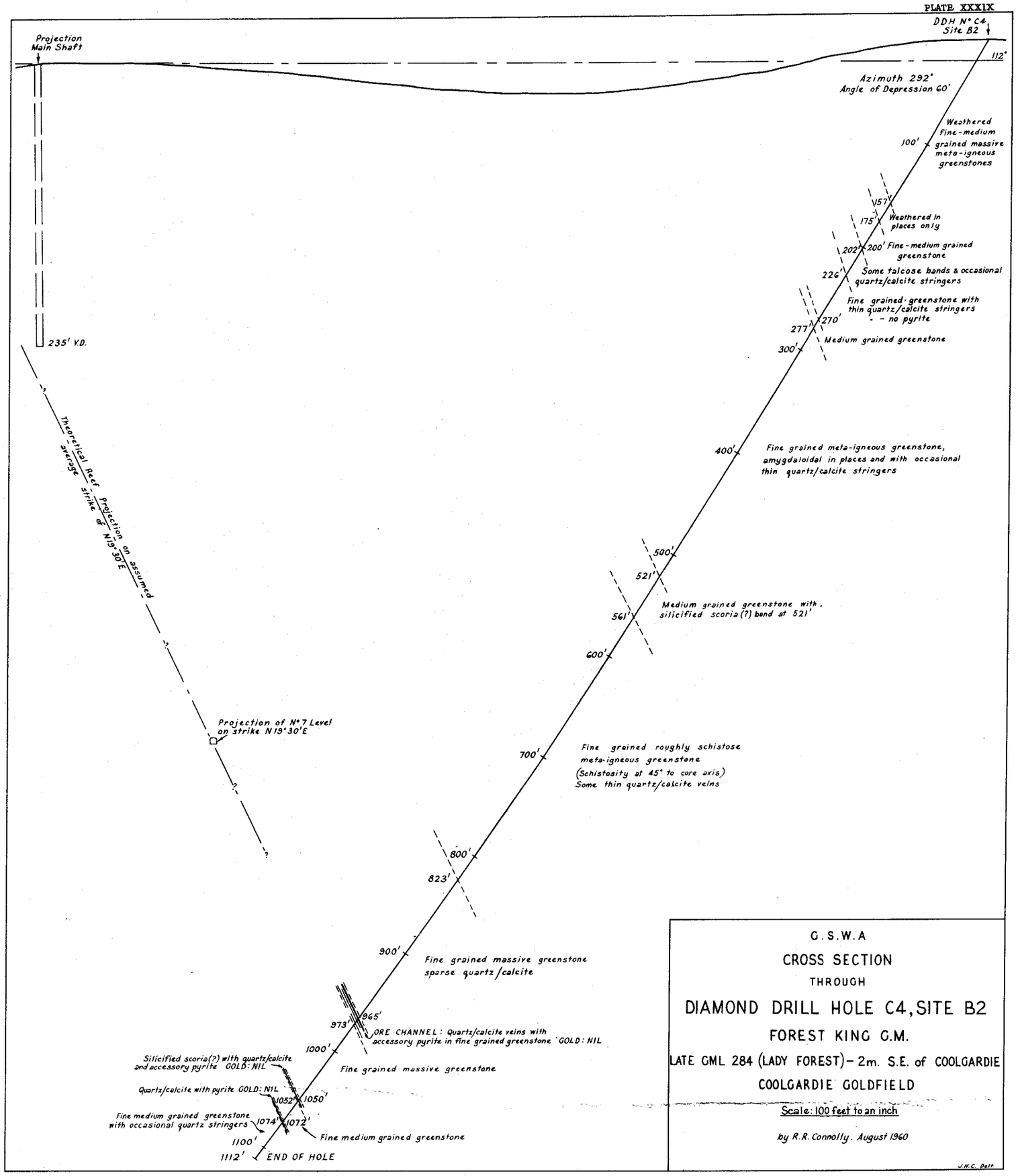
"FOREST KING" G.M.
Crown Diamond Drilling.
D.D.H. No. C4, Site No. B2.

Position of Hole Collar: 828 feet S 86° E from main shaft.
Azimuth: 292°. Machine Used: Mindrill A2000.
Angle of Depression: 60°. Core Size: AXT.
Commenced: 18th August, 1959. Completed: 17th June, 1960.
Drillers: Jennings, Cant & Rees.
Total Depth: 1112 feet. Logged by: R.R. Connolly.

Summarized Log.

From ft.	From in.	To ft.	To in.	Description
0	0	157	0	Weathered fine-medium grained massive meta-igneous greenstone.
157	0	175	6	Fine grained massive greenstone weathered in places.
175	6	202	0	Fine-medium grained greenstone.
202	0	226	0	Fine-medium grained greenstone with some pale green talcose bands and occasional thin quartz/calcite stringers.
226	0	270	0	Fine grained greenstone with some irregular quartz/calcite veins, no visible pyrite.
270	0	277	0	Medium grained greenstone with occasional thin quartz/calcite veins with a little pyrite.
277	0	521	0	Fine grained meta-igneous greenstone. Amygdaloidal in places and with occasional thin quartz/calcite stringers.
521	0	561	4	Medium grained greenstone with silicified breccia (?) or scoria (?) at 30° to core axis at 521 feet.
561	4	823	4	Fine grained roughly schistose meta-igneous greenstone, schistosity at 45° to core axis. Some thin quartz/calcite veins.
823	4	965	0	Fine grained massive greenstone.
965	0	973	0	Fine grained greenstone with more abundant quartz/calcite veins and some accessory pyrite.
973	0	1,050	0	Fine grained massive greenstone.
1,050	0	1,052	0	Silicified scoria (?) with quartz/calcite and accessory pyrite.
1,052	0	1,072	6	Fine-medium grained greenstone with some thin quartz stringers.
1,072	6	1,074	0	Numerous quartz/calcite veinlets with accessory pyrite.
1,074	0	1,112	0	Fine-medium grained meta-igneous greenstone with occasional quartz stringers.
				END OF HOLE.

PLATE XXXIX



G.S.W.A

CROSS SECTION

THROUGH

DIAMOND DRILL HOLE C4, SITE B2

FOREST KING G.M.

LATE GML 284 (LADY FOREST) – 2m. S.E. of COOLGARDIE

COOLGARDIE GOLDFIELD

Scale: 100 feet to an inch

by R.R. Connolly. August 1960

J.H.C. Delt.

REPORT ON EXAMINATION OF G.M.L. 1942N, "MARGUERITTA" G.M., CHESTERFIELD, MURCHISON GOLDFIELD.

By R. R. Connolly.

Introduction.

The Margueritta mine is located some 33 miles west-north-west of Meekatharra and is reached via the Belele Station road for 23.5 miles, thence westerly by track from the turnoff which is sign-posted "Chesterfield," the total distance from Meekatharra being 34.9 miles.

The writer, assisted by Mr. B. Dawson, cadet draftsman, Mines Surveys Branch, made a surface plane table and telescopic alidade survey of the lease and an underground tape and compass survey of the operating mine in May, 1960. The mine owner, Mr. P. Cassey, readily gave assistance when required.

The object of the work was to determine the suitability of the mine for exploration by surface diamond drilling methods.

General Information.

The Margueritta Lease was first worked in 1900 and produced 3837.47 fine ounces of gold from 3810.51 tons of ore and an additional 106.92 fine ounces from dollied and specimen stone between then and 1909.

Montgomery[1] reported that the mine had been worked out to a depth of 100 feet at which stage further efforts at delevopment had been thwarted by the influx of water estimated at 6,000 gallons per hour in the bottom level, the water rest level being at approximately 60 feet. Montgomery described the ore body as a well defined, north plunging quartz reef averaging 3 to 4 feet wide, striking N.N.W. and dipping at 45° E.N.E. in the lower level. Near the surface, however, as evidenced by the exposed stopes, the dip is vertical or very steep to the East.

According to the present owner, a further attempt to reach the down dip extension of the ore body was made around 1910 by sinking two shafts further to the East in the hanging wall, but although the more southerly of these two shafts cut a quartz body, both were abandoned because of the inability of available equipment to handle the water. It was on these two shafts that Cassey in 1951 commenced the most recent attempt to mine the old company main reef at depth.

Meanwhile, two further production periods are recorded, viz. 1935-36, 113 tons of ore for 38.75 fine ozs. gold and 1947 when 6 tons of ore yielded 16.81 fine ozs. It is not known from which part of the lease this ore was taken.

In 1951 the present owner of both G.M.L. 1942N "Margueritta" and 1946N, "Margueritta East," commenced to recondition and deepen both of the abovementioned hanging wall shafts, calling the northerly shaft his "main shaft" and the southerly shaft his "ore shaft" (see accompanying plan). In the ore shaft the quartz body proved to have payable values towards the footwall and additionally the first few feet of the footwall consisted of schistose lodestuff with good values. At this stage, this ore was considered to be the southerly strike extension of the old main reef faulted eastwards. The ore was worked from the No. 1 (84 feet) level and the No. 2 (124 feet) level, with water difficulties increasing with depth.

Northerly development of the No. 1 level passed out of ore underfoot 147 feet along the drive from the ore shaft, but the top of the ore body was picked up again at a depth of 101 feet in the main shaft. A cross cut westerly from the main shaft located another ore body which the writer considers to be the down tip extension of the old main reef worked in 1900-1909.

Examination of the Lease.

A surface examination of the lease was made using a plane table and telescopic alidade resulting in the accompanying plan at a scale of 100 feet to an inch. The main rock type outcropping on the lease is a talc-chlorite-schist. The strike of the vertical schistosity is generally N 25° W which is apparently coincident with the bedding of thin chert bands near the north eastern edge of the schistose rock zone. To the north east a fine grained dark green epidioritic rock crops out and this rock, being quite massive, is considered to be an intrusive sill.

Auriferous quartz mineralization has taken place along the planes of schistosity and may have been localized by a fault zone or zones in the same direction. No direct evidence of this was seen but the large influx of water in the mines strongly suggests a shattered zone of some magnitude.

Later displacement of the ore bodies may have taken place along possible north-easterly cross faults with the north block moving eastwards, but this is based on rather inconclusive surface evidence and has not been proven in underground workings.

The present worked ore body has been cut by a dyke, probably an offshoot of the large sill mentioned above.

A survey of the present underground workings was made using a compass and tape. A high degree of accuracy is not claimed for this work, which in the bottom level was carried out under difficult conditions. The accuracy is sufficient however for the class of examination. Results of the survey appear on the accompanying plan and sections at a scale of 50 feet to an inch.

The Ore Body.

The ore body at present being mined is a quartz reef with a variable strike averaging N 38° W and a dip varying between 45° and 70° to the east. The upper limit of mineable ore is well defined and above this the ore body gives way to narrow quartz veins (total 18 inches wide at surface outcrop) or in some cases merely quartz leaders. The attitude of the ore body as determined by the backs of the stopes from the No. 1 level indicates a plunge of 20° in a plunge direction approximately N 25° W.

Length.—On the No. 1 level the ore has been worked for 250 feet and ore is still in sight on the south face of the drive. On the No. 2 level 105 feet has been worked and ore remains in sight on both north and south drive faces. Extrapolating the ore body from the north end of the No. 2 level to the ore intersection obtained in the main shaft gives a length of 270 feet at this level with further ore at both ends.

Depth.—From the top of the south stope, No. 1 level (which is 30 feet below the surface) to the bottom of the No. 2 level (124 feet below the surface) gives 94 feet maximum known vertical depth with ore underfoot on the No. 2 level.

Width.—The thickness of the quartz reef where worked is not accurately known in most places as neither the hanging wall nor the footwall have been exposed except at a few points. Existing stopes vary from 3 to 7 feet true width as shown on the longitudinal projection. Additionally some lodestuff up to 3 feet wide occurs at the footwall of the quartz reef and it has been in this material that best values have been obtained. On existing openings therefore it would be safe to assume a mineable width of 5 feet.

Grade.—The present owner has taken 2,960 tons of ore from the workings mapped for a return of 710 fine ounces gold and 6.65 ounces silver over the plates indicating a grade recoverable by amalgamation of 4 dwts. 18 grains per long ton. The sands, which have not been treated, are reputed to contain better than 3 dwts. per ton. The overall grade of the ore body could therefore be 8 dwts. per ton.

The grade of the old main reef was approximately 1 oz. per ton and if, as the author suspects this is the reef exposed in the crosscut from the main shaft, then prospects are good for high grade ore from this source.

Conclusions and Recommendations.

In attempting to reach the deeps of the original Margueritta main reef, the present owner has discovered and profitably worked a parallel reef to the west. Difficulties with water and the necessity

[1]Montgomery A.: Report on the State of Mining Progress in Certain Centres in the Murchison and Peak Hill Goldfields. Department of Mines, 1909.

for exploratory development work recently caused the owner to seek financial assistance by way of loan from the Government and this was granted. Use of this loan money resulted in the location of the old main reef and the relocation of the east reef to the north despite adverse labour conditions and other setbacks.

The relationship between the old main reef and the currently worked reef is not known, and the new reef could be the faulted southerly extension of the old. No evidence to suggest this was seen however and the two reefs could equally well be separate parallel bodies.

Future exploratory work to ascertain the extent of both ore bodies in the direction of plunge of the known gold shoot could be well done by surface diamond drilling in view of present difficulties with water in the lower level. If drilling is successful, further capital expenditure to improve the working conditions of the mine, in particular the drainage, would be necessary. In this regard, water taken from the mine should be taken well away, preferably to the east, not immediately to the south as at present practised.

No driving should be attempted on the old main reef from where presently exposed. The extent of the old workings is not accurately known, but they could be close to the present workings and a danger of quick flooding from the old mine is apparent.

13/6/60. R. R. CONNOLLY.

REPORT ON SUBSIDISED DIAMOND DRILLING, MOUNTAIN VIEW NORTH PROSPECT, G.M.L.'S 573D, 671D, 674D, DAY DAWN, MURCHISON G.F.

Approximate Latitude: 27° 25′ S.
Approximate Longitude: 117° 45′ E.

By W. R. Jones, B.Sc. (Hons.), Geological Survey of W.A.

Introduction.

Day Dawn is a siding on the Meekatharra railway line 400 road miles from Perth. It once served the rich Great Fingall gold mine but is now abandoned save for occasional prospecting activities.

In August, 1960 the Geological Survey was asked to supervise the drilling programme commenced by Western Queen (1936) N.L. and agreed to on a £ for £ basis by the Mines Department. At the date of the request one hole had been completed and a second commenced.

The programme was initiated by Western Queen (1936) N.L. as optionors to prospect north of the Mountain View mine for further rich ore shoots of the type which had produced some 48,429 fine ounces of gold from 21,998 tons of ore which was produced by a party in the period August 1941 to 1947 and by the Mountain View Company from 1947 to 1957.

A Drilling Plan and Sections accompany this report.

Drilling.

The drill sites had been selected and pegged for Western Queen (1936) N.L. by a consultant company in May and June, 1960. Drilling commenced on 18th July, 1960, and by 31st December, 1960, seven holes had been completed for a total footage of 2,699 ft.

A further 411 ft. were drilled in hole No. 10 which was commenced on 9th January, 1961, and completed on 24th January, 1961. Two sites between holes Nos. 1 and 3 and between Nos. 3 and 5 on the eastern line (see plan) were not drilled because of the disappointing results, and work ceased with the completion of hole No. 10.

Core recovery was excellent apart from a few isolated sections which were in all cases highly oxidised zones related to shearing.

Geology.

References:

1907—Woodward, H. P.: A Report upon the Geology together with a Description of the Productive Mines of the Cue and Day Dawn Districts, Murchison Goldfield. *G.S.W.A. Bull. 29.*

1950—Gray, N. M. Report on the Proposed Diamond Drilling of the Great Fingall Orebody, Day Dawn, Murchison Goldfield. *G.S.W.A. Ann. Prog. Rept. for 1948.*

1953—McMath, J. C.: A Reconnaissance Survey of the Cue and Day Dawn Districts, Murchison Goldfield, W.A. *G.S.W.A. Ann. Prog. Rept. for 1950.*

1960—Noldart, A. J.: Report on Diamond Drilling of the Great Fingall Quartz Reef in Depth. *G.S.W.A. Ann. Prog. Rept. for 1959.*

The rich Mountain View ore shoot was in a pronounced "S" curve in the Fingall reef immediately to the north west of the Great Fingall mine. North block west movement along the north westerly striking reef had offset the margin of the north easterly striking dolerite host. The Mountain View "S" is in this offset with a dolerite footwall and a slate hanging wall. The oreshoot plunges westerly at about 50°. The ore was characteristic Fingall grey blue quartz with abundant free gold.

On the surface the reef splits going north from the Mountain View workings. It was thought that there was a possibility of the repetition of the "S" on one of these branches paricularly as the footwall reef shows a strong bend near 1550 N. 800 E. The limited target (40 ft. long) presented by a Mountain View oreshoot within any "S" structure which may have been found necessitated drill holes at a 40 foot spacing.

The relationship of the Mountain View orebody to the Great Fingall mine is shown by the Composite Plan of the workings, and the Longitudinal Section accompanying Noldart's Report. Gray (1950) gives some notes on the mapping done by him, but the map was not published. The board geological features are shown by McMath (1953).

Results.

The most important intersection was 36 inches of quartz assaying 25.3 dwts/long ton from 99 ft. to 102 ft. in hole No. 1. This was on the hanging wall reef at a vertical depth of 85 feet. The eastern line of drill holes intersected the footwall reef as planned but the dwt/in value of assayed sections was low, and there was no development of the "S" structure.

Intersections of the hanging wall reef at about 300 ft. vertical depth in the western line of holes were as planned in holes Nos. 6, 7 and 8, but no reef as planned but the dwt/in. value of assayed No. 10 was much shallower than expected.

It was recommended that there be no further testing of the reefs. There is a possible target down plunge from the 25.3 dwts intersection in hole No. 1, but the absence of reef from holes Nos. 9 and 10 indicates that the size of any shoot is extremely limited.

Details of core, samples and assays follow.

W. R. JONES,
Geologist.

1/3/61.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L'S 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V.1.

Hole No. M.V.1, Site A.1.

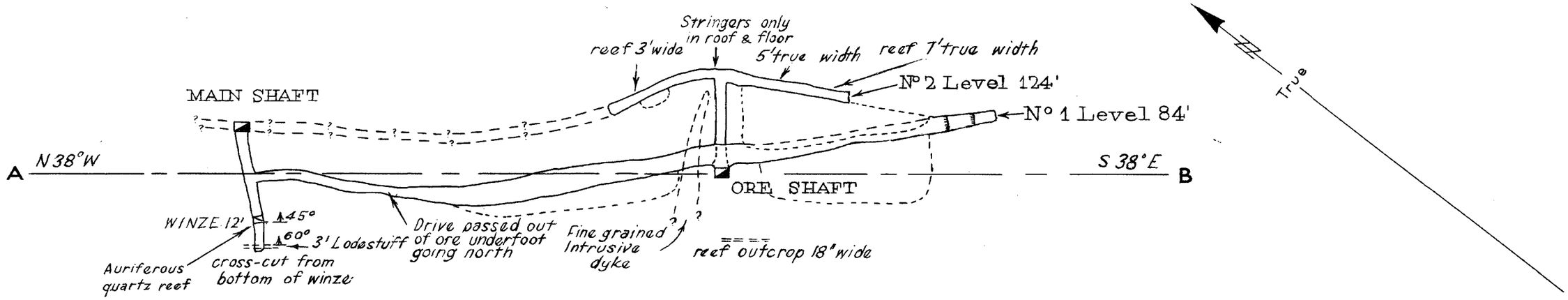
Station: 1490N, 475E (G.S.W.A. Great Fingall drilling co-ordinates).

Angle of Depression: 65° collar, 65° at 350′ (acid tube).

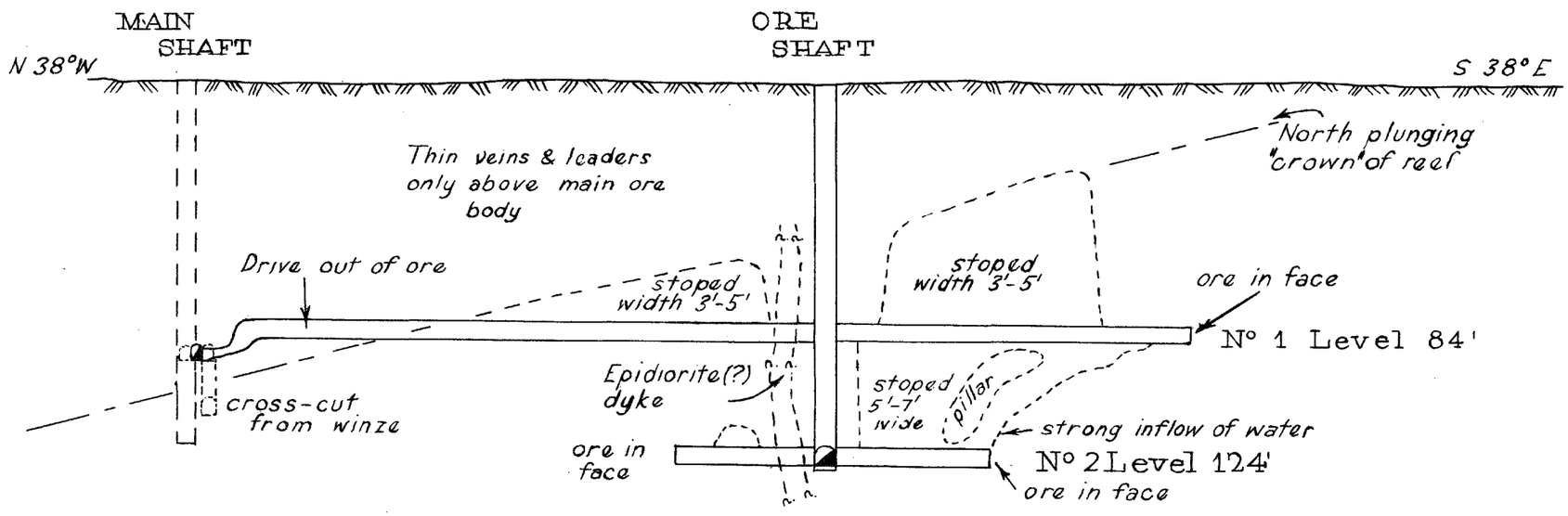
Azimuth: 90° T. Core Size: AXT.

Commenced: 17th August, 1960. Contractors: K. & W. H. McCallum.

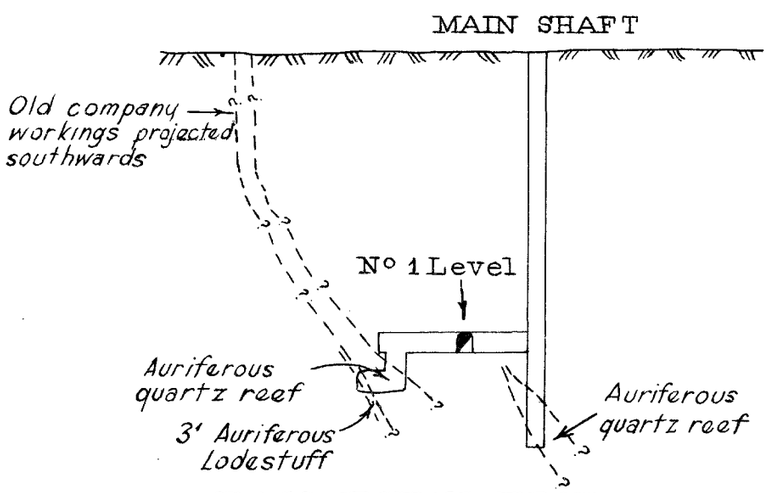
PLATE XL



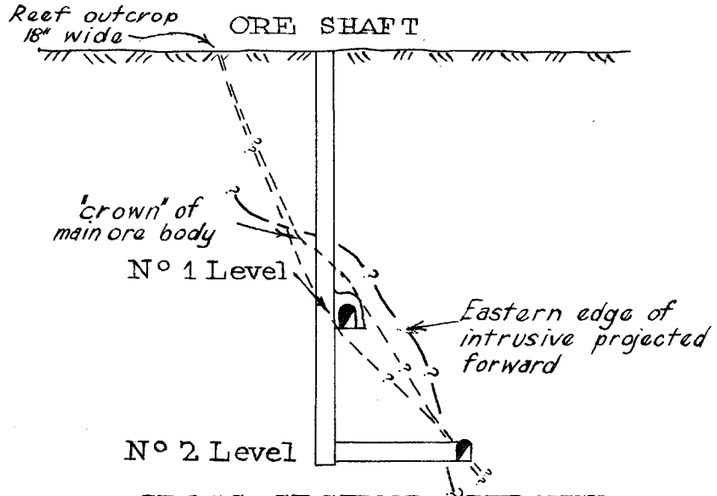
PLAN



LONGITUDINAL PROJECTION ON PLANE A-B : N 38° W LOOKING EASTWARDS



CROSS SECTION THROUGH MAIN SHAFT LOOKING N 38° W



CROSS SECTION THROUGH ORE SHAFT LOOKING N 38° W

G. S. W. A.
PLAN & SECTIONS OF
"MARGUERITTA" GM
(GML 1942 N)

CHESTERFIELD, MURCHISON G.F.

Scale: 1 in = 50 ft

ft 50 40 30 20 10 0 50 100 ft

From tape & compass survey by R. Connolly & B. Dawson, May 1960

BD

G.S.W.A
GEOLOGICAL PLAN
OF
"MARGUERITTA" GM
(GML 1942N)

CHESTERFIELD , MURCHISON G.F.

Scale: 1in=100ft

ft 100 50 0 100 200 ft

Plane Table & Telescopic Alidade survey
by R Connolly & B Dawson May 1960

— REFERENCE —

- Approximate geological boundary
- Assumed geological boundary
- Strike & dip of bedding
- Strike & dip of schistosity
- Strike of vertical schistosity
- Fault with vertical dip
- Shaft accessible
- Shaft inaccessible

fine green grained igneous rock

Trench in schistose greenstone

85°

80°

Weathered greenstone schists with some thin chert beds

To the "Dorothy" workings

House

True

Shaft V.D. 20' approx

Stoped vertical to Surface

Shaft V.D 60'

Scattered Quartz rubble over schists

SPARSE VEGETATION

Shaft V.D. 16' in weathered schist

Old company main shaft V.D approx 85

Shallow Creek Bed

QUARTZ STREWN FLATS

Stoped to surface

GML 1946N

"Margueritta East"

course grained igneous rock (granodiorite?)

Scattered quartz

80°

fine grained green igneous rock

Quartz out-crop

Schists & cherts

Line of workings following 6" quartz vein in greenstone schist

granodiorite?

Compressor Shed

MAIN SHAFT

Tank

Mulloch dump

Shaft VD 40'

Shaft V.D?

Machinery Shed

Mill

Shaft V.D 85' cross-cut at 60'

Shaft V.D? ORE SHAFT

To Meekatharra

Line of workings

Quartz reef outcrop 18" wide

Shaft V.D? OLD COY WATER SHAFT V.D?

Camp

Old boiler & engine foundations

Casey's sands flats (not treated)

Shaft V.D?

weathered schists

Old Company Sands Dump (Treated)

Shaft V.D? with trenches partly filled with sands

GML 1942N
(1904 on posts)
"Margueritta"

To old "Chesterfield" govt well

BD

Completed: 8th September, 1960. Completed Depth: 393 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	14 0	....	....	No core.
14 0	54 0	40 0	36 0	Basic lava. Fine grained, weathered, numerous fractures. A 2 in. fault at 26 ft. at 30° to core axis.
54 0	57 0	3 0	3 0	Dolerite. Fine grained contact at 35° to core axis.
57 0	69 0	12 0	11 0	Basic lava.
69 0	74 0	5 0	5 0	Dolerite. Fine grained. Sheared contact at 69 ft. at 35° to core axis.
74 0	77 0	3 0	3 0	Basic lava.
77 0	99 0	22 0	17 0	Dolerite. Fine grained strongly weathered and sheared at 45° to core from 92–99 ft.
99 0	105 0	6 0	5 3	Reef Zone. Bluish quartz, completely silicified dolerite and a few 2 in. mullock seams.
105 0	180 0	75 0	66 0	Dolerite. Fine to medium grained. Strongly weathered near reef.
180 0	181 0	1 0	1 0	Fault.
181 0	188 0	7 0	6 0	Basic lava. Sheared.
188 0	236 0	48 0	45 0	Dolerite. Fine to medium grained.
236 0	256 0	20 0	20 0	Basic lava or fine grained intrusive.
256 0	260 6	4 6	4 6	Dolerite.
260 6	262 0	1 6	1 6	Porphyrite.
262 0	266 6	4 6	4 6	Dolerite.
266 6	270 0	3 6	3 6	Chlorite schist.
270 0	275 6	5 6	5 6	Dolerite. Medium grained.
275 6	286 0	14 6	13 6	Chloritic rock. Probably basic lava. Silicified.
286 0	339 0	53 0	51 0	Dolerite. Medium grained. Numerous irregular vuggy quartz veinlets.
339 0	343 0	4 0	3 3	White quartz.
343 0	350 6	7 6	7 0	Dolerite. Sheared and strongly weathered.
350 6	356 6	6 0	4 6	Reef Zone.
356 6	369 0	12 6	3 6	Completely weathered rock.
369 0	380 0	11 0	0 0	No core.
380 0	393 0	13 0	10 0	Dolerite.
				END OF HOLE.

Assay Results.
D.D.H. No. M.V1, Site A. 1.

Sample No.	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13205	99 0	102 0	36	32	25·3
13206	102 0	105 0	36	31	0·1
13207	339 0	343 0	48	39	0·1
13208	350 6	353 0	30	27	2·25
13209	353 0	356 6	42	24	0·5

NOTE : The values are in bluish quartz and silicified dolerite.

W. R. JONES,
Geologist.

6th October, 1960.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L's 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V.3.

Hole No.: M.V.3, Site A.3.
Station: 1410 N, 487 E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90° T. Core Size: AXT.
Commenced: 18th July, 1960. Contractors: K. & W. H. McCallum.
Completed: 12th August, 1960. Completed Depth: 403 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	20 0	....	....	NO CORE.
20 0	252 6	232 6	206 0	Dolerite. Medium grained. Highly weathered to 115 ft. Maximum oxidation centred on 75–95 ft. from which only 9 ft. core recovered. This is the shear zone associated with the H.W. reef. Numerous ¼ in. wide stringers of quartz and narrow (1–2 in.) faults.
252 6	263 3	10 9	10 3	Chloritic rock, fine grained, schistose—meta-sediment.
263 3	266 0	2 9	2 6	Dolerite. Medium grained.
266 0	270 0	4 0	4 0	Chloritic schist. Fine grained schist—core angle 60°. 2 in. quartz at 269 ft.
270 0	336 0	66 0	62 0	Dolerite. Medium grained. General irregular bleaching and silicification. Maximum bleaching 315–320 ft. Numerous quartz-carbonate stringers. Several ¼–1½ in. vuggy white quartz veinlets.
336 0	344 0	8 0	7 0	Chloritic schist. Fine grained Contorted in part.
344 0	345 6	1 6	1 0	Blue quartz. Stained but little mineralisation.
345 6	346 6	1 0	2½	Blue quartz.
346 6	349 0	2 6	1 0	Fault zone. Blue and white quartz with silicified crush breccia. Dark brown by oxidation.
349 0	350 0	1 0	6	White quartz. Vuggy.
350 0	370 0	20 0	3	Indeterminate. Appears to be chloritic schist but may be sheared dolerite.
370 0	376 0	6 0	5 0	Schist. Fine grained, Completely kaolonised. ? lava.
376 0	403 0	27 0	25 6	Dolerite. Medium grained. Strongly kaolinised to 384 ft. Contact with schist difficult to pinpoint.
				END OF HOLE.

Assay Results.
D.D.H. No. M.V. 3, Site A.3.

Sample	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13201	344 0	345 6	18	12	0·05
13202	345 6	346 6	12	2½	0·1
13203	346 6	349 0	30	12	2·0
13204	349 0	350 0	12	6	0·1

NOTE : 1. The reef zone intersected from 344 ft. to 350 ft. coincides with the target area.
2. The reef in this intersection is not a massive unit and percentage core recovery was low.

W. R. JONES,
Geologist.

5th September, 1960.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L.s. 573'sD. 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V.5.

Hole No.: M.V.5, Site A.5.
Station: 1330 N, 525 E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90° T. Core Size: AXT.
Commenced: 12th September, 1960. Contractors: K. & W. H. McCallum.
Completed: 30th September, 1960. Completed Depth: 387 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	16 6	....	....	No core.
16 6	17 6	1 0	....	Dolerite. Weathered.
17 6	20 0	2 6	2 1	Quartz. White and bluish.
20 0	21 0	1 0	4	Fault rock. Siliceous.
21 0	230 4	209 4	179 0	Dolerite. Weathered to 100 ft. Strongly sheared in places, with high core loss, most prominent sections are :— 45–55 ft.—5 ft. 6 in. core lost. 61–65 ft.—3 ft. core lost. 65–75 ft.—9 ft. core lost. 78–96 ft.—11 ft. core lost.
230 4	242 0	11 8	11 0	Chloritic rock. Probable meta-sediment.
242 0	248 0	6 0	5 0	Dolerite.
248 0	262 0	14 0	12 0	Chlorite schist. Meta-sediment.
262 0	280 0	18 0	12 0	Chloritic rock. More massive but probably continuous with 248 ft. to 262 ft.
280 0	298 0	18 0	15 0	Basic lava.
298 0	301 0	3 0	2 6	Carbonaceous shale with some pyrite.
301 0	304 0	3 0	2 6	Quartz. White and bluish.
304 0	320 0	16 0	2 6	Platy quartz. From separate 1 in. wide silicified shears. A little unidentified rubble.
320 0	387 0	67 0	47 0	Basic lava. Weathered to 352 ft. END OF HOLE.

Assay Results.

D.D.H., No. M.V.5, Site A.5.

Sample No.	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13210	17 6	20 0	30	25	8·6
13211	301 0	304 0	36	27	*Nil*
13212	312 0	319 0	84	10	0·1
13213	319 0	319 6	6	5	19·2

NOTE : The ten inches of quartz in sample 13212 is a single reef and appears to be continuous with that of sample 13213.

W. R. JONES,
Geologist.

28/10/60.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT. G.M.L.'s 573D, 671D, DAY DAWN, MURCHISON G. F.

D.D.H. No. M.V. 6.

Hole No.; M.V. 6, Site B. 5.
Station: 1110N, 280E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90° T. Core Size: AXT.
Commenced: 4th October, 1960. Contractors: K. & W. H. McCallum.
Completed: 19th October, 1960. Completed Depth: 366 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	4 0	....	....	No core.
4 0	130 0	126 0	117 0	Dolerite. Medium grained. Grain size smaller towards 130 ft.
130 0	312 0	182 0	174 0	Basic lava. Minor chloritic schist 203–209 ft. Quartz veinlets and irregular silicification prominent 271–272 ft.
312 0	315 3	3 3	3 0	Carbonaceous slate. In part silicified and weakly mineralised.
315 3	318 0	2 9	2 8	Quartz. With 3 in. coarsely crystalline carbonates near 318 ft.
318 0	323 0	5 0	4 6	Carbonaceous slate. Weakly mineralised.
323 0	366 0	43 0	42 0	Basic lava. END OF HOLE.

Assay Results.

D.D.H. No. M.V.6, Site B5.

Sample No.	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13214	315 3	318 0	33	32	0·5

NOTE : The reef zone has not opened where it has crossed the slate The quartz of sample 13214 is essentially silicified slate.

W. R. JONES,
Geologist.

22nd November, 1960.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT G.M.L's 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V. 7.

Hole No.: M.V. 7, Site B.4.
Station: 1150N, 265E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90°T. Core Size: AXT.
Commenced: 7th November, 1960. Contractors: K. & W. H. McCallum.
Completed: 23rd November, 1960. Completed Depth: 382 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	9 0	....	....	No core.
9 0	198 0	189 6	175 0	Dolerite. Medium grained. Light occasional bleaching from 110 ft. Strong bleaching associated with shearing at 138 ft. and 161 ft. Finer grain and in part silicified towards 198 ft.
198 6	321 6	123 0	113 0	Basic lavas. Strong irregular quartz-carbonate injection 290 ft. to 286 ft. 6 in.
321 6	326 6	5 0	4 8	Quartz and silicified carbonaceous slate.
326 6	330 0	3 6	3 3	Carbonaceous slate.
330 0	382 0	52 0	50 0	Basic lava. END OF HOLE.

Assay Results.

D.D.H. No. M.V. 7, Site B.4.

Sample No	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13215	321 6	324 0	30	28	0·15
13216	324 0	326 6	30	28	0·07

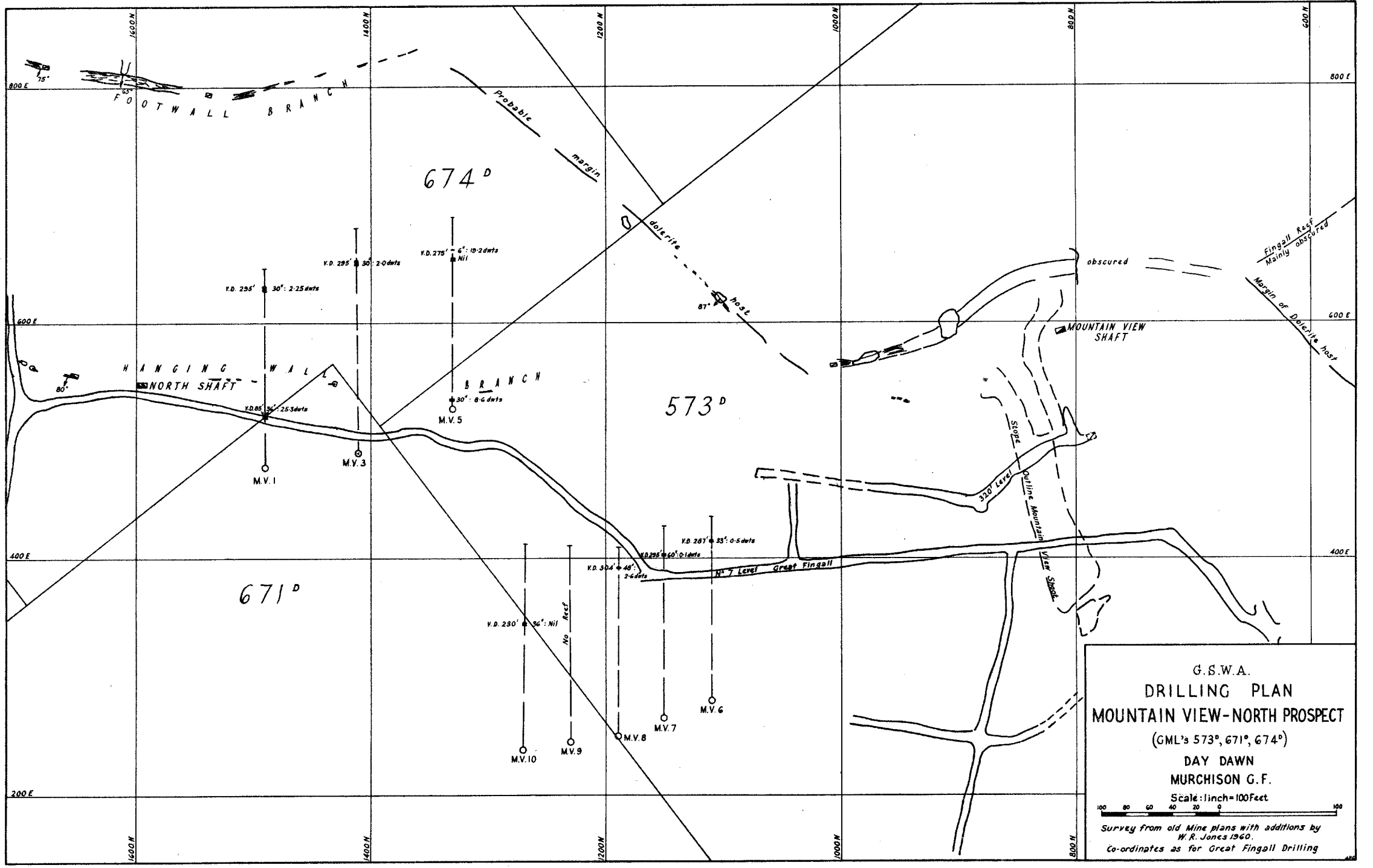
W. R. JONES,
Geologist.

14th December, 1960.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L's 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V. 8.

Hole No.: M.V. 8, Site B3.
Station: 1190N, 250E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90°T. Core Size: AXT.
Commenced: 29th November, 1960. Contractors: K. & W. H. McCallum.
Completed: 12th December, 1960. Completed Depth: 373 feet.



G.S.W.A.

DRILLING PLAN
MOUNTAIN VIEW-NORTH PROSPECT

(GML's 573°, 671°, 674°)

DAY DAWN

MURCHISON G.F.

Scale: 1 inch = 100 Feet

100 80 60 40 20 0 100

Survey from old Mine plans with additions by W. R. Jones 1960.

Co-ordinates as for Great Fingall Drilling

D.D.H Nº MV1

W

No Core

65° Basic Lava

H.W. REEF (Weak)

600 H

E

F.W. REEF

Main Lode

100'

99'–102' : 25·3 dwts

200'

300'

350'6"–353' : 2·25 dwts
353'–356'6" : 0·05 dwts

393'

GML 671D

GML 674D

Nº 7 level Great Fingall

600 H

G. S. W. A.

SECTION OF DIAMOND DRILL HOLE MV 1

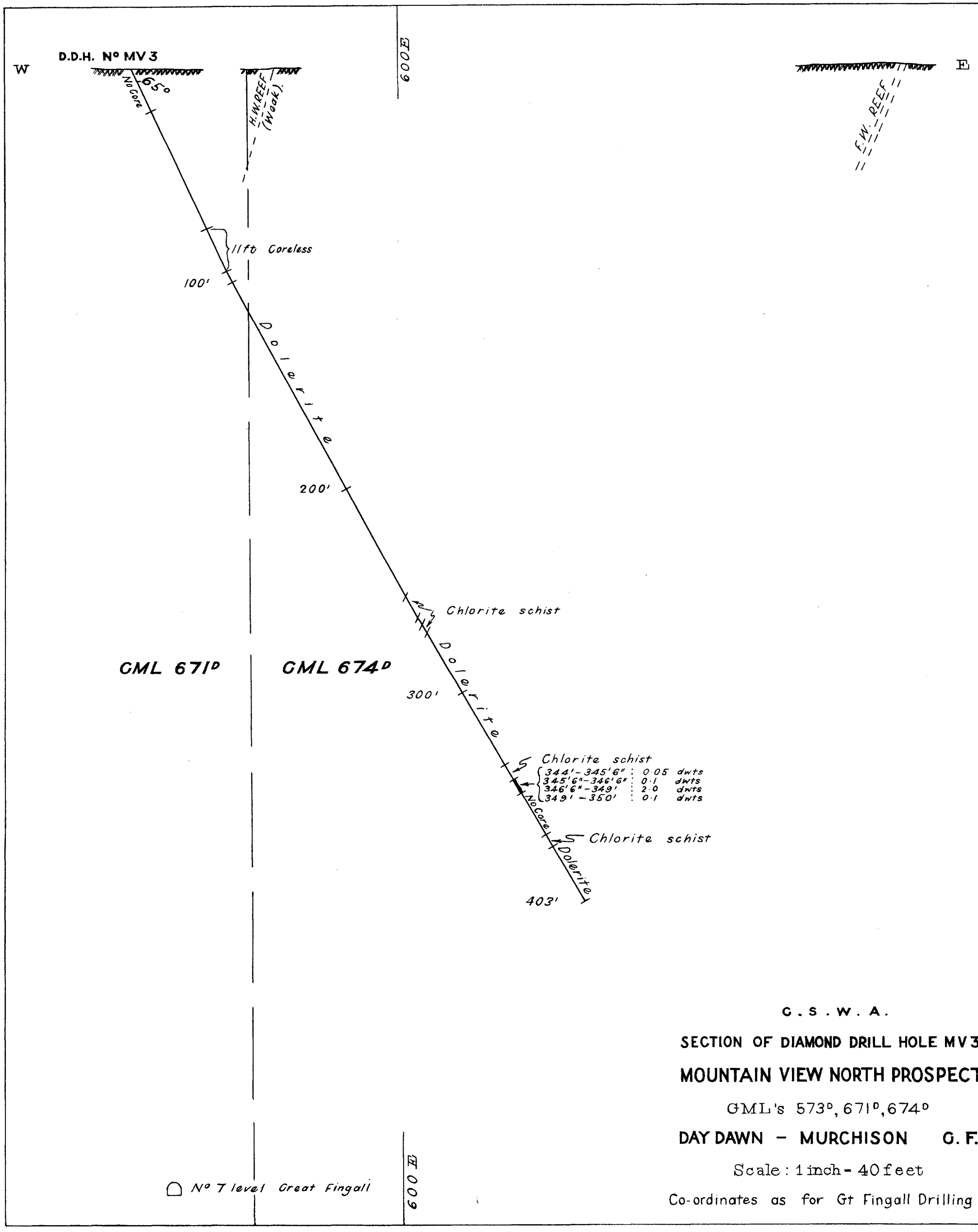
MOUNTAIN VIEW NORTH PROSPECT

GML's, 573D, 671D, 674D

DAY DAWN – MURCHISON G. F.

Scale : 1 inch = 40 feet

Co-ordinates as for Gt. Fingall Drilling



C.S.W.A.

SECTION OF DIAMOND DRILL HOLE MV3

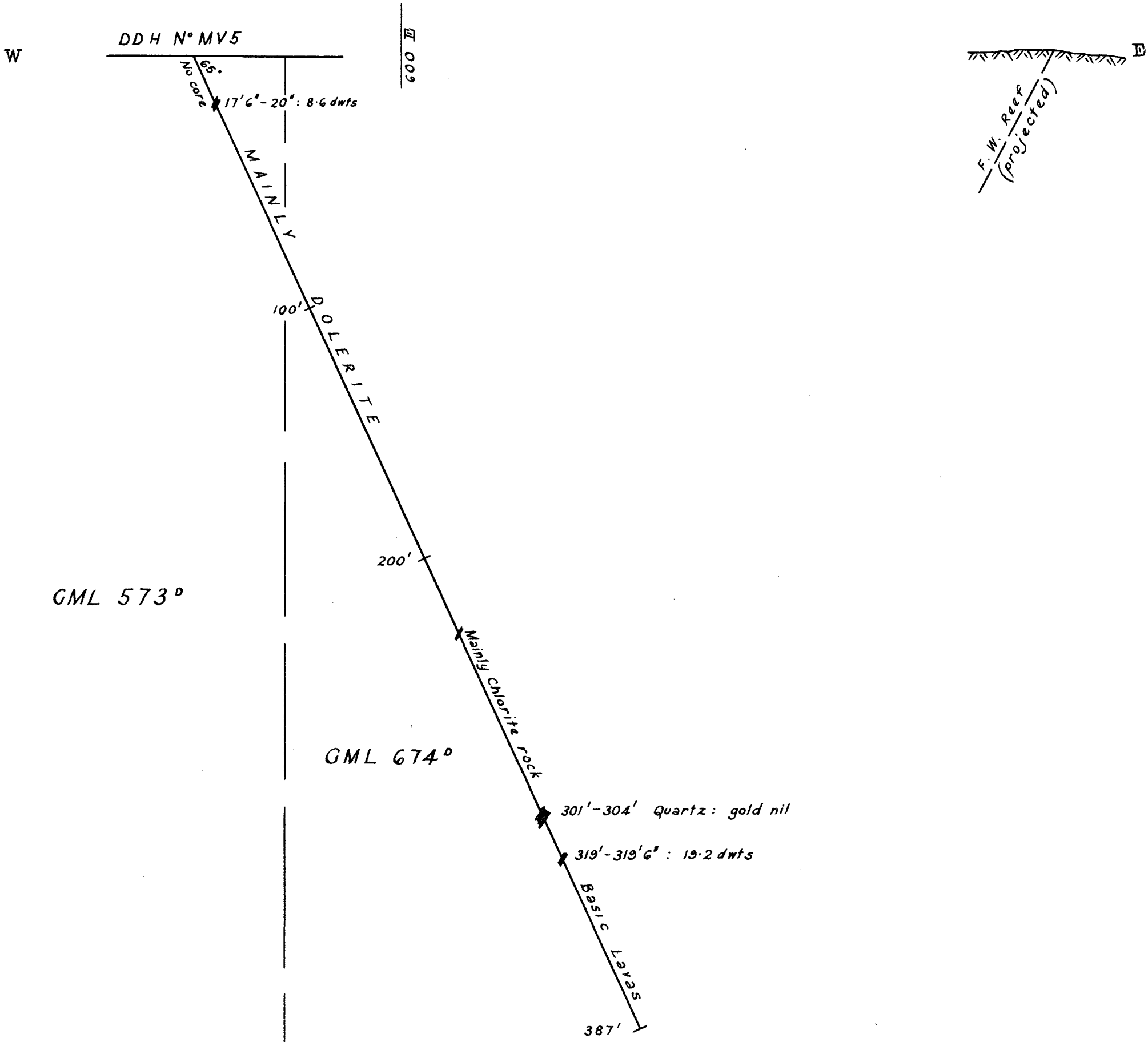
MOUNTAIN VIEW NORTH PROSPECT

GML's 573D, 671D, 674D

DAY DAWN – MURCHISON G.F.

Scale: 1 inch - 40 feet

Co-ordinates as for Gt Fingall Drilling



N° 7 level Great Fingall

G.S.W.A.

SECTION OF DIAMOND DRILL HOLE MV5

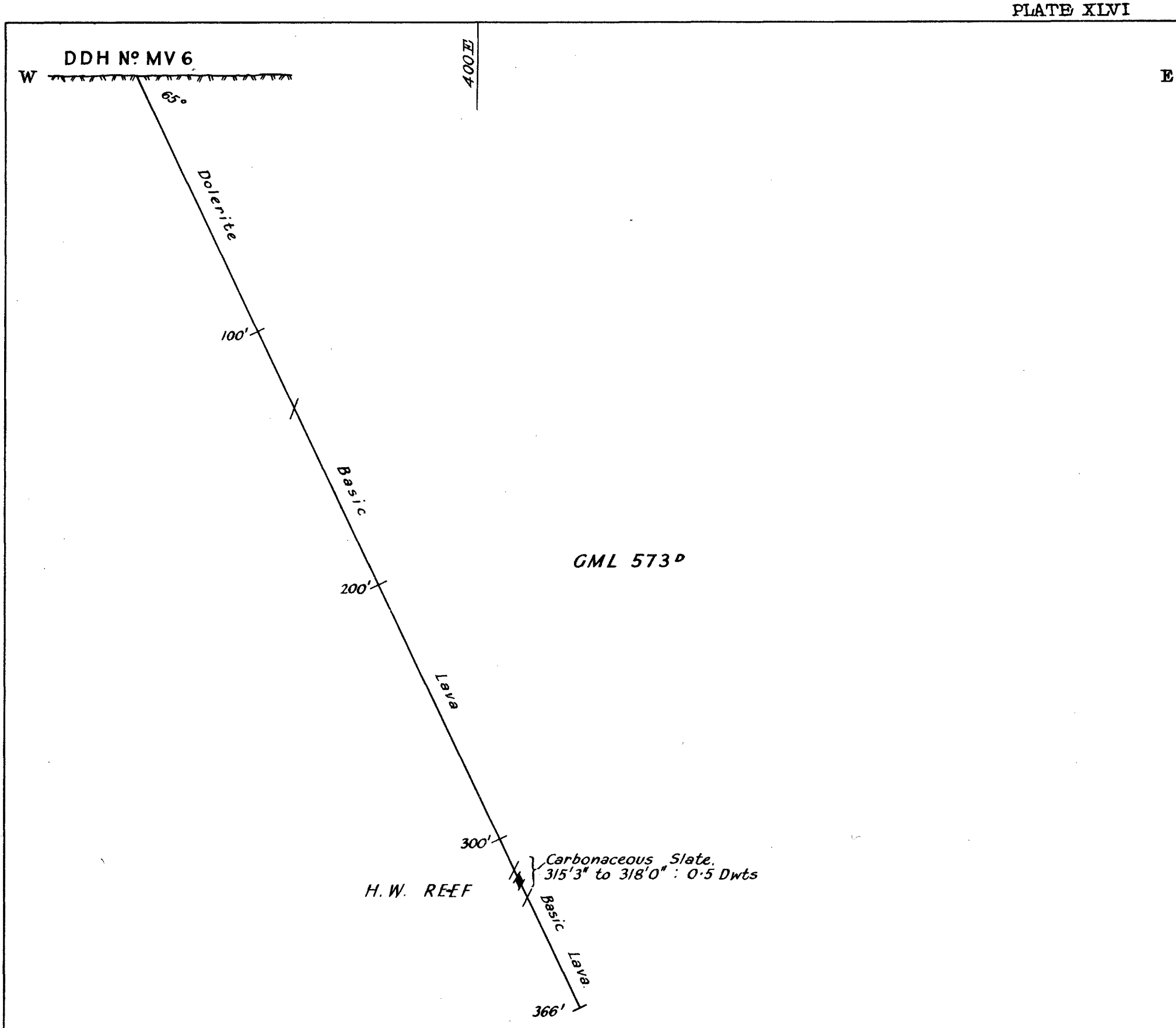
MOUNTAIN VIEW NORTH PROSPECT

GML's 573D, 671D, 674D

DAY DAWN – MURCHISON G.F.

Scale 1 inch = 40 feet

Co-ordinates as for Gt. Fingall Drilling



G . S . W . A

SECTION OF DIAMOND DRILL HOLE MV6

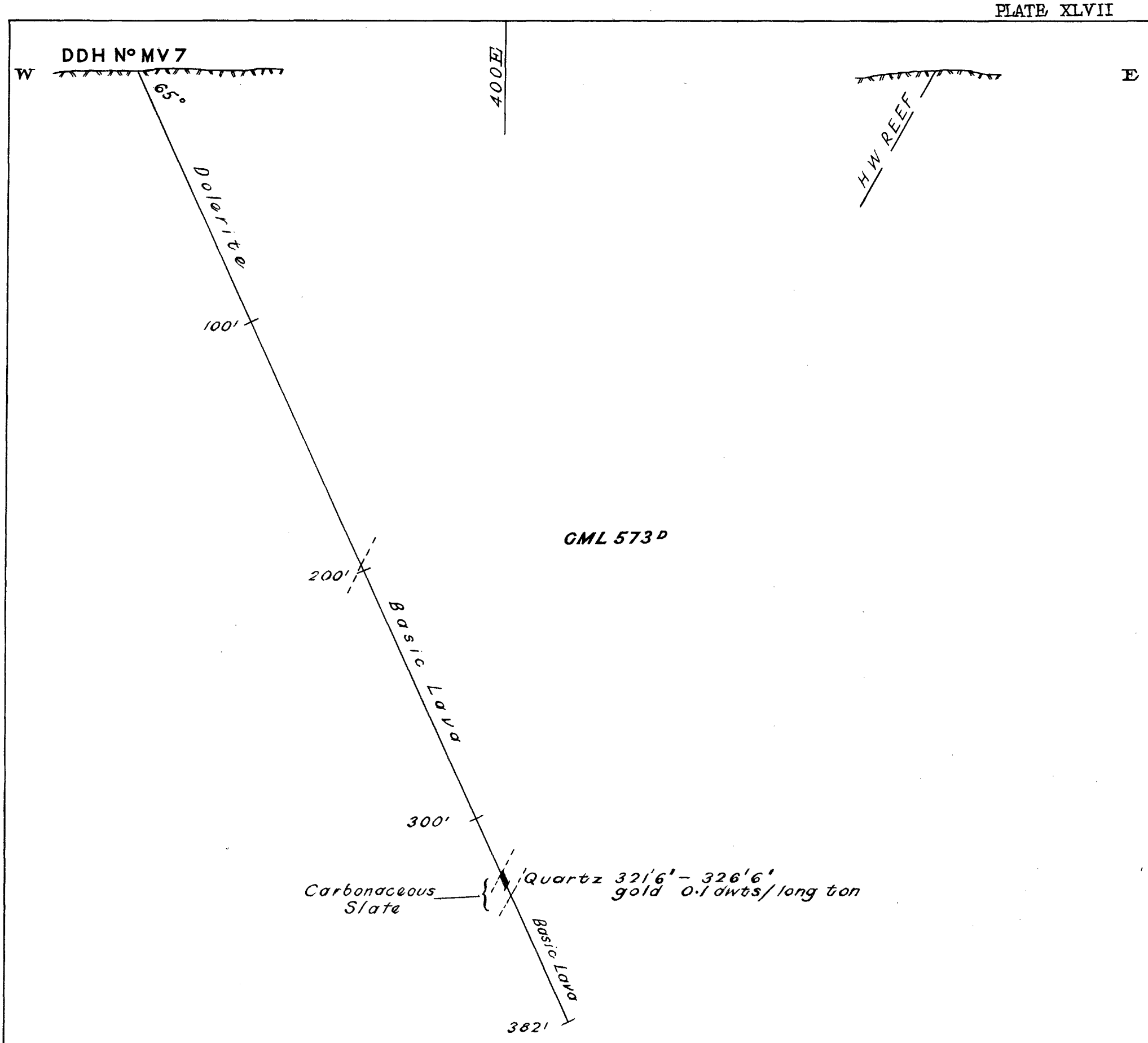
MOUNTAIN VIEW NORTH PROSPECT

GML 573P

DAY DAWN — MURCHISON G.F.

Scale : 1 inch = 40 feet

Co-ordinates as for Gt Fingall Drilling



G. S. W. A.

SECTION OF DIAMOND DRILL HOLE MV7

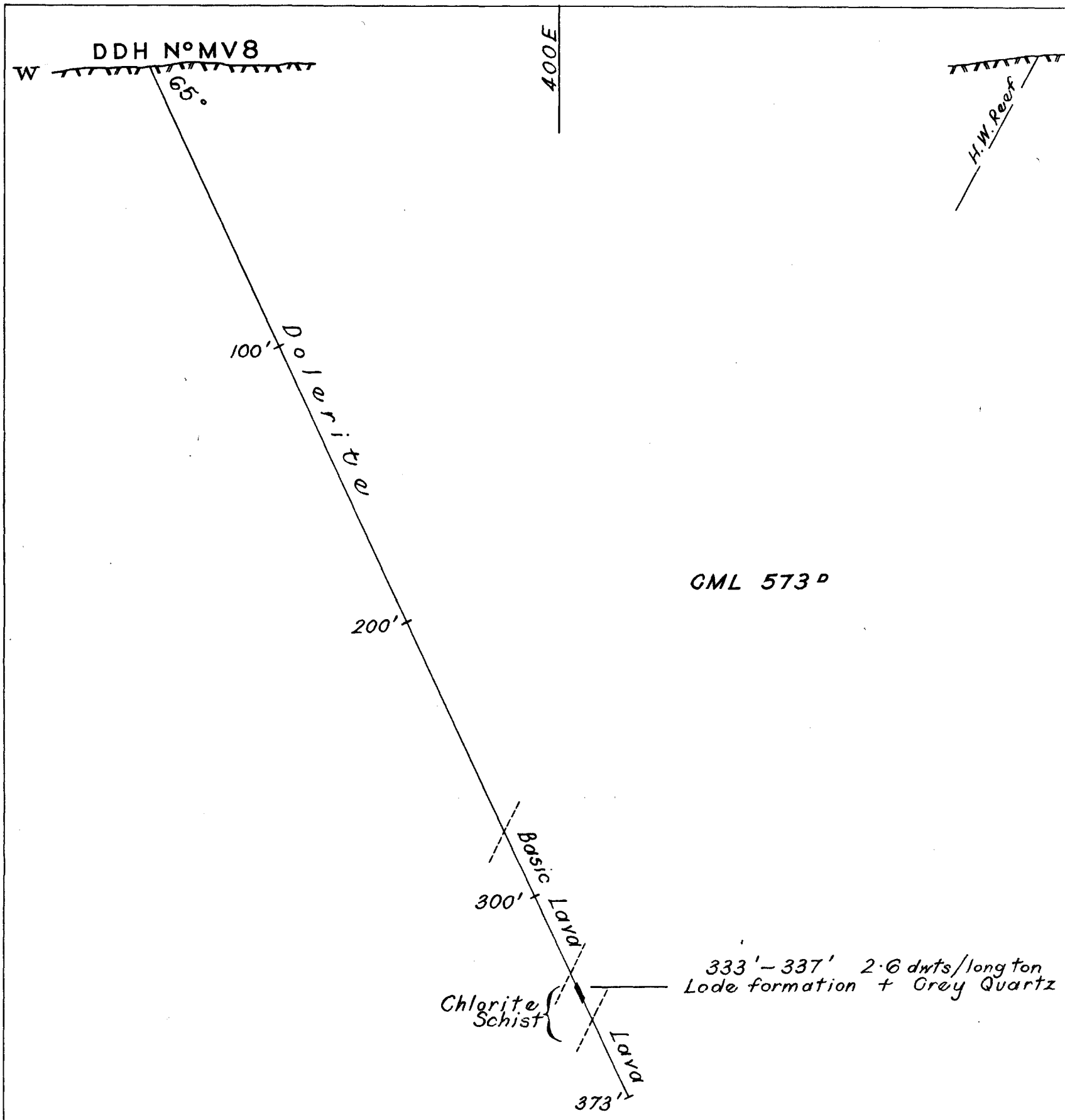
MOUNTAIN VIEW NORTH PROSPECT

GML's 573D 671D 674D

DAY DAWN - MURCHISON GF

Scale : 1inch - 40 feet

Co-ordinates as for Gt Fingall Drilling



G. S. W. A.

SECTION OF DIAMOND DRILL HOLE MV8

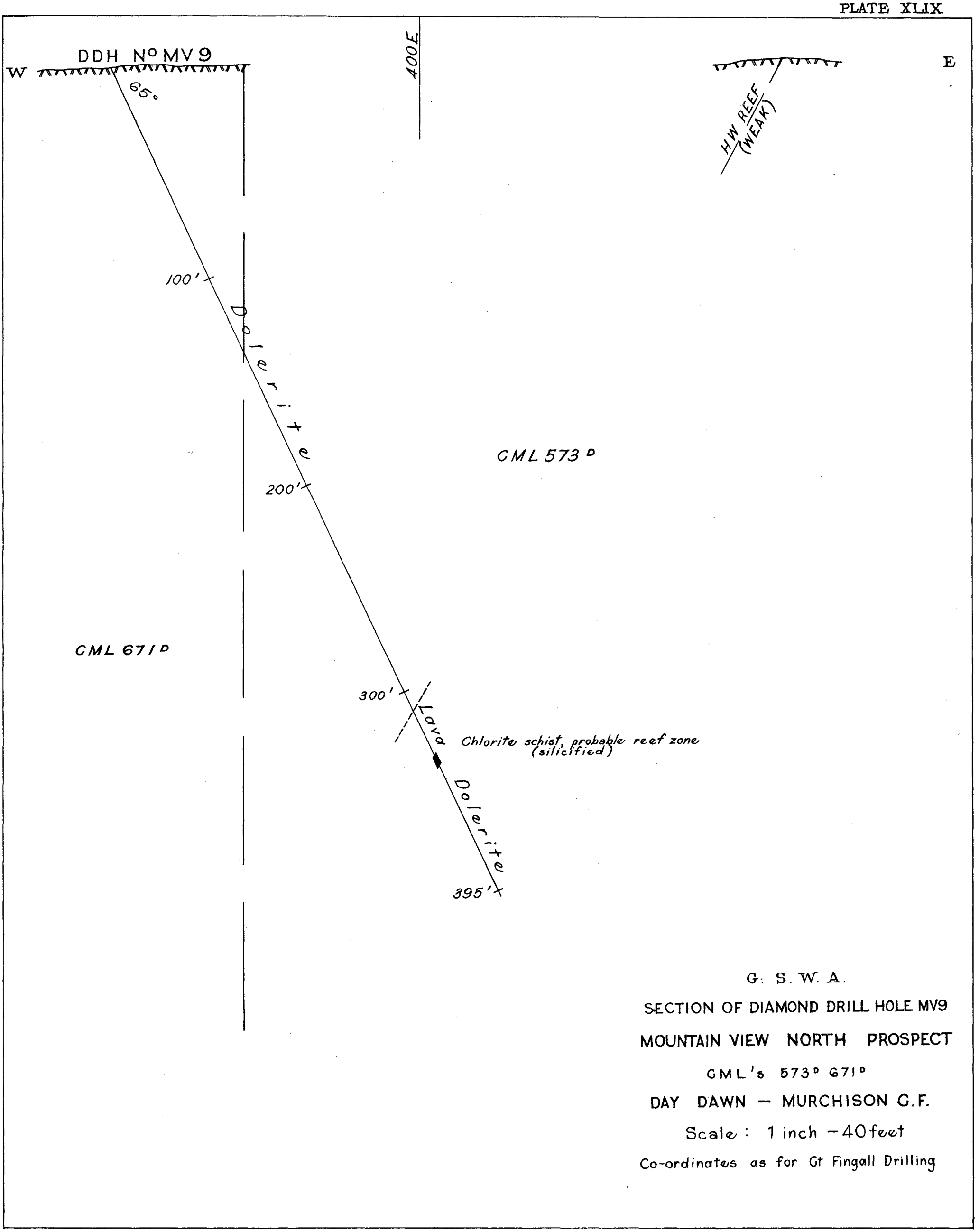
MOUNTAIN VIEW NORTH PROSPECT

GML 573 D

DAY DAWN — MURCHISON G.F.

Scale : 1 inch = 40 feet

Co-ordinates as for Gt. Fingall Drilling



G. S. W. A.

SECTION OF DIAMOND DRILL HOLE MV9

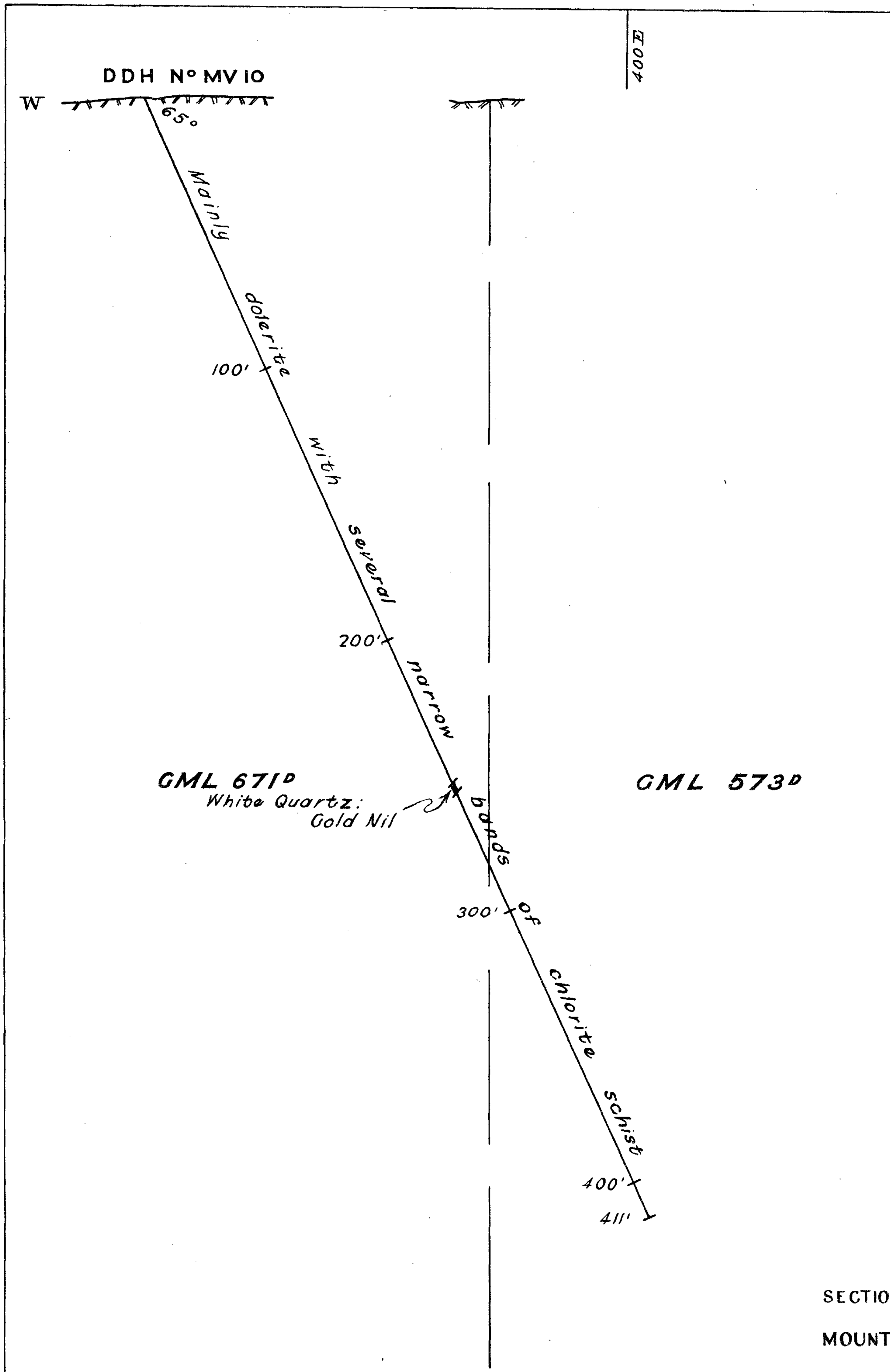
MOUNTAIN VIEW NORTH PROSPECT

GML's 573 D 671 D

DAY DAWN — MURCHISON G.F.

Scale : 1 inch — 40 feet

Co-ordinates as for Gt Fingall Drilling



G. S. W. A.

SECTION OF DIAMOND DRILL HOLE MV 10

MOUNTAIN VIEW NORTH PROSPECT

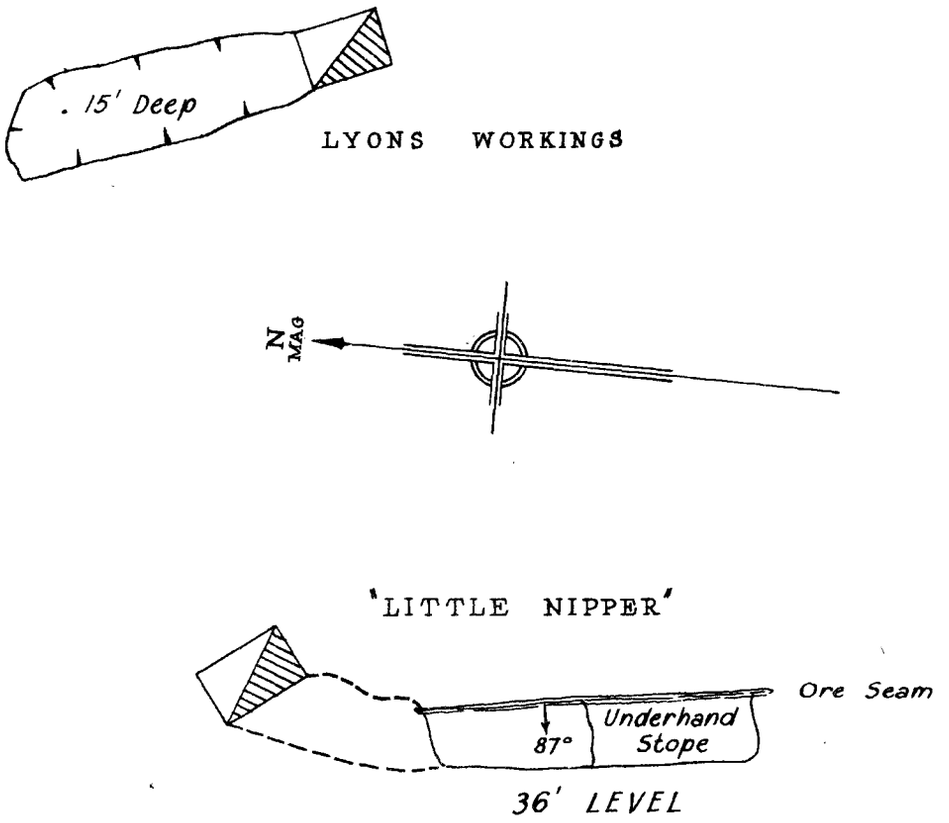
GML's 573D & 671D

DAY DAWN MURCHISON GF

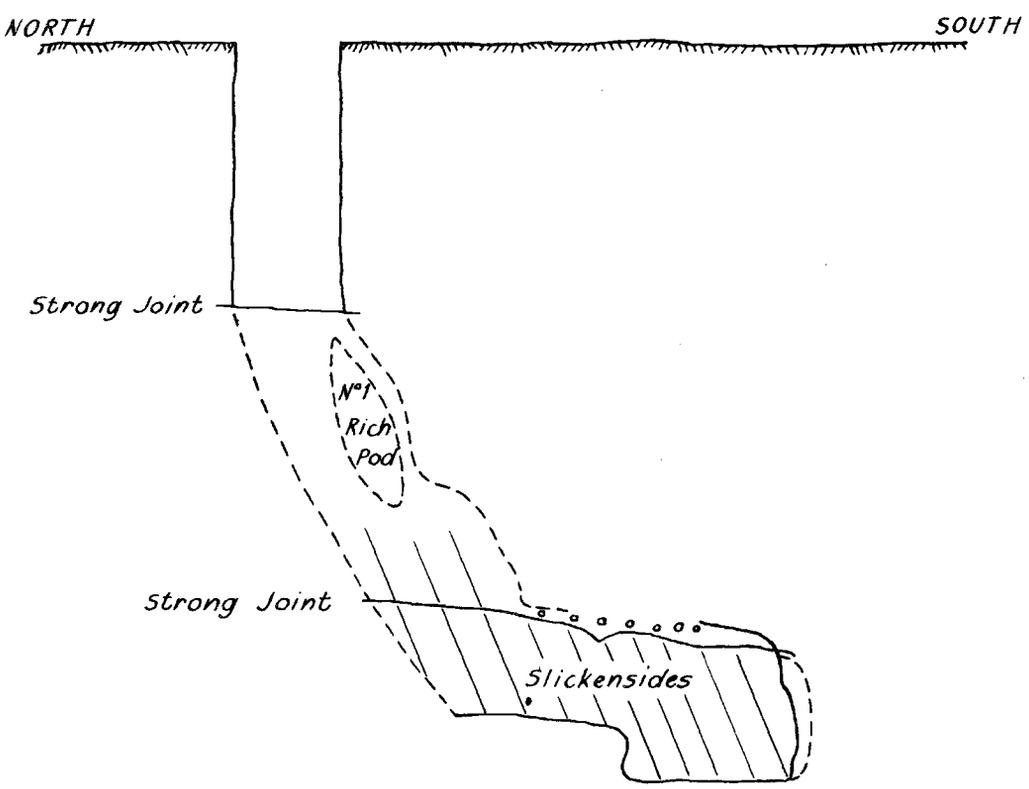
Scale: 1 inch - 40 feet

Co-ordinates as for Gt Fingall Drilling

PLATE LI



— PLAN —



— LONGITUDINAL SECTION —

G . S . W . A .

GML 5999 LITTLE NIPPER

RYANS FIND

COOLGARDIE G . F .

AS AT 5th Oct 1960

Scale : 1 Inch to 10 Feet

Prepared by. W.R. Jones Oct. 1960.

Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.
Assays by: Government Chemical Laboratories, Perth.

Core Log.

From	To	Width	Core Recovered	Particulars of Cor
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	10 0	....	....	No core.
10 0	276 0	266 0	252 0	Dolerite. Massive, medium grained to 269 ft. Grain size decreases rapidly from 269 ft. to be very fine at 276 ft. General strong silicification. Weakly sheared and oxidised 178–181 ft., weakly schistose 219–221 ft. A few inches of porphyry near 131 ft. and at 139 ft.
276 0	328 0	52 0	48 0	Basic lava. Massive 276–315 ft., schistose 315–328 ft.
328 0	332 0	4 0	4 0	Chlorite schist.
332 0	339 0	7 0	6 6	Lode formation. Mineralised chlorite schist with some grey quartz.
339 0	345 0	6 0	6 0	Chlorite schist.
345 0	373 0	28 0	27 0	Basic lava. END OF HOLE.

Assay Results.
D.D.H. No. M.V. 8, Site B.3.

Sample No.	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13217	333 0	335 0	24	23	2·5
13218	335 0	337 0	24	23	2·7
13219	337 0	340 0	36	34	0·3

W. R. JONES,
16th January, 1961. Geologist.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L's. 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V. 9.

Hole No.; M.V. 9, Site B. 2.
Station: 1230N, 245E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90° T. Core Size: AXT.
Commenced: 19th December, 1960. Contractors: K. & W. H. McCallum.
Completed: 31st December, 1960. Completed Depth: 395 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	10 0	....	....	No core.
10 0	188 0	178 0	151 0	Dolerite. Massive, medium grained. Highly weathered and core much broken to about 60 ft. General silicification. Occasional weak carbonate mineralisation.
188 0	191 0	3 0	3 0	Chlorite schist.
191 0	308 0	117 0	112 0	Dolerite. Medium grained. Altered zones (or possibly lavas) 242–249 ft. and 276–280 ft. White quartz 4 in. at 285 ft., 1 in. at 287 ft., 288 ft. and 289 ft.
308 0	330 0	22 0	20 0	Basic lava. Silicified.
330 0	334 6	4 6	4 6	Chlorite schist. Meta-sediment, silicified.
334 6	395 0	60 6	58 0	Dolerite. Medium grained silicified. END OF HOLE.

NOTE: The hanging wall reef was not cut. The reef zone is probably represented by the silicified chlorite schist from 330 ft. to 334 ft. 6 in.

W. R. JONES,
17/1/61. Geologist.

DIAMOND DRILLING OF MOUNTAIN VIEW NORTH PROSPECT, G.M.L's. 573D, 671D, DAY DAWN, MURCHISON G.F.

D.D.H. No. M.V. 10.

Hole No.; M.V. 10, Site B. 1.
Station: 1270N 238E (G.S.W.A. Great Fingall drilling co-ordinates).
Angle of Depression: 65°.
Azimuth: 90°T. Core Size: AXT.
Commenced: 9th January, 1961. Contractors: K. & W. H. McCallum.
Completed: 24th January, 1961. Completed Depth: 411 feet.
Object: To test for the possible repetition of the Mountain View orebody.
Logged by: W. R. Jones.

Core Log.

From	To	Width	Core Recovered	Particulars of Core
ft. in.	ft. in.	ft. in.	ft. in.	
0 0	41 0	....	....	No core.
41 0	178 6	137 6	126 0	Dolerite. Massive, fine to medium grained. Core broken to near 60 ft. Oxidised to 130 ft. Numerous quartz-carbonate stringers. Strongly bleached at 115 ft. and 118 ft. to 119 ft.
178 6	185 0	6 6	6 0	Porphyry.
185 0	198 0	13 0	12 0	Dolerite. Medium grained massive.
198 0	202 0	4 0	4 0	Chlorite rock. Meta-sediment.
202 0	238 0	36 0	35 0	Dolerite.
238 0	244 0	6 0	6 0	Chlorite rock. Meta-sediment.
244 0	251 0	7 0	7 0	Dolerite.
251 0	254 0	3 0	3 0	White quartz. Unmineralised.
254 0	275 0	21 0	20 0	Dolerite.
275 0	281 0	6 0	6 0	Meta-sediment.
281 0	338 0	57 0	54 0	Dolerite.
338 0	345 0	7 0	7 0	Chlorite schist.
345 0	411 0	66 0	62 0	Dolerite. From 365 ft. to 371 ft. is finer grained altered section, contorted in part. May be intrusive. END OF HOLE.

Assay Results.
D.D.H. No. M.V. 10, Site B1.

Sample No.	From	To	Width	Core	Gold
	ft. in.	ft. in.	in.	in.	dwts/ long ton
13221	251 0	254 0	36	36	*Nil*

W. R. JONES,
10th February, 1961. Geologist.

REPORT ON G.M.L. 5999, "LITTLE NIPPER", RYANS FIND, COOLGARDIE GOLDFIELD.

Approximate Latitude 30° 45′ S.
Approximate Longitude 120° 10′ E.

By W. R. Jones, B.Sc. (Hons.), Geological Survey of W.A.

General.

Interest in the old mining centre of Ryans Find was revived in the second half of 1959 when Messrs. Voumard and Walls found rich gold ore on abandoned P.A. 6767. It was highlighted again in September, 1960 by a further rich parcel from Voumard and Walls and to that date a total of 778 ozs. of gold bullion has been recovered by them from about half a ton of selected ore.

The mine was inspected in early October, 1960 to record the mode of occurrence of the gold.

Location.

G.M.L. 5999 is 29.7 miles by graded track northerly from Boorabbin, a siding on the Eastern Goldfields Railway some 60 miles east of Southern Cross. It is about one and a half miles south south easterly of Ryans Find.

General Geology.

The Ryans Find area is near the southern limit of an elongate greenstone belt which extends north and west to Jackson in the Yilgarn G.F.

This greenstone belt and its associated iron ore has been described by Sofoulis in Bulletin 114 of Geological Survey, West Australia, 1960, p. 27. Details of past production recorded therein show that Ryans Find was unimportant.

The workings on G.M.L. 5999 are near the southern limit of a low (10 feet to 15 feet) ridge trending north. There is no outcrop near the workings but close by are several low ridges of jaspilite and blocky hornblende schist.

The Workings and the Lode.

Messrs. Voumard and Walls have sunk a shaft 36 feet deep following a strong shear in which they detected fine gold in the bottom of an old pothole. The pothole was 30 feet west of an open cut 20 feet long by 15 feet deep from which it is reputed Mr. A. Lyons some years ago produced about 80 ozs. gold from 4¼ tons ore.

A drive is in 17 feet at the 36 feet level and about half has been underhand stoped to 3 feet 6 inches below the floor.

The gold is associated with a strong fault zone 3 feet to 4 feet wide, striking 350° and dipping 87° W. (below 15 feet) in hornblende schist. The zone is bounded by clean cut planes which make good walls in the drive. The rich ore (an ounce/lb.) is confined to a 3 inch to 6 inch band sheared to actinolite schist on the footwall in which it is in pods 4 feet to 8 feet long plunging southerly at 65° as do the well marked slickensides exposed on the hanging wall and footwall planes. In places the gold has spread across the fault zone along well developed, flat (about 5°) east dipping joint planes. From this has been mined about ten tons of battery ore which is at grass.

At a depth of 30 feet on the footwall of the shaft is a strong joint or fault which dips flatly to the south along the wall of the drive. To date the best gold has been won from below this joint.

A flat saddle-like quartz reef cut by the shaft near the surface and exposed in old trenches 25 feet south-west of the shaft is a feature. It contains no gold and its relationship to the fault zone is not clear. The lessees are to be commended for the manner in which they have followed the fine colours down the shear through the barren quartz.

Other Prospects.

Nearly two miles southerly from G.M.L. 5999 Mr. H. Boucher is working P.A. 7402. The gold is in discontinuous quartz reefs 10 feet-25 feet long 6 inches-9 inches wide whose average strike is about 300° and dip 65°-70° south-west. The gold values are highly erratic and except for the possibility of a "patch" the reefs do not impress.

Other prospectors have been working the area with no success to date.

An attempt was made to trace the gold shear north and south from the "Little Nipper" and the old workings at Ryans Find were inspected with this in mind. However apart from quartz rubble of doubtful affinity nothing shows at the surface.

There is then no impression of a major gold line although deep loaming of the soil south of G.M.L. 5999 is warranted.

W. R. JONES,
Geologist.

18/10/60.

INDEX TO GEOLOGICAL SURVEY ANNUAL PROGRESS RFPORT FOR 1960.

DIVISION V

School of Mines, Western Australia

Annual Report — 1960

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 1960. The Report covers the work done in Kalgoorlie, in Norseman, and in Bullfinch.

KALGOORLIE.

Enrolments.

The number of students enrolled during 1960 was 332—a decrease of 33 by comparison with 1959. Table I gives the individual and class enrolments for 1960 and for the four previous years; Table II, the enrolments in individual subjects for 1960; and Table III, the enrolments in the various Courses. In 1960 the School year was divided into two terms and mid-year examinations were held. Previously the School year was divided into three terms and examinations were held each term. Table III shows that the number of students enrolled for set courses is about the same as in the previous year. The decrease in enrolments by comparison with 1959 occurred in the "no set course" group. This tendency has been noticeable since 1958, and with the continued improvement of educational facilities in Kalgoorlie will probably continue to some extent.

Revenue.

The following moneys were received during 1960 and during the two previous years:—

	1958	1959	1960
	£ s. d.	£ s. d.	£ s. d.
Class Fees.	623 16 6	1,253 4 0	1,339 9 6
Registration Fees.		62 0 0	85 10 0
Lecture Notes.		63 12 6	57 17 6
Laboratory Deposits.	39 0 0	154 0 0	114 7 0
Supplementary Examinations.	44 0 0	20 0 0	21 0 0
Metallurgical Laboratory Trust.	468 10 6	859 16 8	1,056 5 1
Apparatus and Equipment Trust Fund.	1,000 0 0	1,000 0 0	1,000 0 0
Commonwealth Grants Trust.	3,736 8 6	1,151 10 0	2,500 0 0
Mine Managers and Underground Supervisors.	56 10 6	60 0 0	32 0 6
Sundries.	83 17 1	54 14 8	42 5 0
Total.	6,052 0 11	4,714 18 10	6,248 14 7

The fees paid by students vary according to their ages, and numbers of students falling into the various groups are given in Table IV. This table shows that there has been a decrease in the number of students under 18 by comparison with the previous years.

TABLE I.

Enrolments, Kalgoorlie.
1956-1960.

Year	Individual	Class
1956	365	878
1957	387	951
1958	380	928
1959	365	916
1960	332	967

TABLE II.

Class Enrolments, Kalgoorlie, 1960.

Subject	First Term	Second Term
Preparatory Chemistry	35	23
Chemistry IA	23	19
Chemistry IB	12	11
Chemistry II	2	2
Analytical Chemistry I	1	1
Analytical Chemistry II	2	2
Chemical Metallurgy I	3	3
Chemical Metallurgy II	2	2
Mineral Dressing I	15	14
Mineral Dressing II	3	2
Mineral Dressing III	2	2
Physical Metallurgy I	5	3
Assaying	13	13
Trade Metallurgy	14	9
Preparatory Mathematics	56	34
Mathematics I	54	37
Mathematics II	49	33
Mathematics III	15	14
Applied Mathematics I	28	20
Applied Mathematics II	6	4
Preparatory Physics	25	13
Physics I	52	43
Physics II	34	28
Physics III	8	8
Trade Mathematics I	....	....
Preparatory Engineering Drawing	40	31
Engineering Drawing I	52	51
Engineering Drawing and Design IIA	15	11
Engineering Drawing and Design IIB	14	11
Engineering Drawing and Design IIC	11	7
Engineering Drawing and Design IID	10	9
Surveying Drawing II	17	10
Mechanical Engineering I	10	10
Mechanical Engineering II	6	5
Practical Electricity	....	....
Electrical Engineering I	16	13
Electrical Engineering II	5	5
Internal Combustion Engines	5	4
Workshop Practice I	12	7
Workshop Practice II	5	3
Workshop Practice IIIA	4	3
Workshop Practice IIIB	....	....
Engineering Workshop Practice	9	8
Welding I	18	16
Welding II	5	3
Steam Engine Driving	....	....
Structural Engineering I	18	17
Structural Engineering II	6	4
Machine Design	3	3
Materials of Construction	10	7
Hydraulics	10	7
Preparatory Geology	34	24
Geology IA	16	11
Geology IB	17	15
Geology IIA	8	8
Geology IIB	8	8
Geology IIC	5	4
Geology IIIA	2	2
Geology IIIB	3	3
Geology IIIC	2	1
Mining I	20	12
Mining II	16	14
Mining IIA	2	1
Mining IIIA	1	1
Mining IIIB	2	2
Mine Ventilation	7	6
Surveying I	23	22
Surveying II	14	12
Preparatory English	....	....
English I	....	....
English IA	27	25
Totals	967	756

	1st Term	2nd Term	3rd Term
Totals, 1959	924	800	686

TABLE III.
Number of Students Enrolled for Various Courses at Kalgoorlie.

Course	Number Enrolled				
	1956	1957	1958	1959	1960
Associateship Courses—					
Mining	30	27	29	35	37
Metallurgy	23	26	21	21	13
Engineering	40	37	43	43	49
Mining Geology	9	10	13	13	15
Total	102	100	106	112	114
Certificate Courses—					
Assayer's	2	2	2	5	3
Surveyor's	15	10	18	23	25
Mine Manager's	2	1	....	....	....
Engineering Draftsman's	11	8	8	9	4
Electrical Engineering	5	2	4	7	2
Mechanical Engineering	1	3	....	....	4
Total	36	26	32	44	38
Technicians' Courses—					
Engine Operation and Maintenance	2	3	3	1	2
Workshop Foreman's	9	8	8	6	7
Welding	13	16	14	7	10
Total	24	27	25	14	19
No Set Course—					
Preparatory Subjects	54	50	52	61	47
External	....	....	....	3	6
Junior and Leaving	....	....	....	2	12
University	....	....	....	10	7
Others	149	184	165	195	89
Total	203	234	217	195	161
Total for Year	365	387	380	365	332

TABLE IV.
Numbers of Students Paying Fees at Kalgoorlie.

Group No.	Description	1960				1959
		Full-time	Part-time	External	Totals	Totals
1	Students under 18. Lecture notes plus Students' Association	7	86	....	93	148
2.	Students 18-21 years. Registration plus Lecture Notes plus Students' Association	9	68	1	78	62
3.	Students over 21. Class plus Lecture Notes plus Student's Association	4	104	5	113	108
4.	Returned Servicemen. Exempt Class Fees	....	31	....	31	35
5.	Staff. Exempt Class Fees	3	5	....	8	9
6.	Scholarship holders. Exempt Class Fees	9	....	....	9	3
	Total	32	294	6	332	365

Staff.

The following staff changes occurred during the year:—

Name	Position	Date	Notes
Brinsden, W. K.	Laboratory Assistant	7/6/60	Appointed
Budrey, D. B.	Messenger	29/8/60	Appointed
Cruickshank, A. C.	Cadet	9/12/60	Completed term of service
Gillespie, A. D.	Typist	3/2/60	Appointed
		7/6/60	Resigned
Gray, D. J.	Laboratory Assistant	25/1/60	Appointed
		25/3/60	Resigned
Hewett, G. R.	Typist	20/4/60	Appointed
Jacobs, H. R.	Typist	12/5/60	Resigned
Parker, S. C.	Head Department	9/12/60	Retired
Rourke, B. L.	Typist	11/5/60	Appointed
Thomas, M. J.	Typist	21/6/60	Appointed
Travis, G. A.	Cadet	9/12/60	Completed term of Service.

At the end of the year Mr. S. C. Parker retired from the position of Head of the Department of Engineering, and thus severed a connection with the School which went back to 1911, when he first attended the School as a student. After a break of a number of years away from Kalgoorlie he was appointed to the Staff of the Engineering Department in 1939 and was promoted to the position of head of that Department in 1947. Mr. Parker served the School well over a long number of years and was held in high regard by his fellow staff members and by students. He has left behind him a number of well trained young engineers, a well established and recognised Engineering Course, and a number of small but well equipped engineering laboratories.

Courses of Study.

These remained as in 1959.

Annual and Supplementary Examinations:

The examination results are summarized in Tables V and VI—Table V is based on class enrolments and Table VI on individual enrolments. The figures do not differ significantly from those for previous years.

The results for individual subjects are given in Appendix 1.

Scholarships and Prizes.

No students were holding either an Entrance or a Senior Scholarship offered by the Mines Department.

Twelve students held Chamber of Mines Scholarships and all but two completed a good year's work. Eight students have now completed Associateship Courses under the Chamber of Mines Scholarship Scheme.

The usual scholarships and prizes were awarded at the end of the year and a list of awards is given in Appendix 2.

Diplomas and Certificates.

During the year 12 students completed Associateship Courses; 11, Certificate Courses; and 5, technicians Courses. The numbers of students completing courses during the past five years is shown in Table VII.

On May 24th a graduation ceremony was held in the Kalgoorlie Town Hall. Diplomas, Certificates, and Prizes awarded at the end of 1959 were presented by the Honourable the Minister for Mines, Mr. A. F. Griffith. The guest speaker was Mr. R. G. Thomas, Chief of the Division of Mineral Chemistry, C.S. & I.R.O., who selected "Mineral Research" as the subject of his talk. The talk was well received by a large audience and was later published by the "Kalgoorlie Miner."

Library.

The position with regard to cataloguing of old stock remains much the same as last year. With the school library fairly well organized, maintenance of library service and current work is almost a full-time job and cataloguing of old material can only be done in school vacation.

Numbered items catalogued at December 31st, 1960 totalled 6,616. In addition, a large amount of unnumbered serial matter such as U.S.B.M. reports have been checked and recorded. New books and bound periodicals added to the shelves in 1960 totalled 487—a further increase on the last two years. The increase in number of books presented to the School is proportionate to the number of books purchased as shown in the following figures:—

	Total additions	Presented
1958	264	50
1959	367	126
1960	487	142

Accurate figures for earlier years are not readily available, but the total acquisitions in 1953 and in 1954 were less than 200. While figures over a few years are not significant these conform to the findings of libraries which have kept such statistics over 50 years or more—that is a definite trend towards a consistent increase in the number of annual acquisitions. This is to some extent inevitable and is due to the expansion of knowledge in all subject fields. Holdings of branch schools are included in the above figures, and although their annual additions are too small to influence the figures much, the initial stock for a new branch at Wittenoom may have some slight effect in 1961.

The card loan system referred to previously will be in operation in all departments when school reopens in 1961 and will considerably simplify recording of loans and recall of overdue material.

The subject catalogue started last year has been favourably commented on and is being used, although its scope is still very limited. Subject entries are made for all new books (and selected periodical articles) but the subject cataloguing of old material requires some selection and a large amount of copy typing for which time has not been available.

Additional storage space and a central reference and administration section remains a basic need. The present arrangements are inadequate and inconvenient particularly to students, who have no one to help with their needs in the evenings—when most students attend classes. There is also no place where any reading or research can be done in the library. It is hoped a start can be made on this building in 1961.

Services to the Public.

The School continued to provide the usual services to the public in addition to its teaching activities. During the year 404 samples were received from prospectors and others for assay and/or mineral determination. This is about the same number as last year, and again more samples were submitted for gold assay than for anything else. Details are given in Table VIII.

Buildings.

No new buildings were added during the year and only minor repairs were done on existing buildings.

Requirements of the School.

These remain as set down in earlier reports. During the year approval was given for £23,500 to be spent on new buildings over a period of two years and in addition some £5,000 is to be spent on repairs and renovations.

Advisory Committee.

The Committee met on eleven occasions and attendances were as follows: Mr. Harwood, 5 (possible 7); Mr. Kay, 2 (possible 4); Mr. Blown, 8; Mr. Collard, 2; Mr. Field, 10; Mr. Golding, 11; Mr. Hobson, 11; Mr. Mundle, 6.

In September Mr. Harwood left Kalgoorlie and Mr. Kay, who succeeded Mr. Harwood as Warden, was appointed as Chairman. At a special meeting held on September 14 members of the Committee thanked Mr. Harwood for his interest in the work of the Committee and in the School. Mr. Kay was welcomed at the next meeting of the Committee held on September 30.

Grants totalling £2,000 were received from the Mines Department and from the Chamber of Mines and were paid into the Apparatus and Equipment Trust Fund. Equipment to the value of £1,750 was approved for purchase.

TABLE V.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, 1956-1960, Kalgoorlie.

	1956	1957	1958	1959	1960
Class enrolments = A	878	951	928	916	939
Number of entries for Annual Examinations = B	557	577	577	605	596
B/A percent.	63	61	62	68	63
Number of passes at Annual Examinations as a percent. of A	53	48	52	52	54
Number of passes at Annual Examinations as a percent. of B	83	79	84	79	85
Number of passes at Annual Examinations and Supplementary Examinations as a percent. of A	55	52	53	54	55
Number of passes at Annual Examinations and Supplementary Examinations as a percent. of B	86	83	85	80	87

TABLE VI.

Students Sitting for Annual Examinations, 1958, 1959, 1960, Kalgoorlie.

Course	1958 Number Enrolled	1958 Per cent. Sitting	1959 Number Enrolled	1959 Per cent. Sitting	1960 Number Enrolled	1960 Per cent. Sitting
Associateship	106	91	112	86	114	85
Certificate	32	81	44	73	38	84
Technicians'	25	88	14	79	19	58
No Set Course	217	47	195	44	161	43
Total	380	64	365	61	332	63

TABLE VII.

Diplomas and Certificates Awarded, 1956-1960.

	1956	1957	1958	1959	1960
Associateship Courses—					
Mining	6	3	7	6	3
Metallurgy	4	5	2	11	5
Engineering	8	3	3	4	4
Mining Geology	1	....	1	1	....
Total	19	11	13	22	12
Certificate Courses—					
Assayer's	2	4	3	3	2
Mine Manager's	3	1	....	3	1
Mine Surveyor's	4	2	9	5	....
Engineering Draughtsman's	....	2	....	1	2
Electrical Engineering	....	....	1	1	3
Mechanical Engineering	....	....	1	2	4
Total	9	9	14	15	12
Technicians' Courses—					
Engine Operation and Maintenance	....	2	2	4	2
Workshop Foreman's	2	1	1	1	1
Welding	3	2	3	5	2
Total	5	4	6	10	5

TABLE VIII.

Work Done on Samples Received from Prospectors and Others—Kalgoorlie.

	1956	1957	1958	1959	1960
Assay—gold	147	106	105	220	263
Assay—gold and other constituents	23	6	....	4	1
Assay—metals other than gold	20	42	18	16	35
Assay plus mineral determination	11	11	3	5	3
Mineral examination	150	223	130	140	94
Rejected or transferred to Metallurgical Laboratory pay	42	10	5	13	8
Total	393	398	261	398	404

TABLE IX.

Kalgoorlie Metallurgical Laboratory—Summary of Work.

	1956	1957	1958	1959	1960
Investigations outstanding (1st January)	5	8	7	3	3
Investigations asked for (710–712 inclusive)	14	13	7	3	....
Total	19	21	14	6	3
Investigations completed	10	11	11	3	1
Investigations outstanding (31st December)	8	7	3	3	2
Investigations cancelled	1	3	....	....	....
Total	19	21	14	6	3
Certificates issued (assays, analyses, etc.)	71	70	106	481	395

Kalgoorlie Metallurgical Laboratory.

One Report of Investigation and 395 Certificates were issued during the year. In addition numerous free assays were made for prospectors and others, and have been referred to earlier in this report. Two investigations were in progress at the end of the year. More information about the work done in the Laboratory is given in Appendix 3.

The Senior Research Metallurgist continued as a member of the Chamber of Mines Metallurgical Committee, and some test work was done in the Laboratory in association with the mine laboratories. The Senior Research Metallurgist also visited the North West Mining N.L. at Nullagine on two occasions to advise the Company concerning plant procedure.

Students' Association.

The Students' Association was again very active during the year and is to be congratulated on the work done. The Association continued and extended the activities of the previous year—Ball, Dinner, Scholarships, Magazine, Hockey Club—and, in addition, took a lively interest in the general affairs of students.

NORSEMAN.

Enrolments.

The number of students enrolled during the year was 61—an increase of 6 by comparison with the previous year. Table X sets out the individual and class enrolments during the year and for the two previous years; Table XI, the enrolments in individual subjects; and Table XII, the numbers enrolled for the various courses. The school year in 1960 was divided into two terms.

Revenue.

The revenue received at Norseman was £236 3s.

TABLE X.

Enrolments, Norseman, 1956-1960.

Year	Individual	Class
1956	60	163
1957	60	178
1958	67	180
1959	55	140
1960	61	146

TABLE XI.

Class Enrolments, Norseman, 1960.

Subjects	First Term	Second Term
Chemistry IA	6	5
Preparatory Mathematics	3	4
Mathematics II	8	10
Preparatory Physics	7	5
Physics I	7	6
Trade Mathematics I	6	6
Trade Mathematics II	10	9
Preparatory Engineering Drawing	7	7
Engineering Drawing I	9	10
Engineering Drawing and Design IIA	2	1
Surveying Drawing II	....	2
Electrical Engineering I	6	5
Workshop Practice I	15	15
Workshop Practice III	4	4
Welding I	17	15
Welding II	8	8
Materials of Construction	5	5
Geology IA	4	4
Mining IIA	6	7
Surveying I	5	5
Totals	135	133

Totals, 1959	First Term	Second Term	Third Term
	136	125	103

TABLE XII.

Number of Students Enrolled for Various Courses at Norseman.

COURSE	Number Enrolled				
	1956	1957	1958	1959	1960
Associateship Courses—					
Mining	6	3	6	....	2
Metallurgy	....	....	....	....	....
Engineering	....	....	2	3	2
Mining Geology	....	....	1	....	....
Total	6	3	9	3	4
Certificate Courses—					
Assayer's	1	....	....	....	....
Surveyor's	5	8	7	8	10
Mine Manager's	1	1	....	....	....
Engineering Draughtsman's	....	1	....	1	2
Electrical Engineering	....	....	1	....	1
Mechanical Engineering	....	....	....	....	....
Total	7	10	8	9	13
Technicians' Courses—					
Engine Operation and Maintenance	27	22	18	14	6
Workshop Foreman's	2	2	4	3	8
Welding	1	4	6	4	5
Total	30	28	28	21	19
No Set Course—					
Preparatory Subjects	5	11	13	9	3
Others	12	8	9	13	22
Total	17	19	22	22	25
Total for Year	60	60	67	55	61

Staff.

The following appointment was made:—

Lewis, J. T.—Lecturer; 8/2/60; appointed.

During the year seven part-time lecturers were employed.

Subjects Taught.

Twenty subjects were taught at Norseman, and use was again made of the workshops of Central Norseman Gold Corporation for practical instruction in Workshop Practice, in Practical Electricity, and in Welding.

Examinations.

The results of the Annual Examinations are summarised 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 tables show that the entries for the Annual Examinations was higher than in previous years, but that the percentage of those passing remained about the same.

The results for individual subjects are given in Appendix 1.

Scholarships and Prizes.

The Reg Dowson Scholarships for 1960 were awarded to A. J. Hill and A. L. Benoit. The two students who were awarded Scholarships at the end of 1959 both completed a satisfactory year's work in 1960—D. R. C. Hunter passed in four subjects with two credit passes, and J. Bottegal passed in four subjects.

The Wesley Ladies' Guild Prize, which is awarded to the student obtaining the highest marks in Engineering Drawing I, was awarded to R. Reher of Norseman.

A list of awards is given in Appendix 2.

Buildings.

The buildings and grounds are in good condition and adequate for the needs of the School.

TABLE XIII.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, 1956-1960, Norseman.

	1956	1957	1958	1959	1960
Class enrolments = A	163	178	180	140	146
Number of entries for Annual Examinations = B	111	116	95	93	123
B/A percent.	68	65	52	66	84
Number of passes at Annual Examinations, as a percent. of A	58	52	37	53	65
Number of passes at Annual Examinations, as a percent. of B	86	79	70	80	77
Number of passes at Annual and Supplementary Examinations, as a percent. of A	61	53	38	57	66
Number of passes at Annual and Supplementary Examinations, as a percent. of B	89	81	73	86	78

TABLE XIV.

Students Sitting at Annual Examinations, 1958-1960, Norseman.

Courses	1958		1959		1960	
	Number Enrolled	Per cent. Sitting	Number Enrolled	Per cent. Sitting	Number Enrolled	Per cent. Sitting
Associateship	9	89	3	100	4	100
Certificate	8	86	9	89	13	93
Technicians'	22	79	21	76	19	95
No Set Course	22	31	22	41	25	76
Totals	67	66	55	65	61	87
Kalgoorlie for Comparison	380	64	365	61	332	63

TABLE XV.

Examination Results, Kalgoorlie, Norseman and Bullfinch.

Notes:

(i) Information based on class enrolments.
(ii) The Letters "A" and "B" have the same meaning as in Table XIII.

	1956	1957	1958	1959	1960
B/A percent.—					
Kalgoorlie	63	61	62	68	63
Norseman	68	65	52	66	84
Bullfinch	58	56	63	65	51
Total passes as a percent. of A—					
Kalgoorlie	55	52	53	52	55
Norseman	61	53	38	53	66
Bullfinch	39	35	54	46	41
Total passes as a percent. of B—					
Kalgoorlie	86	83	85	79	87
Norseman	89	81	73	80	78
Bullfinch	67	62	85	71	80

Advisory Committee.

The Advisory Committee with Mr. W. L. Dutton as Chairman continued to meet and to take an interest in the affairs of the School. It is with regret that I record the death of Mr. E. L. Walker, who was a member of the Advisory Committee since 1953.

BULLFINCH.

Enrolments.

The number of students enrolled was 63—an increase of 15 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.

Revenue.

The revenue received was £147 10s.

Staff.

Mr. Lloyd and Mr. Browne continued as Officer-in-Charge and part-time Registrar respectively. Seven part-time lecturers were employed.

Subjects Taught.

Twelve subjects were taught.

Examinations.

The examination results are summarised in Tables XIX and XX—Table XIX is based on class enrolments and Table XX on individual enrolments. Table XIX shows that fewer entries were received for the Annual Examinations, but that the percentage of passes was higher. A comparison of the Bullfinch results with those of Kalgoorlie and Norseman is given in Table XV.

The results for individual subjects are given in Appendix I.

Scholarships and Prizes.

No awards were made to Bullfinch students.

TABLE XVI.

Enrolments, Bullfinch, 1956-1960.

Year	Individual	Class
1956	33	77
1957	57	114
1958	47	87
1959	48	85
1960	63	98

TABLE XVII.

Class Enrolments, Bullfinch, 1960.

Subjects	First Term	Second Term
Preparatory Mathematics	18	6
Mathematics I	4	3
Mathematics II	5	3
Applied Mathematics I	6	3
Preparatory Physics	6	3
Preparatory Engineering Drawing	12	11
Engineering Drawing I	12	9
Engineering Drawing and Design IIA	4	4
Welding I	16	16
Welding II	8	7
Mining I	6	2
Mining II	1	....
Total	98	67

	1st Term	2nd Term	3rd Term
Totals, 1959	81	68	66

TABLE XVIII.

Number of Students Enrolled for Various Courses at Bullfinch.

Course	Number Enrolled				
	1956	1957	1958	1959	1960
Associateship Courses—					
Mining	....	....	....	....	....
Metallurgy	....	1	2	1	1
Engineering	....	....	....	....	....
Mining Geology	2	1	2	1	....
Total	2	2	4	2	1
Certificate Courses—					
Assayer's	....	....	....	....	....
Surveyor's	3	4	7	3	2
Mine Manager's	....	....	....	1	....
Engineering Draughtsman's	....	....	....	1	1
Electrical Engineering	1	2	....	1	1
Mechanical Engineering	....	....	....	....	1
Total	4	6	7	6	5
Technicians' Courses—					
Engine Operation and Maintenance	....	....	....	....	....
Workshop Foreman's	....	1	4	2	....
Welding	....	....	....	1	....
Total	....	1	4	3	....
No Set Course—					
Preparatory Subjects	10	7	4	8	16
Others	17	41	28	29	41
Total	27	48	32	37	57
Total for Year	33	57	47	48	63

TABLE XIX.

Results of Annual and of Supplementary Examinations Based on Class Enrolments, Bullfinch, 1956-1960.

——	1956	1957	1958	1959	1960
Class enrolments = A	77	114	87	85	98
Number of entries for Annual Examinations = B	45	64	55	55	50
B/A percent.	58	56	63	65	51
Number of passes at Annual Examinations as a percent. of A	39	33	54	46	36
Number of passes at Annual Examinations as a percent. of B	67	59	85	71	70
Number of passes at Annual and Supplementary Examinations as a percent. of A	39	35	54	46	41
Number of passes at Annual and Supplementary Examinations as a percent. of B	67	62	85	71	80

TABLE XX.

Students Sitting for Annual Examinations, Bullfinch.

	1958		1959		1960	
Courses	Number Enrolled	Per cent. Sitting	Number Enrolled	Per cent. Sitting	Number Enrolled	Per cent. Sitting
Associateship	4	75	2	50	1	100
Certificate	7	100	6	100	5	100
Technicians'	4	25	3	100	....	....
No Set Course	32	47	37	68	57	61
Total	47	55	48	73	63	65
Kalgoorlie for Comparison....	380	64	365	61	332	63
Norseman	67	66	55	65	61	87

Buildings.

The buildings including the quarters are in satisfactory condition and adequate for the needs of the School. External painting will be required in the near future.

Advisory Committee.

The Advisory Committee did not meet during the year.

ACKNOWLEDGEMENTS.

I would like to acknowledge the assistance and co-operation received from all members of the Staff —in particular Heads of Departments, the Senior Research Metallurgist, Officers-in-Charge at Norseman and at Bullfinch, the Registrar at Kalgoorlie and the Registrars at Norseman and at Bullfinch. Students have received guidance and help from all members of the Staff and information has been given as required to the Public. Members of the part-time staff have also worked well and have given generously of their time. The information given in the various tables in this report has been compiled by the Registrar and members of the office staff—in particular Mrs. B. Rourke and Miss H. Jacobs.

Thanks are due to members of the Advisory Committee for giving of their time to help the School, to the mining companies at Norseman and at Bullfinch for making their workshops available for classes, to Head Office staff, and to the staff of other branches of the Mines Department for co-operation and assistance during the year.

R. A. HOBSON,
Director, School of Mines.

APPENDIX I

School of Mines of Western Australia.

ANNUAL EXAMINATIONS.

1960.

PASS LIST.

Passes are in order of merit.

(E) denotes equal.

* denotes year fee scholarship.

Preparatory Chemistry.

Credit:
*Genovese, C. J. (E)
Tonks, G. A. (E)
Brinsden, W. K.

Pass:
Ruane, M. A.
Karczub, L. D.
Karczub, D. L.
Tovey, T. F.
Timewell, R. J.
Wise, S. A.
Andrews, D. N. M.
Paull, T. J.
Delbridge, R. J.
Fraser, H. S. (E)
Lithgow, J. R. (E)

Chemistry IA.

Credit:
*Wilson, R. Y.

Pass:
Taylor, E. B.
Magnus, E. R.
Yates, P.
Black, N. R.
Jasson, K. E.
Chamberlain, H. I.
Ghor, A.
Maguire, D. W.
Miller, J. J.

Supp. Exam. Granted:
Foong, K. H.
Poole, R. H.
Vujcich, J. M.

Chemistry IB.

Pass:
Travis, G. A.
Lewis, R. P. J.
Veale, I. L.
Fogarty, J. M. (E)
Frank, P. H. (E)
Klose, W. F.

Supp. Exam. Granted:
Thornton, W. F.

Chemistry II.

Credit:
*Bourne, R. W.

Pass:
Sceresini, B. J. S.

Analytical Chemistry I.

Pass:
Sceresini, B. J. S.

Analytical Chemistry II.

Credit:
*Bourne, R. W.

Pass:
Campbell, A. D.

Chemical Metallurgy I.

Credit:
*Sceresini B. J. S.

Pass:
Campbell A. D. (E)
Kops, J. N. (E)

Chemical Metallurgy II.

Credit:
*Dowson, J. W.

Pass:
George, T. J. F.

Mineral Dressing I.

Credit:
*Schultz, K.

Pass:
Goode, W. D. (E)
Letts, I. R. (E)
Cruickshank, A. C.
Lewis, R. P. J. (E)
Leyland, E. C. (E)
Magnus, E. R.
Fraser, P. G.
Hooker, N. R.

Mineral Dressing II.

Credit:
*Campbell, A. D.

Pass:
Sceresini, B. J. S.

Mineral Dressing III.

Pass:
George T. J. F.
Dowson, J. W.

Physical Metallurgy I.

Credit:
*Buckett, G. A.
Bourne, R. W.

Pass:
Sceresini, B. J. S.

Assaying.

Credit:
*Frank, P. H.
Worth, I. R.
Thornton, W. F.
Hurley, B. J. (E)
Lubbock, F. N. (E)

Pass:
Hopkins, G. M. F.
Meiklejohn, G. (E)
Parry, K. F. (E)
Magnus, E. R.
Kozuh, D.
Shugg, P. J. (E)
Sloan, R. B. (E)
Argus, J. C.
Satapuntu, S.

Trade Metallurgy.

Credit:
*Bostelman, L. E.

Pass:
Head, T. A.
Stretton, B.
Joyce, M. J.
Baldwin, N. G.

Preparatory Mathematics.

Credit:
*Perry, D. G.
Moore, P. F.
Ridley, R. H.

Pass:
Timewell, R. J.
Amos, R. J.
Haldenwanger, H. E.
Erbe, K. J. J. (E)
Terrell, G. G. (E)
Trounson, E. (E)
Bone, K. R.
Delbridge, R. J.
Brooks, R. G.
Fisher, R. W.
Humphrey, J. (E)

Keogh, A. G. (E)
Peden, R. W. (E)
Moyle, P. A.
Bevans, E. T.

Supp. Exam. Granted:
Delbridge, A. G.
Thomas, G. N.
Veale, T. J.
Woollams, R. J.

Mathematics I.

Credit:
*Falls, G. W.
Brinsden, W. K.

Pass:
Ghor, A.
Foong, K. H.
Gray, V. F.
Woolhouse, M. L.
Bostelman, L. E.
Rogers, L. S.
Russell, C. W.
McGushin, G.
Attrill, D. M. (E)
Brown, L. A. (E)
Wise, S. A.

Supp. Exam. Granted:
Hill, J. W.
Lauri, J. M.
Mand, E. D.
McDowell, J.
Daws, D. C.

Mathematics II.

Credit:
*Schultz, K.
Blurton, L. N.

Pass:
Cruickshank, A. C.
Manners, R. B.
McDougall, D. D.
Donovan, R. J. (E)
Egan, H. P. (E)
Goode, W. D. (E)
Willis, R. J.
Baldwin, W. E.
Frank, P. H. (E)
Dykstra, F. D. (E)
Peacock, A. A.
Keogh, J. T.
Dodge, G. J.
Kops, J. N.

Supp. Exam. Granted:
Banks, F. R.
Hooker, N. R.
Jongen, P. J. F. G.
McNally, B. T.
McNally, R. T.

Mathematics III.

Credit:
*Hardy, R. J.
Murray, B. F.

Pass:
Buckett, G. A.
Hunter, S. T.
McIntyre, A. T.
Muncaster, I. M.
Forrest, R. N.
Bennett, V. G. (E)
Miller, J. J. (E)
Lawson, K. S. (E)
White, R. (E)
Slocomb, J. H.

Applied Mathematics I.

Credit:
*Blurton, L. N. (E)
*McGushin, P. J. (E)
Baldwin, W. E.

Pass:
Weir, D. J.
Argus, J. C.
Ghor, A.
Hamilton, I. R. (E)
Pearson, C. A. L. (E)
Fraser, P. G.
Magnus, E. R.
Marshall, D. A.
Leslie, W. E.
Foong, K. H.
Woolhouse, M. L.

Supp. Exam. Granted:
Coumbe, J. T.
Daws, D. C.
Wills, M. F.

Applied Mathematics II.

Pass:
Pearson, C. A. L.
Forrest, R. N.
Bennett, V. G.

Preparatory Physics.

Credit:
*Keogh, J. T.
Brinsden, W. K.
Moore, P. F.
Amos, R. J.
Andrews, D. N. M.

Pass:
Gillett, L. W.

Supp. Exam. Granted:
Thomas, G. N.
Woollams, R. J.

Exemption Granted from Practical Work for 1961:
Woollams, R. J.
Bailey, J. R.
Thomson, R. J.
Delbridge, R. J.

Physics I.

Credit:
*Ghor, A.
Mand, E. D.
Klose, W. F.
Tonkin, D.
Leslie, W. E.
Foong, K. H.
McGushin, P. J. (E)
Weir, D. J. (E)
Woolhouse, M. L.

Pass:
Murphy, A. J.
Daws, D. C.
Ridley, R. H.
Hooker, N. R
Attrill, D. M.
Perks, A. C.

Supp. Exam. Granted:
Flanagan, K. J.
Harvey, J. S.

Exemption Granted from Practical Work for 1961:
Harvey, J. S.
Miller, J. W.
Younger, B. A.

Physics II.

Credit:
*Schultz, K.
Baker, S. R.
Willis, R. J.

Pass:
Parry, K. F. (E)
Travis, G. A. (E)
Worth, I. R. (E)
Forrest, R. N.
Crocker, R. F. (E)
Donovan, R. J. (E)
Blurton, L. N. (E)
Cruickshank, A. C. (E)
Manners, R. B.
Lubbock, F. N.
Hurley, B. J.
Baldwin, W. E.
McIntyre, A. T.
Jordan, A. F.
Lawson, K. S. (E)
Van Der Hoek, B. J. D. (E)
Pearson, C. A. L.

Supp. Exam. Granted:
Goode, W. D.
Hennessy, R. M.
Miller, J. J.

Physics III.

Credit:
*Buckett, G. A.
Murray, B. F.
Hunter, S. T.
Hardy, R. J.

Pass:
Bennett, V. G. (E)
Muncaster, I. M. (E)
White, R.
Lawson, K. S.

Preparatory Engineering Drawing.

Credit:
*Banks, F. R.
Dorotich, E. W.
Marr, E.
Keogh, A. G.
Blurton, L. N.
Bostelman, B. K.

Pass:
Johns, D. T.
Law, A. D.
Hill, J. W.
Reid, R. H. J.
Tarr, R. C.
Foong, K. H.
Head, T. A.
Hurley, P. E.
Bailey, J. R.
Ghor, A.

Engineering Drawing I.

Credit:
*Falls, G. W.
Banks, F. R.
Bevans, E. T.
Boschis, A.
Blurton, L. N.

Pass:
Curran, B. G.
Terrell, G. G.
Zani, L. R.
Foong, K. H.
Hill, J. W.
Brooks, R. G.
Woolhouse, M. L.
Law, A. D.
McDowell, J.
Brinsden, W. K.
McGushin, G.
Head, T. A.
Timewell, R. J.
Humphrey, J.
Brealey, D. J.
Ghor, A.
Evans, V.
Delbridge, R. J.
Walker, D. H.

Engineering Drawing and Design IIA.

Credit:
*Duncan, H. F.
Cruickshank, A. C.
Livingstone, N. R.
Daws, D. C.
Willis, R. J.
Baldwin, W. E.
White, R.

Pass:
Hobson, J. C.
Argus, J. C.
Jordan, A. F.
Nesbitt, W. H.
Satapuntu, S.

Engineering Drawing and Design IIB.

Credit:
*Buckett, G. A.
Lawson, K. S.
Jasson, K. E.
Duncan, H. F.
Slocomb, J. H.
Hunter, S. T.
Terrell, R. J. H.
White, R.

Pass:
Thompson, B. M.
Manners, R. B.

Engineering Drawing and Design IIC.

Credit:
*Bagworth, B. A.
Crocker, R. F.
Jasson, K. E.
Duncan, H. F.
Terrell, R. J. H.
White, R.

Engineering Drawing and Design IID.

Credit:
*Bagworth, B. A.
Duncan, H. F.
Jasson, K. E.
Hunter, S. T.
Terrell, R. J. H.

Pass:
Thompson, B. M.
White, R.
Manners, R. B.

Surveying Drawing II.

Credit:
*Mackay, I. D.
Letts, I. R.
Kozuh, D.

Pass:
Cooper, G. H.
Colgrove, J. E.
Frank, P. H.

Mechanical Engineering I.

Credit:
*Worth, I. R. (E)
*Parry, K. F. (E)

Pass:
Murray, B. F.
Muncaster, I. M.
Willis, R. J.
Donovan, R. J. (E)
McIntyre, A. T. (E)

Mechanical Engineering II.

Credit:
*Bagworth, B. A.
Buckett, G. A.
Hardy, R. J.

Pass:
Hunter, S. T.
White, R.

Electrical Engineering I.

Credit:
*Willis, R. J.
Worth, I. R.
Donovan, R. J.

Pass:
Hennessy, R. M.
Murphy, A. J.
Jordan, A. F.
Bennett, V. G.
McDougall, D. D.
Slocomb, J. H.

Supp. Exam. Granted:
Hamilton, I. R.

Electrical Engineering II.

Credit:
*Buckett, G. A.
Murray, B. F.
Mullins, H. D.

Pass:
Muncaster, I. M.
Thompson, B. M.

Internal Combustion Engines.

Pass:
Tindall, E. R.
Raymond, J.
Hosking, M. J.

Workshop Practice I.

Pass:
Caple, D. F.
Woolhouse, M. L.
Kallawk, B. R.
Ghor, A.
Johns, D. T.

Exemption Granted from Practical Work for 1961:
Bostelman, B. K.

Workshop Practice II.

Credit:
*Mitchell, R. J.

Pass:
Golding, J. T.
Evans, V.

Workshop Practice IIIA.

Pass:
Currie, E. G.
Moir, L. W. J.

Examination Theory Only

Pass:
Terrell, R. J. H.

Engineering Workshop Practice.

Pass:
Marshall, D. A.
Mullins, H. D.
Daws, D. C.
Yates, P.
Perks, A. C.
Baldwin, W. E.
Hamilton, I. R.
Blurton, L. N.

Welding I.

Credit:
*Caple, D. F.
Muncaster, I. M.

Pass:
Head, T. A.
Buckett, G. A.
Tindall, E. R.
Baldwin, N. G.
Williams, L. T.
Joyce, G. D.

Exemption Granted from Practical Work for 1961:
McGowan, L. B.
Morris, T. W. J.

Exemption granted from Attendance from Lectures for 1961:
Stretton, B.

Welding II.

Credit:
*Bostelman, L. E.

Pass:
Joyce, M. J.
Stretton, B.

Structural Engineering I.

Credit:
*Buckett, G. A.
Letts, I. R.
Meiklejohn, G.
Hunter, S. T.
Muncaster, I. M.
Lubbock, F. N.

Pass:
Murray, B. F.
Hurley, B. J.
Thompson, B. M.
Donovan, R. J.
Dykstra, F. D.
Hopkins, G. M. F.
Poole, R. H.
Maguire, D. W.
Egan, H. P.
McNally, R. T.

Structural Engineering II.

Credit:
*Bagworth, B. A.
Crocker, R. F.
White, R.
Duncan, H. F.

Machine Design.

Credit:
*Forrest, R. N.
Mullins, H. D.

Pass:
McIntyre, A. T.

Materials of Construction.

Credit:
*Ghor, A. (E)
*Perks, A. C. J. (E)
Willis, R. J.
Leslie, W. E.

Pass:
Kilderry, T. J.
McIntyre, A. T.
Egan, H. P.

Hydraulics.

Credit:
*Buckett, G. A.
Bennett, V. G.
Muncaster, I. M.

Pass:
Crocker, R. F. (E)
Terrell, R. J. H. (E)
Murray, B. F.

Preparatory Geology.

Credit:
*Falls, G. W.
Sykes, J.

Pass:
Brown, L. A.
Brinsden, W. K.
Mackay, I. D. (E)
Sivyer, B. M. (E)
Clark, B. F. (E)
Tarr, R. C. (E)
Delbridge, R. J.
Hill, J. W. (E)
McGee, A. R. (E)
Foong, K. H. (E)
Gould, R. J. (E)
Haldenwanger, H. E. (E)
Loxton, I. W.
Coumbe, J. T. (E)
Morocz, G. (E)
Gould, G. A.
McGushin, G.

Geology IA.

Pass:
Cooper, G. H.
Colgrove, J. E.
Lubbock, F. N.
Hurley, B. J.
Cruickshank, A. C.
Flanagan, K. J.

Supp. Exam Granted:
Jongen, P. J. F. G.

Exemption granted from Practical Work for 1961:
Jongen, P. J. F. G.
McNally, B. T.

Geology IB.

Credit:
*Lewis, R. P. J.
Klose, W. F.
Colgrove, J. E. (E)
McNally, B. T. (E)

Pass:
Cooper, G. H.
Hurley, B. J. (E)
Lubbock, F. N. (E)
Ivanac, K. W.
Lauri, J. M.
Magnus, E. R.
Thornton, W. F.
Kozuh, D.
Pivac, A. M.

Geology IIA.

Credit:
*Schultz, K.
Travis, G. A.

Pass:
Goode, W. D.
Fogarty, J. M.
Dykstra, F. D.
Leyland, E. C.

Supp. Exam. Granted:
Morel, F. R.

Exemption Granted from Practical Work for 1961:
Morel, F. R.

Geology IIB.

Credit:
*Travis, G.A.
Schultz, K.

Pass:
Goode, W. D.
Fogarty, J. M. (E)
Veale, I. L. (E)
Frank, P. H.
Parry, K. F.

Exemption from Attendance at Lectures Granted for 1961:
Shugg, P. J.

Geology IIC.

Credit:
*Bourne, R. W.

Pass:
George, T. J. F. (E)
Sceresini, B. J. S. (E)
Wills, M. F.

Geology IIIA.

Pass:
Mahalingham, S. S.
Connelly, M. A.

Geology IIIB.

Credit:
*Hopkins, G. M. F.

Pass:
Mahalingham, S. S.

Geology IIIC.

Pass:
Mahalingham, S. S.

Mining I.

Pass:
George-Kennedy, R. J.
Boschis, A. (E)
Magnus, E. R. (E)
Simmons, R. O.

Supp. Exam. Granted:
Satapuntu, S.

Mining II.

Credit:
*Schultz, K.
Travis, G. A.
Letts, I. R.
Hurley, B. J.

Pass:
Frank, P. H.
Goode, W. D.
Lubbock, F. N.
Cruickshank, A. C.
Fraser, H. S.
McNally, B. T.
Hennessy, R. M.
Loxton, I. W.

Supp. Exam. Granted:
Van Der Hoek, B. J. D.

Mining IIA.

Pass:
Davey, C. R.

Mining III.

Credit:
*Worth, I. R.

Mining IIIA.

Pass:
Leyland, E. C.

Mining IIIB.

Pass:
Parry, K. F.

Mine Ventilation.

Credit:
*Worth, I. R.

Pass:
Meiklejohn, G.
Shugg, P. J. (E)
Van Der Hoek, B. J. D. (E)
Jordan, A. F.
Henderson, G. A.

Surveying I.

Credit:
*Schultz, K.
Blurton, L. N.
Veale, I. L.

Pass:
Lewis, C. J. B.
Baldwin, W. E.
Jasson, K. E.
Thompson, B. M.
Donovan, R. J.
Goode, W. D.
Foong, K. H. (E)
Yates, P. (E)
White, R.
Crocker, R. F.
Satapuntu, S.
Bennett, V. G.

Supp. Exam. Paper A:
Magnus, E. R.

Exemption Granted from Practical Work for 1961:
Currie, E. G.
Magnus, E. R.

Exemption from Attendance at Lectures Granted for 1961:
George-Kennedy, R. J.

Surveying II.

Credit:
*Travis, G. A.
Hurley, B. J.

Pass:
Cooper, G. H.
Frank, P. H.
Hopkins, G. M. F.
Colgrove, J. E.
Fraser, H. S.

Supp. Exam. Paper B:
Davey, C. R.
Lubbock, F. N.
Solomon, B. H.

English, IA.

Credit:
*Schultz, K.
Campbell, A. D. (E)
Worth, I. R. (E)
Bagworth, B. A.
Kops, J. N.

Pass:
Hurley, B. J.
Mullins, H. D. (E)
Murray, B. F. (E)
Goode, W. D. (E)
Lubbock, F. N. (E)
Meiklejohn, G. (E)

Muncaster, I. M.
Donovan, R. J. (E)
Slocomb, J. H. (E)
Connelly, M. A. (E)
Maguire, D. W. (E)
Shugg, P. J. (E)
Van Der Hoek, B. J. D.
Wills, M. F.
Jongen, P. J. F. G.

Supp. Exam. Granted:
McNally, R. T.

School of Mines—Norseman.

ANNUAL EXAMINATIONS.

PASS LIST.

Chemistry IA.
Pass:
Hunter, D. R. C.
Lea, E. J.
Cook, G. J. S.
Hug, R. L.

Preparatory Mathematics.
Credit:
Campbell, R. D.
Pass:
Reher, R.
Morton, D. C.

Trade Mathematics I.
Credit:
Coles, J. E.
Pass:
Goodwin, H.
Salmon, L. J.
Murrie, A. W.

Trade Mathematics II
Credit:
Rose, F. W.
May, C. F.
Benoit, A. L.
Pass:
Bottegal, J.
Murphy, F. J.
Giles, K. W.
Prime, G. G.

Mathematics II.
Pass:
Lea, R. J.
Brouwer, J. H.
Hunter, D. R. C.
Powell, P.
Kerr, P. H.
Supp. Exam. Granted:
Denison, J. L.
Swain, G. B.

Preparatory Physics.
Pass:
Kleppe, G. K.
Hill, A. J.
Mahony, A. J.
Supp. Exam. Granted:
Prime, G. G.
Exemption Granted from Practical Work for 1961:
Johnson, R. A.

Physics I.
Credit:
Lea, R. J.
Hunter, D. R. C.
Pass:
Cook, G. J. S.
Supp. Exam. Granted:
Denison, J. L.
Exemption Granted from Practical Work for 1961:
Denison, J. L.

Preparatory Drawing.
Credit:
Sharpe, C. K.
Bennett, W. J.
Goodwin, H.
Pass:
Giles, K. W.
Monks, B. R.

Engineering Drawing I.
Credit:
Reher, R.
Pass:
Murphy, F. J.
Shave, D. A.
Bottegal, J.
Murrie, A. W.
Green, J. W.
Rose, F. W.
Delamotte, R. C.

Engineering Drawing and Design IIA.
Credit:
Squance, K. D. W.

Surveying Drawing II.
Pass:
Kleppe, G. K.
Daly, P. R.

Electrical Engineering I.
Pass:
Avery, A. E.
Kerr, P. H.
Hug, R. L .

Workshop Practice I.
Pass:
Rose, F. W.
Johnson, R. A.
Murphy, F. J.
Prime, G. G.
Bottegal, J.
Bingham, B. J.
Exemption Granted from Practical Work for 1961:
Coles, J. E.
Delamotte, R. C.
Giles, K. W.
Goodwin, H.
May, R. I.

Workshop Practice IIIA
Pass:
Mahoney, A. J.
May, C. F.

Welding I.
Credit:
Hill, A. J.
Pass:
Coles, E. T.
Benoit, A. L. (E)
Bottegal, J. (E)
Prime, G. G. (E)
Willoughby, B. G. (E)
Graham, A. R.
Wise, H. A.
Salmon, L. J.
Murphy, F. J. (E)
Orton, A. A. (E)
Johnson, R. A.
Coles, J. E.
Delamotte, R. C

Welding II.
Credit:
Sharpe, C. K.
Sharpe, V. C.
Stewart, D. A.
Pass:
Mayberry, A. J.
Horne, R. H.
May, C. F.
Maitland, R. E.
Bastow, S. J.

Materials of Construction.
Credit:
Hunter, D. R. C.
Bassett, C. H.
Sainsbury, J. A.
Hill, A. J.
Pass:
Avery, A. E.

Geology IA.
Pass:
Brouwer, J. H.

Mining IIA.
Credit:
Hall, H. E.
Pass:
Powell, P.
Lea, R. J.
Brouwer, J. H.
Moffat, B.
Denison, J. L.
Supp. Exam. Granted:
Burgess, R. J.

Surveying I.
Credit:
Brouwer, J. H.
Pass:
Stewart, D. A.
Kleppe, G. K.
Daly, P. R.
Bennett, W. J.

School of Mines—Bullfinch.

ANNUAL EXAMINATIONS.

PASS LIST.

Preparatory Mathematics.
Pass:
Browne, N. A. C.
Ryan, W. B.
McGregor, G. R.
Dawson, W. D.

Mathematics I.
Supp. Exam. Granted:
Campbell, F. C.
Patrick, A. K.

Mathematics II.
Pass:
Harken, R. M.

Applied Mathematics I.
Pass:
Annear, E. J.

Preparatory Physics.
Pass:
Ryan, W. B.
Supp. Exam. Granted:
Ryan, T. E.
Exemption Granted from Practical Work for 1961:
Ryan, T. E.

Preparatory Engineering Drawing.
Credit:
Annear, E. J.
Pass:
Williams, P. J.
Crunkhorn, L. G.
Faulkner, R. H.
Sack, R. S.
Williams, R. T.
Knowler, J. A.
Divitini, A.
Sawyer, D. J.
Ding, T. E.

Engineering Drawing I.
Pass:
Patrick, A. K.
Ryan, T. E.

Engineering Drawing and Design IIA.
Pass:
Lanfranchi, J. J.
McGregor, G. R.
Campbell, F. C.

Welding I.
Credit:
Liddle, F. R.
Carstairs, G.
Doughty, E. E.
Beaton, K. M.
Munsel, E. G.
Pass:
Patroni, R.
Greensill, W. A.
Faulkner, R. H.
Smith, J. A.
Manacini, E.
Supp. Exam. Granted:
Crunkhorn, L. G.
Exemption Granted from Practical Work for 1961:
Kuiper, M.
Crunkhorn, L. G.
Knowler, J. A.
McDougall, N. V.
Exemption from Attendance at Lectures Granted for 1961:
Ickeringill, G. D.

Welding II.
Credit:
Carroll, N. J.
Pass:
Nunn, A. S.
Exemption from Attendance at Lectures Granted for 1961:
Basten, L. J.
Dixon, W. R.

Mining I.
Pass:
Knowler, B. A. B.

SUPPLEMENTARY EXAMINATIONS.

February, 1960.

The following students passed in the subjects listed below:—

Kalgoorlie.

Chemistry II.
George, T. J. F.

Mathematics I.
Chisholm, M. R.

Applied Mathematics I.
Hobson, J. C.

Electrical Engineering II.
Terrell, R. J. H.

Surveying II.
Flanagan, K. J.

Preparatory English.
Younger, B. A.
English IA.
Mackay, I. D.

Norseman.

Trade Metallurgy.
Sharpe, V. C.

Mathematics I.
Denison, J. L.
Applied Mathematics I.
Hunter, D. R. C.
Kerr, P. H.
Sainsbury, J. A.
Welding I.
Sharpe, V. C.

APPENDIX 2.

SCHOOL OF MINES OF WESTERN AUSTRALIA.

SCHOLARSHIPS AND PRIZES, 1960.

MINES DEPARTMENT.

Entrance Scholarship: No award made.
Senior Scholarship: Black, N. C.

CHAMBER OF MINES PRIZES.

Metallurgy: Sceresini, B. J. S.
Mining: Magnus, E. R.
Engineering: Willis, R. J.
Mining-Geology: No award.

SCHOOL OF MINES STUDENTS' ASSOCIATION SCHOLARSHIPS.

Metallurgy: Bourne, R. W.
Mining: Letts, I. R.
Engineering: Hardy, R. J.
Geology: Hopkins, G. M. F.

INSTITUTE OF MINING SURVEYORS' PRIZE.

£10: Schultz, K.
£5: Travis, G. A.

SOCIETY OF W.A. SCHOOL OF MINES ASSOCIATES' PRIZE.

Falls, G. W.

REG. DOWSON SCHOLARSHIPS.

Group A: Hill, A. J.
Group B: Benoit, A. L.

ROBERT FALCONER PRIZES.

£5 5s.: Brinsden, W. K.
£2 10s.: Delbridge, R. J.

C. A. HENDRY PRIZE.

Cruickshank, A. C.

"FINANCIAL STANDARD" PRIZES.

Mining I.: George-Kennedy, R. J.
Mineral Dressing I.: Schultz, K.

WESLEY LADIES GUILD PRIZE.

Reher, R. (Norseman).

SOCIETY OF ENGINEERS PRIZE.

No award.

APPENDIX 3.

KALGOORLIE METALLURGICAL LABORATORY.

By E. Tasker, A.W.A.S.M. (Met.), A.M. (Aust.), I.M.M., Senior Research Metallurgist.

INTRODUCTION.

One report of investigation and three hundred and ninety five certificates of testing or analyses were issued during the year. A brief description of the investigation is included in this report.

For further information regarding this report apply to:—

Research Secretary,
Industrial and Physical Sciences,
Commonwealth Scientific and Industrial Research Organisation,
314 Albert Street,
East Melbourne, C.2, Victoria.

from whom copies of the report can be obtained, usually six months after date of issue.

In addition to the report issued, two 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 by the laboratory staff during the year.

Some test-work was carried out in conjunction with local mine laboratories as a result of discussions at meetings of the Metallurgical Committee of the Chamber of Mines of W.A.

COMPLETED INVESTIGATION.

Report No. 710.

Beneficiation tests were made on samples of low-grade manganese ores from the Ripon Hills and Balfour Downs deposits, for the Government Geologist of W.A.

The test-work showed that all three ore samples tested could be upgraded by magnetic separation after crushing and reduction in an atmosphere of hydrogen. High grade manganese products could be produced by this method of beneficiation but manganese recoveries were low.

INCOMPLETE INVESTIGATIONS.

Report No. 700.

Washing tests on low-grade gypsum samples taken from various W.A. lakes were completed and the report was being prepared.

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.

CERTIFICATES.

Three hundred and ninety five certificates of testing or analyses, were issued during the year, covering the usual wide range of measurements. The major portion of the certificates issued covered gold assays of ore and metallurgical products.

KALGORLIE METALLURGICAL LABORATORY.

Summary of Year's Work, 1960.

Report Number	Owner	State	Locality	Ore Type	Type of Investigation	Confidential Until	Number of Metallurgical Tests	Number of Assays	
								Gold	Other
710	Government Geologist, Perth	W.A.	Ripon Hills and Balfour Downs	Manganese	Beneficiation Tests	2/3/61	48	....	468
						Totals	48	....	468
	Certificates Nos.: 833–866, 868–917, 919–928, 930–1119, 1121–1231	....	....	....	....	....	....	1,1161	829
	Free Assays	....	....	....	....	....	....	303	41
	School of Mines	....	....	....	....	....	....	28	18
						Totals	48	1,492	1,356
THE FOLLOWING INVESTIGATIONS WERE INCOMPLETE OR PENDING AT 31st DECEMBER, 1960									
700	Government Geologist, Perth	W.A.	Various W.A. Lakes	Gypsum	Beneficiation Tests	....	35	....	160
712	Warman, Equipment Co. Perth	W.A.	Capel	Zircon	Concentration	....	16	....	6
						Totals	99	1,492	1,522

DIVISION VI

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Annual Report of the Inspection of Machinery Branch of the Mines Department for the Year 1960

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Operations under the Inspection of Machinery Act, 1921-1958

Annual Report of the Chief Inspector of Machinery and Chairman of the Board of Examiners for Engine-Drivers for the Year ended 31st December, 1960, with statistics

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 ended 1960.

E. E. BRISBANE,
Chief Inspector of Machinery.

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 equipments 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 117 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, 2,113 were not in service.

Return No. 3.

Therein is a summary of operations for the year. Of some importance which is contributory to the industrial welfare of this State 117 boilers manufactured locally were to orders received from other parts of the Commonwealth and Overseas; exportations to other States numbered 108 and destinations for the balance were in New Zealand and southern parts of Asia.

Return No. 1.

Showing the Number of Boilers of Each Type, and Country of Origin of New Registrations for the Year ended 31/12/60.

	Countries of Origin						
	Germany	United Kingdom	U.S.A.	Eastern States	Western Australia	Unknown Sources	Total
Ret. Multi Stat. Int. Fired	....	....	....	1	139	....	140
Water Tube	....	....	....	3	2	....	5
Digester	....	....	....	1	5	....	6
Vulcanizer	....	....	....	21	2	....	23
Steam Jacketed Vessels	....	....	....	1	19	....	20
Sterilizer	....	1	....	12	13	....	26
Air Receiver	1	10	5	34	56	13	119
Gas Receiver	....	....	2	6	17	....	25
Autoclave	....	....	....	6	5	....	11
Electric Heated Bioler	....	....	....	....	2	....	2
Total	1	11	7	85	260	13	377

Return No. 2.

Showing Classification of Various Types of Useful Boilers in Proclaimed Districts on 31/12/60.

Types of Boilers	Districts Worked from Perth	Districts Worked from Kalgoorlie	Total
Lancashire	44	23	67
Cornish	227	59	286
Semi Cornish	14	1	15
Vert. Stationary	417	41	458
Vert. Port.	39	10	49
Vert. Multi. Stat.	47	4	51
Vert. Multi. Port.	8	1	9
Vert. Pat. Tubular	50	....	50
Loco. Rect. F/Box Stat.	74	20	94
Loco. Rect. F/Box Port.	160	17	177
Loco. Circ. F/Box Port.	92	2	94
Locomotive	78	11	89
Water Tube	556	65	621
Ret. Multi. U/fired Stat.	259	7	266
Ret. Multi. U/fired Port.	....	5	5
Ret. Multi. Int. Fired Stat.	143	6	149
Sterilisers	470	25	495
Autoclaves	56	1	57
Digesters	295	7	302
Gas Receivers	340	....	340
Air Receivers	1,796	589	2,385
Vulcanizers	454	9	463
Steam Jacketed Vessels	624	14	638
Not Elsewhere Specified	176	5	181
Total Registration Useful Boilers	6,419	922	7,341
Total Boilers out of use, 31/12/60	1,520	593	2,113

Return No. 3.
Showing Operations in Proclaimed Districts during Year ended 31/12/60.

Boilers	Districts Worked from Perth	Districts Worked from Kalgoorlie	Total 1960	Total 1959
Total number of useful boilers registered	6,419	922	7,341	7,141
New boilers registered during year	369	8	377	413
Boilers inspected thorough	4,008	328	4,336	4,091
Vessels exempt under Act constructed for export thorough	14	....	14	12
Boilers inspected working	891	1	892	1,163
Boilers condemned during year temporarily	14	....	14	4
Boilers condemned during year permanently	54	15	69	115
Boilers sent to other States during the year	108	....	108	55
Boilers sent from other States during the year	79	....	79	94
Boilers sent from other countries during year	19	....	19	....
Boilers sent to other countries during year	9	....	9	13
Transferred to other Departments	....	....	....	1
Transferred from other Departments	6	....	6	3
Re-instated	....	....	....	2
Converted	1	....	1	1
Number of notices of repairs issued during year	558	37	595	465
Number of certificates issued including those issued under Section 30 during year	4,019	328	4,347	5,177

MAINTENANCE AND MISCELLANEOUS.

Reports of Inspectors are indicative of the good care and maintenance of boilers being more widespread than has been noticeable over past years. This is due in part to those many owners who previously did not take sufficiently serious interest in this direction having ultimately become really convinced by hard facts in their own or others' experience.

To no small degree, the improvement undoubtedly has resulted also from repeated efforts of departmental officers and those specialists in the sphere of water treatment business in advising boiler operators who hitherto failed to acknowledge in a tangible form the necessity for proper maintenance.

There yet remain however many users who are tardy in coming into line toward exercising satisfactory diligence in the careful operation of plant, and this is particularly emphasised in the case of the package type fully automatically controlled boilers.

Some owners are most difficult of being impressed that automatic equipment in itself must be subjected to daily routine testing if the safety of the boiler to which it is fitted is not to be dangerously impaired. It would almost appear that they confuse the term "automatic" as being synonymous with perpetual motion and think that no attention at all is necessary to appliances of this character.

In a previous annual report attention was drawn to the feature of very fast steaming rate—in other words, high evaporative capacity—which boilers of the package type possess but which seems yet overlooked by some owners to the detriment of their plants. Associated with vessels of this description and high output is the utmost necessity of uninterrupted correct water treatment coupled with the vital importance of assiduous attention to having float control, chambers kept free of sludge and, also, to methodical frequent testing of all automatic operations for complete efficiency of control of the various events: during this last year, as on occasions previously, there were instances of neglect of these requirements being the cause of damage to boilers.

Fortunately, none of these incidents was attended by disaster but outside this State an explosion of a return multitubular internally fired boiler fitted with automatic equipment occurred during the year when the furnace ruptured by it becoming overheated due to shortage of water.

Upon enquiry into the circumstances there was little doubt that insufficient attention had been given to assurance that the control equipment was functioning correctly with the result that the control unit float had been prevented from operating to the designed amount by some sludge remaining in the float chamber.

Section 2.
EXPLOSIONS AND INTERESTING DEFECTS.

There was no explosion of any pressure vessel to report but certain defects which occurred are considered as being of note.

Defects.

Water Tube Boiler.

In this case it was necessary to permanently condemn the vessel after not more than nine years service due to internal deterioration along bottom of drum and also the tube ends which within 12 months had occurred at a remarkably rapid rate.

This was an oil fired boiler having a steam/water drum length 54 in., diameter 17 in., with nine 1¼ in. diameter water tubes attached at the ends of each of each tube to the lower part of the horizontal drum: design working pressure was 120 p.s.i. but the allowable W.P. was reduced to 70 p.s.i. to conform with the working pressure of vessels to which it was coupled without the provision of a reducing valve in the main steam supply line.

The fan with D.C. motor used in association with the fuel equipment was mounted on the boiler casing and considerable leakage of current through the casing to ground was found to exist.

All circumstances being considered it was concluded that the abnormal rate of wastage must be attributed to the passage of current through the wetted surfaces of the boiler.

Double Shell Autoclave.

This is a horizontal vessel of a type commonly used in hospitals for sterilising purposes. The overall dimensions of the outer shell are 3 ft. 6 in. length, 1 ft. 6 in. diameter and this forms a jacket of the cylinder and one end of an inner chamber: steam is supplied to the jacket and also inner chamber at 20 p.s.i.

During the 12 months of the year under review deterioration to an unusual extent has taken place concerning this unit in use at a Government hospital: the following are extracts of a Notice to Owner from our Inspector to the management of the hospital, and his report to this department consequent upon this particular annual survey:—

8th September, 1960.

Autoclave Reg. No. 2956.

Considerable corrosion of the inner vessel has taken place over the past year, and quantities of loose copper oxide scale were found in the chamber at this inspection.

The Engineer also reports that trouble has been experienced with both steam traps blocking up with fine black powdery material. This would indicate that further corrosion is occurring within the jacket, probably being caused by the carry over of occluded gases with the steam supply.

Some investigation into the source of this corrosion should be undertaken, as at the present rate of attack, the vessel may require renewal within 12 months.

Deputy Chief Inspector of Machinery,

At a recent inspection of the above it was noted that the inner vessel was showing considerable corrosion over practically all the surfaces of the inner chamber.

The Engineer of the hospital reported that considerable trouble had been experienced over the previous few months, in keeping the steam traps on this vessel in working order. On several occasions, these traps had to be dismantled and cleared of heavy accumulations of a fine black powdery material. Since one of these traps is connected to the steam jacket

space, it is an indication of possible corrosion occurring within the jacket. This space is of course inaccessible for visual inspection.

The vessel is an Army disposal unit first registered in this Department on 14/10/47. The original inner shell was of 8 gge. copper and was in continuous use until about October, 1957. The two reports previous to this date made mention of corrosion and scale formation on the inner chamber surfaces. In November, 1957. the unit was sent to a firm well recognised for this class of work for repairs and a new inner vessel was ordered by this Department. A new inner of 11 gge. Cusilman Bronze was fitted and the autoclave recommissioned in September, 1958. Now, after two years' work, the corrosion is as extensive as it was before repair.

The chemical composition of Cusilman is as follows:—

	Per Cent.
Copper	96
Silicon	3
Manganese	1

The autoclave operates under 20 p.s.i. steam pressure. From inquiry of the hospital staff the only chemicals introduced for autoclaving are a normal Saline Solution (approxi. 0.9 per cent. Na Cl) and Sodium Citrate Solution (approxi. concentration 3.8 per cent. Sodium Citrate) contained in open necked jars. If proper procedures are not followed in sterilising these solutions they may boil over occasionally, and could cause the type of corrosion noted. This however would not account for any corrosion initiated on the jacket side of the vessel.

The only other factor which could be taken into account is the fact that a chemical boiler treatment has been introduced since the installation of this unit, approximately 12 months ago. This is a standard boiler water treatment and does not apparently contain any constituent capable of affecting the material to any extent.

One outstanding feature noted, was that in the vicinity of the heavy door ring, over a band of about 2 in. wide, the plate is unaffected; also an area approximately 8 in. x 2 in. in the vicinity of the jacket drain. This would indicate that the temperature of the material has some effect on the corrosion, as these areas would possibly be some degrees cooler than the rest of the shell.

An analysis of the scale obtained shows it to contain copper and silicon, and it has been suggested that the silicon content could affect the corrosion rate at the temperatures involved (approx. 260° Farenheit). These tests have not yet been completed but it is hoped that some conclusive evidence may be obtained from them.

Investigations were commenced into the cause of the corrosion under the assumption that it must have been caused either by chemical or electrolytic action. Some test strips of copper foil set in a rubber stopper have been placed in the autoclave so that no direct electrical contact is possible with it. Further strips have been introduced so that electrical contact is possible.

Any further information or conclusions regarding the result of the above tests will be forwarded as soon as available.

At a much later date we were forwarded a copy of a letter addressed from the Medical Department to the Secretary of the hospital and this is quoted hereunder:—

Theatre Autoclave.

A chemical analysis of the scale from the above steriliser which was sent by your Engineer has been received from the Government Chemical Laboratories and the report finishes with the following information:—

> The analysis of these scales confirms that they are formed from corrosion of the bronze, possibly due to the high oxygen and carbon dioxide contents of the steam.
>
> Our enquiries have suggested that if the steriliser is to be replaced, stainless steel would be superior to bronze for this purpose.

In view of the above analysis and recommendation the Department's Engineer will shortly obtain an estimate for the replacement of this unit in the near future and submit it for approval.

The result of this analysis is rather interesting and does appear as if it will be necessary to carry out a further treatment in the boilers to prevent this from happening elsewhere. This trouble has been met recently in most of the major metropolitan hospitals and a special treatment is under test in two hospitals. This treatment is not very expensive and if it proves successful you will be requested to carry this out in your boilers.

Up to the present time we are not in receipt of further information relative to the investigations as proposed in the final paragraph.

Hospital Steriliser.

This is a single shell horizontal steriliser, 22½" length, 16" diameter, having the door secured by the provision of bars capable of being removed in a radial direction by the manipulation of a central screw assembly fitted to the door. To secure the door against pressure the ends of the bars must be projected a sufficient distance into a locking ring attached around the end of the vessel in order that adequate engagement to withstand the load imposed on the door by the internal pressure may be attained.

The accident now being quoted arose from the locking bars only to a very small amount making engagement with the locking ring although the attendant nurse stated she had exerted her utmost power on the screw mechanism.

The steriliser had been under steam for approximately three minutes when the locking bars dislodged from the ring and the door in being blown open tore itself from its hinge. It was miraculous that the nurse who was in the near vicinity was not injured.

During investigation of the incident it was stated that previously on occasions some difficulty had arisen regarding thickness of joints. When fitted into the socket they had been whittled down to make them flush with the metal surface but it was found difficult to then make them steamtight.

Apparently, on the day of the accident the joint was again renewed and on this occasion it was found by the inspector investigating the occurrence that the joint protruded ⅛" outside the socket: this feature kept the door further detached from the face of the locking ring and thereby this probably had the adverse effect of precluding a satisfactory entry of the locking bars into their designed position in the locking ring.

It was stated that after the fitting of this new joint the steriliser had been in service a number of times that day prior to the occasion of the accident. The nurse on duty when the mishap took place said that she had already used the steriliser about six times previously that same day.

Whether in this particular instance the customary caution of this operator became a little impaired due to some circumstance is of course a matter of conjecture, but she stated to the investigating inspector she had rotated the wheel of the screw until it was hard home but could not recollect how far the locking arms were past the edge of the ring.

It is not known whether steriliser operators are instructed sufficiently regarding the importance of assuring for themselves that everything is as it should be when doors are in a closed position preparatory to placing such vessels under steam. This factor may already be included with other instructions regarding the operation of sterilisers but at the same time it is most strongly recommended that particular emphasis should be given to the matter of tutorage of members of hospital staffs who are assigned to the operation of sterilisers.

Section 3.

INSPECTION OF MACHINERY.

(See Returns Nos. 4, 5 and 6.)

At the expiration of the year 43,370 groups of machinery were in the register: this indicates an increase of 1,363 groups in comparison with the figures for the previous year. Respective of Lifts, figures reveal an increase of 17 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, 1960.

Classification	Districts Worked from Perth	Districts Worked from Kalgoorlie	Total 1960	Total 1959
Number of groups driven by Steam Engines	126	376	502	505
Number of Groups driven by Oil Engines	3,077	740	3,817	3,750
Number of Groups driven by Other Power	69	211	280	280
Number of Groups driven by Electric Motor	35,806	2,965	38,771	37,472
Totals	39,078	4,292	43,370	42,007

Return No. 5.

Showing Operations in Proclaimed Districts during Year ended 31st December, 1960.

(Machinery only.)

Classification	Districts Worked from Perth	Distr'cts Worked from Kalgoorlie	Total 1960	Total 1959
Total Registrations Useful Machinery	39,078	4,292	43,370	42,007
Total Inspections made	24,715	3,912	28,627	30,410
Certificates (Bearing Fees)	6,125	534	6,659	6,084
Number of Extension Certificates issued under Section 42 of Act	....	....	....	....
Notices issued (Machinery dangerous)	499	42	541	397

Return No. 6.

Showing Classification of Lifts on 31st December, 1960.

Types	How Driven	Total 1960	Total 1959
Passenger	Electrically driven	257	250
	Hydraulically driven	1	1
Goods	Electrically driven	121	121
	Hydraulically driven	1	1
	Belt driven	3	3
Service	Electrically driven	88	84
	Hydraulically driven	1	1
Excalators	Electrically driven	25	19
Totals	....	497	480

Accidents to Machinery.

There were four accidents worthy of note but as these involved injuries to persons reports of these incidents are contained in references to Cases A, B, C and D under Accidents to Persons, Section 5 hereinafter.

Section 4.

PROSECUTIONS FOR BREACHES OF THE ACT.

No prosecutions to report.

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 indicates accidents caused by machinery not subject to registration with this department, but investigated under a provision of Section 50. The overall total of occurrences shown in the three returns number 105.

With much regret it is to be reported that two of the accidents resulted in fatalities—one in each case.

Foundry Cupola Charging Hoist.

Case A.

In this instance a fitter was killed as a result of being struck by a falling cupola charging bucket which dislodged him from his position on a safety rail surrounding a floor opening on which he was standing and caused him to fall through the opening to the ground below where he struck his head on a weighing machine.

Deceased with a workmate was endeavouring to restore the bucket rope into the groove of its sheave from which it had become displaced and jammed between the sheave and sheave bracket attached to the hoist cradle.

It has been said that he thought he could feed the rope back into its place if it were inched without detaching its suspended load and requested his mate to proceed to the hoist control and operate it accordingly.

The 7/16 in. diameter rope, which was new and had only a short while previously been installed, apparently during the inching attempt became completely fouled, however, and parted with the consequence that the bucket in falling hit against the fitter who, as stated in the foregoing, was standing on the floor opening safety rail.

Mobile Crane.

Case B.

This accident which resulted in the second fatality was not solely attributable to machinery.

Heavy steel plates were being unloaded from a Jinker with a mobile crane and stacked on edge in a storage rack. The person who died was acting as "hooker on" when he was crushed between dislodged steel plates and some metal containers.

The circumstances surrounding the fatality may be given the best explanation by quoting from the crane driver's statement:—

> I received instructions from the Yard Foreman to unload sheets of steel from the firm's Jinker and stack them in the Steel Rack. The Sheet Steel Racks comprise two rows of 4 inch by 4 inch posts at the western end of the yard. Whilst the posts are set about 5 feet apart, the rows are also about 5 ft. apart.
>
> Against the northern posts and on the north side leaned a 20 ft. by 6 ft. by ¾ in. steel plate whilst on the opposite side was a similar plate only ½ inch thick.
>
> Leaning against the posts on the south side were eleven 20 ft. by 6 ft. by ¼ in. steel plates and on the north side leaned twelve similar plates.
>
> There was a space of about 3 ft. between the southern steel plates and a row of 3 steel containers.
>
> The firm's motor wagon with jinker on which was a quantity of ¼ inch steel plates, was standing at a point with its front close to the eastern end of the steel containers. I drove the Mobile Crane in a southerly direction with its front about midway along the sheets of steel.
>
> I had previously attached a self gripping tool to the centre of the top sheet of steel plate on the jinker. Deceased then attached the hook of the crane to the tool.
>
> After this was done I raised the plate and after reversing the Crane to a suitable position, drove forward, that is in a westerly direction, and when the plate was in a suitable position on the south side of the Rack, de-

ceased signalled me to stop and I then lowered the plate into position. I then alighted from the vehicle and showed deceased how to remove the tool.

I procured a ladder and whilst I stood on this he stood behind me on a steel container. After doing this I asked him if he understood the tool and he said he did.

I then reversed the Crane and drove southwards at a right angle to the Jinker. The next two sheets of steel plate were together. Each plate weighs about 11 cwt.

As the Crane is capable of lifting 3 tons I attached the tool to lift both plates and then arranged with deceased to attach the hook.

I lifted the 2 plates without incident and mentioned to him I would place these on the north side of the rack. The purpose of doing this was to counter balance the pressure of the steel plates on the south side. After reversing the Crane again I lowered the plates until their bottom edge was 2 ft. to 2 ft. 6 inches above the ground. I then drove forward again with a right hand turn towards the west.

Before I commenced to travel westwards and the leading edge of the plates was about 20 ft. east of the rack, I stopped the Crane whilst deceased "lined up" the plates with the north side of the rack.

From my position in the Cab of the vehicle I could see he had lined up the plates. I signalled to him it was correct and he acknowledged my signals. I then noticed him walk away from the front of the vehicle to the south and I commenced to drive forward watching the plates for movement caused by the forward motion of the vehicle and uneven ground.

When I had driven forward and could see the plates were in position ready for lowering and was about to apply the brakes of the Crane to stop, preparatory to lowering them, the right hand end of the front bumper of the Crane struck the eastern edge of the half inch steel sheet on the southern side of the northern rack, causing it to twist to the south.

In the next instant it fell on the quarter inch sheets of plate steel, pushing them to the south and tipping those on the southside against the containers. I then called "Look out" and not hearing any response looked about and noticed deceased was in a standing position facing south, pinned against the northern side of the eastern most transport.

Straightaway I got out of the vehicle and after calling for help I tried to push the plates away in a northerly direction without success.

The comments of the Inspector who made the investigation into the occurrence were to the effect that there was no evidence of any fault in the equipment of the crane and that he considered the 4 in. x 4 in. timber posts forming the vertical support to safely contain the load imposed by the plates being stacked against them were inadequate structurally for their purpose.

I concur entirely with his determinations.

Case C.

Ferris Wheel.

As a result of an accident in which a Ferris Wheel in an amusement area at Scarborough Beach was involved two teenage girls were seriously injured during the New Year holiday season; here below is the substance of the report of an Inspector of this department relevant to the occurrence:—

> This machine is powered by a 20 h.p. petrol engine with the drive arranged from the engine through Vee belts to a rear axle assembly to which is fitted a rope drum driving an endless rope passed around the wheel near the periphery.
>
> To the drive unit is fitted a hydraulic brake operated by a handlever: the engine is controlled by hand through a Bowden cable leading to the carburettor, and a driver is in constant attendance whilst the wheel is in operation.
>
> At the time of my investigation the driver of the machine was not available but upon interrogation the proprietor stated that the two girls were the only riders on the wheel during the period the accident occurred and the driver was applying a little extra throttle to the engine as the unbalanced load was rising.
>
> It was ascertained further from the proprietor that the spring, against which the throttle lever operates, broke and the engine revolutions suddenly increased.
>
> The surge of speed introduced to the wheel resulted in five cars, including the one occupied by the girls, becoming unhooked from the suspension yokes and it was stated that the wheel completed about one and one-half revolutions before being brought to a stop.
>
> The suspension yokes where connected to the cars are doubled back about 4½ inches to form a hook and where suspended from the crossbars between the two side frames of the wheel the yokes are retained in position by collars five inches in diameter.
>
> After some consideration I am of the opinion that it is possible the cars would have become unhooked due to a sudden application of the brake more than to a surge of power, although perhaps the surge in itself did cause considerable swaying.
>
> I consider a safety link should be fitted across the hooks at the car ends of the yokes and also under the crossbars to prevent the cars jumping the hooks or the yokes overriding the collars on the crossbars.
>
> A further alteration which could be embodied to add to the safety of the machine would be a method of limiting the power of the engine: perhaps a smaller jet in the carburettor would add to a measure of safety.

It will be noted our officer was informed that the wheel made about one and one-half revolutions before being brought to a stop. On the other hand the Insurance Company Assessor during a discussion with me read from a statement by the driver, whom he succeeded in interviewing, that the wheel did four revolutions from when it rapidly speeded up to the time he stopped it.

Apparently the driver had stated he was afraid to apply the brake suddenly, due to the rapidity at which the machine was revolving, in case he caused cars to become dislodged from their suspensions. He further stated that he attempted to stop the engine by manipulation of the carburettor.

It is my personal opinion that unwittingly he may have applied the brake with sufficient harshness to introduce an abrupt or shock retardation of the motion of the wheel. At this stage the fast moving cars would have continued to describe momentarily an arc around the pivot points in the throat of the suspending yokes and then those cars in the upper region would have dropped from their inverted position causing them to become unhooked or partially unhooked from their yokes.

This Ferris Wheel is 27 feet in diameter across the points to which the suspending yokes are pivoted and the normal operating speed of the wheel is four revolutions per minute approximately: load eight cars, four persons per car.

Subsequent to the accident this installation has been dismantled and stored for an indefinite period and still remains out of use. The following instructions however have been issued to the owners pending such time it be contemplated restoring the machine to service:—

> (a) The hooks of yokes being fitted with guard links or effective mousing, or some other acceptable method of secure attachment between yokes and cars being adopted;

(b) a guard link fitted across the throat of each yoke to prevent the yoke from being displaced from its pivot point on its cross-arm of the wheel; and

(c) a smaller jet fitted to the carburettor or some other means of automatic governing of speed to be provided on engines having appreciable surplus power.

Case D.

Portable Grinding Wheel

This machine being driven by motor power of less than 1 h.p. was not subject to registration with the department but under a provision of section 50 of the Inspection of Machinery Act an investigation was made into the circumstances of an accident in which personal injuries were caused.

This machine was defined by the manufacturers as suitable for a four inch grinding wheel and fitted by them with a guard appropriate to this dimensions of wheel, but apparently when a wheel six inches in diameter was fitted for use in grinding flush some welding on steel plates the original wheel guard supplied was removed as it was of course unsuitable for the larger fitment which was then used unguarded.

During these operations the grinding wheel disintegrated and a workman distant approximately seven feet from where the grinder was being worked received injuries which resulted in the loss of an eye.

The speed specified for this machine was 5,000 r.p.m. but when checked after the accident it was ascertained that the "no load" speed was 6,500 r.p.m.—the maximum allowable speed for the 6" wheel fitted was 6,050 r.p.m. From this it will be noted that the revolutions of this particular unit exceeded what was permissible for the larger size grinding wheel which had been fitted.

Apart from the discrepency between allowable and actual revolutions, the clamping flanges, designed and suitable for 4" diameter wheels were utilised for the larger size disc, and for this purpose they were definitely unsuitable.

Case E.

Boiler Fuel Explosion.

This incident occurred in the furnace of a boiler and the attendant on duty received severe burns. The following is an extract from the report of the Inspector who investigated the accident:—

> This accident occurred on the Lancashire boiler Registered No. 2350. It is fired with sawdust enriched with used oil.
>
> The fuel storage, treatment and handling is as follows:—
>
> > Used Oil in 45 gallon drums is obtained from three or more suppliers and in the main is used engine sump oil, but I would say that lighter oils such as distillate and perhaps even petrol would be present in some drums and as such leaves a great deal to be desired from the safety angle particularly.
> >
> > These drums are emptied into a tank below floor or ground level, as also is the sawdust. An adjustable supply of oil—manually controlled—feeds onto the sawdust while being elevated above the firing floor level. From the top of the elevator the combined fuel flows by gravity to the bunker space in front of the boiler, from where it is fired by hand shovel.
>
> I interviewed the injured person the day after the incident at Royal Perth Hospital. The lower part of his arms appeared to be the main part of his body burned. The fireholes are rather low down in relation to the floor.
>
> By what he could remember, he had fired the left hand furnace 4 or 5 minutes prior to pitching 2, 3 or perhaps 4 shovels of fuel into the right hand furnace. It was then the explosion and "blow back" occurred.
>
> From his information and also from the observation of another man who was the first person to arrive on the scene, both fuel dampers were open. Ashpit dampers are only sections of light plate and not secured to the boiler. Firehole doors are of light plate and no latches are fitted.
>
> It was noticed the fire bridges were paticularly high in both flues and that the fuel tended to collect up and over them.
>
> Minor blowbacks are reported to have occurred previously on a number of occasions without causing damage or personal injury.
>
> I consider the probable cause was due to saw dust impregnated with oil more volatile than sump oil being dumped in the heap on the firebars—heat causing gasification in the core of the heap and finally igniting with explosive force, sufficient to cause flame blowing in all directions.

Consequent upon this report I addressed a letter to the owners, some extracts of which are as follows:—

> There are certain factors concerning this additive and the boiler parts which we consider should receive serious consideration toward avoidance of any further serious incident of similar nature. It was learned that minor blowbacks have occurred prior to this instance.
>
> The Inspector noted that the bridges at the back of both furnaces are paticularly high and that fuel tended to bank up against and over the top of these. The rather restrictive passage thus formed above the bridges could present a greater retardation to escape of the product of a major eruption in the bed of fuel.
>
> It was also observed that (a) the firedoors lack latches to secure them in a closed position when firing tools are not being used and (b) the ashpit damper doors are only sections of light plate not fitted with any attachment to secure them in position.
>
> It is very important that with this type of fuel an attendant be able to shut the ashpit dampers at all times he has occasion to have the firedoors open.
>
> Each of these doors should be hung on hinges or suspended by hooks to a cross bar fitted across the mouth of the ashpit. The doors should be of a reasonably snug fit to completely close the ashpits and thus prevent the passage of draft thereto while furnace doors are open for attention to the fires.

Case F

Crane Sling Appliance.

A rigger was severely injured when the bridge of a new overhead travelling crane was being raised from the ground for placing it on its runways. The accident occurred in the following circumstances.

The rigger, it is understood, was supervising operations when the load, suspended from a mobile crane, dropped after being raised only a few feet from the ground.

It was stated that the bridge was being lifted by balancing the load in the centre with the utilisation of a length of 6" x 3" R.S.J. This appliance was not secured to the bridge in any way and was simply located across from one 20" x 6½" R.S.J. bridge beam to the other and took the load under the top flanges: a ¾" chain sling was attached to the 6" x 3" cross piece and the mobile crane hook.

From information it appears that the injured person had rigged and balanced the load: it was then raised and by means of a guide rope attached to it the bridge was turned longitudinally with the overhead runway by the rigger and another man pulling on the rope.

When the load was approximately 5 feet off the ground the suspending girder slipped from its engagement with the bridge girders and the rigger was struck by the falling load. The man assisting him with the guide rope was uninjured.

Case G.

Crane.

Involved in this accident were two employees of a firm engaged in the supply and fitting of tubular steel roof trusses in connection with the erection of a new bulding. The trusses were in course of being positioned and secured in place with the aid of a mobile crane having the raising and lowering operations actuated by hydraulic rams attached directly to the jib.

One of the injured men was a welder and the other a framer and they received injuries when, during the period one of the trusses was being positioned, it became disengaged from the crane hook while in only a landed stage of positioning on the two walls of the building and had not been affixed thereto.

The circumstances surrounding the incident are contained in the following extract from the report of our Inspector who enquired into the mishap:—

> I interviewed the driver of the mobile crane who has given me the details of what occurred.
>
> The factory had the side walls completed and tubular steel trusses were being placed in position with this crane. The span of the trusses is 43′ and the side walls at the centre of the building are 2″ out at either side making the opening greater. A wire rope sling with links 6″ x 2″ secured at each end was used to left the truss which was raised into position on the outer wall and when lowered on to the centre wall it was found that it rested by approximately ¼″.
>
> The driver left his crane and joined two men who were standing under the truss with the builder discussing what they were to do when the truss fell striking both the former and severely injuring them. No person actually saw what happened.
>
> With the truss resting on the edge of the wall it appears that the oil leaked through the pump for the hydraulic lift, allowing the jib to creep lower and the links on the sling to slip off leaving the truss unsecured.
>
> The truss not being secured it toppled over and fell to the ground.
>
> To raise the jib the clutch of the engine is used to engage the hydraulic pump and when the jib is at the required position the pump gear is disengaged and the hydraulic system holds the jib in position. A release valve is used to lower the jib.
>
> Instructions were issued to have the hydraulic system overhauled, particular emphasis being placed on the release valve.

Case H.

Farm Tractor Power Take-Off.

This refers to an accident in which a part owner of the property was seriously injured when, apparently, his trousers became fouled with the head of a grease nipple protruding from the power take-off attachment as he was stepping backwards off the tractor after starting the machinery for the operation of an arc welding set mounted on a trailer attached to the tractor by a towbar.

The drive pulley on the welding machine was connected to the power take-off spline shaft by a universal joint and a length of 2″ pipe with internal square in the end to mate with the square section of the take-off adapting connection.

The grease nipple which caused the accident was screwed into the length of 2 in. tubular drive shaft approximately 4¼ in. from that end in which a square section was formed: the nipple protruded ¾ in. from this drive shaft.

The purpose of the nipple is for lubrication of the mating square portions, but for the use which the take-off was serving at the time the nipple would be an unnecessary fitting as the welding set would not be in operation at the same time the trailer was being towed.

It is of course understood that lubrication at this point would be required when a field machine is in use and being towed and operated by a tractor.

If a suitable guard or shield had been fitted around the drive shaft, particularly at the location of the grease nipple, this accident would have been avoided and possibly it would not have occurred if the nipple was not in position.

Upon enquiry at the local office of the manufacturers of the tractor it was learned that the firm provides a standard construction of a telescopic trough shape guard to cover the take-off and drive shafting when a tractor is supplied with a harvester.

RETURN No. 7.—SHOWING NUMBER OF SERIOUS ACCIDENTS, BOTH FATAL AND NON-FATAL, WHICH OCCURRED IN PROCLAIMED DISTRICTS DURING THE YEAR ENDED 31st DECEMBER, 1960

"F" denotes Fatal

Industry	Circular Saw	Buzzer (Planer)	Spindle Moulder (Shaper)	Belts and Shafting	Gearing	Chain Drive	Conveyor (Belt, Screw, Box)	Ferris Wheel	Can Washer	Shaper (Metal)	Wire Galvanising M/c.	Stacking M/c.	Crane (Charging)	Crane (Mobile)	Fibre Teaser	Revolving Screens	Planing M/c. (Metal)	Guillotine (Paper, Metal)	Press (Metal)	Printing M/c.	Cardboard Box M/c.	Soaking M/c.	Rolls	Hoisting Rope	Brushmaking M/c.	Matchbox Mfg. M/c.	Pneumatic Forging Hammer	Tractor Power Take-off	Shoetrimming M/c.	Plastic Processing M/c.	Boiler Furnace Blowback	TOTALS PER INDUSTRY
Woodworking and Furniture	3	8	1	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	13
Metalworking and Engineering	2	1	....	2	....	....	1	....	....	1	....	....	1 (F)	1	....	....	1	2	4	....	....	....	3	....	....	....	....	....	....	....	....	19 (1F)
Printing and Allied Industries	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	2	1	....	....	....	....	....	....	....	....	....	....	4
Fertiliser Manufacturing	1	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Food and Drink Processing	....	....	....	2	1	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	7
Safety Match Manufacturing	....	....	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	3
Wool Processing	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Building Materials and Building	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Mining	....	....	....	1	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	4
Other	2	1	....	....	1	....	1	1	....	....	....	....	....	3 (1F)	1	....	....	....	....	....	....	....	1	....	1	....	1	1	1	1	....	16 (1F)
Totals per Type of Machine	8	10	1	8	3	1	5	1	1	1	1	1	1 (1F)	5 (1F)	1	1	1	3	4	2	1	1	4	1	1	1	1	1	1	1	1	73 (2F)

MINOR ACCIDENTS

RETURN No. 7A.—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, 1960

Industry	Circular Saw	Bandsaw	Spindle Moulder (Shaper)	Belts	Chain Drive	Conveyor (Belt)	Abrasive Wheels	Wiredrawing Machine	Fibre Teaser	Guillotine (Metal)	Press (Metal)	Stapling Machine	Autoclave (Steriliser)	Mincer	Cement Mixer	Wool Opening Machine	Amusement Train	Buff	Rolls	C.O. Fumes	Tota's per Industry
Woodworking and Furniture	1	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3
Metalworking and Engineering	....	....	....	....	....	....	1	1	....	1	1	....	....	....	....	....	....	1	1	....	6
Printing and Allied Industries	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	2
Fertiliser Manufacturing	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Food and Drink Processing	1	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	2
Wool Processing	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	3
Building Materials and Building	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....	2
Other	2	....	....	....	....	1	1	....	1	....	....	....	1	....	....	....	1	....	....	1	8
Totals per Type of Machine	6	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	27

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, 1960

Industry	Circular Saw	Abrasive Wheel	Abrasive Wheel (Portable)	Press (Metal)	Totals per Industry
Metalworking and Engineering	....	1	2	1	4
Printing and Allied Industries	1	....	....	....	1
Totals	1	1	2	1	5

Section 6.

EXAMINATION OF ENGINE DRIVERS, CRANE DRIVERS AND BOILER ATTENDANTS.

The Board of Examiners granted 112 engine drivers', 185 crane drivers' and 80 boiler attendants' certificates.

Compared with the previous year these figures constitute increase 5, increase 52 and decrease 20 respectively in the number of certificates granted.

Section 7.

AMENDMENTS TO ACT.

No amendment to be reported.

Section 8.

STAFF.

During the year Messrs. H. M. Shaw and F. S. Downes were appointed to the inspection staff to fill two vacancies which were occasioned by retirements.

Due to the intensity with which industrial activities have increased in both productivity of formerly established undertakings and number of new installations the stage has been reached where the existing allowable complement is far from adequate to cope with the position, despite the unstinted efforts of every member of the inspectorial section in all situations which emerge from the progressive expansion of work. The question of increase of staff is in course of submission for consideration.

The number of members of the clerical section is unchanged. Here again, extensions to the industrial sphere reflect in much greater demands on personnel of that staff also, and at all times there have been energetic responses.

I wish to thank all officers of both sections of the Branch for their readiness to assist in the conduct of the many phases of our work over the year.

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 occurences, and in various ways connected with such enquiries have rendered much assistance to our department.

On conclusion of this report, and on behalf of the members of our staff who on many occasions have been closely associated in discussions with officials in other divisions of the Department of Mines respective of problems affecting the work of this Branch, I would like to express our appreciation of all assistance given to us in helping to confront any major difficulty.

J. F. WINZAR,
Deputy Chief Inspector of Machinery.

DIVISION VII

Government Chemical Laboratories Annual Report—1960

Under Secretary for Mines:

I have the honour to present to the Hon. Minister for Mines a summarised Annual Report on the operations of the Government Chemical Laboratories for the year ending 31st December, 1960.

Administration:

Two major administrative changes were made during 1960.

1. As mentioned in my Report for 1959 building for the conversion of the sewage treatment works at Subiaco to the activated sludge process included provision for a laboratory. This laboratory was completed early in 1960 and that section of our staff dealing with sewage work moved into it, vacating the unsatisfactory accommodation at the Smith Street Annexe Laboratory. With this staff located at the treatment works it was considered that administrative efficiency would be increased if the staff were transferred to the Metropolitan Water Supply, Sewerage and Drainage Department and this was effected as from 1st February, 1960. The staff transferred consisted of two chemists and one laboratory technician. This transfer has resulted in a marked decrease in the total number of samples received at the Government Chemical Laboratories and this is referred to later in this report.

2. In the re-organisation of the Department of Industrial Development it was decided to transfer the Bureau of Research & Development from that Department to our Laboratories. This transfer involved three chemists, a number of wages staff and the pilot plant works at Bentley, some 5 miles East of Perth.

In the interim of re-organisation and before transfer the work of the Bureau had been allowed to lapse to a considerable extent but since the transfer to us as from June 1st, 1960, efforts have been directed towards building up the staff and work of the Bureau which is now known as the Engineering Chemistry Division of the Government Chemical Laboratories. At 31st December, 1960, the staff of this Division consisted of a chief chemical engineer, two industrial chemists, a laboratory technician and five wages staff. The Annual Report of this Division included here covers the whole of 1960, not just the period since June, 1st, especially as no Annual Reports of the Bureau were issued under the Department of Industrial Development.

Endeavour has been made to modify the policy of the former Bureau as little as possible, alterations being kept to the minimum necessary to conform to the Laboratories' Regulations.

Thus these Laboratories now consist of 6 Divisions, a Physics Section, a central office and a library all under the control of the Director (Government Mineralogist, Analyst and 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 and 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 and 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 Section—N. L. Marsh, B. Sc., Physicist and Pyrometry Officer.

Librarian—Miss H. Duffield.

Office—Miss D. E. Henderson, Senior Clerk.

The increase of 20 per cent. in the number of Divisions controlled by the Director has resulted in a considerable increase in the work and responsibility of the Director. This was particularly so in the latter half of 1960 because of commercial interest in char from Collie coal, a sponge iron industry for the South-West and the advent of the LaPorte Industries to Bunbury, using local ilmenite. All of these were matters in which the new Engineering Chemistry Division was very active.

At 31st December, 1960, the staff of the Laboratories numbered 71, being—

Professional officers	46
General officers	11
Clerical officers	9
Wages staff	5
	71

The close association of these Laboratories with other Government Departments and with kindred associations was maintained during 1960 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.

Commonwealth Scientific Industrial Research Organisation—State Committee.

Food and Drug Advisory Committee.

Insecticides Committee.

Oils Committee of the Government Tender Board.

Paints Advisory Committee of the Government Tender Board.

Swan River Conservation Board.

Veterinary Medicines Advisory Committee.

Water Purity Advisory Committee.

In addition the Director was a member of an inter-departmental committee to set up specifications for ready-mixed concrete.

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 analyses of samples. This has been particularly so for the Swan River Conservation Board, for which a large number of analyses has been made in connection with possible pollution of the Swan River.

The Food and Drug Advisory Committee is very active in dealing with regulations to be uniform throughout Australia and the Pesticides Advisory Committee dealt with 148 applications for registration of pesticides. A matter of great concern to this latter committee is the poisonous nature of most of the newer pesticides, particularly as many of them can be absorbed through the skin.

Equipment.

No major items of equipment were obtained during 1960 but a number of smaller items were purchased to assist us to cope with increased work and to extend our facilities for service to other Government Departments and to the general public.

Accommodation.

As noted in the Annual Report for 1959, extra accommodation is required at these Laboratories and it is pleasing to record that additions to our Library, Office and Refectory are expected to be made early in 1961. We can now concentrate on extensions to the Divisions of Agriculture, Food and Drug, and Minerals. The transfer to us of the present Engineering Chemistry Division has provided ample site space at Bentley for the present and it is intended that some of the present and future equipment of the Divisions of Fuel Technology and of Industrial Chemistry will be housed there, so relieving and preventing pressure on site space for these two Divisions at the Adelaide Terrace site.

However this does not alleviate the position with respect to the Divisions of Agriculture, Food and Drug, and Minerals. For some time past it has not been possible to undertake all the work requested of us, much less the work that could and should be done. In our class of work it is not just a case of more staff and chairs and tables. A chemist requires bench space and equipment and these facilities are now fully occupied for the three Divisions mentioned so that further building is essential if we are to give the services required.

Obituary.

It is with the deepest regret that I have to record the death on 17th October, 1960, of Mr. B. L. Southern, Second-in-Charge, Food and Drug Division. The late Mr. Southern was born on 2nd November, 1898, and commenced his chemical career as a part-time junior assistant in the Laboratories of the Government Analyst in 1917. He progressed steadily in his chosen profession, in 1924 he was elected an Associate of the (now) Royal Australian Chemical Institute and was elected a Fellow in 1956. Until 1947 Mr. Southern worked in the Agriculture Division of these Laboratories with particular interest in soils. In 1947 he was appointed to the position he held at the time of his death, and showed a particular interest in the determination of alcohol in blood and its interpretation in terms of intoxication. He also took a very active interest in the Royal Society of Western Australia and was editor of its joural for some 11 years.

Mr. Southern gave long and meritorious service to these Laboratories and his passing removes from us the last of the "Old Guard," for he commenced in 1917 and of the present staff the next "oldest" commenced in 1934.

Experimental.

One matter of industrial hygiene which the laboratories were called upon to investigate and advise included *inter alia* contaminated ground water. The contaminants were chlorophenols and the weedicide 2:4D. and it was alleged that the use of this water by sprinklers on Kikuyu grass had killed the Kikuyu. To test this a small plot, 5 x 10 yds. of lawn, mainly Kikuyu grass, at these laboratories was irrigated twice weekly with the contaminated water, applying approximately 0.5 ins. of water at each watering. At each end of the test plot an area 5 x 5 yds. was similarly watered from the metropolitan water supply. Watering commenced on 15th November and to date there has been no adverse effect on the Kikuyu grass. Samples of the contaminated water used were analysed and the following table shows the range in analytical data to 31st December, 1960:—

	Range
Appearance	Very cloudy
Colour	Settles clear and colourless
Odour	Chlorophenol
Ferrous iron	present
pH	6·3–6·7
	Grains per gallon
Total soluble salts	109–119
Sodium chloride (calculated from chloride)	80–86
	parts per million
Chlorophenols, calculated as phenols	26–37
2:4D	6–31

General.

The total number of registrations during 1960 was 3,151 covering 12,020 samples. This was a marked decrease on the numbers for 1959, namely 3,591 and 17,483 respectively. This large decrease was due to the transfer of the metropolitan sewage work to the Metropolitan Water Supply, Sewerage and Drainage Department as mentioned earlier. The numbers of samples received, excluding metropolitan sewage samples was 10,287 in 1959 and 10,298 in 1960.

The number of samples received each year does give some measure of the activities of the laboratories 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. This can be well illustrated from the two administrative transfers during 1960. The staff of 3 could handle thousands of sewage samples per year but the Engineering Chemistry Division staff of 6-9 was fully occupied for 7 months with 5 samples. Also it is not possible to give a statistical account of the time and effort devoted to the various Committees previously mentioned, to advice to Government Departments and the public, attendance at Courts of Law, visits to industrial establishments and so on.

The samples received were allocated to the various Divisions of the 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 on samples registered to the Mineral Division. Such samples to the Physicist are not doubly registered, but some others are, so the total shown in Table 1 is greater than the total given above.

This co-operation between Divisions helps to foster the policy that we are one Government Chemical Laboratories not separate Divisions as separate entities, that the 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 1 shows the source of the samples received during 1960 and their allocation to various Divisions.

Table 1.
Source and Allocation of Samples Received During 1960.

Source	Division							
	Agriculture	Engineering Chemistry	Food and Drug	Fuel Technology	Industrial Chemistry	Mineral	Director	Total
Agriculture Department	3,491	....	407	....	....	....	....	3,898
Departmental	9	....	18	20	1	52	1	101
Explosives Branch	....	....	12	....	1	....	....	13
Factories Branch	....	....	42	....	....	....	....	42
Fisheries Department	23	....	....	....	....	....	....	23
Government Geologist	15	....	....	....	....	480	....	495
Industrial Development Department	....	....	....	....	9	....	....	9
Metropolitan Water Supply	160	....	1,874	....	1	....	....	2,035
Mines Department	....	....	....	....	....	596	....	596
Police Department	....	....	850	....	....	....	....	850
Public Health Department	25	....	297	....	....	....	....	322
Public Works Department	365	....	55	15	36	....	....	471
State Batteries Branch	....	....	....	....	....	295	....	295
State Mining Engineer Branch	....	....	39	....	1	....	....	40
Swan River Conservation Board	25	....	206	....	....	....	....	231
Tender Board	....	....	80	....	3	....	....	83
War Service Land Settlement	24	....	....	....	....	....	....	24
Other State Government Departments	23	....	16	12	....	77	....	128
Pay—								
Air Department	....	....	43	....	....	....	....	43
Hospitals	....	....	60	....	5	....	....	65
Milk Board	....	....	189	....	....	....	....	189
Other Commonwealth Departments	18	....	13	....	....	....	....	31
Public	800	5	49	94	25	321	....	1,294
West Australian Government Railways	....	....	11	....	....	....	....	11
Various	15	....	....	5	1	....	....	21
Free—								
Public	....	....	1	....	....	742	....	743
Various	6	....	....	....	....	....	....	6
Total	4,999	5	4,262	146	83	2,563	1	12,059

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 for the general public, 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 and indeed during 1960 we examined samples from 14 of the 28 Government Departments shown in the Public Service List 1960.

Comparing 1960 with 1959 there were some marked alterations in the numbers of various types of samples received. There was an appreciable increase in

bauxite, gold, iron ores, tin ores and titanium ores;

and an appreciable decrease in

milk, sewage, ocean beach pollution, animal toxicology, soils, burnt lime (public), gypsum and heavy sands.

(Sgd.) L. W. SAMUEL,
Director.

AGRICULTURE, FORESTRY AND WATER SUPPLY DIVISION.

The total number of samples received in 1960 is a 9 per cent. decrease on the number received in 1959. This does not mean however that there has been a corresponding decrease in work done, as the expanding variety of work undertaken has thrown additional pressure on the limited laboratory space available.

This is the third consecutive annual report of this Division that stresses the urgent need for more accommodation. It is impossible to give the Department of Agriculture the service they require with the present building. The lack of accommodation is accentuated by the fact that in the initial design of the building insufficient space was allowed for sample preparation and storage and what was inadequate 18 years ago is now a major handicap. An additional need of the Division which can only be supplied after additional space is available, is an increase in the technical staff to relieve professional officers of the simpler routine determinations.

The type and number of samples received in 1960 are listed below in Table 2.

Table 2.
Agriculture, Forestry and Water Supply Division, 1960.

——	Agriculture Department	Departmental	Fisheries	Government Geologist	Metropolitan Water Supply	Public Health Department	Public Works Department	Swan River Conservation Board	War Service Land Settlement	Other State Government Departments	Pay—Public	Pay—Other	Pay—Commonwealth Departments	Other Free	Total
Cereals—															
Cereal rye	19	....	....	....	....	....	....	....	....	....	....	....	....	....	19
Oat plant	63	....	....	....	....	....	....	....	....	....	1	....	....	....	64
Wheat plant	539	....	....	....	....	....	....	....	....	....	1	....	....	....	540
Wheat grain	12	....	....	....	....	....	....	....	....	....	....	....	....	....	12
Wheat straw	60	....	....	....	....	....	....	....	....	....	....	....	....	....	60
Various	16	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Fertilisers—															
Fertiliser Act	63	....	....	....	....	....	....	....	....	....	....	....	....	....	63
Fertiliser other	8	....	....	....	....	....	....	....	....	....	....	2	....	....	10
Limestone and sands	31	....	....	....	....	....	....	....	1	....	8	1	....	....	41
Various	33	....	....	....	....	....	....	3	....	....	9	1	....	....	46
Horticulture—															
Apple leaves	97	....	....	....	....	....	....	....	....	....	....	....	....	....	97
Lemon leaves	10	....	....	....	....	....	....	....	....	....	....	....	....	....	10
Potatoes	46	....	....	....	....	....	....	....	....	....	....	....	....	....	46
Tobacco	231	....	....	....	....	....	....	....	....	....	....	....	....	....	231
Vine leaves and canes	369	....	....	....	....	....	....	....	....	....	....	....	....	....	369
Various	26	....	....	....	....	....	....	....	....	....	....	....	....	....	26
Miscellaneous—															
Animal liver	105	....	....	....	....	....	....	....	....	....	....	....	....	....	105
Deposits	1	1	....	....	3	....	8	....	....	....	4	....	....	....	17
Effluent	....	....	....	....	....	....	....	15	....	....	....	....	....	....	15
Flour	12	....	....	....	....	....	....	....	....	....	....	....	....	....	12
Oilbearing seed	351	....	....	....	....	....	....	....	....	....	....	....	....	....	351
Sheep faeces	29	....	....	....	....	....	....	....	....	....	....	....	....	....	29
Sheep urine	11	....	....	....	....	....	....	....	....	....	....	....	....	....	11
Various	16	1	....	....	1	8	4	1	....	4	9	....	8	....	52
Pasture and Fodder—															
Clover	511	....	....	....	....	....	....	....	....	....	1	....	....	....	512
Fodder	16	....	....	....	....	....	....	....	....	....	....	....	....	....	16
Hay	49	....	....	....	....	....	....	....	....	....	....	....	....	....	49
Kochia brevifolia	14	....	....	....	....	....	....	....	....	....	....	....	....	....	14
Lucerne	13	....	....	....	....	....	....	....	....	....	....	....	....	....	13
Lupin	25	....	....	....	....	....	....	....	....	....	....	....	....	....	25
Native plants	15	....	....	....	....	....	....	....	....	....	....	....	....	....	15
Pasture	96	....	....	....	....	....	....	....	....	....	....	....	....	....	96
Feeding Stuffs Act	95	....	....	....	....	....	....	....	....	....	....	....	....	....	95
Stock foods	18	....	....	....	....	....	....	....	....	....	5	2	....	....	25
Silage	128	....	....	....	....	....	....	....	....	....	1	....	....	....	129
Various	20	....	....	....	....	....	....	....	....	....	5	1	....	....	26
Soil	324	....	....	....	....	....	....	....	....	....	13	7	....	....	344
Water	19	7	23	15	156	17	353	6	23	19	743	1	10	6	1,398
Total	3,491	9	23	15	160	25	365	25	24	23	800	15	18	6	4,999

Soils.

The 344 samples of soils received are a considerable reduction on the number received in 1959 and are more comparable with the number received in 1958.

The following soils are those of most interest:—

1. Eight samples from two profiles of surface sandy soils at Borden and Wagin which had shown marked responses to potash fertilisers were found to be extremely low in acid soluble and exchangeable potassium, to depths of 13 in. in the Borden soil and 22 in. in the Wagin soil.

2. Nine samples representative of soil types taken from alongside the road between Jerramungup and Ravensthorpe were analysed in detail to supply fundamental information about the soils of this district. These were all sandy surfaced soils overlying sandy-clays at depths of 12-15 in. The surface soils from each site were found to be very low in acid soluble phosphorus and potassium and in exchangeable potassium.

3. From a long term rotation experiment designed to find the effect on the soil nitrogen, the method of sub-sampling large bulked samples was checked. Four sub-samples from each of 10 bulked samples were analysed and it was found that the normal 10 gram sample for analysis was a true representative sample of the large bulked sample as none of the individual results varied by more than 0.001 per cent. in an average total nitrogen figure of 0.027 per cent.

(4) "Available" soil potassium. Because of reported slight successes of correlating some form of soil potassium with plant response to added potassium in New Zealand, Victoria and Tasmania a series of a 101 soils and the clover growing on them were analysed for potassium. The soils were extracted by the ammonium acetate rapid extraction method and N-nitric acid method of D. C. Hogg (N.Z. J. Sci. and Tech. Dec. 1957 p. 1015). As appreciable amounts of potassium were found in the coarse organic matter in the soil (greater than 2mm) this was also determined in case it had any bearing on the results; normally the greater than 2mm fraction of a soil is not used in analysis.

Preliminary investigation of the soils showed that the rapid ammonium acetate method gave results equal to the sum of water soluble and exchangeable potassium, so it was considered that separate exchangeable potassium figures would be of little added value.

The results of the analyses showed:

(a) From 51 soils from North Dinninup and Nornalup and the corresponding clovers grown on them it was found that:

(i) There was fair correlation between total clover potassium and yields on both sites.

(ii) There was little correlation between per cent of potassium in the clovers and yields on either site.

(iii) There was no correlation between ammonium acetate extractable potassium (inclusive or exclusive of the greater than 2mm organic fraction) with total clover potassium, per cent potassium in the clover or yield at North Dinninup but there was a trend with each of these respectively at Nornalup.

(b) From grid and transect samples from West Manjimup and Walpole there was a similar trend between ammonium acetate extractable potassium and per cent potassium in the clover, as at Nornalup. No yield figures were available.

(c) From 29 samples of soil and corresponding clovers taken from areas of potash deficient clover and alongside healthy clover, chosen by visual symptoms it was found that:

(i) With two exceptions the visual selection of the clover into deficient and healthy groups also separated the clover into corresponding distinct groups by their potassium content i.e. clover analysis confirmed the visual symptoms.

(ii) Neither rapid ammonium acetate extraction or N-nitric acid extraction of potassium from the soil could separate the clover grown on these soils into two groups of healthy and potassium deficient clover i.e. the soil analysis could not confirm plant deficiencies.

(d) Taking the figure of 0.8 per cent potassium in clover as the dividing line below which maximum growth cannot be expected (Fitzpatrick and Dunne J. Dept. Agric. W.A. May-June 1956 p. 325) then Table 3 can be compiled from the results of these 101 soils and clover.

TABLE 3.

Soil	Clover		
Potassium K* m.e./100 g.	Number of samples		
	Less than 0·8% K	Greater than 0·8% K	Total
0·2 or less	11	4	15
0·2–0·4	34	21	55
0·4 or greater	7	24	31
Total	52	49	101

* Ammonium acetate extractable.

Hence for these particular samples it is found that

(i) 73 per cent of soils having 0.2 milliequivalent per 100 grams or less of ammonium acetate extractable potassium are likely to respond to added potassium, based on plant potassium.

(ii) 77 per cent of soils having 0.4 milliequivalent per 100 grams or more of ammonium acetate extractable potassium are unlikely to respond to added potassium.

(ii) Of the soils having greater than 0.2 but less than 0.4 milliequivalent per 100 grams of ammonium acetate extractable potassium 62 per cent may respond and 38 per cent. are unlikely to respond to added potassium.

A lot more work is warranted in following up these results. It is hoped that soil samples from potash trials from all over the State will be available for analysis to see if further work can lead to the differentiation of soils into responsive and non-responsive groups by soil analysis.

(5) From an experiment on sandy soils at Eneabba designed to supply information on the degree of leaching and profile distribution of added phosphorus, 48 soils were analysed for total and hydrochloric acid soluble phosphorus. These soils were sampled at depths of 0-3, 3-6, 6-9, 9-12, 12-18, and 18-24 inches from plots which over the past three years had received annually 0, 200, 400 and 800 lbs per acre of superphosphate, each soil sample being the bulked sample from six sites. Unfortunately despite the bulking of six sites per sample the initial variation in the plots was too great to allow interpretation of the results. Because of this, in every case except one, an increase in phosphorus over 0-24 inches was found above the amount that was added e.g. in one case 600 lbs per acre had been added and 4,200 lbs of superphosphate over the nil treatment was found.

The results emphasise the variability in chemical composition that can be found in soils which visually appear to be uniform.

(6) A series of 83 soils from stations in the vicinity of the proposed Ord River dam in the Kimberleys which had been sampled in 1944 and 1945 were analysed in detail to provide fundamental information about soils of this area.

(7) 36 surface soils from a soil structure experiment at Brookton were analysed for carbon and nitrogen to find the effect of different rotations on soil structure and soil organic matter. The rotation had completed 5 years and the nitrogen and carbon contents increased in order for the various rotations from continuous fallow to volunteer pasture, volunteer pasture, wheat to volunteer pasture, fallow, wheat to continuous volunteer pasture to 2 years sub clover, oats, oats to continuous sub clover.

(8) 12 samples of greyish sandy clays from three soil profiles at South Quairading were analysed in connection with poor crop emergence and growth. These soils were from flat valley floors subject to winter water-logging. The poor physical structure of the soils which was suspected to be the reason for the trouble, was found to be related to the high exchangeable sodium percentage in the soils which ranged from 5 per cent. of total exchangeable cations in the surface to 27 per cent. at 12-18 inches.

Waters.

The number of water samples received in 1960 was almost the same as 1959. There has been a gradual tendency over the past few years for the proportion of samples from Government Departments to increase, changing from about one third of the total water samples received in 1958 to about one half in 1960.

(1) The majority of samples from Government Departments were received in connection with the routine examination of Canning Dam, Mundaring Weir, Serpentine Dam and Wellington Dam.

(2) To provide information on the effect of new cement lined pipes on the quality of water carried by the pipes, fortnightly samples from a long term experiment were analysed from places along the Wellington Dam-Narrogin-Katanning main. The results to date show no diminution of the increased alkalinity and hardness in the water caused by the new pipes.

(3) Nitrate in water. Despite the occurrence in parts of the State of water high in nitrate, there have never been any reported cases of methaemoglobinaemia in infants attributable to the water. Areas of the State, particularly the drier inland northern pastoral areas, have been known for years to have water high in nitrate. The town water supply of towns such as Cue, Meekatharra, Sandstone and Wiluna have unusually high nitrate contents of the order of 20, 15, 20 and 25 parts per million respectively of nitrate-nitrogen.

World authorities differ considerably in their recommendations of a maximum permissible limit for nitrate in drinking water. One of the most recent standards as given in Water and Water Engineering, June 1957 is—

Nitrate-nitrogen ppm	
20-40	Undesirable for infant feeding.
40-80	Unsafe for infant feeding.
Greater than 80	Dangerous for infant feeding although satisfactory for other children and adults.

A survey of our records of over 250 analyses for nitrate in waters from all over the State showed on the above basis none were dangerous or unsafe for infant feeding and only a few would be classified as undesirable for infant feeding.

(4) Northampton Town Water Supply. The Northampton Town water supply is derived from the Gwalia mine shaft, an old copper and lead mine. Until recently copper and lead analyses on this water showed them to be well below accepted maximum limits for health. However, complaints about deposits in the water and metallic taste led to further sampling in October and the copper content was found to be 9.6 parts per million, which is well above the maximum limit of 3 parts per million for continuous use.

As no alternative source of sufficient supply is available for Northampton, a simple emergency recommendation to remove the copper with the facilities already available was made, plus suggestions for a permanent treatment plant. The addition of 8 ozs. of lime per 1,000 galls. to the water to raise the pH to about 9.5 was found sufficient to precipitate most of the copper from solution. Laboratory tests showed that the copper could be reduced by this means to 0.3 parts per million or less. Until a permanent treatment plant can be erected regular sampling from various parts of the reticulation is being maintained.

Ten parts per million of copper in water is not harmful for human consumption provided it is not used continuously, but water with 10 parts per million of copper has a definite metallic taste and some individuals with sensitive tastes will regard 5 parts per million as objectionable.

(5) Broome Water Supply. The finding of an ample supply of good quality water only eight miles from Broome by the Public Works Department has assured the future water supply of the port. Previously inhabitants have had to use water which had about 200 grains per gallon of total soluble salts. Analysis of the recent bores shows that the water is comparable with that of the Perth Metropolitan Water Supply.

(6) Softening of excessively hard water. An investigation was made into the suitability of commercial domestic water softeners for softening excessively hard waters. It was found that even waters with a total salt content as high as 750 grains per gallon and 150 grains per gallon hardness could be satisfactorily softened. It was found that at high levels of hardness the capacity of the softener is reduced more than proportionately to the ratio of total capacity to water hardness; the quality of the water rapidly deteriorates as more water is passed through the softener.

(7) It is a pleasure to note that our Leaflet No. 2125 on water standards has acquired world reference, a recent publication "Water Quality Criteria" by The Calfornian Water Pollution Authority quotes extensively from this leaflet, in their section on water standards for stock, though unfortunately with minor misunderstandings of the Leaflet.

Fertilisers.

(1) Fertiliser Act.—Generally this year Department of Agriculture Fertiliser Inspectors have paid more attention to sampling fertilisers for the use of primary producers as undoubtedly is the intention behind the Fertiliser Act, and have not been so concerned about home garden fertilisers.

It is unfortunate that the wording of the Fertiliser Act allows a manufacturer to register any constituent that he claims to be of fertiliser value, as registration infers to the public approval by the Department of Agriculture. This registration of ingredients in quantities below useful fertiliser value could be prevented by prescribing minimum chemical standards for registration such as applies to blood and bone, bone dust, superphosphate and ground limestone.

Table 4 below shows the main constituents checked and reported in 1960 and whether or not they comply with the Act and Regulations.

TABLE 4.

Fertiliser Act Samples Reported, 1960.

Constituent	Samples Analysed	Complied	Deficient
Nitrogen N	36	33	3
Water soluble potash K_2O	20	20	....
Phosphoric anhydride P_2O_5—			
Water soluble	29	23	6
Citrate soluble	42	41	1
Acid soluble	40	40	....
Total	41	40	1
Copper Cu	4	4	....
Zinc Zn	3	3	....

It will be seen from this table that only a small number of samples did not comply.

(2) Three comparatively pure samples of commonly occurring copper minerals, malachite, chalcocite and chalcopyrite were ground and graded into three sizes of — 50 + 100, — 100 + 200 and — 200 B.S. mesh, for use by the Department of Agriculture in pot test trials on the availability of copper to plants from each of these minerals. Each size was analysed for total copper content and acetic acid soluble copper, the latter being regarded as a measure of the available copper in the ore. Table 5 below shows that only the malachite had appreciable quantities of "available" copper.

TABLE 5.

Sample	Fraction B.S.S.	Copper Cu	
		Total	Acetic acid soluble
		%	%
Malachite	— 50 + 100	56·9	32·3
	— 100 + 200	56·7	37·8
	— 200	56·5	48·6
Chalcocite	— 50 + 100	15·9	0·82
	— 100 + 200	18·3	0·88
	— 200	19·1	0·50
Chalcopyrite	— 50 + 100	17·6	less than 0·05
	— 100 + 200	17·5	less than 0·05
	— 200	17·8	less than 0·05

Similar work was carried out on nine commercially available copper ores which were also being tested in pot trials.

(3) Because of recent diagnosis of "White Muscle Disease" in this State and its known association with selenium deficiency, interest was shown in the selenium content of locally used rock phosphate and superphosphate. The results of our analyses are shown below:

	Selenium, Se parts per million
Christmas Island Rock phosphate	0·5, 0·6, 0·6, 0·7, 0·9, 1·0 and 1·5
Nauru Island Rock phosphate	1·3
Ocean Island Rock phosphate	2·6
Superphosphate made from Christmas Island Rock phosphate	0·5 and 1·8

Pastures, Fodders and Stock Foods.

(1) Feeding Stuffs Act.—Table 6 shows the number of main constituents checked and reported in Feeding Stuffs Act samples in 1960 and whether or not they comply with the requirements of the Act. This table clearly shows that a large majority of the constituents complied with the Act.

TABLE 6.

Feeding Stuffs Act Samples Reported, 1960.

Constituent	Samples analysed	Complied	Deficient	Excess
Crude protein	71	62	9	....
Crude fat	68	47	5	16
Crude fibre	70	62	....	8
Sodium chloride	66	60	....	6
Phosphoric anhydride	76	63	13	....
Calcium	71	63	8	....

(2) Twenty three samples of meadow hay from an experiment at Albany designed to compare loss of nutritive value of pasture retained under varying conditions were analysed for feeding stuff value and lignin. The six conditions were: (a) pasture left standing, (b) pasture cut and left, (c) pasture cut and windrowed, (d) pasture baled in square bales and left in paddock, (e) pasture baled in round bales and left in paddock, and (f) pasture baled and stored in shed. Samples were taken for analysis at the commencement of the experiment, at the end of two months and at the end of four months. Some anomalies showed up in the protein and fibre contents with storage which could only be attributed to sampling errors. The lignin content, which is considered related to the digestibility of a feed was found to increase in the order (f)-(a) on storage. The increase in lignification of the fibre in treatment (f) was very slight, 37, 36 and 43 per cent. respectively at each sampling, whereas in treatment (a) the increase was from 37 to 41 to 58 per cent.

(3) Thirty-four samples of mixed pasture from Denmark Research Station were analysed for potassium and nitrogen from a pasture management trial. There were seven replications of five treatments of added potassium fertiliser at rate of 0, 56, 112, 224 and 448 lbs. of potassium chloride per acre. Nitrogen uptake was found to be unaffected by added potassium fertiliser and potassium uptake was increased only at levels above 56 lbs. per acre of potassium chloride.

(4) A large variety of native and introduced pastures from all parts of the State were analysed for the Animal Nutrition Officer to assess their feeding value, with special emphasis on their copper and cobalt status.

(5) The 128 samples of silage analysed were mainly from the Australian Dairy Product Board Silage Competition. There were, however, a large number received from wheatbelt districts, showing that the interest in the production of silage is not limited to the dairying areas.

(6) The B-carotene and carotenoids content of three samples of tree lucerne suggested as a poultry supplement were found to range from 116-315 and 450-730 parts per million respectively, which is higher than we have found in lucerne or imported lucerne meal.

Cereals.

(1) *Barley.*—Only 10 samples of grain and plants were analysed in 1960, mainly from cereal grazing and recovery trials.

(2) *Oats.*—(a) Of the 67 samples of oat plants received, the majority were from cereal grazing and recovery trials at Avondale, Bramley, Esperance, Merredin and Wongan Hills Research Stations.

(b) An investigation was made of several samples of oats and groats returned from a shipment of W.A. oats to the Continent. Complaints had been made that the oats were unfit for milling because of a bitterness imparted to them after milling and because of discolouration of a small percentage of the rolled oats. The discoloured oats were suspected of being responsible for the so-called objectionable taste of the milled oats. Analysis and examination of a sample of the shipment showed no abnormalities and a limited investigation (because of the smallness of the sample provided) into the free fatty acid content of the discoloured milled oats was fruitless. High free fatty acid contents are generally associated with bitterness in oats. No satisfactory conclusion could be arrived at and a larger sample of affected oats is awaited for a more thorough investigation.

(c) In the course of analysis of grazing trial samples from wheatbelt Research Stations, it was noted that they all had abnormally high potassium contents from 3.3-5.3 per cent. dry basis. Our own previous analyses for similar samples ranged from 0.2-3.3 per cent. and Goodall and Gregory "Chemical Composition of Plants" quote the normal range for oat plants at flowering as 0.4-1.6 per cent.

These high figures were independent of whether the samples were from the light sandy soils of Esperance and Wongan Hills Research Stations or from the heavy soils of Avondale and Merredin Research Stations. It is obvious that cutting and removing oats for hay or silage with such high potassium contents could rapidly deplete soil potassium reserves especially in a light soil.

(3) *Wheat.*—(a) Analyses of the 1959-60 F.A.Q. wheat and flour prepared from it in a Brabender mill are given below with the 1958-59 figures for comparison.

	F.A.Q.			
	Wheat		Flour	
	1959/60	1958/59	1959/60	1958/59
	%	%	%	%
Moisture	9·8	10·2	12·6	11·8
Protein as analysed	10·4	9·1	9·5	8·2
Protein at 13·5% moisture	10·0	8·8	9·4	8·1
Ash at 13·5% moisture	1·18	1·26	0·62	0·63
Maltose figure (Kent-Jones)	....	....	2·77	2·96

(b) 24 samples of wheat plants from a source of copper fertiliser trial at Woogenellup were analysed for copper. Copper ores from four sources and copper sulphate all slightly suppressed the uptake of copper in both August and September cuts.

(c) 360 samples of wheat plants from Avondale and Wongan Hills Research Stations from experiments designed to test the effects of time of application of ammonium sulphate to five varieties of wheat, were analysed for nitrogen. The treatments were (i) 600 lbs at seeding (ii) 600 lbs at earing (iii) 300 lbs at seeding and 300 lbs at earing At the first cutting, treatment (ii) gave the greatest uptake of nitrogen. At the later two cuttings there were little differences between nitrogen uptake for each treatment or within varieties.

(d) A further 128 samples of wheat plants were analysed for nitrogen from a rate and time of application of ammonium sulphate experiment at Wongan Hills Research Station. The results showed that:

(i) Nitrogen uptake increased with applied ammonium sulphate at seeding for both the first and second cuttings for all varieties.

(ii) Nitrogen uptake increased for ammonium sulphate applied in early August for all varieties at the second cutting.

Plant Nutrition.

(1) *Apple Leaves.*—The effect on the salt content of apple leaves by irrigating with saline water, as high as 300 grains per gallon in total soluble salts, was examined on 83 samples of leaves from orchards at Bridgetown and Kendenup. Samples were taken for comparison from properties which had had (a) no irrigation (b) 1 year of irrigation (c) several years irrigation and (d) 21 years of irrigation.

Generally the salt content, which ranged from 0.08 to 0.39 per cent sodium chloride was lowest in the unirrigated leaves and highest in those with only 1 year of irrigation. The exceptions to this relation and the relatively narrow range of salt figures found, suggest that there is no significant increase in leaf salt content with irrigation on these orchards.

(2) *Clover Leaves and Petioles.*—The 510 samples of clover received serves as a further example of the dependence of West Australian agriculture on clover pasture. Of the samples analysed the following were of most interest:—

(a) 28 samples from a zinc fertiliser experiment at Esperance Plains Research Station were analysed for zinc. The increase in zinc uptake with added zinc oxide fertiliser is shown below, the zinc figures being the average of four replicates.

Treatment : Zinc Oxide (lb./acre)	0	½	1	2	4	8	16
Clover Zinc, Zn (p.p.m.)	37	44	54	56	86	152	140

(b) The results of zinc uptake from analysis of 55 samples from a residual zinc oxide fertiliser experiment at Esperance Plains Research Station are shown below. The zinc figures are the average of 5 or more replicates.

Treatment : Zinc Oxide (lb./acre)	0	2	2	2	4	4	4
When applied		1953	1953 and 1956	1955 and 1958	1953	1953 and 1956	1955 and 1958
Total Zinc Oxide added (lb./acre)	0	2	4	4	4	8	8
Clover Zinc, Zn (p.p.m.)	27	36	44	52	44	51	58

(c) The uptake of copper by 55 samples of clover from a residual copper fertiliser experiment at Esperance Plains Research Station is shown below. The copper figures are the average of 5 or more replicates.

Treatment : Copper sulphate (lb./acre)	0	5	5	5	10	10	10
When applied		1953	1953 and 1956	1953 and 1956 and 1958	1953	1953 and 1956	1953 and 1956 and 1958
Total copper sulphate applied (lb./acre)	0	5	10	15	10	20	30
Clover copper, Cu (p.p.m.)	5·9	10	14	10	8·1	9·6	10

(d) Uptake of phosphorus from various rates of different phosphatic fertilisers was studied in a series of trials involving the analysis of 229 samples of clover:—

(i) At Muchea on acid sands, the uptake of phosphorus was found to be greater from rock phosphate dust than from superphosphate, when applied at equal rates of phosphorus.

(ii) At Bramley Research Station on gravelly sands the uptake of phosphorus increased with added superphosphate applied at rates of 224-1,792 lb. per acre in 1957. With equivalent amounts of rock phosphate there was no increase in phosphorus uptake over the nil treatment, except at the highest level of 1,333 lb. per acre applied in 1957.

(iii) At Manjimup Tobacco Research Station for the August sampling there was very little difference in the uptake of phosphorus with varying equivalent amounts of the following phosphatic fertilisers: superphosphate, basic superphosphate, 50/50 lime super, Rhenania phosphate, rock phosphate and superphosphate mixed with varying proportion of ground limestone. Results were similar for the November sampling except that uptake from rock phosphate was a little lower than from the other fertilisers.

(iv) At Kendenup, clover phosphorus levels increased with added phosphate fertiliser, whether as superphosphate, fine rock phosphate or rock phosphate dust. The uptake was slightly higher with superphosphate than with the other two fertilisers.

(v) At West Manjimup phosphorus uptake was found to increase with all levels of added superphosphate.

(e) A sample of clover from Harvey which had received excess molybdenum fertiliser was found to contain 8.3 p.p.m. of molybdenum although it exhibited molybdenum deficiency symptoms. New Zealand work suggests that this level of molybdenum is potentially dangerous to stock. However, fortunately for this farmer, the copper in this sample was 19 p.p.m. which is sufficiently high to prevent molybdenum toxicity.

(f) Over 50 samples of clover were analysed for confirmation of field diagnosis of nutrient deficiencies or imbalance, mainly with respect to copper, potassium and zinc.

(3) *Lettuce Leaves.*—Possible toxicities through the over enthusiastic use of minor element fertiliser mixtures was emphasised by a sample of badly affected young lettuce plants, showing marginal blotchy yellowing. This sample which had been treated with excess minor element mixture had 1,200 p.p.m. of manganese compared with a normal figure of between 20-200 p.p.m.

(4) *Parsnips.*—A manganese toxicity in parsnips was also confirmed by analysis. 2,090 p.p.m. of manganese were found in affected leaves compared with 35 p.p.m. in nearby healthy leaves. The

difference in root manganese was not as great, 34 p.p.m. in the affected sample and 8 p.p.m. in the healthy sample.

(5) *Potatoes.*—Forty-six samples of potato tubers were analysed for dry matter in a survey of West Australian potatoes suitable for the Middle-East market. Generally W.A. potatoes were found to be too low in dry matter for the requirements of this market.

Specific gravity determinations on these samples confirmed the formula relating dry matter to specific gravity, published in the American Potato Journal 1955 p. 332.

The formula slightly modified is—

$$\text{Dry matter} = 250\ \frac{(\text{sp. gr.}-1)}{\text{sp. gr.}} + 2.00$$

(6) *Tobacco.*—(a) From a rate and method of potash fertiliser application experiment at Manjimup Tobacco Research Station, 108 samples were analysed for chloride, nitrogen and potassium. The experiment, designed to give information on a recommended fertiliser composition for tobacco, consisted of 27 treatments of combinations of the following 0, 1000 and 2,000 lb per acre of potassium sulphate applied as a pre-treatment 2 months before planting; 120, 240 and 480 lb. per acre of potassium sulphate applied at planting and 0, 150 and 300 lb. per acre of potassium sulphate applied as a side dressing. The results from the average of four replicates show:—

(i) Nitrogen uptake was slightly increased with potash fertiliser applied at planting, but pre-treatment and side dressings with potash fertiliser did not have any effect on nitrogen uptake.

(ii) Chloride uptake by the leaves generally increased with potash fertiliser applied at planting and slight increases were obtained with pre-treatment potash fertiliser. Side dressing with potash had no effect on chloride absorption.

(iii) Potassium uptake increased with potash fertiliser applied as pre-treatment and at planting. Side dressings had no effect on potassium uptake with the nil pre-treatment but slightly suppressed potassium uptake when there was pre-treatment.

(b) The result of comprehensive analysis of representative samples of lugs, cutters, subdivision leaf and leaf grades of the 1959 tobacco crop are given Table 7 below. The samples analysed represent 1 leaf from every 10th bale offered for sale; in all, 800 leaves grouped into their appropriate leaf position category.

Table 7.

Sample	Lugs	Cutters	Sub-leaf	Leaf
pH (1 : 25)	4·8	4·9	4·9	4·7
	Per cent. dry basis			
Starch	1·7	4·3	2·3	6·1
Sugar before inversion	22·1	25·0	21·9	24·2
Total sugars	24·3	30·9	35·6	30·0
Resins	4·5	4·5	4·8	4·7
Total nitrogen, N	1·44	1·19	1·34	1·18
Protein nitrogen, N	0·89	0·81	0·89	0·81
Total alkaloid as nicotine	1·04	0·96	1·05	0·88
Nicotine	0·85	0·83	0·88	0·71
Nor-nicotine	0·18	0·12	0·15	0·15
Total volatile bases	0·21	0·17	0·20	0·17
Ash	15·3	11·7	14·0	10·1
Chloride, Cl	3·66	2·76	3·58	2·37
Calcium, Ca	3·31	2·58	2·95	2·09
Potassium, K	1·94	1·71	1·87	1·50
Sodium, Na	0·08	0·06	0·08	0·06
Phosphorus, P	0·17	0·16	0·17	0·17

(c) From a fertiliser experiment on old land at Manjimup 72 samples of leaves were analysed for chloride, nitrogen and potassium. The experiment consisted of 2 replicates of 36 treatments involving combinations of 50, 100, 200 and 300 lb. per acre of ammonium sulphate, 200, 400 and 800 lb. per acre of superphosphate and 150, 300 and 600 lb. per acre of potassium sulphate. The average of replicates shows:—

(i) Chloride uptake was unaffected by added fertiliser.

(ii) Nitrogen uptake was unaffected by potassium sulphate or superphosphate and increased slightly with added ammonium sulphate.

(iii) Potassium uptake increased with added potassium sulphate but was unaffected by superphosphate or ammonium sulphate.

(d) Results of a similar experiment on new land at Manjimup showed:—

(i) Chloride uptake unaffected by added fertiliser.

(ii) Nitrogen uptake generally shows a slight increase with all rates of added potassium sulphate and with ammonium sulphate above 100 lb. acre but was unaffected by added superphosphate.

(iii) Potassium uptake increased with added potassium but was unaffected by added superphosphate or ammonium sulphate.

(e) From a depth of ploughing and nitrogen application trial at Manjimup 48 samples were analysed. These were from 12 replicates, of 4 treatments, of a combination of ploughing to a depth of 6 and 12 inches and application of 50 and 150 lb. per acre of ammonium sulphate. The results show that (i) chloride uptake was slightly less in the leaves from plots that had been ploughed to 12 inches (ii) nitrogen uptake increased only slightly by addition of the high rate of ammonium sulphate and was unaffected by depth of ploughing.

(7) *Vine Leaves.*—(a) Four hundred and seventy-eight samples of currant vine leaves from a vineyard at Caversham were analysed for sodium chloride content. On this property there is a serious salt problem and the analyses were done in an attempt to follow the effect on leaf salt content of seasonal changes, differing ages of leaves, soil drainage and ground water salt content.

Results show that generally there was a high salt content in young leaves in November, which dropped fairly rapidly and remained comparatively low towards the end of the season. Levels as high as 11.3 per cent. salt were found among vines where serious leaf drop had occurred. An inference from the high salt content of young leaves is that accumulated salt in the canes could be passed on to the new growth. Seven subsequent samples of canes from dormant vines ruled this out, as low values ranging from 0.07-0.42 per cent. only were found in the canes.

(b) Four samples of muscat leaves from vines medium and severely affected with leaf mottle and necrosis were found to contain 9.7 and 11.0 per cent. of water soluble salts in the stalks and 3.8 and 4.7 per cent. in the blades.

(8) *Miscellaneous Leaves.*—Samples of bean, carrot, cauliflower, celery, lemon, lettuce, lucerne, lupin, orange and pear leaves were analysed for confirmation of visual symptoms of nutrient deficiencies or imbalance.

Miscellaneous.

(1) *Corrosion and Deposits.*—(a) A sample of "white rust" from the inside of a 1½ inch galvanised pipe was found to be nearly all zinc oxide. The pipe had been in use for 14 months in the Koorda reticulation and the deposit had built up rapidly through corrosion of the galvanising by high pH water caused by the passage of Mundaring Weir water through new cement lined mains. The galvanising was calculated as being removed at the rate of one thousandth of an inch per year.

(b) Several test pieces of water pipe coated with coal tar epoxy resins, bitumen and coal tar applied by various procedures of painting and dipping, were examined for continuity and adherence of coating and for possible production of "tastes" in water. This was part of an investigation by the Public Works Department into a method of re-using scraped, corroded piping or of economically treating new piping to prevent corrosion and associated "red water" complaints.

(c) Assistance was given to the Goldfields and Country Water Supply Branch of the Public Works Department into an investigation of the corrosion of impellers and seal rings in the electric pumps at Mundaring Weir. These pumps had been in use for 6 years without any sign of corrosion of impellers, but with the introduction of chlorination on the suction side of the pumps rapid corrosion of the first stage of the impellers occurred. Results to date are inconclusive but there is an indication that the metallic mercury based grease used since installation but since replaced with high temperature grease, could have formed an amalgam with the impellers and seal rings, which became active corrosion cells with the introduction of oxidising conditions by chlorination.

(d) Several water formed or derived deposits from water mains, hospital sterilisers, cooling systems and boilers were analysed to determine how they formed and recommendations made to prevent a recurrence.

One unusual deposit came from a boiler tube which was completely blocked with a crystalline deposit of mainly common salt, derived from the softened feed water. Blowdown from this boiler must have been negligible.

(2) *Spectrography.*—Semi quantitative spectrographic analysis was used as a preliminary to chemical analysis of a number of plant ashes, minerals, water formed deposits, corrosion products, oil ashes and analytical precipitates.

Useful confirmatory evidence was obtained in a police case in associating broken glass from the scene of an accident with similar broken glass from a suspect vehicle.

(3) *Animal Liver Analysis.*—The considerable increase in the number of animal livers for analysis is associated mainly with the interest in the cobalt nutritional status of sheep and cattle and with Department of Agriculture research into the "lupinosis" problem.

Vitamin E determinations have been required with this research and a satisfactory method has been developed for this difficult determination. At present research into a method of differentiating the vitamin E or total tocopherol content into the individual tocopherols, mainly γ -tocopherol, by paper chromatography, is progressing satisfactorily.

(4) A problem of rot-proofing hessian bags with copper naphthenate according to Australian Standard Association requirements was investigated on behalf of the Commonwealth Aeronautic Inspection Directorate. Sample treated bags were found to be irregularly coloured from the copper naphthenate treatment and the copper content was found to be below the standard required. Our investigations showed that the trouble could be mainly overcome by increasing the concentration of the dipping solution and paying more attention to the method of draining and drying the dipped bags.

(5) A number of industrial effluents from tanneries, plating works and fertiliser factories were analysed for the Swan River Conservation Board to check on possible pollution of the river by excess acidity and aluminium, chromium, copper, cyanide or iron in the effluents.

(6) One hundred and ninety-nine samples of linseed, safflower and castor oil seeds were analysed for their oil content and iodine value. The A.O.A.C. refractive index method for determination of oil in linseed was found to be equally applicable to safflower seeds.

(7) Forty-eight samples of post mortem blood samples were analysed for alcohol by the Kozelka and Hine method as recommended by the Analytical Committee of "The Analyst." These were done as an independent check on the modified United States Army method used by the Food and Drug Division in their routine blood alcohol determination. Excellent agreement between the two methods was found.

ENGINEERING CHEMISTRY DIVISION.

This new Division was created by the transfer to the Government Chemical Laboratories of the personnel, the premises and the equipment of the Research Section of the Department of Industrial Development at Bentley as from 1st of June, 1960.

During the second half of 1959, a wave of resignations from the staff hit the Research Section, and since the vacant positions were not filled by Department of Industrial Development, the Section (later the Division) started work in 1960 with a greatly depleted staff, viz., with two professional officers on the permanent staff, and three wages staff. It was not before the month of October, i.e., four months after the transfer to the Laboratories, that the staff of the Division was brought back to approximately its previous strength.

Owing to the shortage of staff, and uncertain position in the Department of Industrial Development, which was in the course of reorganisation, only one original research project, viz., the upgrading of local ilmenite, was continued during the year, the work on the second project, viz., the production of high grade lime from local calcareous beach sand, being discontinued at the beginning of the year. All other work listed in the report was done for outside interests.

Upgrading of Ilmenite.

Following the laboratory scale work, carried out earlier on the recovery of elemental sulphur from pyrites and gold-bearing pyrite concentrates using hydrometallurgical methods, investigations into possibilities of upgrading local ilmenite by these methods were commenced in the second half of 1959. Combining the experience gained from the investigations into the production of sponge iron from local iron ores, carried out by the Section in 1950/51 and in 1959, with that gained from the hydrometallurgical work on pyrites, a process for upgrading ilmenite was formulated. This process involves the reduction of iron oxide in ilmenite to metallic iron, as the first stage, and subsequent removal of this iron by oxidising aeration of reduced ilmenite in suspension in water, as the second stage. Two products are recovered: upgraded ilmenite, i.e., ilmenite greatly enriched in titanium oxides, and a light precipitate of hydrated iron oxide of pigment value.

In the laboratory scale investigations, the ilmenite was reduced by Collie sub-bituminous coal char in metal boxes, containing about 1,000 grammes of ilmenite, these boxes being heated in a "Birlec" electric furnace to temperatures ranging from 900°C to 1100°C. The aeration of reduced ilmenite was carried out in a vessel of about three litres capacity, with agitation.

As an example, from ilmenite assaying:

	Per cent.
TiO_2	56.6
FeO	22.2
Fe_2O_3	18.2

i.e., containing 30.0% of total iron, two products were obtained:

One assaying:
90.0% TiO_2 and
5.0% FeO

And another:
81.5% iron oxide, calculated as Fe_2O_3 and
7.1% TiO_2.

The titanium oxide was present in the second product owing to inefficient mechanical separation.

It was found that the application of pressure in the aeration stage was not essential, and the oxidation took place at a satisfactory rate under atmospheric pressure, provided that the initial pH of the liquid was adjusted to about four.

No subsequent addition of acid was generally necessary.

Among the oxidation catalysts tried, ammonium salts were found to be the most promising.

For the reduction of ilmenite on a larger scale, a rotary kiln, 14 and 16 inches internal diameter and 16 ft. long, was used. All the heat required for the reduction process was supplied by burning char (and volatiles, in the rear portion of the kiln, when coal was used) in the charge.

Air was introduced by two air jets, one being inserted into the kiln from each end. As distinct from the Kalling-Domnarfvet process, where one air jet with small holes directing the air towards the charge, is used, the air jets employed here did not have any holes on the side, the air being blown straight forward along the kiln. The two jets working against each other, but not in line, create a circulation of air, gas and products of combustion within the kiln along its axis.

It was found that for a satisfactory reduction, a larger proportion of carbon, i.e., char or coal, in the carbon-ilmenite charge was required as compared with iron ores dealt with in the same small kiln. In general, the ratio of 1 : 2 to 1 : 3 of ilmenite to char (or its equivalent in form of coal) gave satisfactory results. Also, the temperature of the reaction zone had to be higher, viz., in the range of 1050° to 1150°C as against 900° to 950°C in case of iron ores tested.

The degree of reduction of iron oxides attained so far in the rotary kiln is in the region of 90 per cent., a maximum of 92.3 per cent. being recorded on one occasion.

In order to determine the usefulness of sawdust as reducing medium and fuel, an exploratory run with dried sawdust was carried out in the rotary kiln. The results indicate that under the existing conditions it was impossible to attain a satisfactory length of the hot reaction zone in the kiln, because sawdust would not burn at a sufficiently high rate unless the air jet impinged directly on it, causing the char to be blown away. Satisfactory results were, however, attained by burning some town gas (oil can be used as well) in the kiln above the char.

It was also noticed that sawdust char acted as a matte, preventing segregation and burial of the ilmenite in the char for the prevention of oxidation. It is thought that this problem can be solved by the use of some coarser coal, char or wood chips admixed with sawdust.

Reduced ilmenite is separated from char by magnetic means, and is further treated by aeration in hot water in an aerator having a working volume of 46 gallons. The aerator is fitted with a propellor type stirrer and the air is introduced from the bottom of the vessel. Exhaust gas is continuously analysed for oxygen by means of a Beckmann apparatus for indications of oxygen take-up. By externally applied gas flame, the charge is kept at a temperature between 70° and 80°C.

The iron oxide formed is precipitated and separated from upgraded ilmenite by decantation.

The results recorded so far are best illustrated by the following example:—

From ilmenite assaying:

	Per cent.
TiO_2	55.1
FeO	23.4
Fe_2O_3	17.4

Reduced ilmenite analysing:

TiO_2	43.4
Ti_2O_3	15.8
FeO	5.1
Fe, metallic	31.0

was produced in the rotary kiln.

The upgraded ilmenite, i.e., the material obtained by aeration, analysed:

	Per cent.
TiO_2	64.5
Ti_2O_3	21.9
FeO	7.8
Fe_2O_3	0.4
Fe, metallic	0.7

or having a total titanium content, calculated as TiO_2, 88.9 per cent.

As there are no standard methods for the determination of the solubility of the titanium in ilmenite or ilmenite products in sulphuric acid (an important factor in utilisation of these products in the present day titanium pigment industry), no absolute solubility values for upgraded ilmenite were determined. The indications are, however, that the material produced so far, is somewhat less soluble in sulphuric acid than the original ilmenite from which it was made.

The question of increasing the solubility of the product in sulphuric acid, which appears to be controlled in the reduction stage of the process, and that of the applicability of the process for upgrading other ores, e.g. manganese, tantalite, chromium, etc. ores, are items on the research agenda of the Division for the next year.

Production of Char from Collie Coal.

17.8 tons of Collie coal were carbonised in the pilot plant retort on the request of a coal company. The coal analysis indicated 22.6—22.8 per cent moisture and 2.7 per cent ash.

The coal was carbonised at 800°—825° C (rinsing gas inlet temperature). The char produced contained 1.3 per cent to 2.0 per cent volatile matter and 5.0 per cent to 6.0 per cent ash. The char yield was 49.4 per cent of coal on the "as received basis."

The char was screened to sizes: plus ¼ in. and minus ¼ in. plus ⅛ in., and bagged for dispatch overseas for testing as raw material for production of calcium carbide, and as an admixture to coking coal in coke oven coke production.

Calcination of Bauxite and Dolerite.

A quantity of bauxite and dolerite from the Darling Range was calcined in the rotary kiln on the request of a local firm. The calcination was carried out at a temperature 1500° C or below. At temperatures exceeding 1500° C some sintering was evident.

It was noticed, that the iron contained in bauxite ran into small balls (possibly aluminium ferrite or similar complex). It is thought that by roasting bauxite under reducing conditions, elemental iron might be formed, which in turn might be removable by magnetic separation or by oxidation under water (as in the process for upgrading ilmenite). It is intended to carry out these investigations next year.

Calcination of Pellets for Production of Lightweight Aggregate for Concrete.

The pellets, prepared by a local industry, were calcined in the rotary kiln. The objective was to determine the possibility of, and the optimum conditions for their expansion in the rotary kiln by internal evolution of gas during calcination.

In order to obtain the desired conditions for expansion, the angle of the kiln was increased from 1° to 2¼° and then to 3½°.

The results of these tests indicated that an expanded aggregate, which would float on water, can be manufactured in a rotary kiln from the material supplied, provided that the surface temperature of the pellets was high enough for the surface to become slightly fused. If the surface temperature was too high, fusion and densification of pellets took place. If the temperature was not high enough, the expansion of pellets was inadequate.

Calcination of Galvanizing Residues.

This work was carried out at the request of a local enterprise with the object of obtaining a zinc concentrate suitable for addition to fertilisers. The experiment was more of a nature of "stab in the dark" since not sufficient basic knowledge of the properties of the material was obtainable beforehand.

Calcination of Spodumene.

A small quantity of spodumene from the Ravensthorpe area, a lithium silicate of the form $LiAl(SiO_3)_2$, was calcined in the "Birlec" electric furnace. The objective was to determine optimum conditions, i.e. temperature and time, for conversion of the hard crystalline alpha-spodumene to soft amorphous beta-spodumene.

It was established that pieces of the size of about 2" x 2½" x 3" and smaller can be calcined successfully to beta-spodumene in ½ to ¾ hours at a temperature around 1050° C.

Calcination of Zircon in the Rotary Kiln.

On the request of a local industrial undertaking, a quantity of zircon, separated from ilmenite sands, was treated in the rotary kiln with the objective of liberating zirconia by the removal of silica.

Production of Sponge Iron from Low-grade Iron Ores.

Extensive pilot plant work on the production of sponge iron from Koolyanobbing and Yampi Sound iron ores in a specially adapted rotary kiln using Collie sub-bituminous coal as reducing medium, was carried out by the Division in 1950/51 (then the Bureau of Research and Devolopment under the Department of Industrial Development). This work was taken up again in 1959, when some sponge iron briquettes were produced from Koolyanobbing high grade ore, from pyrite cinders, and from limonite ores.

This work greatly stimulated the interest of local commercial and industrial circles for the production of sponge iron for export, and the utilisation of sponge iron process for beneficiation of local low-grade ores, deposits of which were known to be widely distributed in the South-West of the State, i.e. not far from the Collie Coal Field.

Some further work of an exploratory nature on the production of sponge iron from low-grade iron ores of the South-West region was carried out by the Division in the second half of 1960.

As the result of the research activities of the Division into the production of sponge iron and of the interest shown by a local industrial undertaking, a Japanese Technical Mission visited this State. The principal aim of this Mission was the assessment of possibilities for the establishment of a sponge iron industry in Western Australia. The subsequent events would justify the hope of early establishment of such an industry in the South-West of the State, and that additional deposits, some containing appreciable quantities of low-grade iron ore, have been discovered.

The iron ore from two different sources was treated on the laboratory scale, viz. two ore samples from the Darling Range, and one sample from the South Coastal area, both ores indicating between 42 per cent. and 46 per cent. of total iron content. In addition, two larger samples of the Darling Range ore were reduced in the rotary kiln using Collie coal as reducing medium and fuel. One of these runs was witnessed by the above mentioned Japanese Sponge Iron Mission, comprising one geologist, one metallurgist and one commercial man.

In an attempt to upgrade the ore before reduction the latter two larger samples were treated by the Industrial Chemistry Division in their ore dressing set-up prior to delivery to this Division.

By crushing and screening the ore prior to reduction, and polishing, crushing and magnetic separtion of the reduced ore, a sponge iron with a metallic iron content of 77.7 per cent. was produced in the laboratory from one of the Darling Range ore samples, and sponge iron with a content of 81.2 per cent metallic iron was produced from the sample of the South Coastal ore. Microscopic examination suggested that a higher grade sponge iron was probably more easily produced from the ore of the South Coastal area, which contains mainly discrete particles of silica as gangue, than from the Darling Range ore containing alumina in an intimate mixture with iron oxide.

Two Darling Range ore samples reduced in the rotary kiln, and the product upgraded by polishing, crushing and magnetic separation, yielded a sponge iron containing 70.4 per cent. and 65.9 per cent. metallic iron, the degree of reduction being 92.5 per cent. and 90.4 per cent. respectively.

Lime from Calcareous Beach Sands.

Western Australia has reasonably large reserves of high grade limestone, but the most important deposits are situated far from the established or possible future industrial centres. There are, however, huge deposits of calcareous sands along the West and the South-West coasts, containing 12 per cent. to 30 per cent. and more of silica. These beach sand deposits are a potential source of high-grade lime, an important industrial raw material especially for chemical industries.

Investigations into the possibility of beneficiation of calcareous beach sands, conducted by the Division (then the Bureau of Research and Development) in 1950/52, indicated that this can be done easily by electrostatic separation of silica from sand heated to about 100°-120° C.

Owing to its fineness (98 per cent. minus 52 mesh, 37.5 per cent. minus 100 mesh B.S.S.) the economic calcination of the beneficiated sand posed, however, a problem which could not be solved by application of any of the known lime burning methods.

During 1958/59 a process was evolved by the Division consisting of the calcination of beneficiated limesand in entrained bed. A few experiments in a simple kiln, designed by the Division (shaft 6 in. x 6 in. x 12 ft.), confirmed the soundness of the basic principles of the process. Further investigations, aimed at the evaluation of the process for commercial application, were interrupted by resignations from the Staff of the Section.

The furnace has now been partially re-erected in a more convenient position, and preparations made to continue this investigational work in 1961 as other work permits.

In order to be useful as an industrial raw material, limestone has to be in some instances in a lump form. Some exploratory investigations were, therefore, conducted into the possibilities of agglomeration of beneficiated lime sand.

The results so far indicate that reasonably strong briquettes, with a collapsing strength of about 2,000 lb./sq. in. can be produced by adding to the beneficiated limesand 20 per cent. of slacked lime (produced from the same beneficiated sand), and briquetting the mixture under a pressure of 12 tons/sq. in. The strength of briquettes was increased to 4,000 lb./sq. in. by treating them with carbon dioxide gas. The briquettes had a cold collapsing strength of around 350 lb./sq. in. after being calcined at 1,000° C.

General.

During the year many discussions were held with interstate and overseas visitors to the Division, among which the most important were:—

(1) The Chairman (Mr. W. W. Pettingell) and the Technical Secretary (Dr. R. K. Warner) of the Commonwealth Coal Utilisation Research Advisory Committee, who were on a fact finding visit to this State in February.

The summary of discussions and their findings are published in the C.U.R.A.C. Report "Coal Utilisation in Australia," October, 1960, p.p. 26-28.

(2) The Development Engineer (Mr. B. B. Bennett) of the Gas and Fuel Corporation of Victoria. The process developed here for production of metallurgical coke from sub-bituminous Collie coal, and the production of hard char from Victoria brown coal were the main topics of the discussions.

The difficulties encountered in the Lurgi Brown Coal Gasification Works at Morwell were also discussed.

(3) The Japanese Sponge Iron Mission. The production of sponge iron by the process developed by the Division, and that developed by Dr. Sasagava in Japan, were discussed during five day visit in August/September. Technical and economic problems associated with the establishment of a sponge iron industry in this State based on low-grade ore of the South-West, were also discussed at great length.

The visit of the Mission was an indirect result of the Division's research activities into the production of sponge iron, as outlined previously.

(4) The Laporte Industries Technical Mission. The process for upgrading ilmenite, developed by the Division, and technical problems associated with the establishment of a titanium pigment industry in this State were the main topics of the two days discussions.

Besides activities outlined above, the technical advisory service to the existing and prospective local industries was continued by the Division throughout the year (as under Department of Industrial Development). Most of the service was given by personal contact, few enquiries being received and answered by telephone.

The Research Officer of the Section, Mr. R. G. Becher, (now Engineering Chemist with the Division) was a delegate to the symposium on Hydrometallurgy, organised by the A'asian Institute of Mining and Metallurgy in Adelaide in February. On this occasion he visited also the Australian Mineral Development Laboratories.

The Principal Research Officer of the Section, Dr. S. Uusna (now Chief Chemical Engineer with the Division) visited Melbourne on the request of the Mineral Mining & Export Co., and availed himself of the opportunity to inspect the Australian Mineral Development Laboratories in Adelaide on his way back.

These visits confirmed that the original research work being carried out by the Division and aimed at the utilisation of local industrial raw materials compares more than favourably with the similar work done in the Eastern States. Little of our work, however, had been apparently heard of there.

It was evident that owing to the geographical isolation of this State, there is an urgent need for still much more work to be done locally on the practical utilisation of the mineral wealth of Western Australia, this being the cornerstone for the future industrialisation of the State.

FOOD, DRUGS, TOXICOLOGY AND INDUSTRIAL HYGIENE DIVISION.

Most of the work carried out by this Division during 1960 consisted of chemical examinations for the Departments of Public Health, Police and Agriculture, as well as the Milk Board of Western Australia and the Swan River Conservation Board, but a wide variety of miscellaneous work was performed for other Government Departments and the general public.

For the first three months of the year chemical work was also performed for the Metropolitan Water Supply, Sewerage and Drainage Department, when 1874 samples were examined. Following the completion of a laboratory building at the Sewage Treatment Plant, Subiaco, this work was carried out at the new laboratory, and the three officers of this Division engaged in sewage chemistry were transferred to the administrative control of the Metropolitan Water Supply, Sewerage and Drainage Department as from 1st February, 1960. Following these changes the personnel of the Division comprised eleven permanent officers located at the main Government Chemical Laboratories, Adelaide Terrace.

Two thousand four hundred and thirty-six samples other than sewage were received during the year. The number of samples received from Ocean Beach pollution surveys was much less owing to the transfer of this work to the Sewage Laboratory, and approximately 100 less samples of milk were examined, but there was a marked increase in the number of toxicological exhibits. A broad outline of the variations over recent years is indicated in the following classification:—

Classification	1956	1957	1958	1959	1960
Milks	227	240	189	281	194
Cheese	72	40	54	113	84
Exhibits—Alcohol	154	164	229	316	358
Human Toxicology	146	162	284	290	421
Animal Toxicology	31	46	64	69	34
Industrial Hygiene	75	132	86	305	327
Pollution Surveys—					
Swan River	231	237	205	128	204
Bunbury	50	72	48	48	48
Ocean Beaches	145	146	113	239	48*
Total Sewage Samples	9,917	9,981	7,605	7,465	1,826
Other than Sewage	1,830	2,364	2,604	2,639	2,436

* Ocean Outfall Survey—February, 1960.

Table 8 shows the source and description of samples received during 1960.

TABLE 8.

Food and Drug Division, 1960.

	Agricultural Department	Explosives	Factories	Metropolitan Water Supply	Police	Public Health Department	Public Works Department	State Mining Engr.	Swan River Conservation Board	Tender Board	Departmental	Other State Government Depts.	Pay—Air Department	Pay—Hospitals	Pay—Milk Board	Pay—Public	Pay—W.A. Government Rlways.	Pay—Other Com. Departments	Free—Public	Total
Foods—																				
Cheese	84																			84
Grapes	22																			22
Milk—Cow						3									189			2		194
Human						6														6
Various	8				2	30				9		2				4				55
Industrial Hygiene—																				
Air			26			41		39												106
CO Tests						4	2													6
Chrome-plating Solution			10																	10
Urine			1			129						6		23		23	11			193
Various			5			7														12
Miscellaneous—																				
Bones, etc.	35																			35
Criminal Cases					72															72
Detergent						1				63										64
Drugs and Medicines					1	4						7								12
Explosives		12																		12
Natural Vegetable Products	144																			144
Oxygen													43							43
Pesticides	33					3	1									1		1		39
Sheep Tissue	36																			36
Soil							4									8				12
Water						34			1		14					1				50
Various	21				3	22				8	4	1				6		5	1	71
Pollution Survey—																				
Bunbury							48													48
Ocean Beach				98																98
Swan River									204											204
Trade Waste				15																15
Various					1				1							1		5		8
Sewerage—																				
Activated Sludge Pilot Plant				541																541
Ocean Effluent				250																250
Routine				970																970
Toxicology—Human																				
Exhibits—Alcohol					354											4				358
Exhibits—Toxicology					413	6								2						421
Specimens ex Patients						2								35						37
Toxicology—Animal	24				4	5										1				34
	407	12	42	1,874	850	297	55	39	206	80	18	16	43	60	189	49	11	13	1	4,262

Foods.

A total of 361 samples of foods of various kinds was examined during 1960. 189 of these were samples of cows milk submitted by the Milk Board of W.A., and consisted largely of milks which were suspected of being adulterated or of failing to comply with the standards required by the Regulations under the Milk Act. Of these samples 4.3 per cent contained less than the legal minimum amount of milk fat (3.2 per cent.), but 51.3 per cent. of the samples contained less than the legal minimum of solids not fat (8.5 per cent.), and 77.2 per cent. failed to comply with the legal standard for freezing point of milk (0.540 degrees Centigrade below zero). 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	1.1
3.00 — 3.19	3.2
3.20 — 3.49	16.9
3.50 — 3.74	23.8
3.75 — 3.99	14.8
More than 3.99	40.2
	100.0

Milk Solids not Fat.

Per cent. in Sample.	Per cent. of Total Samples.
Less than 8.00	1.1
8.00 — 8.24	11.1
8.25 — 8.49	39.1
8.50 — 8.74	34.4
8.75 — 8.99	11.1
More than 8.99	3.2
	100.0

Freezing-point.

Degree C. Below Zero.	Per cent. of Total Samples.
0.510 - 0.519	3.2
0.520 - 0.529	16.9
0.530 - 0.539	57,1
0.540 - 0.550	19.6
More than 0.550	3.2
	100.0

In presenting this distribution of the analytical figures it is emphasised that these were samples for which there was *prima facie* evidence of their failure to comply with legal standards.

Eighty-four samples of cheese were analysed for the Dairying Division of the Department of Agriculture as control checks of the quality of cheese produced by factories in this State. Of this number 81 per cent. contained more than 50 per cent. of fat calculated on the moisture-free basis.

Four samples of butter were also received from this Division. These were examined for compliance with the standards of the Dairy Industry and the Food and Drug Regulations.

Nine samples only of food were submitted by the Government Tender Board. These consisted of chutneys, pickles and tomato sauces, which were examined as to their suitability for supply to Government institutions.

Thirty-nine samples of food were received from the Public Health Department. These included frankfurts, mincemeats and an imported packed fish product, which were examined for their compliance with Food and Drug Regulations, and a "sausage binder" which was incorrectly labelled as to its preservative content.

Samples of cream of tartar and carbonate of soda were submitted for identification, and four infant foods were analysed to ascertain their general nutritional value.

Two samples of tomato sauce and three of "Honey spread" were submitted for identification of the artificial colourings in these products.

Five samples of food essences were examined to determine their quality in respect of generally accepted standards and their compliance with the Food and Drug Regulations.

Several samples of cows milk were the subject of extensive chemical analysis in an investigation into the nature of their adulteration.

Four samples of stored apples were examined in connection with experimental work by the Department of Agriculture into the control of "scald" in apples, and twenty samples of grapes were analysed to assess their maturity following experiments in the use of various plant hormone treatments.

Four "Umpire" samples of meat products were analysed following disputed analyses in Court proceedings, and a number of miscellaneous samples of food were examined for the general public.

Human Toxicology.

There was a marked increase in the number of samples received under this classification, 421 samples from 108 cases being submitted in connection with death from suspected poisoning.

In 34 cases no poison or drug was detected, while in 74 cases a poisonous substance or other physiologically active drug was identified on analysis.

In a number of cases more than one poison or drug was detected, and in 31 of the 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	27
Barbitone	2
Carbromal	5
Carbon monoxide	18
Chloral	6
Aspirin	7
Phenacetin	6
Codeine	4
Arsenic	3
Quinine	2
Organic "phosphate"	2
*Various (one only of each)	9
Negative	34
	125

* These comprised alcohol, cyanide, bismuth, lead, mercury, thallium, chlorpromazine, morphine, paraldehyde.

It was observed that carbromal was always associated with pentobarbital, both being derived from over-dosage of carbrital.

An unusual case concerned a part-aboriginal who died with classical symptoms of lead poisoning. The diagnosis was supported by toxicological analysis of post mortem specimens. Deceased had, in the past, been treated for lead poisoning on a number of occasions, but the source of lead had not been discovered. Police enquiries revealed that deceased had been in the habit of chewing tobacco mixed with wood ashes. Analysis of partly chewed wads of tobacco as well as of ashes from the household stove confirmed the presence of high concentrations of lead. Further enquiries revealed that the wood recently used for burning was old painted timber including exterior timbers from demolished weatherboard houses.

Blood-Alcohol Analyses (Post Mortem).

As in 1959 a considerable number of samples of blood and urine were analysed for alcohol content. Of these 166 were samples of blood submitted by the Police Department in connection with traffic

accidents or sudden death from various causes. The distribution of the analytical figures is indicated in the following table:—

Alcohol Per cent.	Number.
Negative	89
Less than 0.05	15
0.05 — 0.09	6
0.10 — 0.14	21
0.15 — 0.20	13
0.21 — 0.25	9
0.26 — 0.30	9
0.31 — 0.35	3
More than 0.35	1
	166

Included in this number are 24 samples of blood from 12 cases in which heart and femoral blood were both analysed for alcohol content. As in 1959, this work was carried out for the information of the Police Surgeon in order to ascertain the alcohol levels in these two sources of blood when death occurred after the ingestion of alcohol. Three of these cases proved to be negative; the results of analysis of the other nine are listed hereunder:—

Alcohol Per cent.	
Heart Blood.	Femoral Blood.
0.01	0.02
0.09	0.09
0.11	0.11
0.11	0.12
0.12	0.12
0.13	0.13
0.13	0.14
0.17	0.18
0.20	0.24*

*Only small sample available for analysis.

Voluntary Blood-Alcohol Tests.

128 samples of blood were submitted by the Police Department in connection with charges of "driving while under the influence of alcohol." These samples were taken from persons who, when charged with such an offence, had exercised the right provided by the Traffic Act to offer a sample of blood for chemical analysis.

The 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.	Number of Cases.
Less than 0.15	5
0.15 — 0.20	35
0.21 — 0.25	42
0.26 — 0.30	38
0.31 — 0.35	7
More than 0.35	1
	128

Animal Toxicology.

The number of samples received in connection with suspected poisoning of animals was less than usual, only 15 cases being examined during 1960. In 6 cases no poison was detected, and in 9 cases a poisonous substance was identified, as indicated in the following table:—

Poison.	No. of Cases.
Arsenic	3
Lead	2
Lead arsenate	1
Strychnine	2
Metaldehyde	1
Negative	6
	15

Thirty six samples of animal tissues were analysed for the Animal Division of the Department of Agriculture in connection with a feed experiment. These comprised samples from 5 groups of sheep, 4 of which had received selected supplementary feed treated with 4 different fungicides, namely copper carbonate, ceresan (an organic mercurial), thiram and hexachlorbenzene. The fifth group constituted "control" animals. After slaughter of the animals, samples of liver, muscles, kidney and fat were analysed to determine the distribution in the body of copper, mercury, thiram and organic chlorine compounds respectively. The results of analysis are summarised in the following table:—

Tissue	Copper	Mercury	Thiram	Organic Chlorine
Liver	Present	Present	Trace	Trace
Muscle	Trace	Trace	Nil	Present
Kidney	Trace	Present	Nil	Nil
Fat	Nil	Trace	Nil	Present

Industrial Hygiene.

The considerable increase in the volume of industrial hygiene work which occurred in 1959 was maintained in 1960 when 327 such samples were received and examined.

One hundred and sixty of these were specimens of urine from persons exposed to actual or potential lead hazard, and which were subject to chemical analysis in order to assist the clinical diagnosis. 73.8 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 for lead workers. 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	73.8
0.09 — 0.15	15.0
0.16 — 0.20	3.7
0.20 — 0.50	5.0
More than 0.50	2.5

Of the 26.2 per cent of samples which contained more than 0.08 parts per million of lead, many were repeat analyses carried out for investigational or supervisory purposes.

Twenty eight analyses were also performed on specimens of urine for other toxic metals, although not all of these were associated with industrial toxicology. These consisted of analyses for mercury 12, thallium 10, arsenic 4, and copper and tin 1 each.

Thirty four 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.

One hundred and twelve samples of air were analysed during the year. 38 of these were received from the State Mining Engineer in connection with investigations into the gases produced by explosives used underground in mining. 26 samples represented tests made into working conditions at wheat storage bins following fumigation of the stored wheat with phostoxin tablets. 25 tests of air were made at a factory where operations involved the use of benzene, and 8 similar tests were made to determine the concentration of toluene. Other samples of air were analysed for lead 5, mercury 2, carbon monoxide 6, and benzene hexachloride 2.

Ten samples of plating solution from chrome plating "baths" were examined to check that the "bath" contained sufficient concentration of surface active agent to prevent the throw-off of a hazardous amount of "chrome spray" during plating operations.

Miscellaneous samples included paint flakes and dust examined for lead, wheat dusts analysed for benzene hexachloride, a leather dye for toxic solvent, and a dust respirator whose efficiency was suspect.

Sewage Control.

The Annexe Laboratory situated at Smith Street, North Perth, continued to undertake chemical control work and other investigations for the Metropolitan Water Supply, Sewerage and Drainage Department for the first three months of the year. In this period 1826 sewage samples were analysed, 970 of which represented routine chemical control in connection with the operation of the treatment plants at Subiaco, Swanbourne and Fremantle.

Five hundred and forty-one samples were received from the operations of the Activated Sludge Pilot Plant, while 300 samples were examined in connection with the chlorination of effluents from the existing treatment plants at Subiaco and Swanbourne.

Pollution Surveys.

(1) *Metropolitan Ocean Beaches.*—Forty eight samples of seawater were received in February, 1960, from the "Ocean Outfall" survey of the section of the beach where the effluents from the Subiaco and Swanbourne treatment plants discharge into the ocean.

Further work in these surveys was transferred to the new Sewage Laboratory at Subiaco.

(2) *Swan River.*—With the establishment in 1959 of the Swan River Conservation Board and the appointment of an inspector of the Board, there was a marked increase in the number of samples examined in 1960, namely 204, as compared with 128 in 1959. The whole of the river was sampled at three-monthly intervals, and other selected sections were further examined when more detailed surveys were required. A close check was kept by the Board's inspector on drains emptying into the river and samples were examined as the need arose.

(3) *Leschenault Inlet, Bunbury.*— The normal summer and winter surveys were carried out in February and July, when 48 samples were collected and analysed. The general pattern of pollution in the summer survey appeared similar to that of previous years, but there appeared to be somewhat more pollution in the winter, associated with the decrease in salinity of the water in the Inlet at this time of the year.

Miscellaneous.

One hundred and forty four samples of oil-bearing seeds were examined for the Department of Agriculture. Seventy seven of linseed were analysed for oil content, while the oil content and the iodine value of the oil were determined on another 38 linseeds and 17 safflowers, and on several samples of sesame, castor, cotton and soyabean seeds.

Thirty five samples, chiefly of bones for fluorine content, were analysed in connection with supplementary diet experiments conducted by the Animal Division of the Department of Agriculture.

Sixty three samples of detergents were the subject of extensive consideration in order to advise the Government Tender Board as to those which appeared to be most suitable for use in Government institutions.

Forty three samples of "high altitude" oxygen were examined for the Department of Air. Laboratory checks of each batch are carried out as a routine measure, in addition to factory inspection tests, because of the exacting specifications to which this oxygen must conform.

Twenty four samples of pesticides from various sources were received during the year. These consisted chiefly of concentrated formulations, comprising dieldrin 14 samples, chlordane and D.D.T. two of each, and malathion and 2:4D ester one of each.

Twelve samples of soils were examined for dieldrin content as a check on the efficiency of spray treatments for termite control.

Four samples of children's toys were examined under the Toxic and Hazardous Substances Regulations. All samples were highly inflammable and contained celluloid, but were not marked with the required warning label.

Forty eight samples of water were examined in investigations concerning the source, extent and effects of unusual chemical contamination.

Samples of children's plastic sunglasses which were said to have caused unusual skin reactions were examined without any cause being detected. It was concluded that individual idiosyncrasy was probably responsible for the symptoms reported.

Eighteen samples of suspected poison baits were submitted by the Police Department. In five samples, strychnine was detected, while another contained an organic phosphorus compound.

A variety of exhibits were submitted in connection with criminal investigations or other police enquiries. These included: "hit-run" cases, 13 samples; theft, etc., 13; alleged poisoning, nine; fraud, four; vandalism, four; and assault, seven.

Miscellaneous samples examined in the normal course of the activities of the Division included liquors, paint, explosives, tallow, ambergris, cattle dips, floor polishes, vermin poisons, building materials and drugs and medicines.

Numerous enquiries for information were received during the year, usually by telephone, but also by personal application, 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 and the late Mr. B. L. Southern, in connection with their official duties.

Limitation of staff and accommodation still confine the work of the Division to the "routine" activities presented in the foregoing report, and preclude the investigation of problems demanding attention. Inability to devote attention to these demands is likely in time to affect both the status and efficiency of the Laboratories.

FUEL TECHNOLOGY DIVISION.

146 samples of coal, wood, oil, gas and miscellaneous have been examined and reported on during 1960, the nature and source of these being shown in table 9. Two examinations of steam supply and boiler efficiency of an extensive nature have been conducted in the course of which directive advice has been given on boilers and fuel for institutional requirements which are under the Public Works Department's supervision.

One of these institutional steam supplies is from two Lancashire boilers at Claremont Hospital. These boilers had been tested in 1959 and it was then suggested that an improvement in performance could be effected by attention to brickwork to reduce air infiltration and bypassing of flue gas and by substitution of more closely spaced firebars for the widely spaced bars which were then in use for mixed wood and coal firing. In 1959 (Table 10) the CO_2 in flue gas was only 4.8 per cent. and the amount of unburnt coal falling through the bars gave a loss of 15.7 per cent. of the heat supplied as fuel to the boilers. The boiler efficiency was only 44.2 per cent.

The recommended changes were made and during 1960 further trials were made on the boilers. The results were disappointing. Although there was an improvement in the CO_2 in flue gas and the unburnt fuel in ash was markedly reduced the boiler efficiency still remained low, averaging 45.5 per cent. over three tests.

The cause of this low efficiency was found to lie in unburnt carbon monoxide and hydrogen in the flue gas. Even when firing thinly and frequently the sum of these combustible gases was 1.8 per cent. equivalent to 10.5 per cent. loss of heat from the fuel.

In a further trial made on 28th October with only one of the boilers carrying the full load of the institution a much lower loss of unburnt gas was found, amounting to only 1.8 per cent. of the fuel and the boiler efficiency rose to 53.8 per cent. It would appear that when one boiler is carrying the full load and firing at a higher rate to meet it, the turbulence of gases over and beyond the grate is

increased and so combustion of gases is more complete. The boilers have Galloway tubes across their flues but these do not seem to be effective in promoting mixing of excess air with combustible gases from the firebed at the lower velocities obtaining when the two boilers are steaming together.

Experience was also gained with shell type boilers in working on a problem of steam supply for the Fremantle Hospital. There are two Cornish boilers using wood fuel with a steam raising efficiency of about 48 per cent. associated with a low figure of 6.0 per cent. of CO_2 in flue gas. The rate of evaporation of these boilers was also low.

TABLE 9.

Fuel Technology Division, 1960.

	Departmental	Public Works Department	Other State Government Departments	Pay—Public	Pay—Other	Total
Briquetting	1	....	7	....	....	8
Coal—Boiler Trials, Various	2	10	....	73	4	89
Gas ex Rotary Kiln	6	....	....	....	....	6
Sawdust, Smuts, Flue Gas, etc.	....	3	....	3	1	7
Thermometers and Pyrometers	3	....	1	12	....	16
Miscellaneous	8	2	4	6	....	20
	20	15	12	94	5	146

The recommendation made here was to consider the installation of Colonial type boilers, that is boilers fired under the shell with return fire tubes from back to front of the boilers. Boilers of this type which have been tested on wood show a good flue gas analysis. It will be valuable during the coming year to test one of these boilers on wood fuel comparatively with a Cornish boiler to determine characteristic rates and efficiencies. Firewood will apparently be in good supply for many years to come. It is a clean fuel and at present low in price it compares to advantage with oil and coal. Characteristic figures for performance should therefore be obtained.

Neither wood nor Collie coal can be expected on theoretical grounds to give a good performance in Lancashire boilers because their initial flame temperature is low and this limits the heat transfer by radiation on which shell boilers with fire tubes and outside return flues depend.

Colonial boilers, on the other hand, have a number of advantages in their favour; larger, tighter combustion chambers with the brickwork metal cased and the return of the flue gases through firetubes giving excellent heat transfer. An efficiency of 65 per cent. on Collie coal or on wood can be anticipated from them. It will be valuable to determine maximum evaporation rates with wood fuel.

Of our other interests in plant development, flash drying of ilmenite and flash calcining of gypsum can be reported on favourably. The performance of the ilmenite drier has been improved by ventilation of the dried product as it leaves the drier, to remove moisture retained by the product and the flue gas associated with it. A dust problem associated with the gypsum calciner appears to have been solved by spraying the outlet gases with water to coagulate the dust of plaster particles into aggregates which settle easily in a brick settling chamber.

Sawdust firing only claimed attention in respect of one boiler installation. These were Babcock boilers hand fired on both flat and step grates. The performances were poor, with low CO_2 in flue gas and considerable smut emission. Dust catchers without reduction of inleakage of excess air would have to be unecessarily large in size. On the other hand it would be difficult to reduce air inleakage without drastic changes and reconstruction of the boilers. The installation is one which generates its own electricity and complete modernisation of the plant to provide high pressure steam for use with passout turbines or engines would probably be justified. But there has been no opportunity to go into these aspects of the use of sawdust.

Two samples of clay have been tested from the Maddington area. One was a red clay from the surface which burnt easily at 1,000°C, the other was a white clay taken 20 feet below the surface and was of much more refractory character requiring a burning temperature of 1,250-1,300°C. Little appears to be known about the big body of alluvial clay in this Maddington area where a number of small brickworks are situated.

The work during the past year has been handicapped by absences on long service leave and through illness. The number of routine samples coming into the laboratory for analysis has been reduced by cessation of work on briqcoke production by the Engineering Chemistry Division.

TABLE 10.

Boiler Test Results.

Date	28/10/60	4/10/60	27/9/60	13/9/60	24/3/59
Number of Boilers Steaming	1	2	2	2	2
Coal fired, lb/hr	574	679	683	667	602
Steam f&a 212°F, lb/hr	3058	3190	3150	2855	2602
Boiler Efficiency, per cent.	53·8	47·0	46·6	42·9	44·2
CO_2 in flue gas, per cent.	9·4	7·8	9·5	9·2	4·8
$CO+H_2$ in flue gas, per cent.	0·3	1·8	....	....	....
Heat lost in ash, per cent. of heat in fuel	8·7	6·4	4·4	5·5	15·7

INDUSTRIAL CHEMISTRY DIVISION.

Introduction.

Secondary industry in Western Australia showed an appreciable expansion during 1960 and this expansion was reflected in the increasing amount of work which this Division was called upon to do. Perhaps one of the most significant developments was in the field of plastics. Whilst the actual manufacture of plastics from raw materials is not likely to come to Western Australia for some years yet, there can be little doubt that formulation of plastics and their use in the building industry in particular, is bound to increase very appreciably in the next year or two.

With only a small staff to call on, it was not possible to do a great deal of developmental work, or short term research during the year. Nevertheless investigations on hand at the end of 1959 were concluded or continued, and one or two new lines of investigation were opened.

The staff as it is at present, is now working to the limit and the time has come to consider an expansion. It is quite clear, in our experience, that local manufacturers require technical assistance and there are now a large number of firms in operation who are not yet in a financial position to recruit their own chemical staff. The assistance which these Laboratories can give such firms can play a significant part in their expansion.

As in previous years, the work of the Division can be placed under three headings:—

(1) Technical inquiries.

(2) Physical and chemical testing in connection with developing projects and the examination of material failures.

(3) Research work.

Technical Enquiries.

In 1960 a total of 4,102 technical enquiries was received. This is almost ten times the number in the first year in which the enquiry section operated. A large number of these enquiries was quite simple to answer and some 3,005 were replied to almost right away. 1,416 enquiries were referred to specialists and at the end of the year 36 queries were still to be dealt with of which 24 could probably not be answered satisfactorily.

During the year, what little time was available was taken to continue the card indexing of the technical literature in the Division. Thanks to the co-operation of an increasing number of manufacturers, agents and suppliers, we have been enabled to expand the range of this literature and to keep it up-to-date. The card index, so far as it has been prepared, is now in daily use.

An analysis of the nature of the enquiries may be of interest:—

	Per Cent.
(a) Plastics	24
(b) Queries relating to the supply of raw materials, machinery and to agencies supplying materials, and to specifications for chemicals or chemical plant	25
(c) Paint and paint pigments and vehicles	10
(d) Cement and concrete	19
(e) Other building materials	11
(f) Miscellaneous	11

Of enquiries received, 36 per cent came from Government Departments and 64 per cent. from private industry.

Enquirers from private industry included manufacturers and manufacturers' agents, builders, engineers, architects, chemists, insurance assessors, viitors from the Eastern States, England and Germany, and quite a few householders.

It would not be possible to maintain this enquiry service without the willing co-operation of suppliers of chemicals and machinery as well as experts on special branches of secondary industry. The writer once more has the pleasant duty of conveying his warmest thanks to many friends in Western Australian industry who have done so much to help the Division in all branches of its work.

Physical and Chemical Testing.

83 samples were examined and reported on for various Government Departments and for the public, the source and description being shown in Table 11.

At the beginning of the year methyl benzoate was recovered and xylene purified for Royal Perth Hospital. Arrangements were then made for the work to be done by a jobbing chemist. Two samples from him were examined by infra-red spectrometry and found to be up to standard.

For the Architectural Branch of the Public Works Department, investigations included a proprietary line of asbestos/cement tiles. Apart from possible failure of colouring material in some of the tiles, they were of a high standard. Other materials examined and reported on for the Architectural Branch were cement additives, an electric light shade, P.V.C. sheeting and some sealers. The protective coating on the light shade was found to be unsatisfactory.

The cause of staining on a door submitted by State Building Supplies was determined and a corrective indicated.

The setting time of plaster of paris at elevated temperatures was determined for the State Mining Engineer.

TABLE II.

Industrial Chemistry Division.

	Department of Industrial Development	Mines Department	Metropolitan Water Supply	Public Works Department	State Building Supplies	Pay—Public	Pay—Hospitals	Tender Board	Total
Assistance to Industry	5	....	....	....	....	5	....	....	10
Building Materials—									
Cement and Concrete	....	....	....	5	....	....	....	....	5
Paint	....	....	....	15	....	8	....	3	26
Tiles	....	....	....	13	....	1	....	....	14
Other	....	1	....	1	1	3	....	....	6
Ores and Minerals	4	1	....	....	....	2	....	....	7
Plastics	....	....	....	2	....	2	....	....	4
Various	....	1	1	....	....	4	5	....	11
	9	3	1	36	1	25	5	3	83

In connection with the painting of the gates of the Ord River Dam, eleven samples of paint, and of ingredients used in their manufacture, were examined and a few performance tests carried out. Apart from some minor deviations from standard of two or three of the ingredients, all paints were of satisfactory quality. It will be necessary to do further work with these paints, particularly on the development of hot-weather thinners. Paint made to present specifications dries in about 15 minutes at 80° F. Since much of the paint may have to be sprayed on surfaces with a temperature as high as 145° F, and in a shade temperature of 105° to 110° F, it will be necessary to have special low-volatile thinners. Investigations have shown that methyl iso-amyl ketone and isophorone are not only excellent solvents for P.V.C. but have relatively low volatility. Practical trials of these and other solvents and of blends of these are scheduled for early in the new year.

Work on suitable plastic linings for water pipes and valves, which was mentioned in the 1959 report was continued. Three different linings have now been under test for some months. Water at elevated temperatures has been circulated almost constantly over the linings, except for short periods of rest, thus simulating actual working conditions. So far none of the coatings have shown signs of breaking down. The work is to be continued for a further six months.

Deterioration of glazing stabilizers in a Terrace building was traced to the use of natural rubber stabilizers instead of neoprene as specified in the contract.

Discolouration of the interior walls of a few houses was found to be due to mould. The mould was cultured and the culture used to produce discolouration artificially.

Production troubles in the moulding of high density polyethylene were found to be due to incorrect pre-heating which affected the degree of polymerization.

Of 25 samples which were submitted by private industry it is possible to comment on four only because of the confidential nature of the work. These comments are given under the next heading, since they involved a certain amount of investigational work.

Research Work.

Under this heading will be discussed some work which was more strictly investigational or developmental, rather than research work. This has been done since the work, while it did involve some physical or chemical testing, also required a considerable amount of experimental work.

An investigation was made of the failure of coal tar pitch enamel coating on steel water pipes. These investigations were carried out partly at the factory where the coatings were being applied and partly in the laboratory. As a result of the work, some changes in the formulation of the coatings were suggested and it is understood that the trouble has now been overcome.

Flexible vinyl tiles on occasion have been found to lift after having been laid for a period for as little as a month, and as long as a year. This trouble occurred to a considerable extent in Fremantle Hospital. Investigations showed that the adhesive which was being used was susceptible to water. Water used in washing the floor had permeated between the joints in the tiling. It was suggested that a less water-susceptible adhesive be used, that water should be used less lavishly in cleaning operations and that mopping up after cleaning operations srould be as thorough as possible.

A manufacturer of wax emulsions was encountering trouble with his dry well, which was blocking up frequently. The blockage was traced to precipitation in the well of a wax which occurred in the wash water in very small proportions and in a very finely divided state. By reducing the quantity of the wash water, and treating the wash water to remove traces of wax, the problem was overcome.

Adhesion failure of ceramic wall tiles in extensions to Parliament House was traced to an unsuitable additive in the mortar.

A number of failures of paint and paint primers on structural steel work occurred during the year. Investigation showed that failures in every case were due to inattention to proper surface preparation. It does not appear to be generally realised that different primers and different paints may need different surface preparations.

The work on the painting of karri panels was continued. At the Exposure Station at South Fremantle Power House, nine primers, four undercoats and four top-coats are being tested. After one year's exposure, two of the primers and the top-coats over them have failed. The remaining seven are in good condition. The slight deterioration which is apparent in the top-coats is normal for the type of paint, the time of exposure and conditions of exposure. These slight changes have, therefore, apparently not been caused by the substrate. It would thus appear that suitable primers for use with karri have been found. The work will be continued but it has been greatly retarded this year by a shortage of staff.

One of the most spectacular advances in the use of plastics in recent years has been the use of plastic foams in a wide number of applications. Anticipating application of foam production in W.A., a literature survey was made and a report produced covering raw materials, methods of production, preparation and uses of all types of plastic foams. Two manufacturers are now almost ready to produce polyurethane foams in W.A. and polystyrene foams have been in regular production for nearly three years. Quite apart from their use for heat and sound insulation, foams of different types have a great potential in the building industry. Technical assistance is being given to foam manufacturers with view to improving their production or accelerating it and in the development of other forms of plastic foam.

Some work has been done on plastic floor coverings and toppings. The use of resins in floor toppings has been known for some time but has only now been actively practiced in W.A. Toppings based on epoxy resins have been applied with very pleasing success on a number of jobs. These toppings resist wear and the action of many chemicals extremely well. They are, therefore indicated for floors in factories where spillages of chemicals are likely. Such toppings are expensive initially, but more than compensate for the first cost with a very much longer period of service. It occurred to us that it should be possible to replace the expensive epoxy by polyesters which would be equally efficient and probably much cheaper. Preliminary work on polyester/graded sand compositions has been most encouraging and the work is being continued.

At the beginning of the year, extract of Scaevola spinescens was being prepared for fifteen patients. At the end of the year, only one patient was receiving the extract. No further work was undertaken on the composition of the Scaevola spinescens extract.

Information on the toxicity of certain ingredients used in the manufacture of polyurethane and of epoxies was brought to the attention of the Commissioner of Public Health. Danger from toxic ingredients is most likely to arise from careless use. We are, therefore, trying to ensure that manufacturers now entering the field locally, use safe and efficient equipment and procedures.

During the year, considerable use has been made of the single beam infra-red spectrometer. It was necessary initially to develop techniques in the preparation of samples and in the handling of the instrument, so as to permit the accurate and rapid identification and estimation of a very wide range of organic materials, particularly plastics. After techniques had been established, work was begun on a library of standard infrared spectra. Manufacturers, both in W.A. and the Eastern States kindly supplied samples of standard plastics and chemicals. The spectra of most of these have been recorded and the rather complicated work of indexing these spectra has begun.

This work has already produced very useful results. On one occasion a small sample of material was identified by the spectrometer and by reference to the spectra index, followed by a check in our technical literature index, it was found possible not only to identify the material, but also to name the manufacturer, and his local agent. This work took little more than an hour. It is quite clear that the infra-red spectrometer will play an increasingly important part in the work, not only of this Division, but of other Divisions as well. Unfortunately the spectrometer we now have, is a single beam instrument. This imposes limitations on the identification of important groups of materials, for example, P.V.C. resins. It also requires a considerable amount of time for accurate quantitative estimations. These disadvantages could be overcome by using a double beam spectrometer, and an investigation into the types of double beam instrument now available has been made.

The Chief Industrial Chemist visited the Eastern States from the 3rd to the 19th July. He met a number of chemical manufacturers and visited a number of chemical and chemical engineering firms. He had discussions also with officers of various Divisions of C.S.I.R.O. Much useful information was obtained as a result of the visit and valuable contacts established. It is considered vital that the Industrial Chemistry Division should keep in touch with progress in chemical manufacture and utilization of raw materials in the Eastern States especially, and also abroad. It would be most helpful if visits could be made to the

Eastern States by senior officers at regular intervals. It would also be worth considering a visit to Britain, America and the Continent by a senior officer of the laboratories who would derive a considerable amount of benefit from such a visit, as well as making scientific colleagues in other countries aware of Western Australia's science and scientists.

MINERALOGY, MINERAL TECHNOLOGY AND GEO-CHEMISTRY DIVISION.

General.

In a laboratory of this nature, the number of samples handled is no direct criterion of the amount of work done, as obviously a complete mineral analysis, for example, is far more time consuming than a considerable number of single iron ore assays. It is nevertheless worth recording that in 1960 the Division handled over a thousand more samples than in the preceding year, and, with a total of 2,563 during 1960, exceeded the total in any other post-war year.

This large increase was due mainly to two major iron-drilling programmes undertaken at Koolyanobbing and Mt. Goldsworthy.

The main sources of samples were:—

General public, (free)	742
General Public, (pay)	321
Geological Survey Branch	480
State Batteries Branch	295
Mines Department (other Branches)	596

Table 12 details the nature and source of all samples allotted to the Division.

Owing to changes in the senior staff of the Metallurgical Research Laboratory of the Western Australian School of Mines, the National Association of Testing Authorities decided to re-assess that Laboratory with respect to its registration as a testing laboratory approved by the Authority. Messrs. Payne and Burns of this Division were requested to act as assessors and a visit was accordingly made to Kalgoorlie in September for that purpose. The opportunity was taken to visit also mineral deposits at Grosmont, Londonderry and Koolyanobbing, where a number of specimens were collected.

In the same month another staff member, Mr. M. Pryce, attended a Radiological Reconnaissance Course held at the Civil Defence School, Mt. Macedon, Victoria.

TABLE 12.

Mineral Division, 1960.

	Pay	Free	Government Geologist	State Batteries	Mines Department	Departmental	Other State Government Departments	Total
Aggregates	20	....	....	....	....	....	21	41
Alloys and Metals	16	....	....	....	....	....	1	17
Burnt Lime	8	....	....	11	....	....	1	20
Ceramics	3	25	....	....	....	....	....	28
Mineral Identification	32	349	5	....	....	14	14	414
Minerals and Ores—								
Bauxite	2	15	3	....	....	....	....	20
Beryl	18	13	2	....	....	....	....	33
Bismuth	3	6	....	....	....	....	....	9
Copper	18	47	5	1	....	2	1	74
Gold—Ores	61	101	73	....	....	....	....	235
Tailings	....	....	....	221	....	....	....	221
Umpire	....	....	....	48	....	....	....	48
Gypsum	5	9	....	....	....	....	....	14
Heavy Sands	2	9	....	....	....	....	....	11
Iron	34	41	338	....	596	1	....	1,010
Lead	4	5	....	2	....	....	....	11
Limestone	5	9	37	....	....	....	....	51
Lithium	5	4	2	....	....	....	....	11
Manganese	14	6	6	....	....	1	....	27
Silica	....	7	....	....	....	....	3	10
Tantalite-columbite	27	17	1	....	....	....	2	47
Tin	4	18	....	....	....	....	....	22
Titanium	8	9	....	....	....	19	14	50
Others	4	27	1	....	....	4	2	38
Miscellaneous	28	25	7	12	....	11	18	101
	321	742	480	295	596	52	77	2,563

Mineral Collection.

Ninety specimens were added to the Division's Mineral Collection, bringing the total number of specimens to 2,615.

Of the new specimens, thirteen were received from the Royal Ontario Museum in exchange for Western Australian specimens. The batch included vesuvianite, sapphirine, rhodonite, betafite, gersdorffite and pollucite.

All other additions to the collection were from within the State.

Spodumene samples added to the collection included a grey variety from Ravensthorpe assaying 7.16 per cent. Li_2O,, and a white spodumene intimately intergrown with quartz originating from the vicinity of Roebourne. Spodumene had not been recorded previously from this locality. Other lithium minerals added were montebrasite from Ravensthorpe, and lepidolite from Grosmont.

A batch of manganese minerals was added to the collection after confimatory identification by X-ray. These specimens consisted of braunite, cryptomelane and pyrolusite from the Mt. Sydney and Ripon Hills areas.

Other additions included alunite from Westonia, columbite in calcite from Roebourne, bismuthinite from Mt. Magnet, miloschite from Coongan River, gadolinite from Hillside Station, native bismuth from Yinnietharra, gahnite from Mogumber, arsenopyrite from Mt. Rose and apatite from Yinnietharra.

In addition to the above samples already added to the collection, there is a batch of 415 specimens awaiting attention, which were donated by the Government Geologist. These represent a selection from the Geological Survey of Western Australia's collection and their incorporation in the Government Chemical Laboratories' collection will mean that a most comprehensive collection of this

State's minerals will be available, under the one roof, to any individuals with a general, commercial or professional interest in the subject.

Extra cabinets have been obtained to house these additions, and the whole collection is being reorganised by classification into the chemical system recommended by Dr. M. H. Hey of the British Museum Department of Mineralogy.

Alloys and Metals.

As in previous years, most work on alloys and metals was carried out at the request of metal merchants. The materials analysed included copper drillings, lead ingots, brass and white metal.

A sample of aluminium was analysed in detail for Public Works Department for conformity with a British Standard Specification.

Building Materials.

A surface stain on bricks was examined at the request of the brick manufacturer. The stain was extremely resistant, neither acids nor alkalies having any noticeable effect, and was demonstrably not the well-known effect due to vanadium in the raw materials.

A concentration of sulphate on the stained surface was established and the conclusion reached that the stain was a scum originating in the drier or kiln. This scum is generally attributed to the presence of soluble salts either in the clay itself or in the mixing water. Of these salts, calcium sulphate is probably the most common offender. Other possible sources of the sulphate ion are pyrite in the clay and sulphurous fumes in the kiln gases.

Burnt Lime.

The number of burnt lime samples submitted by the public continues to decline, only 8 being received during the year, compared with 15 last year, 28 in 1958 and 87 in 1957. This is an encouraging sign in that it suggests agreement between figures obtained by burners and buyers for work assays carried out under fairly difficult conditions.

Of the 11 samples submitted by State Batteries, 9 conformed with Tender Board Specifications. The CaO content on the ignited samples varied only a little from the specified minimum of 86 per cent., while the average free lime figure was 81 per cent.

Analyses were made of the sludge reject from commercial acetylene generators and there appears no chemical reason why this material could not be used as a soil dressing.

Other analyses under this heading included work on hydrated and other lime products for lime-brick manufacturers and for the Department of Industrial Development.

Cement and Concrete.

(1) *Aggregates, General.*—The equipment referred to in the Annual Report for 1959 as being essential to the more reliable determination of the potential alkali reactivity of concrete aggregates has been acquired and put into operation. It enables the length of test mortar bars to be measured at chosen intervals and the expansion, if any, recorded.

Though the accelerated chemical test serves a most useful purpose in quickly grouping aggregates, it is apparent that measurement of the actual expansion of a mortar bar prepared from the aggregate under examination must be a more practical and less empirical test. An obvious disadvantage is that it is, of necessity, a long-term test, significant figures rarely being obtained in less than six months.

(2) *Aggregates, Coarse and Fine.*—Mortar bars were prepared from various mixtures of the coarse and fine aggregates available for concrete work in the vicinities of the Ord and Fitzroy river dam projects being undertaken by the Public Works Department. These bars were prepared late in July and monthly readings to the end of the year had shown no significant expansion.

Three further aggregates from the Fitzroy River area were tested by the accelerated chemical test for potential alkali reactivity. Two were coarse rock-fragments composed of quartz, feldspar and traces of tourmaline, the third was a sand comprised essentially of quartz with a little limolite and traces of ilmenite and tourmaline. Though petrographically there was nothing to suggest that these aggregates would be reactive, the first coarse one was border line, the second potentially reactive and the sand innocuous.

Four rocks composed mainly of carbonates of lime and magnesia were also examined as potential concrete aggregates. The chemical test classified all four as innocuous, showing unusually high values for reduction in alkalinity with the expected very small values for dissolved silica. It is interesting to note that an exceptionally large reduction in alkalinity can result, in the case of aggregates containing magnesite or dolomite, from the reaction of the alkali with magnesium carbonates and there is some doubt as to the significance of this increase when interpreting the results in terms of effects possibly deleterious to concrete. It seems generally accepted that reactions of alkali with silica are much more potentially dangerous than reactions with magnesium minerals.

Work of a similar nature was also carried out for Public Works Department on coarse aggregates from a number of localities including Wyndham and Broome, while private constructional firms are making increasing use of the laboratory testing facilities for this type of work.

Of the sands examined many met all requirements of the appropriate specification except for organic matter content. The usual colour test for organic matter can be regarded only as approxiate but does serve to indicate whether further tests are necessary or not. It is pleasing to see that both British Standards and A.S.T.M. have discarded the rather unrealistic printed colour charts previously used as reference standards, though each now uses different solutions as standards, the A.S.T.M. recommending a potassium dichromate-sulphuric acid standard in place of the older tannic acid solution still adopted by the British Standards.

(3) *Aggregates, Exposed.*—Interest continued in the testing of ornamental stone for use as exposed aggregate, mainly with regard to its potential reaction with the alkali of cement.

Three samples of jasper all proved reactive, as did one of the Mt. Dick serpentine. The latter is an attractive green stone with black veins of magnetite which, though reactive towards cement, could possibly find some application as ornamental wainscoting or sills.

A green rock consisting mainly of epidote with some quartz and feldspar was non-reactive.

Coloured granites from Namban, one pale green and the other containing a dark red feldspar, were examined at the request of the Government Geologist. Both should make satisfactory, and attractive, facing stones or alternatively could be used with safety as exposed aggregates.

(4) *Hardened Concrete.*—Four samples taken as the result of concrete failure in a drying kiln were tested to determine the original mix. Samples of the original ingredients were not available but even taking into account the resulting assumptions that have to be made, the test work indicated that the cement content of the original mix was undoubtedly below that of the specified 6 of aggregate to 1 of cement, being rather of the order of 10 aggregate to 1 cement.

Specimens of concrete obtained from the Causeway piles were submitted by the Main Roads Department. The concrete fragments had resulted from spalling at certain points on some piles and an examination of the aggregate was requested. Three different rock types were identified in the aggregate, viz:—

(a) a grey granite containing microcline, quartz, albite and sericite;
(b) a black epidiorite consisting of hornblende, feldspar, quartz and epidote; and
(c) a greenish-brown schist containing altered biotite and quartz.

There seems little doubt that a schist would be an unsatisfactory constituent of any concrete aggregate, particularly when, as in this case, the biotite had altered to a vermiculite-type mica having a tendency to swell on heating. That type (c) was the aggregate responsible for the spalling was further suggested by its occurrence at the apex of practically all the spalled pieces.

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New Mineral Occurrences.

Sixteen new localities for various minerals were recorded throughout the year. These were tenorite (Lissadell Station) and arsenopyrite (Mt. Rose) from the Kimberley Division; monazite (Roebourne) fluorite (Yinnietharra), topaz (Roebourne), miloschite (Coongan River), spodumene (Roebourne), and columbite (Roebourne) from the North West; bismuthinite (Mt. Magnet), chromite (Callotharra Station), and rutile (Callotharra Station) from the Murchison; nontronite (Thaduna), manganese oxides (Mt. Lawrence Wells) from Central Division and vesuvianite (Kununoppin), pseudomalachite (Warriedar) and tantalite (Munglinup) from the South West.

A number of these minerals will be referred to in greater detail under the heading "Mineral Identifications."

Mineral Identifications.

Three specimens of prehnite were received from widely divergent localities, two of which were the first reported occurrences in their area, namely Roebourne and near the coast road crossing of the Fortescue River. The third sample, from the Londonderry feldspar quarries, occurred both as a translucent green and as a turbid white mineral, the latter form showing considerable alteration not apparent in the green.

Specimens of blende were received from the Nooka Mine at Northampton. Two other interesting zinc minerals were identified in a specimen from Croydon Station in the Roebourne subdivision. They were a pink cobaltian smithsonite and a green hemimorphite containing a little copper. Though the carbonate mineral had previously been recorded from about a dozen localities in the State (including Croydon), hemimorphite had been identified at only four places, namely Braeside, Marble Bar, Mt. Edgar and West Wodgina, and the Croydon occurrence is therefore recorded for the first time.

Another new occurrence in the Roebourne district was topaz, from 18 miles W.S.W. of the town. It was associated with fine-grained muscovite, feldspar, quartz and a little beryl.

Massive garnet rock with sufficient fine green mica throughout to give a distinctive colour was received from the Roebourne area, as was also a pink stone composed of feldspar, quartz and chlorite with large pink fragments of altered epidote. Manganese was present in traces and it is assumed that the pink colour was due to this element.

A single fragment of monazite weighing 258 grams was received from the Wodgina area, other samples of the same mineral coming from Roebourne and Pilgangoora.

Well-formed corundum crystals from Yinnietharra showed a purple colour which could be accounted for by the presence of traces of manganese. Further interesting specimens of this mineral were crystals of pink corundum with a wide black zone of spinel enclosing the corundum. The spinel was intergrown with varying amounts of very fine magnetite.

A particularly fine specimen of diaspore from Noreena Downs Station was donated to the Division collection by the Government Geologist. It occurred as tabular, translucent to transparent crystals associated with fuchsite and altered corundum.

A low-grade chromite assaying 19.0 per cent. chromium and 26.2 per cent. iron originated from Callotharra Station, as did a specimen of rutile. Both specimens represented the first recorded occurrence of their species in that locality.

From Westonia a sample was received consisting of gypsum, clay and alunite. The alunite was in an unusual, compact form, green in colour and gave an X-ray pattern closely resembling the standard alunite picture. The potash (K_2O) content was 8.35 per cent., and soda (Na_2O) 0.81 per cent. Complete analysis suggested a mixture of approximately seven alunite to one of natroalunite.

Increased water-boring activities following on the water restrictions of the 1959-60 summer led to a number of sulphide specimens being submitted for examination from the metropolitan area. A sand sample from the bottom of a bore 100 ft. deep at Guildford proved to contain glauconite associated with clays, quartz, feldspar and mica. An acid-soluble potash content of 2.4 per cent. suggests that approximately one-third of the sand was glauconite.

An interesting specimen from a 17 ft. bore at Walpole consisted of fossil wood in which the organic material had been replaced by marcasite. Massive pyrite, containing traces of galena, was received from the Kathleen Hope lease at Northampton. It was in an unusual layered form suggesting at first sight an artificial origin though it was undoubtedly a natural occurrence.

A colourless tourmaline, associated with a blue tourmaline and a little muscovite, was received from an undisclosed locality in the North-West.

Mineral determinations were carried out on a number of copper ores for the Department of Agriculture for use in experiments to determine the relative availability to plants of the various copper minerals. A real problem in this connection is to obtain samples, particularly of the oxidised minerals, free from contamination with other copper minerals. As a result, special samples were prepared in the Division of pure malachite, chalcocite and chalcopyrite and these were made available to the Department of Agriculture, each in three size ranges.

Two clay samples, from widely separate localities, were reported to have been very attractive to stock as a lick. One was light yellow, the other green due to the presence of ferrous iron. As neither contained any significant salt content it is possible that the smooth greasy texture was the main attraction.

A number of artificial materials were submitted in the belief that they were naturally occurring minerals. These materials included copper sulphate crystals, ferrochrome, ferrosilicon, silicon and white-lead putty.

Minerals and Ores.

(1) *Bauxite.*—Prospecting for bauxite by individuals received a big impetus this year as a result of Press publicity given to the granting of a large reserve to Western Aluminium No Liability, and the subsequent activities of that Company. Apparently a potential market exists in Japan for ores assaying better than 40 per cent. sodasoluble alumina and low in "reactive silica." The term "reactive silica" is used by Western Aluminium N.L. to indicate the silica soluble in dilute hydrofluoric acid when bauxite is treated under conditions which dissolve silicates but not quartz. We are indebted to that company for details of the test methods they used, which will enable a practical standard to be set for comparison of results in this State.

Samples recived from localities such as Gosnells, Donnybrook-Jarrahdale, Mt. Helena, Armadale and South Kimberley varied in alumina content between 4.2 and 37.6 per cent.

(2) *Beryl.*—The relaxation by the Commonwealth Government of the ban on the export of beryl reported on the 18th February, 1960 did not affect the total number of beryl samples submitted during the year, though the drop in price from £15 9s. to £13 10s. per unit must in some degree have discouraged prospecting.

Of the total submitted (33), 18 were paid assays for mineral producers and 13 were free identifications. Two specimens were identified for the Government Geologist.

A request for specimens of beryl from Western Australian localities was received from an international firm. Specimens of pink beryl particularly were sought for a special but unspecified purpose. A number of such specimens were available from Division stocks.

(3) *Bismuth.*—Of the nine samples submitted this year only one was for assay representing a commercial parcel, while the rest were for identification.

As is usual most specimens were of oxidised ores although one specimen contained native bismuth and two the bismuth sulphide, bismuthinite.

A new locality reported for bismuth was from 50 miles east of Roy Hill Station. This occurrence was a complex of bismuth carbonate minerals which were not individually identified.

The sulphide bismuthinite which had previously been reported in the Murchison area only at Melville and Paynes Find, was found during the year at Mt. Magnet.

(4) *Clays.*—Clay samples were submitted this year from nine different localities. Two paid examinations were done; one for moisture in a sample being shipped overseas, and one for reaction to burning under specified conditions.

Of the nine samples whose localities were recorded, three only were subjected to the full burning tests. Clays from two localities close together on the Albany-Denmark road burned to a good terra-cotta colour, although their porosity was high. They differed in hardness at a workable temperature, only one being around steel hard.

A white clay from Gidgiegannup burned with very little shrinkage or distortion to a fairly hard, good white but porous body. The sender was advised to submit samples to local white-ware producers.

The attention of a number of local industrialists has been drawn to the location by the Geological Survey of Western Australia of a commercial quantity of pure halloysite in a lake near Boorabbin. This material is extremely plastic and this property is retained on air drying and subsequent rewetting. The sample was shown by X-ray to be originally the fully hydrated form of halloysite which on partial air drying became a mixture of this and the dehydrated form, metahalloysite. A considerable amount of work requires to be done to prove uses for this material but possibilities exist in the fields of ceramic refractories, paint and soap fillers, masonry waterproofers, in foundry moulding, and possibly as a pozzolan in concrete work. It is interesting to note that the only recorded use of a pozzolan in Australia was of a material stated to be essentially halloysite.

Samples received during the year, other than those mentioned, were not tested beyond identification.

(5) *Copper.*—Copper minerals were received from a number of widely separated localities. Included were specimens from Woodstock Station in the Pilbara Goldfields assaying approximately 23 per cent. copper and 17 per cent. scheelite; from Mt. Edgar carrying 23 per cent. copper and 28 oz. of silver per ton; from Warriedar carrying 44 per cent. copper and nearly 15 oz. silver and from Yampi Sound two samples assaying in excess of 50 per cent. copper.

A number of metallurgical products, mainly flotation concentrates, were assayed for copper, gold and silver and a pay sample from a Northampton area, consisting of a mineralized carbonaceous clay, was assayed for lead, zinc, gold, silver and radioactive minerals as well as copper.

Tenorite was identified in a specimen from Lissadell Station in the Kimberley Division, though possibly the most interesting copper mineral received during the year was pseudomalachite from Warriedar in the Yalgoo Goldfields. This basic copper phosphate mineral occurred in a matrix, made up of opaline material, sericite, quartz, chlorite and clay.

This occurrence of pseudomalachite was the third only recorded for this State, previous samples being found at Watheroo and Collier Bay (West Kimberley), in both of which the source of phosphate was obviously guano deposits. It is understood that no such deposits are apparent in the vicinity of the Warriedar find. It was not possible to isolate completely pure mineral but hand-picked material, containing traces only of malachite, and chrysocolla, gave the following percentage analytical figures:—

Copper oxide, CuO	67.39
Phosphorus pentoxide, P_2O_5	22.43
Silica, SiO_2	0.40
Combined water, H_2O+	8.79
Moisture, H_2O-	0.23
Carbon dioxide, CO_2	0.72
	99.96

Analyst—M. B. Costello.

Allowing that the silica was present as chrysocolla and the carbonate as malachite, these figures give the pseudomalachite composition as 5.1 CuO. P_2O_5. 2.9 H_2O which is in close agreement with the generally accepted ideal formula of 5 CuO. P_2O_5. 3 H_2O.

(6) *Gold.*—In all categories (tailings, concentrates, ores) there was a continued increase in the number of gold assays, the total for the year being just over 500.

Both gold and silver were determined in a number of products, particularly in copper-bearing materials. These included sulphide-copper concentrates from an operating plant in the Coolgardie Goldfield and oxidised copper ores from the Yalgoo, Ashburton Downs and Nullagine areas.

An arsenical gold ore was found to contain an unusual amount of sphene, while an ore from Chittering was thought to be rich by virtue of the impressive tail left on panning. The tail was found to be monazite, with a negligible gold content.

Other products assayed included an arsenopyrite ore from Mt. Rose in the Kimberley, Berdan pan tailings and zinc shavings.

Both total and amalgamable gold were determined in some samples. Though no claim is made that plant amalgamation procedure is exactly simulated, a useful idea of the amount of reactive gold can be obtained by simple treatment with mercury in the laboratory. A rich ore from the Upper Gascoyne was stated to give an unexpectedly poor recovery over the plates: it was found in the laboratory that only 25 per cent. of the gold was amalgamable, most of the remainder being coated with a brown acid-soluble skin. The acid-treated gold amalgamated readily and it was suggested that the ore be concentrated by straking and the strakes concentrates amalgamated after acid treatment.

As in past years, samples were received for gold assay in which pyrite, chalcopyrite, fine mica and even streaks from brass boot-studs had been mistaken for gold.

Work for the Government Geologist dealt mainly with cores from drilling programmes at Forest King Gold Mine, Coolgardie, and Mountain View North mine at Day Dawn.

(7) *Gypsum.*—Activity directed toward finding exportable deposits of gypsum has dropped off during this year and only 5 paid samples were dealt with.

Of the prospectors' samples examined free of charge, none completely fulfilled the requirements of the plaster industry although a number may have satisfied local demands for soil dressing and cement additives. For the plaster industry, a granular product (sizing between ¼ inch and 1/50th inch) containing at least 98 per cent. gypsum is required, while for the cement industry, though the sizing is not so critical, the product must still carry at least 70 per cent. gypsum.

Localities represented in this year's samples include Dowerin, Cunderdin, Woolgangie (5 m west of Coolgardie), Baandee, Mt. Barker, Mt. Magnet, Irwin River and a salt lake 50 m south-east Shark Bay.

(8) *Heavy Sands.*—Less than a dozen samples of heavy sands were received, contrasting with 323 during the ilmenite boom in 1957. An unusual feature was the proportion originating from inland areas, including Fairfield Station in the Kimberley, Jimblebar, Newdegate, Lake Grace, Wongan Hills and Mullalyup. Ilmenite predominated in the heavy fraction of all these sands, magnetite being next most common.

Two garnet sands were submitted, including one from a beach 40 miles north of Geraldton. Samples of this material are received practically every year but unfortunately no significant commercial use for it has yet been found. The possibility had been raised of its application as an ornamental concrete aggregate but as far as is known, no progress has been made in that direction.

(9) *Iron.*—Work on iron ores was far more extensive than in past years. This was due mainly to two drilling programmes, namely those conducted by The Broken Hill Pty. Co. Ltd. at Koolyanobbing and by the Geological Survey of Western Australia at Mt. Goldsworthy.

Drilling in the Koolyanobbing area commenced in the middle of February and finished three months later. During that time 596 samples were received for determination of acid-soluble iron, acid-insoluble material and ignition loss. The samples originated from Koolyanobbing, Dowd's Hill and Bungalbin.

A large percentage of the samples from Koolyanobbing and Dowd's Hill assayed in excess of 60 per cent. acid-soluble iron, three from Dowd's Hill being above 68 per cent, the actual maximum figure reported being 68.6 per cent iron. An appreciable proportion of Bungalbin figures were between 58 per cent and 60 per cent iron, with 61 per cent. as a maximum.

The iron minerals present were limonite and hematite. There were field reports of magnetite in about half a dozen samples only.

The Mt. Goldsworthy drilling operations were still in progress at the end of 1960. The first samples were received in May and a total of 227 from four drill holes had been handled by the end of the year.

On individual core samples, only acid-soluble iron was determined, but seven composite samples were run for total iron, silica, sulphur, phosphorus, titanium, manganese, magnesia, lime, alumina and ignition loss. Results of the composite made up of samples representing portion of drill hole C1 were as follows:—

	Per cent. on Dry Basis
Total iron, Fe	66.0
Acid-soluble iron, Fe	65.9
Silica, SiO_2	4.05
Sulphur, S	less than 0.01
Phosphorus, P	0.01
Titanium, Ti	0.05
Manganese, Mn	0.53
Magnesia, MgO	0.01
Lime, CaO	0.05
Alumina, Al_2O_3	0.28
Ignition loss	0.51

The highest individual sample in this composite assayed 69.2 per cent. iron, the lowest 59.7 per cent. The highest individual assay for the whole series was 69.7 per cent. from drill hole B1.

A mineral identification was carried out on each sample, the only iron minerals detected being limonite and hematite, no evidence being found of martite or magnetite. Gangue minerals were quartz, clay and an oxidised chlorite.

Another project which involved a large number of analyses was the sampling by the Geological Survey of Western Australia of lateritic iron ores in the Pilbara. The 60 samples submitted, averaging for the most part between 55 per cent. and 58 per cent. iron, were divided into 10 groups according to locality, and a composite of each group analysed for iron, titanium, sulphur, silica, phosphorus, manganese, alumina and moisture. The composites did not contain detrimental minor constituents in amounts in excess of that generally acceptable in normal blast furnace practice, taking acceptable maxima as silica 8 per cent., phosphorus 0.18 per cent. sulphur 0.1 per cent., titanium 1.0 per cent.

Other ores were analysed on behalf of the company interested in developing the large low-grade deposits in the extreme south-west, including the Scott River area.

Two samples of pyritic cinders were assayed for iron and copper prior to shipment overseas. These cinders result from the calcination of flotation concentrates originating from plants in the East Coolgardie and Dundas goldfields.

An iron ore from Gabanintha was found to contain 0.69 per cent. vanadium.

Eleven iron ores from the Northwest were examined for iron and silica on behalf of a prospecting party representing a large Eastern States mining company.

A large number of iron mineral samples were received from individuals all over the State, and a marked increase in numbers can be expected following the easing in December of the Commonwealth Government embargo on export of iron ore.

(10) *Lead.*—Only two lead-zinc products were assayed for State Batteries Branch, both originating from the Northampton area. Determinations were made for lead, copper, zinc and iron, as well as the size distribution of the various sulphides in a product that was proving difficult to table.

Sulphide samples were received from Yalgoo and Cape Berthelot, the latter being an occurrence not previously recorded. Predominantly cerussitic specimens were sent in from Maroonah and Yinnietharra Stations while an interesting sample from an undisclosed locality contained siderite, galena, pyrite, chalcopyrite and oxides of manganese and assayed 11.7 per cent. lead and 5.7 per cent. manganese.

Some large specimens of anglesite were obtained from the Northampton fields.

(11) *Limestone.*—The possible establishment of an iron industry in Western Australia stimulated the search, particularly towards the end of the year, for limestone suitable for fluxing purposes, and the number of samples submitted can be expected to increase in future.

Four samples from 25 m N. of Boorabbin were submitted by the Government Geologist and later a batch of 31 was received from the Albany area. The latter batch included sandy, cap and soft limestones, calcareous sands and mollusc shells and, as would be expected, a wide spread of lime figures was obtained ranging from stone assaying 53 per cent. CaO down to calcareous sands assaying little more than one tenth of that figure.

Shell from the well-known Hamelin Pool deposits was assayed, one sample showing 53.6 per cent. CaO, 0.31 per cent. MgO with a total iron (Fe) figure of 0.14 per cent. On burning, the presence of this iron resulted in a slightly off-white calcine.

Samples were submitted by private individuals from a number of localities, including Waroona, Frenchman's Bay, South Fremantle and Albany. Only one sample, that from Albany, showed a purity in excess of 90 per cent.

Dry bulk density of two samples of limestone from a Wanneroo quarry was measured for the State Mining Engineer. As these were only small irregular-shaped specimens of a friable, highly porous stone, skin-sealing of the pores was necessary before measurements could be made. One sample gave a bulk density of 87 lb/c. ft., the other of 133 lb/c. ft. These figures represent approximately the extremes of density recorded for limestone of the Swan coastal plain, previously recorded figures ranging from 73 to 140 lb/c. ft.

(12) *Lithium.*—The interest in lepidolite ore assaying 3.5 per cent. Li_2O or better, referred to in the 1959 report, continued during the early months of 1960 but apparently no commercial production eventuated. Samples from the Coolgardie area assayed between 2.8 and 3.9 per cent Li_2O, with an iron content near the maximum specified concentration of 0.1 per cent. Fe_2O_3.

Attempts by interested parties to exploit the spodumene deposits at Ravensthorpe have lead to a variety of analyses in this Division. The mineral is marketable either for use as such by the ceramic industry or as a source of lithium compounds such as the carbonate. Samples arising from preliminary experiments along both these lines were analysed for lithium and iron contents, as well as lime, magnesia and sulphur, while a complete analysis was made of the original mineral.

The complete analysis, published by permission of Dr. W. R. Frayne, holder of the claims being worked, was as follows:—

	Per cent.
Silica, SiO_2	62.61
Alumina, Al_2O_3	27.77
Ferrous oxide, FeO	0.09
Ferric oxide, Fe_2O_3	0.04
Manganese oxide, MnO	0.04
Lime CaO	nil
Magnesia, MgO	0.18
Lithia, Li_2O	6.63
Soda, Na_2O	0.63
Potash, K_2O	0.69
Phosphorus pentoxide, P_2O_5	trace
Combined water, H_2O+	0.97
Moisture, H_2O-	0.14
	99.79

Analyst—J. R. Gamble.

A crystal of grey spodumene from the same claim, submitted through the Government Geologist, contained 7.16 Li_2O.

Other lithium minerals of interest included a quartz-spodumene intergrowth from Roebourne, being the first report of spodumene in this area, and a sample of montebrasite from Ravensthorpe.

(13) *Manganese.*—Most of the pay assays for manganese were check figures obtained for producers or buyers on commercial parcels mainly from the Pilbara area. Check assays were also carried out for the Government Geologist on five manganese-bearing rocks from the Nullagine district.

Prospectors' specimens were received from a number of localities including Mt. Walter, Ashburton Downs, Mullewa and Lake Way Station. The latter specimen, consisting mainly of cryptomelane, was the first occurrence of manganese reported from the locality.

X-ray studies were made of ores from six different Pilbara deposits. Most common manganese mineral constituents were braunite, cryptomelane and pyrolusite. One specimen from Mt. Sydney was associated with baryte.

(14) *Quartz and Sand.*—In addition to the usual number of specimens of massive quartz submitted as possible beryl samples, some quartz crystals have been received, one in error for beryl and the others from curiosity. These crystals were flawed and discoloured and of little value even as collection pieces.

The radio industry buys quartz crystals only on inspection and insists that they be transparent and free from bubbles, cracks and inclusions, not water worn or discoloured, and of a weight at least 4 ozs. with at least one natural crystal face present.

An interesting specimen from Mt. Francisco received in 1945 was re-examined this year to identify a brilliant yellow mineral associated with the quartz. This mineral proved to be chalcedony stained by iron oxide whch had replaced a micaceous mineral—probably muscovite or biotite. The specimen was added to the Division's collection.

One suite of samples of sand from Jandakot was submitted by Department of Industrial Development for assessment of their glass-making possibilities. Further work was abandoned by that Department following our report of acid-soluble iron oxide percentages (namely 0.010, 0.054, 0.002).

(15) *Radioactive and Rare-Earth Minerals.*—A particularly interesting specimen was received from Yinnietharra, consisting of a black central core surrounded by orange and yellow zones grading off to a brown mass composed in part of well formed crystals. The whole was strongly radioactive.

From X-ray, spectrographic and optical data the following four fractions were described:—

(a) Central black stone of uraninite.

(b) Red-orange zone consisting of uranium oxide with significant amounts of thorium, barium, calcium, potassium, sodium and lead. X-ray analysis suggests that this is the "Mineral A" described by the American mineralogist Clifford Frondel in his papers on the secondary uranium minerals, the so-called gummites.

(c) Yellow zone, not identified with certainty, but possibly composed of the hydrated uranium oxide, masuyite, and/or the hydrated lead uranium oxide, vandendriesscheite.

(d) Brown zone in which the apparently pseudomorphous crystals gave X-ray patterns similar to those from the yellow zone.

A similar type of sample, received earlier in the year from the same locality, assayed 51 per cent. uranium oxide (U_3O_8). The sample had been obtained from a pegmatite and therefore represents a sporadic occurrence unlikely to be of commercial significance.

A columbite specimen from Yinnietharra, probably originating from the same or a nearby pegmatite, was coated with a yellow unidentified secondary uranium mineral which could safely be classified among the gummites.

A complex, raidoactive mineral was received from the Lalla Rookh Station and tentatively identified as samarskite. It was a rare-earth oxide containing niobium and tantalum with partial replacement of the rare-earth elements by uranium and thorium. It contained less than 10 per cent. of total rare-earths and so would be a poor-grade source of these elements compared with such minerals as euxenite or yttrotantalite.

(16) *Tantalite-Columbite.*—An interesting feature of the demand for tantalum-niobium minerals has been the value which the market has placed on tantalum relative to niobium. The value of these ores is calculated in an intricate manner from either of two scales—one on total "mixed oxide" content and a second on tantalic oxide content. The scale used for each ore has depended on its composition.

Early in the year parcels around 25 per cent. Ta_2O_5 were valued at about £600 per long ton on the mixed oxide basis, 25 per cent. being considered a minimum Ta_2O_5 figure, with little interest below 30 per cent. At the end of the year, tantalite with 60 per cent. Ta_2O_5 was quoted at £3,000 per long ton with the following scale for lower grade ores:—

30 per cent. Ta_2O_5—750 shillings/long ton unit C.I.F., U.K.

45 per cent. Ta_2O_5—850 shillings/long ton unit C.I.F., U.K.

55 per cent. Ta_2O_5—950 shillings/long ton unit C.I.F., U.K.

60 per cent. Ta_2O_5—1,000 shillings/long ton unit C.I.F., U.K.

Despite these figures however, the number of samples submitted to these laboratories has increased only slightly, this increase being in paid assays for mineral buyers.

The magnetic rejects from the plant of one mineral processor were examined for "mixed oxide" content, and a couple of samples were assayed for Ta_2O_5 content to provide a standard for a commercial laboratory.

One sample from the Department of Native Welfare was examined to give officers of that department an idea of the value of material sold by natives in cases of suspected exploitation.

New localities reported for tantalite include an occurrence at Roebourne of fragments ranging from 14 to 59 per cent. Ta_2O_5, and 66 to 25 per cent. Nb_2O_5 in a deposit including quartz, chert and limonite.

A second new locality reported is at Munglinup. The specimen concerned consisted of a single piece of specific gravity 6.86, equivalent to Ta_2O_5 61 per cent. and Nb_2O_5 23 per cent.

Interesting associations of tantalum bearing minerals received have been 18 per cent of microlite in a tantalite from Strelley and approximately 2 per cent in one from Wodgina. Forty four per cent. cassiterite was found in a tantalite also from Wodgina. The rare-earth tantalum mineral fergusonite was found to the extent of 60 per cent with 40 per cent cassiterite in a sample from an undisclosed source. The attention of the Government Geologist was directed to the occurrence of traces of a secondary uranium mineral with tantalite from Yinnietharra.

Some interest in this field was aroused during the year by an enquiry from a consulting chemist and metallurgist of London, for contacts who might be interested in a process he has developed, for removing from tantalite the percentages of tin which are often left behind by the normal magnetic beneficiation treatment. This work could be of value in view of the nature of some West Australian deposits and the penalties applied for tin.

(17) *Tin.*—The number of samples examined for tin was considerably increased from last year, due to the submission of one suite of samples of rock thought to contain cassiterite as an accessory mineral. Unfortunately very few of these samples had a significant content of tin, and the prospect of beneficiating the whole deposit did not appear to be economic.

Four only of the samples submitted during the year, represented saleable parcels of cassiterite, and a number were for identification and assay for prospectors of tin. The remainder were made up of check assays on behalf of producers collecting parcels of tantalite-columbite. The penalty for tin in tantalum ores is imposed for SnO_2 contents above 4 per cent. Tin was found in tantalite-columbite ores from Hillside, Nullagine and Wodgina in amounts of up to 45 per cent cassiterite.

Investigation of a new area in the Strelley field produced a sample having a cassiterite content of 5 per cent.

One interesting sample was of fine material from a claim encroaching on the Greenbushes townsite. This sample contained 32 per cent cassiterite concentrated mainly in the +30 mesh fraction, so that a considerable beneficiation could be achieved by simple screening.

(18) *Titanium Ores and Products.*—The titanium materials examined this year numbered almost twice those dealt with last year although the number of paid assays for mineral producers had dropped to less than one half the previous number. The overall increase was made up of samples connected with a Department of Industrial Development investigation. A further 19 samples from the same investigation were examined as departmental work after the Department of Industrial Development Research Section became part of the Government Chemical Laboratories.

This project, which aimed at production of an upgraded ilmenite, included the reduction of ilmenite followed by aeration of a water pulp to oxidise and subsequently remove the liberated iron. The analytical work associated with this involved the employment of methods whereby metallic iron, FeO, Fe_2O_3, TiO_2 and Ti_2O_3 could be estimated on the same sample. A complete analysis of the head sample of these experiments was also done.

Methods have also been obtained from overseas titanium companies for the estimation of the reactive content of ilmenite.

Chemical work for ilmenite producers has included the examination of works samples from various production stages for TiO_2 and P_2O_5. Shipment parcels of ilmenite and leucoxene have also been examined.

Specimens of titanium ores for mineral identification have included an occurrence of massive rutile, from a new locality on Callotharra Station, 60 miles east of Gladstone. Other specimens have been massive ilmenite from Noreena Downs and Yinnietharra and alluvial ilmenite from Bamboo Springs. Unfortunately these specimens of massive minerals from inland locations cannot compete as a source of titanium with the readily-mined beach sands, particularly on the present depressed market.

Complete Analyses.

Complete mineral analyses were carried out for the University Department of Geology on samples isolated during a research programme. The minerals involved were spinel, hypersthene, phlogopite and sapphirine. The results of these analyses will be published by the University authorities at the completion of the project.

It is interesting to note that the sapphirine sample, originating from Quairading, represented only the second recorded occurrence of the mineral in Australia, the first being from Dangin.

Other complete analyses were of spodumene from Ravensthorpe, pseudomalachite from Warriedar and ilmenite from Capel.

Miscellaneous Analyses.

The Division participated in a programme initiated by the National Association of Testing Authorities, one aim of which was to examine methods for the determination of phosphorus in low-phosphorus cast iron. Four laboratories, two in Western Australia, one in Victoria and one in New South Wales, carried out analyses of three different samples of cast iron. The method used by the Division consisted in the colorimetric measurement of phosphovanadomolybdate after extraction with iso-amyl alcohol. The methods used by the other laboratories were respectively, the alkalimetric titration of quinoline phosphomolybdate, indirect gravimetric estimation by weighing lead molybdate, and the alkalimetric titration of ammonium phosphomolybdate. The phosphorus content of the samples was of the order of 0.05 per cent and agreement between the testing laboratories was closer than + 4 per cent of the average figures.

Determinations were made of fluorine on three hornblende and one gabbro specimens for the University Department of Geology and of ferrous and ferric iron on local and overseas sapphirine for the same department.

Two samples of salt from Lake Lefroy, one as harvested, the other after washing, were analysed for the Department of Industrial Development. Results showed a sodium chloride content of 96.4 per cent with lesser amounts of potassium, calcium, sulphate and carbonate with traces only of magnesium. There was no appreciable difference in the figures before and after washing.

One Ravensthorpe and two Wundowie slags were analysed, on behalf of commercial interests, for silica, lime, magnesia, alumina, ferrous and ferric iron.

PHYSICS SECTION.

Pyrometry.

A total of 11 mercury in glass thermometers was received for calibration against laboratory standards. The total temperature range covered was from — 40°C to + 300°C.

A field test was carried out for the Forestry Department. This comprised a determination of the temperatures to which a plywood beam was subjected during a burning test.

Internal work covered final preparations for registration with National Association of Testing Authorities in the field of heat and temperature measurement.

Differential Thermal Analysis.

The apparatus for use in this method has been tested. It will shortly be put into use for routine work on clays and other natural products.

X-ray Diffraction.

Of the samples received by the Mineral and other Divisions for analysis and identification, a total of 42 was submitted for X-ray identification, involving 250 exposures. Of these, 11 samples were clays and seven were rare earth minerals. The total number is of the same order as received in 1959.

In addition to this, a start has been made in verifying the identification of metamict and normal radioactive minerals in the mineral collection of the Laboratories. In many cases identification of such is difficult without recourse to X-ray analysis and occasionally some specimens require renaming.

Two of the Mineral Division's mineralogists, with whom most of the X-ray samples originate, are receiving instruction in using the equipment. When proficient they will handle much of the routine work under supervision. Hence more time will become available for such projects as metamict identification in which it is expected the differential thermal apparatus will play an important part.

DIVISION VIII

Annual Report of the Chief Inspector of Explosives for the Year 1960

The Under Secretary for Mines:

I have the honour to inform the Hon. Minister on the functioning of the Explosives Branch in 1960.

Importation of Explosives.

An innovation was inaugurated last May by direct railage of mining explosives to Kalgoorlie from the Nobel factory at Deer Park, Victoria. The remainder, accounting for about one-half of the State's requirements in the broken period under review, continued to traverse the southward ocean route, with proportionate reduction in the frequency and size of shipments reaching Woodman's Point Explosives Reserve. By the north came the usual supplies for the iron ore industry, supplemented by several movements across Messrs. Australian Iron and Steel's jetty at Kwinana into vessels which would otherwise return without cargo after discharging steel at the rolling mills. This scheme, still on a small scale, helped to cope with increased demand consequent upon development of Koolan Island.

So important has railage become that more than passing reference seems merited. Reasons underlying the change were the heavy cost of replacing the over-age main supply ship and a saving of several hundred miles haulage by the direct transcontinental route compared with the ocean-plus-rail journey to Kalgoorlie. From this major consuming centre, distribution to several other goldfields held promise of greater economy than by rail or road transport ex the coastal depot. Elimination of lightering and additional handling involved when loading explosives onto ships at Altona Anchorage, Victoria, also stressed the advantages of a single movement from supply magazine to rail van, even although further transfer was entailed at the change in gauge. Another consideration was the perfection about a year ago of strong light fibreboard outer containers in replacement of the familiar pine cases. Their properties and suitability for explosives under consignment by rail are described later.

A statement in last year's report advocating large explosives loadings per train may now be modified to express satisfaction with existing practice of frequent single vanloads. Small quantities in units of 300 cases were found to come amply within handling facilities at the Parkeston goods terminal and subsequent road conveyance to the Somerville magazine area. Previous investigation into current American and South African practice of running special trains hauling 150 to 250 tons of explosives disclosed certain attractive features, against which storage capacity and safety distances would have necessitated substantial increases to render the scheme acceptable here.

Procedure at Kalgoorlie is straightforward. The Commonwealth rail vans on arrival are shunted onto a deadend line remote from general goods traffic and the explosives placed manually aboard the truck alongside. During transference each case is inspected visually and a minimum two per cent. representation of the several varieties and sizes of explosives forwarded unopened to Woodman's Point Reserve for detailed examination identical with that to which shipments are submitted. The incoming bulk, meantime conveyed by road to the magazine area about 1.8 miles west of Kalgoorlie, must await certification of compliance with State requirements before distribution to the Golden Mile and more distant consuming points.

During its eight months' operation in 1960, direct railage proved an undoubted success. The satisfactory general set-up at Kalgoorlie is expected further to improve if the projected westward extension of the 4 ft. 8½ in. gauge railroad becomes an actuality. Explosives often reach goldfields magazines within ten days or a fortnight of manufacture compared with several-fold this interval when the vicissitudes of shipping have to be taken into account. So far, there is no evidence of deterioration by heat or moisture during conveyance. The scheme's future seems assured at least until the economics of impending changes in despatching from factory to ship have been assessed. Under this plan, if adopted, an isolated deepwater jetty now being constructed near Point Cook, Victoria, would obviate lightering and burdensome, though necessary, restrictions at Altona by a system of direct loading from road vehicles onto ships at berth.

Types of Explosives.

No new compositions appeared locally during the year. Acceptance of the ammonium nitrate-fuel oil admixtures was steady but not spectacular except in the geoseismic field. Progress was recorded in the adaptation of these explosives to smaller diameter shotholes than formerly considered essential for propagation, and considerable interest evinced concerning a physical form of ammonium nitrate requiring neither booster charges nor detonating fuse. Confirmation of its properties was not forthcoming, but sensitivity of the order indicated opened the possibility of classification as an explosive, to the detriment of present freight and storage concessions. As an outcome of studies in U.S.A. on toxic atmospheres following detonation, an extended field of use for ammonium nitrate mixtures in confined space blasting may be developed.

Use of Explosives.

Blasting agents mixed on the job from non-explosive components accounted for about 9.6 per cent. of the 1960 aggregate. Ammonium nitrate was therefore included in the total when computing proportionate usage by various industries. Figures thus derived showed apparent retrogression in some instances where conventional explosives were wholly or mainly employed but indicated a considerable increase for geoseismic purposes in which the mixtures outweighed factory-made explosives by 2.26 to 1.

Gold mining consumed 60.2 per cent. of the State's importations, followed by geoseismic blasting at 12.7 per cent. quarrying 6.5 per cent. and asbestos 5.7 per cent. Collieries accounted for 5.2 per cent. and lead, tin, iron, manganese, copper and pyrite 4.2 per cent. Public works, including road and railway construction, required 1.6 per cent. and another 0.6 per cent. went into the brick-making, timber and whaling industries. The remaining odd 3 per cent. was applied in demolition work, sub-soiling, post holing and for numerous unrecorded miscellaneous purposes.

The Quality of Explosives.

In pursuing its primary function of ensuring high standards of packaging, composition, stability and safety in all explosives released for consumption, the Branch conducted many thousand physical examinations, followed by nearly 3,000 determinations of heat-test, sensitivity and detonation velocity. Firing trials and occasional chemical analyses were also undertaken. Mines Regulations requirements for safety fuse involved timing the burning rate of 500 sample lengths. A few checks for electrical continuity in detonators were made, although these accessories, whether plain or electric, have never lent themselves to any ready non-destructive test for serviceability. Much the same might be said of explosives generally. Systematic examination of a cross-section does not necessarily guarantee perfection in each unit. However, there has always existed a valued co-operation by mines inspectors, the Chamber of Mines and actual users, whose reports and observations have proven important adjuncts to the Branch's work.

As a result of these combined efforts, explosives supplied during 1960 may be pronounced as well-packed and in conformity with requirements of quality and performance. A solitary instance of damage in transit resulted in condemnation of 1,100 lb. affected by oily bilgewater. Another matter causing concern was when chemical analysis of gelignite disclosed the presence of ammonium chloride, permissible within the authorised definition, though not hitherto a normal component of this explosive. While there was no evidence of impaired quality, the introduction of an unknown factor into the very material under comparative investigation for post-explosive gases was ill-timed.

Packaging and Protection.

Two changes, both foreshadowed last year, were introduced. With the object of suppressing carbon monoxide formation on explosion, the wax end seal was eliminated from most explosives supplied to the gold-mining industry. The impregnated preformed paper shells remained unchanged. Under this treatment, gelignite proved slightly less resistant to moisture than when fully waxed, but Semigel showed no inferiority.

The second departure from long-established practice was the substitution of the well-known pine cases by fibreboard containers for explosives despatched by rail. The material had been under development since 1951, when prototypes were distributed experimentally. These early cases, however, offered but slight weight reduction advantages because of the wood-braced ends, and presented difficulties in opening and resealing. Their present counterparts, several pounds lighter than pine, may be unstapled without tools and resealed by adhesive strip. Moisture resistance, enhanced by incorporation of a melamine resin during manufacture, focussed attention on the suitability of fibreboard as a shipping proposition. To examine the effects of pitch, roll, humidity and other prevailing conditions, fibreboard-encased dummy explosives were sent to several Australian ports, including Fremantle, where samples were retained. Inspected first in the hold, all but two cases slightly damaged mechanically showed no deterioration. In subsequent trials a case intentionally exposed to sun, rain and sea spray was handleable after six months, whilst others stacked in the jetty shed neither deformed nor split at the seams. Ability to withstand partial immersion, known to occur rarely in transit despite precautions, has not yet been fully established. A full-scale shipment of live explosives may arrive early in 1961.

From the goldfields one report of alleged mushiness and poor strength in fibreboard was found related to very bad mine storage conditions. Acceptance has been general, even in the face of a lingering regard for the almost traditional pine cases.

Defective and Condemned Explosives.

Apart from the periodic destruction of unwanted samples and small quantities found during inspection or submitted voluntarily for disposal, the situation remained unchanged. In no instance could defects be blamed on faulty manufacture. Explosives used for well-sinking in the metropolitan area presented a minor problem inasmuch that surplus material was sometimes stored unsuitably and insecurely. In one such instance investigated, a dripping carton of old gelignite was removed from a clothes closet in a Dalkeith residence. A nine year old case of the same type of explosive recovered from an East Perth plaster mill showed remarkably little hardening or spoilage by moisture but was condemned because of exuding nitroglycerin. Another interesting job revolved about 7 or 8 lb. of a lumpy metallic-looking mass received from the police. Though not analysed, the composition appeared to contain a light metal admixed with an oxidising agent. It failed to ignite by flame, but under stimulus of a detonator exploded with the noise, blast and cratering of a nitrocompound. Efforts to track down the unlicensed manufacturer were unavailing.

Inspection.

Procedure again followed that described in some detail last year. No flagrant disregard for regulations came under notice; indeed most large licensees were deserving of praise for their attitude toward explosives generally. Offences committed by small owners or vendors were trivial and often of an unwitting nature amenable to future adjustment without recourse to prosecution.

With ever increasing road traffic, inspection of motor vehicles intended for casual or regular explosives conveyance assumed greater importance. All such movements from Woodman's Point Explosives Reserve were by permit under conditions designed to ensure safety and protection of the load. Rigid specifications for body work and fittings on a new truck engaged at Kalgoorlie were formulated, and the vehicle inspected periodically to ensure maintenance at high level.

Explosives Reserves.

Kalgoorlie.—The increased throughput resulting from direct railage having focussed attention on possible future storage requirements, the Reserve at Somerville was inspected and found of adequate size and isolation for expansion. An interesting available alternative was an old gazetted explosives reserve near the Boulder cemetery, never used as far as known, but closer both to the mines and Parkeston goods terminal than Somerville.

Woodman's Point.—About 100 chains of road from the main entrance to the jetty underwent repair prior to resealing. The resident staff rebuilt a fence intended to check sanddrift over a much-used section of railway line and also constructed from materials on the spot a semi-underground firing chamber. Conveniently located, it has saved time and enhanced the safety of determinations such as sensitivity and detonation velocity. Previously this work involved carrying charges and apparatus, including lead plates, several hundred yards to and along the beach, retiring to shelter and subsequently returning to ascertain the results of the explosion.

Explosives and Dangerous Goods Act.

Some misgivings were felt when the passage of another year saw the 1895 Act still operative. The meantime, however, afforded opportunity to clarify many legal and technical points and for conference with all bodies concerned. Their views were collated, analysed and considered before submission to the Crown Law, and at the same time the preparation of Regulations proceeded. It is therefore hoped that if and when proclamation takes place the new legislation will be anticipated, well understood, of general benefit and restrictive only insofar as the interests of safety are best served.

Toxic Gases from Explosions.

Briefly to recapitulate last year's introduction to the subject, heavy wax sealing on explosives cartridges was suspected as an aggravating factor in carbon monoxide formation. Negotiation having resulted in an assured five month supply of waxless ended plugs for use at Kalgoorlie, arrangements were made to conduct a series of gas analyses. As a preliminary move, old and new explosives were comparatively examined to ascertain by what extent the weight of wax had been reduced so that relationships might ultimately be established with the expected lower carbon monoxide concentrations. Some typical results were:—

Explosive	Semigel 1 in.		AN Gelignite 60, 1 in.	
	Fully Waxed	Non end Waxed	Fully Waxed	Non end Waxed
Per cent. by weight—				
Composition	93·05	94·5	93·75	95·01
Paper	3·59	3·8	3·29	3·33
Wax	3·36	1·7	2·96	1·66
Stick count per 50 lb.	182	187	155	160
Average weight per plug (oz.)	4·39	4·28	5·17	5·00
Oxygen Balance of Composition (grams/100 g.)	+3·70	+3·70	+5·36	+5·36
Oxygen Balance, assuming complete combustion of wax and paper	—12·46	—7·03	—9·15	—4·72

A full account of procedure and operational detail in placing and firing charges from which post-explosives fumes were examined has been furnished in the State Mining Engineer's report. Nothing need be added except to commend the planning and conscientious prosecution of the investigation. The Explosives Branch supervised the gas sampling, including that for nitrogen oxides. Broadly stated, results for given charges fired under defined conditions strengthened the assumption that lesser wax tended to reduce carbon monoxide without dangerous increase in nitrogen oxides. Although the data were insufficient for expression on a quantitative basis, the new plugs impressed the mining industry and will henceforth replace the fully waxed ones.

Conferences, Interstate Investigations, etc.

The Branch was represented by Mr. G. A. Greaves at a Port Authorities Sub-Committee meeting in Sydney commencing 8th August. Discussion centred mainly on two model codes for controlling flammable liquids in harbours and dangerous goods generally. Carriage of liquids in fixed or portable tanks on vessels not normally regarded as tankers also came under review. This and further recent trends in packaging and conveyance were deemed inadequately covered by the projected regulations, of which a redraft was therefore recommended.

Whilst in New South Wales Mr. Greaves pursued inquiries into the administrative and technical sides of explosives and dangerous goods legislation. A draft of the anticipated West Australian Act drew favourable comment in its coverage of all essentials and elimination of outmoded detail likely to confuse the issue in interpreting the older Acts.

On 3rd and 4th March the writer attended meetings at Melbourne of the Commonwealth-State conference on the transport of dangerous goods. This was a sequel to earlier deliberations on the United Nations Organisation proposals for classification, listing, labelling and shipping documentation. The Chairman reported progress but deplored the fact that international uniformity was still remote because of certain inherent difficulties and the lack of response from several countries. It was agreed to form a permanent committee comprising one representative of each department or authority, and the terms of reference were duly drafted.

A few extra days at Melbourne provided opportunity for discussing topicalities such as direct explosives railage, reduced waxing, toxic gases and packaging materials.

Pyrotechnics.

As usual, the main supply sources were Great Britain, Hong Kong and two Australian factories from which in total 1,895 packages entered the State. Several hundredweight of sparklers came from Germany and indications of Japanese interest were evidenced by arrival of "parachutes" and "spectrum crackers," both harmless party novelties. An established English manufacturer who submitted a box of considerably over-size fireworks was advised not to exploit the local market because his wares were found unnecessarily noisy and alarming. The samples, however, were chemically and constructionally sound, and except for the ubiquitous defective throwdowns, all other importations similarly complied with requirements. Indeed the season was a fairly routine one until a child's death from burns allegedly caused by fireworks touched off a storm of protest against pyrotechnics of all descriptions. The Explosives Branch neither ventures opinion nor possesses the power to impose a total ban unless by medium of fantastic regulations designed to debar the entire shopgoods firework class. Such prohibition, which could even extend to toy pistol caps and bonbon crackers, would naturally need gradual application because of merchants' carryover stocks and advance ordering. All fireworks present some risk if thrown, pointed to give a low-level projectile effect or otherwise misused. Such actions are obviously beyond departmental control, but by unrelenting insistence on standards formulated by Australasian explosives inspectors in conference, the element of danger has been minimized. Modern fireworks are not prone to spontaneous or premature ignition, and accidents when investigated are usually ascribable to carelessness or gross misuse.

Due probably to early summer fire hazards, more than the usual number of suggestions that "bonfire night" be held at a less risky time of the year than November 5th were received. In New South Wales, except at Broken Hill, the traditional celebration is in May. With due notice to all concerned, there seems much to commend a similar change here.

General.

Another bird-scaring device consisting of a delay-action explosive projectile fired from a shotgun was examined in conjunction with practical tests by the Firearms Branch. It proved capable of penetrating light materials at short range and starting ignition when discharged into dry vegetation. Dangers of unrestricted use were obvious, and the Police recommended accordingly.

Acknowledgments.

The writer's gratitude is expressed to the staff during a year in which long service leave and developments at Kalgoorlie brought additional duty and responsibility into being. Appreciation of the relationships existing with other departments and officers, whether governmental or private, is placed on record, with special reference to co-operation by explosives importers and distributors.

F. F. ALLSOP,
Chief Inspector of Explosives.

DIVISION IX

Report of Chairman, Miner's Phthisis Board and Superintendent Mine Workers' Relief Act

Under Secretary for Mines:

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 1960.

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, Phillips River, Peak Hill, Pilbara, West Pilbara, Murchison, East Murchison, Coolgardie, North Coolgardie, Yilgarn and Mt. Margaret Goldfields, the Northampton Mineral Field and Esperance, Outside Proclaimed Field.

Mine Worker's Relief Act.

The examinations under the Mine Worker's Relief Act during the year totalled 5,759 as compared with 5,818 for the previous year, a decrease of 59. The results of the examinations for 1960, together with the figures for the previous years, are shown in the Table annexed hereto. Graphs are also attached illustrating the trend of the examinations since 1940. In explanation of these figures I desire to make the following comments:—

Normal, Etc.—These numbered 5,214 or 90.54 per cent. of the men examined and include men having first class lives or suffering from pneumoconiosis only. The figures for the previous years being 5,242 or 90.1 per cent.

Early Silicosis.—These numbered 523 of which 50 were new cases and 473 had been previously reported, the figures for 1959 being 66 and 485, respectively. Early silicotics represent 9.08 per cent. of the men examined, the percentage for the previous year being 9.47 per cent.

Advanced Silicosis.—There were 5 cases reported and all were men who advanced from early silicosis during the year. Advanced silicotics represent 0.09 per cent. of the men examined, the percentage for the previous year being 0.15 per cent.

Silicosis plus Tuberculosis.—Eleven cases were reported compared with seven in 1959.

Tuberculosis Only.—Three cases were reported which is the same number as in 1959.

Asbestosis.—One case of asbestosis with tuberculosis and two cases of asbestosis early previously asbestosis early were reported.

Mines Regulation Act.

Examinations under the Mines Regulation Act totalled 1,626. These were in addition to the 5,759 examinations under the Mine Workers' Relief Act. There was an increase of 175 examinations under this Act in 1960 as compared with those in 1959. Of the total of 1,626 men examined 1,212 were new applicants and 414 were re-examinees.

Particulars of examinations are as follows:—

New Applicants:	
Normal	1185
Pneumoconiosis	4
Silicosis early	1
Silicosis early plus tuberculosis	1
Query tuberculosis	13
Other conditions	8
Total	1212

Of the above applicants for admission into the industry, 1,186 received the Initial Certificate (Form 2), 10 received the Temporary Rejection Certificate (Form 3), and 16 received the Rejection Certificate (Form 4). Thus of the 1,212 applicants, 1,186 or 97.85 per cent. were eligible for employment anywhere on a mine.

Re-examinations:	
Normal	323
Pneumoconiosis	58
Silicosis early	18
Query tuberculosis	2
Pneumoconiosis plus query tuberculosis	1
Silicosis early plus query tuberculosis	1
Silicosis early plus tuberculosis	Nil
Silicosis advanced	Nil
Tuberculosis	1
Other conditions	10
Total	414

These men had previously been examined and some were engaged in the industry prior to this examination. 338 received the Initial Certificate (Form 2), 2 received the Temporary Rejection Certificate (Form 3), 2 received the Rejection Certificate (Form 4), 34 received the Re-admission Certificate (Form 5), 24 received the Special Certificate (Form 9) and in 14 cases no certificate was issued. Thus of the 414 men examined, 372 were eligible for employment anywhere on a mine, 24 were eligible for surface work only and 18 were not eligible to work on a mine.

Grouping the two sets of figures discloses that the following certificates were issued under the Mines Regulation Act:—

Initial Certificates (Form 2)	1,524
Temporary Rejection Certificates (Form 3)	12
Rejection Certificates (Form 4)	18
Re-admission Certificates (Form 5)	34
Special Certificates (Form 9)	24
No certificates	14
Total	1,626

The percentage of men of normal health (Initial Certificates) to the number examined was 93.73 per cent. compared with 92.01 per cent. in 1959.

Miner's Phthisis Act.

The amount of compensation paid during the year totalled £12,734 1s. 10d. compared with £13,718 9s. 8d. for the previous year.

The number of beneficiaries under the Act on the 31st December, 1960, was 114, being 9 ex-miners and 105 widows.

Administrative.

On the 19th September, 1960, Warden Arthur Edward Kay was appointed Government Member and Chairman of the Mine Workers' Relief Board vice Warden Maurice Harwood transferred.

W. Y. R. GANNON,
Chairman, Miner's Phthisis Board,
and Superintendent, Mine Workers' Relief Act.

9/3/1961.

Table Showing Results of Periodical Examination of Mine Workers from Inception of Examinations (1925).

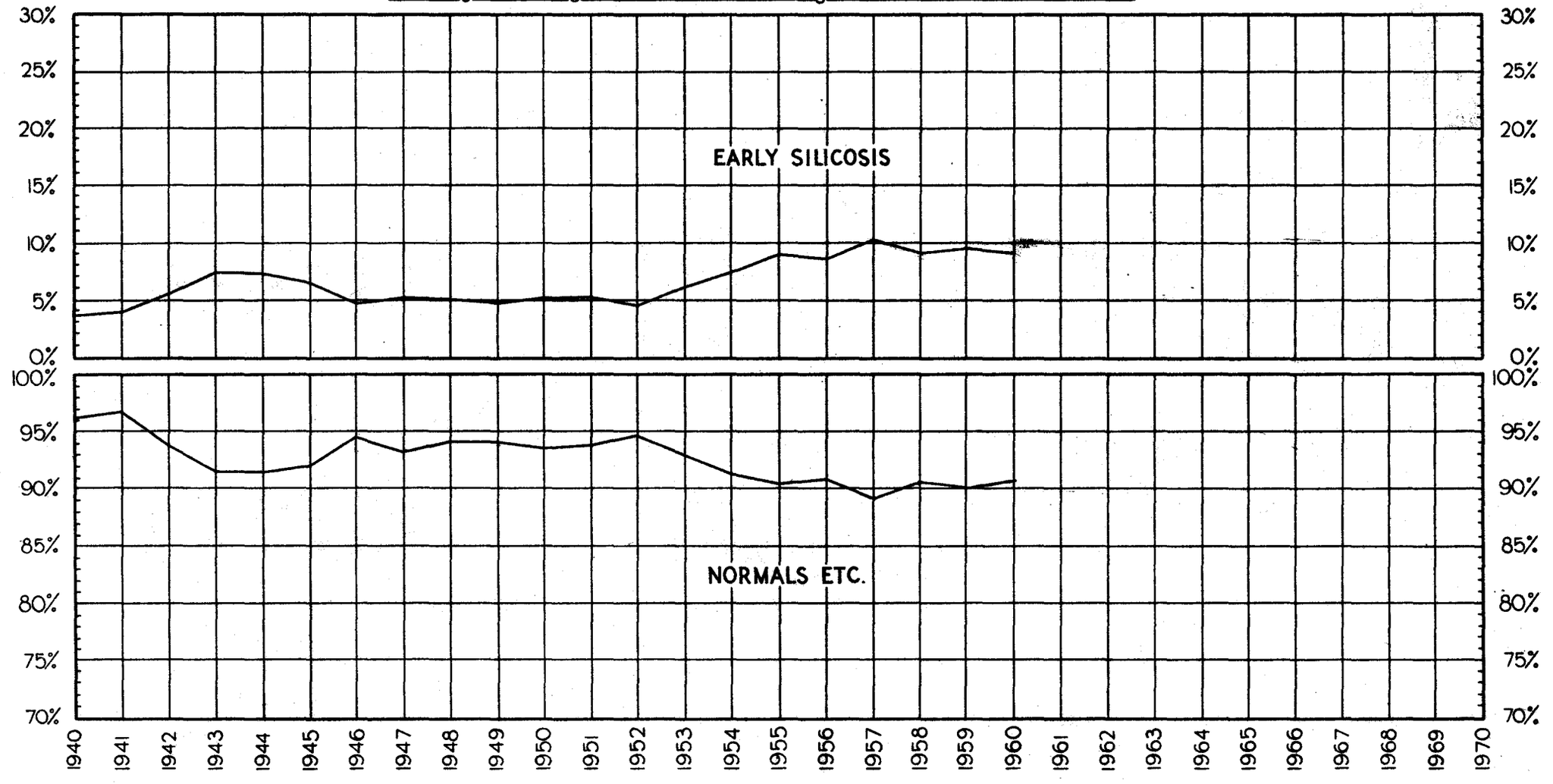
Year of Examination	Normal, etc.				Silicosis Early					Silicosis Advanced						Silicosis plus Tuberculosis							Tuberculosis Only					Total number of Men Examined
	Previously reported as Normal etc.	New Cases	Total	Per cent.	Previously reported as Normal etc.	Previously reported as Silicosis Early	New Cases	Total	Per cent.	Previously reported as Normal etc.	Previously reported as Silicosis Early	Previously reported as Silicosis Advanced	New Cases	Total	Per cent.	Previously reported as Normal etc.	Previously reported as Silicosis Early	Previously reported as Silicosis Advanced	Previously reported as Silicosis plus Tuberculosis	New Cases	Total	Per cent.	Previously reported as Normal etc.	New New	Total	Per cent.	Asbestosis	
1925–1926	....	....	3,239	80·5	....	....	....	459	11·4	....	....	....	....	183	4·5	....	....	....	....	....	131	3·3	....	....	11	0·3	....	4,023
1927	2,290	826	3,116	83·6	....	348	33	381	10·2	....	....	85	8	93	2·5	13	27	62	....	26	128	3·4	....	....	10	0·3	....	3,728
1928	2,738	239	2,977	85·5	47	303	12	362	10·4	1	16	79	2	98	2·8	10	14	10	....	8	42	1·2	3	1	4	0·1	....	3,483
1929	2,099	21	2,120	81·9	100	224	2	326	12·6	....	34	60	....	94	3·6	8	14	19	....	....	41	1·6	7	....	7	0·3	....	2,588
1930	2,751	34	2,785	81·9	133	247	3	383	11·3	....	22	43	2	67	2·0	6	60	46	....	2	114	3·3	47	3	50	1·5	....	3,399
1931	2,530	....	2,530	84·0	94	252	....	346	11·5	....	18	35	....	53	1·8	4	35	19	....	....	58	1·9	25	....	25	·8	....	3,012
1932	3,835	....	3,835	89·5	35	338	....	373	8·7	....	6	47	....	53	1·2	3	9	4	....	....	16	·4	8	....	8	·2	....	4,285
1933	2,920	....	2,920	86·5	57	322	....	379	11·2	1	15	44	....	60	1·8	2	9	4	....	....	15	·4	3	....	3	·1	....	3,377
1934	5,140	....	5,140	92·4	54	315	....	369	6·6	1	24	12	....	37	·7	6	6	....	....	....	12	·2	5	....	5	·1	....	5,563
1935	4,437	....	4,437	92·3	35	303	....	338	7·0	....	24	2	....	26	·6	....	5	....	....	....	5	·1	2	....	2	·0	....	4,808
1936	6,972	....	6,972	94·7	29	323	....	353	4·8	1	15	4	....	20	·3	3	8	....	....	....	11	·1	8	....	8	·1	....	7,363
1937	7,487	....	7,487	95·4	15	319	....	334	4·3	....	14	4	....	18	·2	1	10	....	....	....	11	·1	2	....	2	·0	....	7,852
1938	6,833	....	6,833	95·7	13	266	....	279	3·9	....	15	2	....	17	·2	1	8	....	....	....	9	·1	3	....	3	·0	....	7,141
1939	6,670	....	6,670	95·6	18	264	....	282	4·0	....	7	3	....	10	·1	1	9	1	....	....	11	·2	2	....	2	·0	....	6,975
1940	7,023	....	7,023	96·2	12	245	....	257	3·5	....	10	1	....	11	·2	....	4	....	....	....	4	·0	4	....	4	·0	....	7,299
1941	6,840	....	6,840	95·8	32	248	....	280	3·9	....	11	3	....	14	·2	....	....	....	....	....	....	....	7	....	7	·1	....	7,141
1942	5,469	....	5,469	93·9	61	264	....	325	5·6	....	20	5	....	25	·4	....	2	....	....	....	2	·0	3	....	3	·1	....	5,824
1943	3,932	....	3,932	91·5	63	262	....	325	7·6	....	25	7	....	32	·7	....	5	....	....	....	5	·1	4	....	4	·1	....	4,298
1944	4,079	....	4,079	91·5	70	270	....	340	7·5	....	21	14	....	35	·8	1	7	....	....	....	8	·2	6	....	6	·1	....	4,468
1945	3,071	....	3,071	92·1	54	166	....	220	6·6	....	26	10	....	36	1·1	3	2	....	....	....	5	·2	2	....	2	·1	....	3,334
1946	5,294	....	5,294	94·4	89	172	....	261	4·7	1	36	2	....	39	·7	3	1	2	....	....	6	·1	6	....	6	·1	....	5,606
1947	6,021	....	6,021	93·3	101	237	....	338	5·2	....	49	9	....	58	1·0	13	11	1	....	....	25	·3	8	....	8	·1	....	6,450
1948	4,827	....	4,827	94·0	24	239	....	263	5·1	....	18	17	....	35	·7	1	3	....	....	....	4	·1	5	....	5	·1	....	5,134
1949	5,162	....	5,162	94·0	24	239	....	263	4·8	....	20	31	....	51	1·0	3	2	....	1	....	6	·1	7	....	7	·1	....	5,489
1950	5,077	....	5,077	93·6	14	269	....	283	5·2	....	14	41	....	55	1·0	....	1	....	2	....	3	·1	8	....	8	·2	....	5,426
1951	4,642	....	4,642	93·9	13	248	....	261	5·3	....	9	20	....	29	·6	....	4	1	1	....	6	·1	4	....	4	·1	....	4,942
1952	5,073	....	5,073	94·6	8	234	....	242	4·5	....	4	31	....	35	·6	....	2	....	....	....	2	·1	7	....	7	·1	....	5,359
1953	4,474	....	4,474	93·03	74	225	....	299	6·22	....	8	24	....	32	·6	....	2	....	....	....	2	·1	2	....	2	·1	....	4,809
1954	5,142	....	5,142	91·33	154	275	....	429	7·62	....	22	21	....	43	·76	1	6	2	....	....	9	·1	7	....	7	·1	....	5,630
1955	4,559	....	4,559	90·40	63	386	....	449	8·90	....	9	22	....	31	·62	1	1	1	....	....	3	·06	1	....	1	·02	....	5,043
1956	4,600	....	4,600	90·78	25	401	....	426	8·41	....	8	25	....	33	·65	1	3	....	....	....	4	·08	4	....	4	·08	....	5,067
1957	3,925	....	3,925	89·08	30	424	....	454	10·30	....	8	10	....	18	·41	1	4	....	....	....	5	·12	4	....	4	·09	....	4,406
1958	5,154	....	5,154	90·20	46	483	....	529	9·26	....	15	9	....	24	·42	....	6	....	....	....	6	·10	1	....	1	·02	....	5,714
1959	5,242	....	5,242	90·10	66	485	....	551	9·47	....	9	....	....	9	·15	1	5	1	....	....	7	·12	3	....	3	·05	6	5,818
1960	5,214	....	5,214	90·54	50	473	....	523	9·08	....	5	....	....	5	·09	2	9	....	....	....	11	·19	3	....	3	·05	*3	5,759

*Asbestos is early previously asbestosis early .... 2 cases
Asbestosis plus tuberculosis previously normal .... 1 case

PERIODICAL EXAMINATION OF MINE WORKERS

GRAPH No. 1

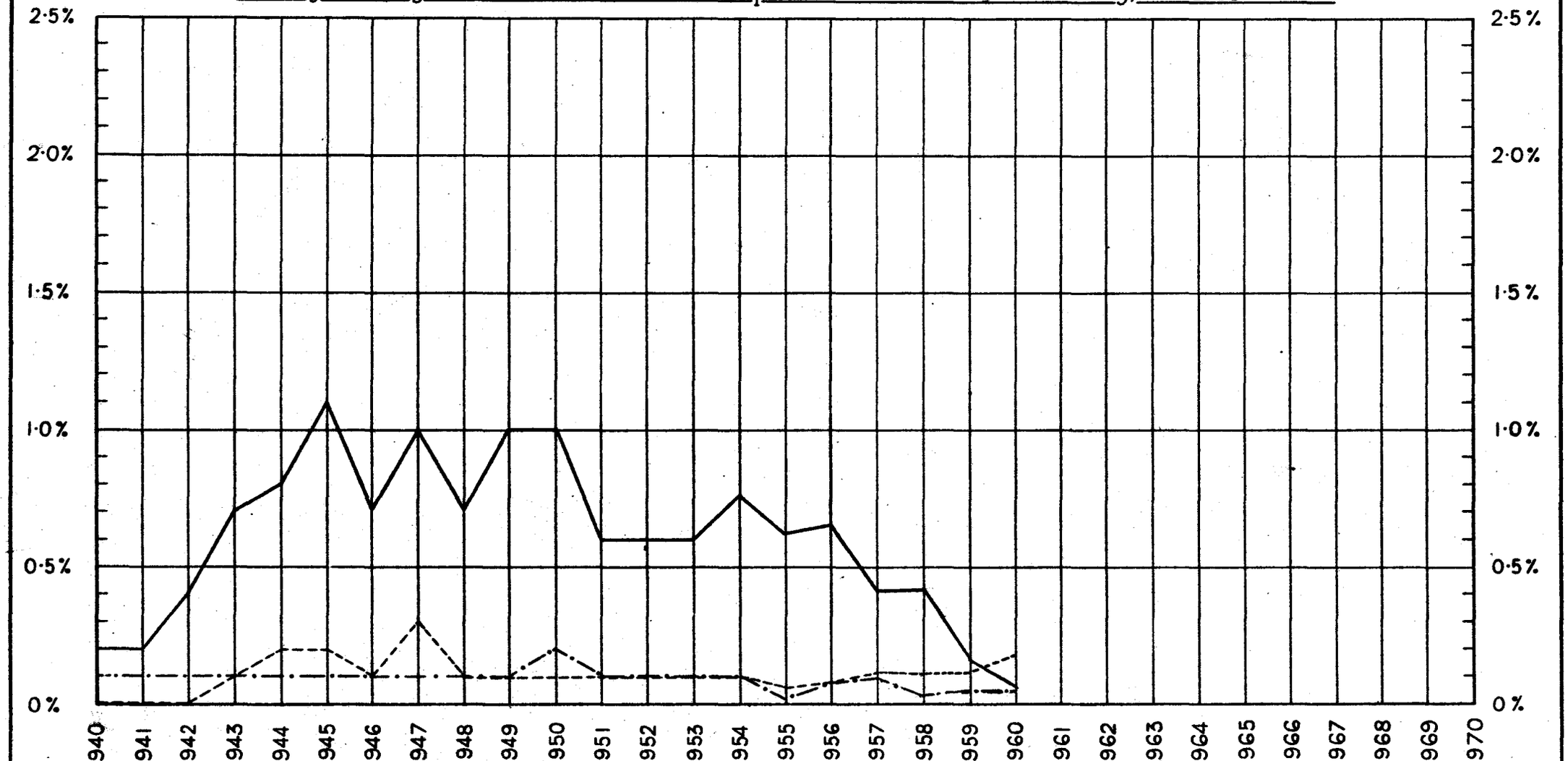
Showing Percentages of Normals and Early Silicotics from 1940 onwards



PERIODICAL EXAMINATION OF MINE WORKERS

— GRAPH No. 2 —

Showing Percentages of Silicosis Advanced, Silicosis plus Tuberculosis and Tuberculosis only, from 1940 onwards



DIVISION X

Report of the Chief Draftsman for the Year 1960

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, 1960.

Staff.

The staff of the Branch at present numbers 28. There has been an increased amount of work in all sections and the staff have co-operated excellently to cope with the demand.

Two cadet draftsmen, B. Dawson and D. Stewart, obtained the Diploma of Cartography at the Perth Technical College.

Opportunity was taken to send Cadets out with Licensed Surveyors to obtain the necessary field experience and carry out survey work in the field in conjunction with Geologists.

Summarised reports of the Surveys, Survey Examination and Mapping Sections follow.

Surveys.

Contract surveys in conformance with Mines Department Regulations to the value of £4,276 16s. 9d. were carried out by survey parties as follows:—

L. M. Norman	 5	field books—14 surveys.
E. Brook	 3	field books—15 surveys.
F. G. Medcalf	 11	field books–128 surveys.
Total	 19	field books–157 surveys.

In addition to normal survey of tenements, a connection was run from the Mineral Claims of Australian Blue Asbestos Ltd. at Wittenoom Gorge to locate the western extremity of the holdings. A proposal to make use of photogrammetric techniques to assist in the survey of Mineral Claims in this difficult terrain is under consideration.

In all cases strict attention is being given to the accurate location of all the mining groups to geodetic control both new surveys and particularly in the case of old groups. This will prove of great value in future "control" for larger scale mapping purposes.

Surveys were carried out at the following localities during the year:—

Outside Proclaimed Goldfield:—
- Geraldton.
- Grass Patch.
- Wuraga.
- Cheyne Bay.
- Doubtful Island Bay.
- Byford.
- Lake Cow-cowing.
- Lake Grace.
- Munglinup.
- Kalgarin.
- Hines Hill.
- Jerramungup.
- Cranbrook.
- Wanneroo.
- Calyerup Creek.

Collie Mineral Field:—
- Ewington.
- Shotts.

Northampton Mineral Field:—
- Northampton.
- Baddera.

Murchison Goldfield:—
- Mt. Magnet.
- Poona.
- Daydawn.
- Lennonville.
- Pinnacles.
- Meekatharra.
- Callie Spring.
- Cue.
- Gabanintha.
- Mindoolah.

East Murchison Goldfield:—
- Barrambie.
- Sandstone.
- Agnew.
- McFarlane.

Phillips River Goldfield:—
- Ravensthorpe.
- Kundip.
- Bandalup.

Mt. Margaret Goldfield:—
- Leonora.

Broad Arrow Goldfield:—
- Ora Banda.
- Paddington.

Dundas Goldfield:—
- Norseman.
- Beete.

East Coolgardie Goldfield:—
- Trafalgar.
- Williamstown.
- Boulder.

Pilbara Goldfield:—
- Shaw River.

West Pilbara Goldfield:—
- Whim Creek.
- Mulga Downs.

Coolgardie Goldfield:—
- Bonnievale.
- Widgiemooltha.
- Tindals.

Survey Examination.

Diagrams of the surveys were drawn and examined. Duplicate and original plans were prepared for 54 Lease Instruments and diagrams of surrender and resumption as required were completed.

Geodetic.

The principal Geodetic programme was resumed and computations for the laying down and cadastral plotting control for the folowing sheets were completed (a total of 34 plans):—

	Sheet Nos. (in 20 chain scale.)
Thaduna 80	14;2
Mulga Downs 80	15
Joffre 80	3;7
Mt. George 80	
Bunningunna 80	4
Ilgarari 80	5
Kumarina 80	9;13
Murramunda 80	14
Carawine	6;10
Pearana	5
Tongololo 80	9;13
Bilyuin 80	9;13;15
Mt. Maitland 80	
Mt. Padbury 80	
Mt. Seabrook 80	

Mapping.

The main mapping programme carried out was as follows:—

(1) Four maps of areas in the Pilbara Goldfield, on 80 chain scale, prepared.

(2) Marble Bar, Split Rock and North Pole, on 80 chain scale, published.

(3) Twelve lithographs on 20 chain scale, published.

(4) Fifty six plans prepared for Geological Surveys plus 485 prints and 552 copyrapid photographs.

(5) Twenty one Standard Plans, Transverse Mercator Projection, completed.

(6) Numerous surveys from field notes, plotted on Compilation System.

(7) Interpretation from air-photos as required.

(8) Copyrapid reproductions for Chemical Laboratories, Explosives and Inspection of Machinery Branches, with miscellaneous plans for State Mining Engineer, Kalgoorlie School of Mines and Chief Coal Mining Engineer.

(9) Diagrams and drawings, etc., for Annual Report.

Public Plans.

Number of Applications dealt with	815
Number of Public Plans in Use and maintained	670
Number of existing mining tenements maintained on Public Plans	3,591
Number of Maps, Underground Plans, Sketches, etc., supplied to Public and Outstations	702
Number of Temporary Reserves applied for (area 77,217 sq. m.)	107

Field Inspections of various areas were carried out during the year.

The increased interest in minerals was exemplified by the great number of public inquiries for information and plans.

General liaison was maintained with various Government Departments, private companies and the public generally.

L. A. JONES,
Chief Draftsman.

MINING STATISTICS

to 31st December, 1960

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TABLE I.

PRODUCTION OF GOLD AND SILVER FROM ALL SOURCES, SHOWING IN FINE OUNCES THE OUTPUT AS REPORTED TO THE MINES DEPARTMENT DURING 1960, 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 Ores and Concentrates. ‡ Denotes mainly derived from Copper Ore and Concentrates.)

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.
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	....	18·28	....	....	....	8,837·69	1,878·12	·75	8·15	....
		Total	....	**18·28**	....	....	....	**8,996·47**	**2,918·92**	**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	....
		Total	....	....	....	....	....	**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	·34
	1107	Bulletin								891·25	425·55	2·02
	850	Federation							8·22	3,026·00	2,203·86	6·35
	1118	Kitchener								100·00	40·03	1·05
	1095, 1096, 1097	Mt. Prophecy Leases	462·00	76·97					24·50	2,868·00	1,056·20	49·63
	817	Prince Charlie	683·00	292·08					3·68	7,453·00	5,327·47	79·42
	1072	Princess May								92·50	24·27	
	924	True Blue	364·00	8·70						2,855·75	104·66	
		Voided leases					13·54	560·19	46,237·85	53,505·43	2·62	
		Sundry claims	34·00	11·48			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									†25,853·75	
Lalla Rookh		Voided leases						14·78	3,612·00	4,696·33	574·01	
		Sundry claims							7,943·00	7,675·09		
Marble Bar	G.M.L. 930 (956)	Alexander Leases							354·50	120·94	·81	
	930	Alexander							640·00	114·59		
	1094	Blue Bar							1,137·00	162·08		
	927, etc.	Halley's Comet							6,360·00	6,390·33	680·36	
	(1125)	Laura Dawn							95·00	73·33	3·06	
	1121	Little Portree							103·00	66·88	6·93	
	(1089)	Repeater							548·20	123·83	6·26	
		Voided leases					45·98	199·09	165,314·29	151,531·94	586·29	
		Sundry claims	205·00	22·03			67·08	255·30	21,177·54	12,825·12	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 Pros. & Dev. 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	37·75	9·40			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	22·00	1·07					145·00	8·71		
		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 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.
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
Wyman's Well	1084	New Copenhagen	....	....	79·50	5·11	....	....	....	770·55	164·04	1·35
		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	....	....	29·50	21·37	....	4·32	239·89	604·00	664·19	40·96
	From District generally :—											
	Sundry Parcels treated at :											
	H. N. Flegg (L.T.T. 1439H)		....	....	....	*1·04	....	....	....	....	*1·04	....
	State Battery, Bamboo Creek		....	....	....	....	....	....	....	40·00	*11,511·65	262·69
	State Battery, Marble Bar		....	....	....	*265·53	40·42	....	....	12·00	*11,883·39	53·11
	Various Works		....	....	....	....	....	....	....	286·95	*1,919·97	5·54
	Reported by Banks and Gold Dealers		3·99	....	....	....	....	14,501·22	456·67	....	15·41	2,223·98
		Total	**3·99**	....	**1,916·75**	**714·78**	**40·42**	**15,257·26**	**4,568·60**	**336,455·47**	**327,485·96**	**32,536·96**
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	G.M.L. 337L	All Nations	....	....	353·50	27·12	....	....	....	353·50	27·12	....
	229L	Barton	....	....	454·75	111·66	....	1·22	....	8,286·75	4,352·28	35·28
	231L, 264L, 265L, 266L	North West Mining, N.L.	....	....	3,400·69	1,989·61	....	....	....	3,400·69	1,989·61	....
	231L, etc.	Prior to transfer to present holders	....	....	....	4·25	....	....	....	53,391·41	32,009·01	10·99
		Voided leases	....	....	....	....	....	....	1·02	18,459·65	11,718·61	8·37
		Sundry claims	....	....	69·75	10·68	....	....	18·69	6,117·60	2,437·40	....
Mosquito Creek	331L	Ard Patrick	....	....	....	....	....	10·80	....	78·00	10·21	....
		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	....	....	99·00	40·60	....	....	....	99·00	40·60	....
		Voided leases	....	....	....	....	....	....	599·59	9,192·75	13,376·46	36·92
		Sundry claims	....	....	49·40	14·14	....	315·53	684·67	6,615·95	10,534·39	15·22
Spinaway Well	314L	Copper Hills Copper Mine	....	....	....	....	....	....	....	....	‡15·44	‡483·78
Twenty Mile Sandy	M.C. 112L	J. C. and 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 :											
	Bartons 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	9·86	16·88	....	....	....	10,038·08	147·52	....	29·81	5·80
	Total	**9·86**	**16·88**	**4,427·09**	**2,198·06**	....	**10,416·50**	**2,902·01**	**141,290·29**	**130,609·17**	**1,067·30**

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	....	Voided leases	....	....	....	....	....	....	1·10	653·20	402·22	....
		Sundry claims	....	....	20·00	3·45	·35	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*—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.
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	1·91	....	....	....	....	6,102·62	177·50	103·50	231·54	·87
		Total	**1·91**	....	**20·00**	**3·45**	**·35**	**6,339·37**	**374·74**	**24,769·96**	**24,303·97**	**1,910·06**
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
Uaroo		Voided leases	....	....	....	....	....	....	....	....	....	†7,713·22
		From Goldfield generally :—										
		Sundry claims (Silver Lead)	....	....	....	....	....	....	....	....	....	†33,787·67
		Reported by Banks and Gold Dealers	·55	....	....	....	....	8,890·33	123·17	....	7·12	....
		Total	**·55**	....	....	....	....	**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	....	....	....	....	†26·92	....	49·09	....	....	†26·92
		Sundry claims	....	....	37·00	137·48	....	....	....	37·00	137·48	....
		From Goldfield Generally :—										
		Reported by Banks and Gold Dealers	....	1·49	....	2·56	....	604·64	24·69	....	2·56	....
		Total	....	**1·49**	**37·00**	**140·04**	**26·92**	**693·61**	**113·55**	**424·00**	**657·33**	**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. (600P)	Horseshoe East			261·00	31·21				261·00	31·21		
	568P	Horseshoe Lights			2,015·00	293·21				8,013·00	1,087 ·07		
	568P, etc.	Anglo-Westralian Mining Pty. Ltd.								135,872·00	22,870·80	1,407·05	
		Prior to transfer								3,914·00	894·44		
		Voided leases						15·57	1,975·37	5,393·38	2,787·35	2·00	
		Sundry claims						20·12	829·58	2,191·35	790·99		
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				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						1·69	2·87	4,703·75	589·15		
	599P	Bobby Dazzler			97·00	26·98				517·00	52·27		
	511P	Commercial								3,475·25	591·05		
	584P	Dazzle Star			15·00	7·50				318·00	88·48		
	567P	Miner Bird								2,043·00	932·20		
	553P	Morning Star			387·50	27·20			4·43	3,191·75	437·29		
	601P	Mt. Pleasant			771·00	46·87				771·00	46·87		
	587P	Murray Heath								41·00	6·17		
	506P	No. 1 North			895·00	50·06			86·47	8,104·70	1,714·55		
	492P	North Star						23·20	69·63	13,186·50	2,079·21		
		Voided leases						7·39	920·21	521,841·33	247,054·04	2,285·63	
		Sundry claims						61·51	306·63	34,406·35	8,955·54		
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		
Wilthorpe		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.										*1,686·20		
	State Battery, Peak Hill								3·05	15·00	*1,771·41		
	Various Works									1,332·00	5,723·81	23·12	
	Reported by Banks and Gold Dealers		2·30					2,855·14	444·36		14·32		
		Total	**2·30**		**4,451·00**	**498·35**		**3,384·35**	**5,300·33**	**775,095·73**	**322,007·92**	**3,768·47**	

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.
East Murchison Goldfield.												
LAWLERS DISTRICT.												
Kathleen Valley	G.M.L. (1365)	Beth Heno	....	....	....	....	....	....	....	60·00	8·33	....
		Voided leases	....	....	....	....	....	....	144·85	80,503·66	49,020·54	....
		Sundry claims	....	....	65·00	15·75	....	14·37	526·03	5,758·75	2,658·73	893·45
Lawlers	G.M.L. 1363	Kim Prospecting Dev. Synd.	....	....	290·00	25·64	....	....	....	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	1·50	....	251·50	120·98	....	401·71	451·61	17,598·98	9,689·67	268·34
Sir Samuel	....	Voided leases	....	....	....	....	....	....	359·03	275,417·55	141,829·52	10,234·80
		Sundry claims	....	....	24·00	7·32	....	57·64	64·96	7,835·00	4,582·33	·02
Wildara Station	....	Sundry claims	20·37	....	....	....	....	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	....	....	....	....	....	6,424·53	101·91	·05	10·00	....
		Total	**21·87**	....	**630·50**	**169·69**	....	**7,069·11**	**2,343·19**	**2,012,155·42**	**822,897·00**	**27,184·22**
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 :												
		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					2·57		59·81	56·58		158·54	11·75
		Total					**2·57**		**232·63**	**1,254·11**	**8,873,578·19**	**1,872,184·97**	**10,298·63**

BLACK RANGE DISTRICT.

Barambie	G.M.L. 1116B	Dingo									1·00	201·93	
	1117B	Scheelite Leases			173·50	41·24					653·75	359·97	
		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		
Maninga Marley		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	1114B	Black Range Gold Mine			·25	135·08			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			65·25	10·87		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 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.
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	....
		Total	....	....	**239·00**	**187·19**	....	**1,670·54**	**18,607·84**	**1,730,808·47**	**954,900·33**	**22,712·29**
Murchison Goldfield.												
CUE DISTRICT.												
Big Bell	G.M.L. 2282	Orange Bell	....	....	267·75	7·58	....	....	....	641·00	91·99	2·34
	2274	Silver City	....	....	135·00	12·46	....	....	....	273·25	61·35	....
		Voided leases	....	....	....	....	....	....	4·49	5,539,857·75	730,970·13	251,813·67
		Sundry claims	....	....	10·00	1·17	....	·39	6·32	563·25	480·93	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	....	....	55·25	7·93	....	....	....	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	....	....	215·75	24·92	....	252·92	894·70	47,089·49	20,521·24	4·24
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
Mindoolah		Voided leases	....	....	....	....	....	3·07	2·54	9,380·28	5,672·31	42·97
		Sundry claims	....	....	10·25	1·93	....	....	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	....	....	....	....	....	170·71	137·16	7,229·00	2,680·84	·62
Tuckabianna	2237	Gidgie	....	....	....	....	....	....	297·73	2,789·90	2,108·79	33·57
	2244	Winston	....	....	25·00	5·71	....	....	671·45	816·00	368·20	4·05
		Voided leases	....	....	....	....	....	649·70	324·77	13,152·23	7,465·12	....
		Sundry claims	....	....	55·75	5·86	....	154·26	489·40	5,377·10	2,778·73	·20

Tuckanarra	Voided leases	....	....	....	....	....	85·37	3,511·10	19,490·00	22,828·99	172·77
	Sundry claims	....	....	·02	·39	....	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 :											
Hannon & Woinar (L.T.T. 1450H)	....	....	....	*23·53	....	....	....	....	....	*23·53	....
A. L. Armstrong (L.T.T. 1425H)	....	....	....	*109·35	....	....	....	....	....	*109·35	....
A. L. Armstrong (L.T.T. 1427H)	....	....	....	*107·79	23·02	....	....	....	....	*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	4·50	....	....	....	....	3,428·73	109·87	....	22·62	·07
Total	**4·50**	....	**774·77**	**308·62**	**23·02**	**5,101·16**	**9,104·99**	**6,811,817·31**	**1,401,634·88**	**274,093·80**

MEEKATHARRA DISTRICT.

Abbot's	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,	Margueritta Leases	....	....	10·00	3·73	....	....	....	2,960·00	708·22	6·65
1946N	Margueritta East	....	....	....	....	....	....	....	1,420·00	250·09	10·65
1946N	Margueritta	....	....	....	....	....	....	....	732·00	197·73	7·74
1942N	Voided leases	....	....	....	....	....	29·02	420·32	6,875·26	7,500·57	·80
	Sundry claims	....	....	38·00	21·10	....	....	42·19	998·55	762·07	....
Gabanintha 1990N	Tumble Gum	....	....	65·25	15·61	....	....	....	188·25	49·09	4·72
1986N	Tumbulgum North	....	....	45·50	40·96	....	....	....	52·50	46·35	....
	Voided leases	....	....	....	....	....	11·79	38·14	32,995·35	22,204·79	815·57
	Sundry claims	....	....	....	....	....	16·78	159·05	5,184·50	2,954·40	....
Garden Gully	Voided leases	....	....	....	....	....	26·36	74·91	30,272·07	21,864·74	1,102·59
	Sundry claims	....	....	17·25	1·33	....	....	18·74	2,931·94	1,720·47	....
Gum Creek	Voided leases	....	....	....	....	....	25·27	91·96	3,893·08	3,819·91	....
	Sundry claims	....	....	5·75	14·50	....	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 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.
MURCHISON GOLDFIELD—continued.												
MEEKATHARRA DISTRICT—*continued.*												
Meekatharra	G.M.L. 1991N	Commodore	....	....	20·00	40·11	....	....	....	20·00	40·11	....
	1975N	Fortune Teller	....	....	59·00	8·99	....	....	....	97·00	13·83	....
	G.M.L. 1977N	Haveluck	....	....	954·10	108·82	....	....	....	1,596·70	179·40	....
	1559N	Ingliston	....	....	....	....	....	....	498·32	3,167·85	1,885·91	....
	(1994N)	Jasper Lode	....	....	73·00	3·80	....	....	....	73·00	3·80	....
	1985N	Lady Central	....	....	....	11·19	....	....	....	327·75	39·19	....
	(1577N)	Mopoke	....	....	....	....	....	....	12·47	1,361·50	827·50	....
	(1989N)	Pharlap	....	10·66	....	119·74	14·60	....	10·66	109·50	140·60	14·60
	1529N	Prohibition	....	....	1,012·00	117·21	....	....	....	5,632·25	2,093·31	4·25
	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. 74N	C. J. S. White & W. E. Fisher	....	....	....	....	....	173·82	43·80	372·50	131·88	....
		Voided leases	....	....	....	....	....	7·57	1,641·09	1,712,375·62	927,853·37	2,455·04
		Sundry claims	....	....	1,009·00	85·61	....	279·84	1,009·74	30,886·95	11,482·79	....
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	....
Munaro Gully	....	Voided leases	....	....	....	....	....	....	....	13,283·50	6,559·93	....
		Sundry claims	....	....	....	....	....	....	34·23	1,009·75	373·74	....
Nannine	G.M.L. (1992N)	Queen of the Lake	....	....	....	....	....	....	....	3·00	1·90	....
		Voided leases	....	....	....	....	....	47·31	844·02	129,489·88	76,480·88	167·45
		Sundry claims	....	....	....	....	....	138·95	1,301·28	6,748·68	4,726·36	....
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	....
State Well	....	Voided leases	....	....	....	....	....	....	200·12	21,362·00	9,566·18	....
		Sundry claims	....	....	....	....	....	31·91	34·73	1,003·60	584·54	....
Star of the East....	....	Voided leases	....	....	....	....	....	....	....	27,244·00	20,305·40	....
		Sundry claims	....	....	....	....	....	....	....	127·62	94·97	....
Yaloginda	1853N	Bluebird	....	....	266·00	27·52	....	....	....	9,713·50	2,966·75	....
		Voided leases	....	....	....	....	....	19·03	1,972·23	28,175·54	14,609·36	8·68
		Sundry claims	....	....	192·50	14·75	....	61·89	647·51	11,440·42	5,059·93	....

		From District Generally :—												
		Sundry Parcels treated at :												
		Hanley & Clemati (L.T.T. 1N/60)	....	....	234·00	9·69	....	....	....	234·00	9·69	....		
		P. Polletti (L.T.T. 2N/59)	....	....	....	....	....	....	....	13·50	4·82	....		
		State Battery, Meekatharra	....	....	....	....	....	....	....	130·00	*27,799·05	24·34		
		Various Works	....	....	....	....	....	....	....	3,699·80	*13,948·46	391·20		
		Reported by Banks and Gold Dealers	2·73	·35	....	....	....	12,239·12	180·05	451·50	97·71	·60		
		Total	**2·73**	**11·01**	**4,001·35**	**644·66**	**14·60**	**14,629·56**	**18,254·55**	**2,303,722·81**	**1,307,455·57**	**5,145·85**		

DAY DAWN DISTRICT.

Daw Dawn	G.M.L. 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	....	....	5·00	10·36	....	96·42	523·56	13,646·26	6,757·05	1·55		
Lake Austin	....	Voided leases	....	....	....	....	....	613·00	3,079·62	36,872·20	51,050·49	....		
		Sundry claims	....	....	48·25	3·28	....	59·07	965·49	3,539·19	1,339·76	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 :												
		F. W. Turner (L.T.T. 1418H)	....	....	....	....	....	....	....	....	*7·13	....		
		Various Works	....	....	....	....	....	....	16·61	988·00	*1,988·33	....		
		Reported by Banks and Gold Dealers	....	....	....	....	....	2,220·42	37·30	....	12·57	·01		
		Total	....	....	**53·25**	**13·64**	....	**3,241·76**	**11,341·63**	**2,037,218·88**	**1,375,521·32**	**169,434·20**		

MOUNT MAGNET DISTRICT.

Jumbulyer	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	....	....	111·00	101·62	....	....	....	111·00	101·62	....		
	1596M	Wheel of Fortune South	....	....	....	....	....	....	....	18·00	51·37	....		
		Voided leases	....	....	....	....	....	....	3,226·91	151,502·55	128,568·28	459·62		
		Sundry claims	....	....	243·75	118·24	....	25·86	108·82	14,945·37	5,773·41	....		

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 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.
MURCHISON GOLDFIELD—continued.												
MOUNT MAGNET DISTRICT—continued.												
Mt. Magnet	1563M	Corona East	....	....	8·75	2·56	....	....	....	8·75	2·56	....
	1527M	Eclipse Gold Mine, N.L.	....	....	6,969·00	7,689·75	764·55	....	....	17,323·00	22,679·86	1,219·69
	1527M	Eclipse	....	....	....	....	....	....	....	272·10	141·41	1·34
	1255M, etc.	Edward Carson Leases	....	....	....	*4·27	....	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	....
	1479M	Hill 50 Consolidated, N.L.	....	....	....	....	....	....	....	68·00	5·10	....
	1282M, etc.	Hill 50 Gold Mine, N.L.	....	....	156,844·00	82,987·96	6,400·64	....	....	1,534,629·40	773,898·99	25,784·27
	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	....	....	....	....	....	....	....	2,092·65	458·61	....
	1475M	Morning Star North	....	....	11·75	8·13	....	....	....	11·75	8·13	....
	1536M	Pat O'Meara	....	....	....	....	....	....	....	34·00	·68	....
	1505M	Perseverance	....	....	....	....	....	....	....	107·25	11·40	....
	1588M	Three Boys	....	....	....	....	....	....	....	48·00	2·47	....
		Voided leases	....	....	....	....	....	29·26	9,811·54	834,324·06	312,772·17	851·39
		Sundry claims	3·38	....	99·77	50·27	....	126·46	2,626·24	61,012·17	29,953·23	4·49
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 :											
	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		18·48	....	....	....	....	2,311·85	114·69	8·00	113·15	·22
		Total	**21·86**	....	**164,288·02**	**90,962·80**	**7,165·19**	**2,597·65**	**20,434·16**	**2,674,824·72**	**1,374,760·64**	**29,112·42**

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	....
Field's 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	....
	(1025)	Carnation	....	....	19,096·05	14,016·94	....
	1236	Marigold	....	....	181·00	38·75	....
		Voided leases	146·70	299·28	62,415·66	52,294·32	....
		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	....
Messenger's 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	39·32	310·31	8,499·05	3,561·25	....
Nyounda		Voided leases	....	217·63	416·00	183·91	....
		Sundry claims	....	30·88	955·00	223·90	....
Pinyalling		Voided leases	....	313·79	2,318·90	1,146·19	....
		Sundry claims	3·13	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	....	....	933·75	369·87	....

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.
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	1·23	....	....	....	....	958·32	58·32	....	48·90	·20
		Total	**1·23**	....	....	....	....	**1,801·76**	**3,223·19**	**442,508·08**	**263,703·11**	**1,503·16**

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	....	....	106·00	4·57	....	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	G.M.L. 399F, etc.	Morgan's 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	....	....	....	....	....	51·15	557·24	6,561·68	4,562·63	....

Redcastle	(557F)	Trixie	....	8·65	....	....	....	....	54·79	177·75	68·44	....
		Voided leases	....	....	....	....	....	4·49	436·54	4,107·20	4,043·41	....
		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 (M.A. 14F)	....	....	....	....	....	....	....	10·00	*26·96	....
		United Aborigines Mission (M.A. 12F)	....	....	....	....	....	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	34·28	....	....	....	....	3,122·74	141·84	10·30	95·75	·68
		Total	**34·28**	**8·65**	**106·00**	**4·57**	**....**	**3,536·25**	**9,398·51**	**1,217,427·31**	**717,672·57**	**5,812·32**

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	....	....	24·00	30·53	....	4·25	121·91	1,889·25	605·54	·66
Diorite	....	Voided leases	....	....	....	....	....	....	945·65	38,879·03	35,144·28	33·18
		Sundry claims	....	....	11·00	8·71	....	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	....	....	1,144·00	100·60	....	....	....	1,881·00	163·91	....
		Voided leases	....	....	....	....	....	....	4,482·18	74,717·46	52,293·77	7·56
		Sundry claims	....	....	....	....	....	129·92	906·52	11,436·62	6,124·25	2·60
Leonora	1829C	Jessie Alma	....	4·76	....	....	....	....	582·87	727·25	1,920·53	....
	1579C, etc.	Sons of Gwalia Ltd.	....	....	138,618·00	32,983·41	3,138·62	....	....	6,613,321·53	2,490,169·77	180,377·88
		Prior to transfer to present holders	....	....	....	....	....	....	....	109,081·00	55,989·21	8·66
		Voided leases	....	....	....	....	....	....	1,866·86	176,575·00	91,197·84	94·57
		Sundry claims	....	8·04	598·00	105·21	....	37·73	377·26	20,447·45	12,270·34	·21
Malcolm	....	Voided leases	....	....	....	....	....	11·65	47·07	62,656·53	47,563·43	....
		Sundry claims	....	....	....	....	....	5·75	33·39	4,576·47	2,711·34	·12
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	....	....	14·00	2·06	....	53·98	1,860·00	5,594·70	3,491·22	....
Pig Well	....	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	....

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.
MOUNT MARGARET GOLDFIELD—continued.												
MT. MALCOLM DISTRICT—continued.												
Websters Find	....	Voided leases	....	....	....	....	....	30·30	....	22,167·50	14,377·65	....
		Sundry claims	....	....	....	....	....	36·84	695·68	2,356·15	1,350·56	....
Wilsons Creek	....	Voided leases	....	....	....	....	....	....	....	333·50	168·27	....
		Sundry claims	....	....	....	....	....	·70	4·24	316·00	261·12	....
Wilsons Patch	....	Voided leases	....	....	....	....	....	....	99·38	28,863·35	13,050·19	1·05
		Sundry claims	....	....	20·00	6·07	....	4·68	54·46	1,632·16	1,422·48	....
	From District Generally :—											
	Sundry Parcels treated at :											
	State Battery, Darlot		....	....	....	*729·56	....	....	....	18·00	*1,515·90	....
	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		56·93	....	....	....	....	3,607·75	252·83	46·50	57·80	....
		Total	**56·93**	**12·80**	**140,429·00**	**33,966·15**	**3,138·62**	**4,021·57**	**16,664·44**	**7,323,105·47**	**2,975,754·96**	**182,246·10**
MOUNT MARGARET DISTRICT.												
Burtville	G.M.L. 2567T	Boomerang	....	....	163·00	4·35	....	....	....	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	4·57	....	....	....	....	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 :											
	State Battery, Laverton	....	....	....	....	....	....	....	....	97·50	*19,327·97	561·11
	Various Works	....	....	....	....	....	....	....	....	214·75	*19,403·68	·24
	United Gold Recoveries Pty. Ltd.	....	....	....	....	....	....	....	·25	....	*3,786·44	3,374·06
	Reported by Banks and Gold Dealers	13·45	....	....	....	....	2,570·59	108·08	....	29·18	....	
	Total	**13·02**	....	**163·00**	**4·35**	....	**4,133·38**	**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	....	....	66·50	8·84	....	....	....	232·25	23·13	....
		Voided leases	....	....	....	....	....	....	419·74	267,385·72	193,243·62	5,355·33
		Sundry claims	....	....	128·75	116·18	....	....	40·19	2,169·96	1,139·01	....
Goongarrie	5740Z	Gulls Blow	....	....	....	....	....	....	164·75	357·50	257·47	....
		Voided leases	....	....	....	....	....	·94	1,385·26	29,897·79	18,124·83	....
		Sundry claims	....	31·02	18·00	20·31	....	46·46	2,140·81	2,853·85	3,362·73	....
Menzies	G.M.L. 5543Z....	Black Swan	....	....	....	....	....	....	....	1,135·63	1,658·49	9·08
	5736Z	Bodington	....	....	....	....	....	....	134·83	150·50	181·15	....
	5511Z	First Hit	....	....	964·00	430·51	....	....	....	5,675·75	7,392·32	21·25
	5511Z, etc.	First Hit Gold Mines (1934), Ltd.	....	....	....	....	....	....	....	68,473·70	49,060·96	6,676·23
	5542Z	Good Block Lease	....	....	241·90	74·46	....	....	7·32	2,883·90	2,993·98	....
	5780Z	Good Enough	....	....	739·20	209·43	....	....	....	1,249·70	338·19	....
	5520Z	Mignonette	....	....	....	....	....	....	....	808·50	404·43	....
		Voided leases	....	....	....	....	....	45·42	1,125·41	937,698·50	727,099·60	13,586·39
		Sundry claims	....	·72	630·15	84·43	....	56·87	624·33	36,424·09	25,812·95	812·86
Mt. Ida	5701Z, etc.	Moonlight Wiluna Gold Mines, Ltd.	....	....	29,880·00	14,591·00	....	....	40·77	292,193·86	151,493·98	787·54
		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	....	....	24·00	13·48	....	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	....	....	....	....	....	*15·20	....
	R. H. Bennetts (L.T.T. 1423H)	....	....	48·25	20·31	....	....	....	....	79·50	31·83	....
	State Battery, Mt. Ida	....	....	....	....	....	....	....	....	1,866·25	*7,553·62	2·04
	State Battery, Menzies	....	....	....	*919·77	548·34	....	....	....	....	*2,663·22	548·34
	Various Works	....	....	....	....	....	....	....	....	3,136·55	*58,757·09	3,062·11
	Reported by Banks and Gold Dealers	....	·18	....	....	....	1,487·17	403·22	100·00	48·49	....	
	Total	....	**31·92**	**32,740·75**	**16,503·92**	**548·34**	**1,685·00**	**7,014·92**	**1,772,253·43**	**1,349,337·46**	**31,859·29**	

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.*												
ULARRING DISTRICT.												
Daveyhurst	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	....	....	387·00	67·53	....	....	208·48	14,160·19	5,787·29	....
Morleys	1094U	First Hit	....	....	158·00	77·06	....	....	....	4,566·00	6,785·54	....
	(1169U)	First Hit North	....	....	....	....	....	....	....	3·50	5·79	....
	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	7,345·50	8,404·06	10·54
		Sundry claims	....	....	54·25	21·20	....	2·16	932·23	1,983·75	2,648·51	....
Mulline	1107U	Ajax West	....	....	16·00	15·08	....	....	1·37	8,355·50	6,653·34	....
	1170U	Golden Wonder	....	....	229·25	388·11	....	....	....	457·75	1,975·09	....
	1173U	Riverina	....	....	·50	14·02	....	....	....	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	....	....	12·25	18·01	....	....	....	37·60	72·15	....
	1176U	Wild Cat	....	....	44·50	43·81	....	....	....	71·50	65·88	....
		Voided leases	....	....	....	....	....	....	274·09	102,683·22	103,366·11	530·75
		Sundry claims	....	....	35·75	32·26	....	10·82	296·42	11,129·39	9,707·01	1·10
Mulwarrie	1153U	Fourmile	....	....	6·00	32·58	....	....	....	89·00	498·92	....
	1113U	Oakley	....	....	280·00	455·62	....	....	....	4,094·00	5,758·64	....
		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, Mulinwarrie	....	....	....	....	....	....	....	613·18	*6,564·16	....
		Linnett and Hawkins (L.T.T. 1252H)	....	....	....	....	....	....	....	....	*162·19	....
		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	....
		Total	....	....	**1,223·50**	**1,165·28**	....	**129·52**	**7,203·12**	**532,681·70**	**442,319·95**	**21,928·23**

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	928G	Altona	....	....	623·25	401·96	....	....	....	10,885·25	6,825·83	·44
	(911G)	Cosmopolitan South	....	....	20·00	15·61	....	....	....	2,650·00	11,365·38	....
	933G	New Gladstone	....	....	....	....	....	....	....	898·25	323·72	....
	937G	Victory	....	....	....	....	....	....	....	81·25	45·47	....
		Voided leases	....	....	....	....	....	3·35	347·30	744,917·21	394,601·81	5,375·97
		Sundry claims	....	....	16·50	4·99	....	60·92	106·60	9,403·30	6,918·05	3·02
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	....
		Total	....	....	**659·75**	**422·56**	....	**1,718·36**	**1,821·77**	**941,173·52**	**527,507·95**	**5,686·69**

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	....	....	10·00	4·09	....	....	....	3,884·00	1,223·63	....
	(1327R)	Nil Desperandum	....	....	50·00	4·59	....	....	....	378·00	80·85	....
	1126R, etc.	Porphyry (1939) G.M. 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	....
	(1340R)	Patricia	....	....	184·00	11·84	....	....	....	465·00	63·83	....
	1339R	Yilgangie	....	....	118·00	55·18	....	....	....	463·00	207·93	....
		Voided leases	....	....	....	....	....	6·30	87·08	44,584·75	21,248·26	2·00
		Sundry claims	....	....	305·00	48·29	....	·87	5·93	17,784·05	6,247·82	·98
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	....	....	2,361·00	1,986·44	351·86	....	....	26,276·75	24,627·61	3,684·17
		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	....	....	20·00	15·98	....	121·67	98·20	3,336·30	2,056·86	·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	....
		Total	....	....	**3,048·00**	**2,126·41**	**351·86**	**1,311·91**	**3,817·12**	**288,088·53**	**171,966·53**	**4,546·70**

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.
Broad Arrow Goldfield.												
Bardoc		Voided leases	....	....	....	....	....	....	2,335·41	85,370·59	55,699·50	203·60
		Sundry claims	....	....	30·75	5·40	....	54·95	1,218·09	17,748·03	8,330·00	....
Black Flag	G.M.L. 2229W	Bellevue	....	....	577·25	70·36	....	....	212·68	3,624·48	3,116·25	·17
		Voided leases	....	....	....	....	....	27·81	405·90	48,277·79	28,175·08	....
		Sundry claims	....	....	159·50	19·07	....	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	....	·09	255·75	30·58	....	1,007·72	3,046·26	34,942·39	17,039·07	·11
Cane Grass		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	....	....	....	....	....	....	....	370·50	251·55	....
	2253W	New Mexico South	....	....	211·25	75·21	....	....	....	3,126·00	3,439·34	....
		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	....	....	....	....	....	....	....	506·50	420·37	....
	2278W	Prince of Wales Syndicate	....	....	125·75	205·54	....	....	....	569·50	1,038·06	....
	2278W, 2277W	(Ora Banda Amalg. Mines N.L.)	....	....	....	2·41	....	....	....	961·00	1,148·58	....
	2299W	Jeanie May	....	....	179·25	44·53	....	....	....	339·85	84·66	....
		Voided leases	....	....	....	....	....	....	274·13	203,675·74	80,047·31	175·00
		Sundry claims	....	....	412·00	28·85	....	....	356·66	7,025·59	3,183·01	....
Ora Banda	T.A. 42W, MA 41	Associated Northern Ora Banda N.L.	....	....	....	....	....	....	....	2,786·50	464·53	21·07
		Prior to transfer to present holders	....	....	....	....	....	....	....	315,958·95	123,252·22	1,664·70
	G.M.L. 2270W	Gimlet South	....	....	980·00	184·59	....	....	....	9,453·75	1,886·55	....
	2300W	Sleeping Beauty	....	....	645·75	267·39	....	....	....	645·75	267·39	....
		Voided leases	....	....	....	....	....	....	846·13	104,719·32	27,471·80	....
		Sundry claims	....	....	225·25	49·22	....	....	467·18	15,200·55	4,848·15	....
Paddington	2298W	Rona Lucille	....	....	133·50	25·68	....	....	....	227·50	40·46	....
		Voided leases	....	....	....	....	....	5,566·30	463·31	196,488·56	86,485·99	32·15
		Sundry claims	....	....	97·85	17·34	....	1,714·16	291·43	17,335·83	9,287·81	....

Riche's Find	....	Voided leases	....	....	....	....	....	....	21·64	7,643·09	6,095·69	71·36
		Sundry claims	....	252·83	19·75	196·83	....	....	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	....	....	8·75	10·25	....	....	....	24·50	20·66	....
		Voided leases	....	....	....	....	....	....	19·19	11,717·71	2,068·58	....
		Sundry claims	....	....	38·25	6·16	....	....	124·29	3,862·59	1,374·92	....
	From Goldfield generally :—											
	Sundry Parcels treated at :											
	H. T. Kingdon (M.A. 4W)	....	1·53	12·50	4·25	....	....	1·53	12·50	4·25	....
	State Battery, Ora Banda	....	....	....	*41·16	18·33	....	....	128·05	*25,645·51	29·89
	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	·12	....	....	4·01	....	10,018·30	150·16	61·68	95·83	....
	Total	**·12**	**254·45**	**4,113·10**	**1,288·83**	**18·33**	**21,981·82**	**27,729·75**	**1,356,837·42**	**739,454·10**	**5,324·21**

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	....	....	73·00	38·72	....	....	716·52	5,766·27	3,275·13	....
Gordon	....	Voided leases	....	....	....	....	....	....	682·54	53,900·58	20,072·51	517·61
		Sundry claims	....	....	19·00	2·63	....	....	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	(1584X)	Atlas	....	....	....	....	....	....	....	68·50	7·51	....
	1572X	Kanowna Red Hill	....	....	275·75	76·33	....	....	2·38	3,078·75	1,007·72	....
		Voided leases	....	....	....	....	....	24·94	4,516·76	685,557·10	380,497·36	2,482·24
		Sundry claims	....	....	177·75	22·92	....	125·32	2,169·07	27,627·27	12,007·14	1·50
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	....	....	....	....	....	....	56·51	764·50	231·13	....
	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	....	....	....	....	....	106,025·29	40·42	·50	109·73	....
	Total	....	....	**545·50**	**140·60**	....	**106,530·67**	**13,526·67**	**1,008,175·26**	**626,951·34**	**3,039·73**

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	(456K)	Purple Patch	....	....	....	....	....	....	....	78·25	64·42	....
		Voided leases	....	....	....	....	....	371·18	3,166·80	4,052·51	3,957·71	6·27
		Sundry claims	....	....	....	....	....	324·12	727·39	4,512·11	2,341·18	....
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
		Total	....	....	....	....	....	**12,835·49**	**8,298·91**	**13,667·32**	**18,828·71**	**12·71**
East Coolgardie Goldfield.												
EAST COOLGARDIE DISTRICT.												
Binduli	G.M.L. 6582E.	Royal Standard	....	....	30·00	2·88	....	....	....	203·00	16·93	....
		Voided leases	....	....	....	....	....	....	....	1,640·35	475·81	....
		Sundry claims	....	....	44·25	9·10	....	....	13·01	5,530·02	1,713·52	....
Boorara		Voided leases	....	....	....	....	....	....	459·07	309,467·82	172,861·95	411·37
		Sundry claims	....	....	....	....	....	·49	145·56	4,186·34	1,562·62	·05
Boulder	6145E	Boomerang	....	....	....	....	....	....	....	77·00	8·00	....
	5531E	Cassidy's Hill	....	....	425·50	32·70	....	....	....	1,124·25	93·30	....
	5964E	Croesus Extended	....	....	....	....	....	....	....	192·75	16·57	....
	6537E	Golden Key	....	....	....	....	....	....	58·22	696·10	772·31	....
	5692E, etc.	Gold Mines of Kalgoorlie (Aust.) Ltd.	....	....	556,247·00	141,238·35	24,924·15	....	....	2,013,202·00	524,954·84	99,916·05
		Prior to transfer to present holders	....	....	....	....	....	....	791·73	15916155·97	6,415,881·49	819,123·27
	5696E, etc.	Great Boulder Gold Mines, Ltd.	....	....	448,398·00	123,874·81	42,279·50	....	1·53	13674277·97	6,270,634·61	1,524,108·87
	5478E, etc.	Lake View and Star, Ltd.	....	....	683,950·00	174,219·00	19,998·80	....	....	15817818·30	4,651,344·78	510,338·32
		Prior to transfer to present holders	....	....	....	....	....	....	8·49	15792500·38	9,149,223·80	1,348,055·28
	5431E, etc.	North Kalgurli (1912), Ltd.	....	....	372,053·00	87,840·67	30,341·75	....	127·55	5,717,948·24	1,561,565·34	339,117·88
	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	....	Voided leases	....	....	....	....	....	....	110·93	863·30	425·16	....
		Sundry claims	....	....	19·25	3·51	....	....	199·00	1,256·35	649·39	....
Hampton Plains	P.P.L. 1	Hampton Boulder	....	....	76·50	4·51	....	....	....	76·50	4·51	....
	P.P.L. 1 etc.	Consolidated Gold Areas, N.L.	....	....	....	....	....	....	....	142,565·73	37,249·15	5,835·85
	P.P.L. 86/48	Golden Hope, N.L.	....	....	....	....	....	....	....	5,964·00	2,006·14	....
	P.P.L. 192	Golden Hope North	....	....	....	....	....	....	....	353·00	201·02	....
	P.P.L. 222	Hampton Jubilee	....	....	122·25	9·83	....	....	....	122·25	9·83	....
	P.PL. 252	Hampton Properties Ltd., Mount Martin	....	....	....	....	....	....	....	14,953·75	557·11	....
	P.P.L. 471	Culleton Cullen & Renton	....	....	....	....	....	....	....	7·05	126·78	....
	P.P.L. 474	L. Rowell	....	....	....	....	....	....	....	20·75	3·96	....
	P.P.L. 460	Hampton Xmas Gift	....	....	....	....	....	6·72	37·57	107·00	89·44	....
	P.P.L. 476	Ivy Rose	....	7·75	57·25	82·88	....	....	7·75	81·30	114·76	....
	P.P.L. 12	Junction Extended	....	....	58·25	7·81	....	....	....	3,640·00	535·55	....
	P.P.L. 277	M. Africh	....	....	904·25	83·84	....	....	....	1,271·25	133·11	....
	P.P.L. 277	Pernatty	....	....	....	....	....	....	....	7,247·75	866·88	·01
	P.P.L. 277	New Hope	....	....	....	....	....	....	17·23	61,468·55	11,175·94	....
	P.P.L. 50	A. McKay	....	....	....	....	....	....	....	80·25	5·46	....
	P.P.L. 23	Mutooroo (Scherini & Rowe)	....	....	....	....	....	....	....	1,747·50	134·82	....
	P.P.L. 10	F. C. Shoppe	....	....	2·75	4·23	....	....	....	891·50	42·05	....
	P.P.L. 175	S. Shackleton	....	....	121·25	7·40	....	....	....	121·25	7·40	....
	P.P.L. 175	Jubilee (F. C. Shoppe)	....	....	....	....	....	....	....	6,708·00	906·81	....
		Cancelled leases	....	....	....	....	....	4,578·52	203·94	126,877·34	39,711·84	69·83
		Sundry claims and leases	....	....	27·50	9·61	....	2·68	70·85	46,466·91	8,519·28	....
Kalgoorlie	G.M.L. (6048E)	Auld Acquaintance	....	....	....	....	....	....	....	7·50	2·36	....
	6562E	Bretvic	....	....	....	....	....	....	....	326·50	26·09	....
	6563E, 6564E....	Champagne Syndicate N.L.	....	....	....	....	....	....	....	12,287·75	1,348·10	61·41
	4547E, etc.	Mount Charlotte (Kalg.) Gold Mines Ltd.	....	....	....	....	....	....	....	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	....
	(5913E)	Devon Consols	....	....	....	....	....	....	93·19	2,561·71	717·00	....
	(5915E)	Edna Derby	....	....	....	....	....	....	....	434·00	93·94	....
	5510E	Golden Dream	....	....	35·00	3·26	....	....	....	207·75	19·29	....
	5774E	Golden Goose	....	....	140·50	20·14	....	....	....	374·50	76·47	....
	(5739E)	Golden Star	....	....	....	....	....	....	....	918·50	85·96	....
	6589E	Grays Central	....	....	531·00	16·98	....	....	....	531·00	16·98	....
	6502E	Western Mining Corporation	....	....	....	....	....	....	....	256·00	65·07	4·28
	(5878E)	Lady Mary	....	....	....	....	....	....	62·05	4,740·50	1,177·07	....
	6091E	Lesanben	....	....	94·50	75·92	....	....	193·96	957·05	534·12	....
	6485E	Maritana Hill	....	....	....	....	....	....	....	3,138·50	394·23	....
	6535E	Mary A.	....	....	787·75	74·49	....	....	....	4,508·00	423·24	....
	(6565E)	Midas	....	....	....	....	....	....	....	8·00	11·41	....
	6321E	North End Extended	....	....	7·75	2·04	....	....	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	....
	(5468E)	Phar Lap	....	....	....	....	....	....	....	2,083·25	750·82	2·50
	(5415E, 5803E)	Return Leases	....	....	....	....	....	....	5·64	3,831·75	656·15	....
		Voided Leases	....	....	....	....	....	242·48	10,572·12	1,458,039·30	578,617·19	45,973·47
		Sundry claims	....	....	343·75	28·54	....	232·41	1,124·61	61,789·53	23,235·34	....

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.
EAST COOLGARDIE GOLDFIELD—continued												
EAST COOLGARDIE DISTRICT—*continued.*												
Wombola	6051E	Big Bull	....	....	....	....	....	....	....	669·75	481·76	....
	5688E (5967E)	Caledonian Leases	....	....	....	....	....	....	....	970·00	659·67	....
	5688E	(Caledonian)	....	....	....	....	....	....	....	4,275·00	3,632·98	....
	(5967E)	North Caledonian	....	....	....	....	....	....	1·27	22·25	8·15	....
	5497E, 5500E	Daisy Leases	....	....	606·50	520·16	....	....	....	16,047·95	11,727·43	84·53
	5497E	(Daisy)	....	....	....	....	....	....	....	6,282·25	5,031·93	....
	5500E	Happy Go Lucky	....	....	....	....	....	....	....	2,075·25	1,675·85	....
	(6032E)	Dry Mount	....	....	....	....	....	....	....	1,366·25	1,161·55	·60
	6325E	Great Hope	....	....	39·50	47·11	....	....	26·66	621·50	252·04	....
	5689E, etc.	Mt. Monger Mining Syndicate	....	....	522·00	353·36	....	....	....	4,458·25	3,024·42	26·18
	5689E, etc.	(Haoma Gold Mines N.L.)	....	....	....	....	....	....	....	9,233·00	7,239·42	269·03
	5689E, etc.	(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)	....	....	....	....	....	....	....	4,102·75	11,676·72	....
	(5616E)	(Leslie)	....	....	....	....	....	....	....	602·00	939·10	....
	6312E	Inverness	....	....	196·75	32·75	....	....	....	2,971·75	531·42	....
	6540E	Launa Doone	....	....	....	....	....	....	....	627·75	152·81	....
	6487E	Leslie	....	....	23·00	16·47	....	....	....	316·75	328·40	....
	6213E	Pauline	....	....	....	....	....	....	....	282·50	229·08	....
	6570E	Rock and Roll	....	....	624·75	175·29	....	....	....	1,475·75	239·51	....
	6533E	Rosemary	....	....	1,506·45	2,256·80	....	....	....	4,158·95	7,048·74	....
		Voided leases	....	....	....	....	....	3·80	2,464·78	29,299·84	41,085·28	....
		Sundry claims	....	....	782·00	63·86	....	....	711·10	25,355·68	14,394·38	....
	From District Generally :—											
	Sundry Parcels treated at :											
	Golden Horseshoe (New) Ltd.		....	....	....	....	....	....	....	....	*350,028·15	354,192·20
	State Battery, Kalgoorlie		....	....	....	*783·08	58·06	....	....	390·70	*34,976·44	131·52
	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		5·30	31·94	....	....	....	16,962·38	10,070·47	392·43	7,498·53	....
	Total		**5·30**	**39·69**	**2,068,778·20**	**531,901·38**	**117,602·26**	**33,680·20**	**41,138·13**	**77471466·70**	**33906712·78**	**5,184,177·79**

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	....	....	140·00	13·76	....	....	....	288·50	39·37	....
	(1336Y)	Rosina	....	....	....	....	....	....	....	184·50	34·05	....
		Voided leases	....	....	....	....	....	107·54	8,526·12	108,330·55	85,785·57	....
		Sundry claims	....	....	246·25	20·86	....	1,655·86	1,611·58	17,871·98	17,954·57	....
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	....
		Total	....	....	**386·25**	**34·62**	....	**27,405·22**	**16,034·57**	**187,598·05**	**132,273·99**	**12·92**

Coolgardie Goldfield

COOLGARDIE DISTRICT

Bonnievale	G.M.L. 5986	Jenny Wren	....	....	17·50	10·36	....	....	....	152·75	59·32	....
	5622	Lucky Hit	....	....	34·25	25·58	....	....	3·28	1,084·10	567·68	....
	(4600)	Melva Maie	....	....	....	....	....	....	....	3,876·65	3,854·37	2·35
		Prior to transfer to present holders	....	....	....	....	....	....	....	614·50	1,099·21	11·63
	5890	Rayjax	....	....	79·00	73·63	....	....	....	464·00	852·25	....
		Voided leases	....	....	....	....	....	....	212·48	358,205·72	191,459·32	5·88
		Sundry claims	....	....	....	....	....	....	163·19	8,191·63	5,392·98	·04
Bullabulling	(5996)	Pakaha's Son	....	....	24·75	30·17	....	....	....	457·25	248·74	....
	6003	Worked Out	....	....	29·75	27·04	....	....	....	29·75	27·04	....
		Voided leases	....	....	....	....	....	....	....	953·31	719·78	....
		Sundry claims	....	....	19·75	1·98	....	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	....	....	138·50	36·15	....	55·05	497·55	16,655·35	9,093·13	....

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.
COOLGARDIE GOLDFIELD—continued												
COOLGARDIE DISTRICT—*continued*												
Cave Rocks	....	Voided leases	....	....	....	....	....	....	....	8,223·16	1,941·42	....
		Sundry claims	....	....	....	....	....	....	50·00	4,473·65	1,082·79	....
Coolgardie	G.M.L. 5935, etc.	Gold Mines of Kalgoorlie (Aust.), Ltd.	....	....	12,869·00	9,081·01	....	....	....	109,514·00	55,818·10	907·43
	5876	(Bayleys West)	....	....	....	....	....	....	....	6·25	2·22	....
	6000	Dendon	....	....	101·25	25·47	....	....	....	101·25	25·47	....
	5868	El Dorado	....	....	....	....	....	....	498·20	175·45	1,034·94	....
	5997	Ellen Jean	....	....	72·25	22·04	....	....	20·01	543·00	228·09	....
	5844	Jack Pot	....	....	857·00	501·57	....	....	....	9,001·25	3,737·19	....
	5884	Lone Hand	....	....	23·75	7·55	....	....	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	....	30·76	774·00	174·31	....	219·08	2,763·51	78,766·94	28,429·56	....
Eundynie	....	Voided leases	....	....	....	....	....	3·70	16·09	31,772·98	16,531·34	1·75
		Sundry claims	....	....	....	....	....	....	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	....	....	10·00	2·74	....	1·39	50·76	3,290·60	1,395·75	....
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. and C. P. Clews	....	....	....	....	....	....	....	149·75	119·66	....
	P.P.L. 338	Dry Hill	....	....	....	....	....	....	....	43·00	58·42	....
	P.P.L. 465	G. Dugan and 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.	....	....	....	....	....	....	....	837·50	364·35	....
	P.P.L. 468	Nichols and Hacket	....	....	....	....	....	....	....	24·25	5·30	....
	P.P.L. 469	Cullen and 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	....	....	17·25	2·17	....	....	....	30·75	4·02	....
	P.P.L. 473	Austin and 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	....	....	46·25	20·27	....	....	....	46·25	20·27	....
	P.P.L. 482	T. R. Baker	....	....	151·25	42·70	....	....	....	151·25	42·70	....
		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	Fairplay Gold Mine	....	....	....	....	....	....	....	28,392·00	3,152·82	·02
	(5995)	Sons of Erin	....	....	15·25	28·58	....	....	....	15·25	28·58	....
	6002	Two Boys	....	....	100·00	62·89	....	....	....	100·00	62·89	....
		Voided leases	....	....	....	....	....	....	482·47	45,586·60	22,030·21	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	....	....	....	....	11·09	105,397·50	26,324·42	....
		Voided leases	....	....	....	....	....	....	....	1,263·31	607·26	....
		Sundry claims	....	....	....	....	....	6·88	128·95	2,035·85	925·28	....
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	....	....	....	....	....	1·77	153·24	2,828·94	752·60	....
Paris	5953, etc.	Northern Minerals Syndicate	....	....	2,140·00	900·07	302·98	....	....	4,967·00	1,773·23	364·71
	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	....	....	....	....	....	15·29	95·72	1,432·64	1,081·62	....
Ryan's Find	5999	Little Nipper	....	302·76	15·50	109·33	....	....	341·74	15·50	109·33	....
		Voided leases	....	....	....	....	....	....	....	54·16	151·69	....
		Sundry claims	....	....	43·00	33·86	....	....	478·00	159·44	389·69	....
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	....	....	....	....	....	46·49	470·06	16,219·66	6,891·03	·07
	From District generally :—											
	Sundry Parcels treated at :											
	State Battery, Coolgardie	....	....	....	*637·70	....	....	....	771·01	*39,845·80	17·00
	Australian Machinery and Investment Co. Ltd. Plant	....	....	....	....	....	....	....	....	*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	1·67	....	....	4·68	....	14,987·21	728·24	48·25	139·56	·65
	Total	**1·67**	**344·61**	**17,579·25**	**11,861·85**	**302·98**	**17,018·36**	**17,973·23**	**2,896,348·60**	**1,499,039·87**	**37,096·68**

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.
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	·19	....	16·25	3·91	....	136·27	96·96	6,446·38	2,274·62	....
Chadwin		Voided leases	....	....	....	....	....	....	....	4,837·80	5,298·69	2·50
		Sundry claims	....	....	15·00	7·93	....	14·28	82·36	5,987·55	2,953·07	·25
Dunnsville		Voided leases	....	....	....	....	....	....	828·58	17,548·85	8,657·45	....
		Sundry claims	....	....	4·50	2·73	....	21·00	1,034·08	3,008·96	2,093·35	....
Jourdie Hills		Voided leases	....	....	....	....	....	....	18·00	28,009·74	19,401·09	28·45
		Sundry claims	....	....	20·75	13·02	....	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	....	....	19·00	8·60	....	111·91	102·70	4,728·53	2,557·35	....
Kunanalling		Voided leases	....	....	....	....	....	86·13	1,734·92	130,303·61	100,812·73	40·77
		Sundry claims	....	....	239·50	97·23	4·30	216·53	815·72	15,690·02	9,841·49	4·30
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
		Total	**·19**	....	**315·00**	**133·42**	**4·30**	**1,520·70**	**5,638·37**	**364,105·20**	**252,996·75**	**755·69**
Yilgarn Goldfield.												
Blackbornes		Voided leases	....	....	....	....	....	....	....	1,282·50	341·37	....
		Sundry claims	....	....	....	....	....	....	....	392·50	81·15	....
Bullfinch	G.M.L. 3350, etc.	Great Western Consolidated, N.L. (Copperhead)	....	....	185,082·00	24,329·92	4,578·79	....	....	2,869,814·00	397,334·43	116,318·48
		Prior to transfer to present holders	....	....	....	....	....	....	64·80	78,404·34	24,644·88	....
	4287	Volcano	....	....	12·00	2·40	·41	....	....	187·00	168·43	·41
		Voided leases	....	....	....	....	....	....	10·14	490,361·07	185,489·03	27,958·41
		Sundry claims	....	....	57·00	37·85	7·25	8·47	45·49	7,564·39	4,114·27	8·50

Corinthian	G.M.L. 3398, etc.	Great Western Consolidated, N.L. (Corinthian)	....	....	26,271·00	3,960·20	634·51	....	....	117,620·00	17,142·26	3,895·69
		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	....	Voided leases	....	....	....	....	....	....	196·74	10,208·06	10,660·65	·01
		Sundry claims	....	....	23·75	22·23	....	2·50	90·95	2,774·35	1,986·79	....
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	....	....	....	....	....	....	....	378·00	144·01	....
Golden Valley	4484	Great Western Consolidated, N.L.	....	....	2,190·00	100·45	14·39	....	....	2,190·00	100·45	14·39
	4247	Lily of the Valley	....	....	....	....	....	....	....	709·00	177·73	....
	4220	Manxman South	....	....	....	....	....	....	....	19·00	4·42	....
	3266, etc.	Radio Leases	....	....	1,702·00	1,871·15	61·42	....	2·70	37,464·80	60,487·20	1,008·24
		Voided leases	....	....	....	....	....	....	36·34	36,835·92	28,969·41	10·99
		Sundry claims	....	....	5·00	1·05	·20	4·58	241·60	6,673·27	4,945·78	1·74
Greenmount	4433	Sydney	....	....	191·00	23·50	4·97	....	....	393·00	62·58	13·49
		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)	....	....	69,170·00	11,186·80	1,971·51	....	....	106,986·00	16,758·40	3,262·70
		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	2·45	47·71	6·75	14·69	....	21·12	92·06	4,607·27	1,432·52	....
Kennyville	3875	Victoria	....	....	19·00	5·91	....	....	....	5,360·00	1,184·74	·63
		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	4243	Christmas Gift	....	....	....	....	....	....	32·56	137·60	66·99	....
	4434	Cornwall	....	....	2,995·00	239·41	42·25	....	....	17,708·00	2,455·96	527·34
	4449 (13P.P.)	Cricket	....	....	....	....	....	....	....	1,671·00	932·04	....
	4039	Cromwell	....	....	....	....	....	....	....	995·50	159·91	....
	(4436)	Dixie	....	....	38·00	5·52	....	....	....	38·00	5·52	....
	3942, etc.	Edward's Reward Leases	....	....	631·00	164·84	12·24	....	....	68,122·50	29,880·74	62·63
	3942	(Edward's 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	Francis Furness	....	....	460·25	305·74	....	....	....	14,884·50	7,212·56	....
	4428	Great Victoria	....	....	11,732·00	1,252·30	234·32	....	....	12,218·00	1,292·88	242·60
	4375	Great Western Consolidated, N.L. (Nevoria)	....	....	66,221·00	12,120·55	2,095·02	....	....	183,159·00	38,096·54	8,551·94

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.
YILGARN GOLDFIELD—continued												
Marvel Loch— (*continued*)	4446	Great Western Consolidated, N.L.	....	....	....	....	....	....	....	252·00	37·67	7·69
	(4479)	Great Western Consolidated, N.L.	....	....	900·00	86·76	19·55	....	....	900·00	86·76	19·55
	4435	I.X.L.	....	....	21·25	6·16	....	....	....	127·25	20·10	....
	3718	Kurrajong	....	....	6·00	·97	....	....	....	9,293·00	3,281·99	....
	3914	May	....	....	....	....	....	....	....	145·00	45·86	....
	4230	May Queen	....	....	....	....	....	....	....	286·00	43·42	....
	3970	Mountain Queen	....	....	....	....	....	....	....	1,231·00	455·65	....
	(4432)	Mountain Queen North	....	....	....	....	....	....	....	218·00	34·66	7·10
	4384	Newry	....	....	301·00	37·95	....	....	....	860·75	157·22	9·08
	4362	North Star	....	....	....	....	....	....	....	104·00	18·60	....
	4478 (107P.P.)	Patalena	....	9·22	40·25	96·96	....	....	9·22	59·25	100·32	....
	4419	Prince George	....	....	4,140·00	436·40	81·35	....	....	4,140·00	436·40	81·35
	4035	Undaunted	....	....	....	....	....	....	....	865·00	113·59	....
		Voided leases	....	....	....	....	....	....	1,504·26	860,034·48	206,859·69	2,474·95
		Sundry claims	....	....	182·50	31·65	....	11·35	809·31	37,865·11	13,720·75	73·81
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
Mount Palmer	4250	Palmerston	....	....	....	....	....	2·03	....	583·00	97·60	....
	4345	Speedie	....	....	....	....	....	....	....	123·25	40·30	....
	M.L. 4	Yellowdine Gold Development Pty. Ltd.	....	....	....	....	....	....	....	93·00	§136·46	....
		Voided leases	....	....	....	....	....	....	....	306,408·40	158,486·81	....
		Sundry claims	....	....	....	....	....	1,643·48	18·19	450·25	387·14	....
Mount Rankin	4462 (81P.P.)	Golden View	....	228·30	43·00	180·94	....	....	300·46	93·00	267·97	....
	4469 (88P.P.)	Lynette	....	....	53·50	20·14	5·10	....	....	799·50	277·66	16·85
	4461 (76P.P.)	Marjorie Glen Reward	....	....	240·00	203·63	....	....	191·46	3,021·55	3,917·47	....
	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	....
Parker's Range	4485	Constance Una	....	....	42·25	27·25	....	....	....	42·25	27·25	....
	4423	Spring Hill	....	....	147·00	16·56	....	....	....	223·50	43·92	....
		Voided leases	....	....	....	....	....	·42	270·76	63,642·10	32,711·48	26·46
		Sundry claims	....	....	270·50	89·63	....	6·59	303·93	13,169·80	5,583·20	·98
Southern Cross	4424	Excelsior	....	....	93·00	7·48	·81	....	....	115·50	10·85	·81
	4002, etc.	Great Western Consolidated, N.L. (Frasers)	....	....	40,519·00	11,646·75	1,999·72	....	....	160,314·00	53,365·00	13,012·66
		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, etc.	(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	....	....	....	....	....	....	....	95·90	648·49	8,365·16	2,642·05	....
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	....	....	....	....	*1,071·40	178·83	....	....	....	....	*4,210·25	964·42
		Great Western Consolidated Plant (N.G.M. Dump)	....	....	....	....	....	....	....	....	....	....	*276·58	....
		Great Western Consolidated (Fraser's Dump)	....	....	....	....	*3·00	·53	....	....	....	....	*1,357·18	85·92
		Great Western Consolidated (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	....	....	....	....	*130·85	19·78	....	....	....	7·00	*4,001·02	19·78
		Harper's Battery (M.A. 44)	....	....	....	....	*479·51	96·24	....	....	....	....	*479·51	96·24
		State Battery, Marvel Loch	....	....	....	....	*181·08	....	....	....	....	29·00	*1,464·40	....
		Various Works	....	....	....	....	....	....	....	....	....	364·98	*99,250·35	120·01
		Reported by Banks and Gold Dealers	....	....	1·91	....	....	....	325·11	81·41	·60	170·54	....	
		Total	....	....	**4·36**	**285·23**	**413,806·00**	**70,399·58**	**12,059·19**	**2,197·92**	**5,785·99**	**7,340,174·39**	**2,285,513·35**	**188,207·85**

Dundas Goldfield.

Beete	....	G.M.L. 1908	....	Beete	....	....	....	....	67·00	65·92	....	....	....	67·00	65·92	....
		1907	....	Eldridge's Find	....	....	....	....	86·25	84·46	....	....	....	129·25	108·84	....
				Sundry claims	....	....	....	....	16·00	3·71	....	....	....	354·50	375·07	....
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	....	....	68·50	39·92	....	·76	413·85	2,226·75	1,155·88	19·64		
Norseman	....	1288, etc.	....	Central Norseman Gold Corporation, N.L.	....	....	190,679·00	101,290·71	49,115·51	....	....	3,050,129·20	1,347,094·36	919,516·20		
				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	....	....	137·00	6·98	....	....	....	137·00	6·98	....		
				Voided leases	....	....	....	....	....	14·27	10,601·15	915,789·67	601,766·42	39,001·23		
				Sundry claims	....	....	483·75	63·03	....	1,052·09	3,451·55	48,513·20	22,487·94	209·67		
Peninsular	....	....	....	Voided leases	....	....	....	....	....	....	24·29	9,603·39	6,102·61	12·20		
				Sundry claims	....	....	....	....	....	....	....	217·25	119·32	·97		
		From Goldfield generally :														
		Sundry Parcels treated at :														
		State Battery, Norseman	....	....	....	....	....	....	....	....	....	417·89	25,351·51	1,051·13		
		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			
		Total	....	....	....	....	**191,537·50**	**101,554·73**	**49,115·51**	**2,250·77**	**16,328·56**	**5,091,401·62**	**2,316,708·99**	**1,337,252·22**		

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.
Phillips River Goldfield.												
Hatters Hill	....	Voided leases	....	....	....	....	....	....	4·38	1,599·55	1,222·72	....
		Sundry claims	....	....	160·00	16·34	....	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.	....	....	....	‡1,312·74	4,983·21	....	....	....	‡3,825·53	17,331·47
	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	....	....	6·25	2·30	....	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	....	....	....	....	....	164·69	12·31	....	8·47	....
		Total	....	....	**166·25**	**1,331·38**	**4,983·21**	**607·11**	**821·02**	**130,659·24**	**107,900·16**	**33,474·55**
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
Jimperding	45P.P. (1P.P. Avon)	Hillsdale	....	....	....	....	....	....	....	1,261·75	308·00	....
Lake Grace	....	Sundry claims	....	....	8·75	12·20	....	....	....	27·75	17·91	....
Northampton	....	Sundry leases and claims	....	....	....	....	†1,360·44	....	....	....	....	†4,684·46

Ongerup	G.M.L. 103H	Hornblende	....	....	....	....	....	....	....	....	24·50	2·85	....
		Sundry claims	....	....	....	....	....	....	1·58	·33	1·74	....
		From State generally :—											
		Miscellaneous voided leases and sundry claims	....	....	....	....	....	245·83	3·07	210·35	45·19	....
		Sundry specimens	....	....	....	....	....	4·24	56·85	....	....	....
		Various Works	....	....	....	....	....	....	....	27·00	*9,009·75	31,521·73
		Reported by Banks and Gold Dealers	16·37	34·53	....	3·14	....	1,177·55	1,039·33	....	822·30	1,140·93
		Total	**16·37**	**34·53**	**8·75**	**15·34**	**1,360·44**	**1,494·87**	**1,144·84**	**4,368·08**	**11,960·03**	**37,362·30**

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 1960.

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	....	....	....	....	....	....	....	....	18·28	....	....	18·28	....
West Kimberley	....	....	....	....	....	....	....	....	....	....	....	....	....
Pilbara	Marble Bar	3·99	....	1,916·75	714·78	718·77	40·42	13·85	16·88	6,343·84	2,912·84	2,943·57	40·42
	Nullagine	9·86	16·88	4,427·09	2,198·06	2,224·80	....						
West Pilbara	....	....	....	....	....	....	....	1·91	....	20·00	3·45	5·36	·35
Ashburton	....	....	....	....	....	....	....	·55	....	....	....	·55	....
Gascoyne	....	....	....	....	....	....	....	....	1·49	37·00	140·04	141·53	26·92
Peak Hill	....	....	....	....	....	....	....	2·30	....	4,451·00	498·35	500·65	....
East Murchison	Lawlers	21·87	....	630·50	169·69	191·56	....						
	Wiluna	....	....	....	2·57	2·57	....	21·87	....	869·50	359·45	381·32	....
	Black Range	....	....	239·00	187·19	187·19	....						
Murchison	Cue	4·50	....	774·77	308·62	313·12	23·02						
	Meekatharra	2·73	11·01	4,001·35	644·66	658·40	14·60	29·09	11·01	169,117·39	91,929·72	91,969·82	7,202·81
	Day Dawn	....	....	53·25	13·64	13·64	....						
	Mt. Magnet	21·86	....	164,288·02	90,962·80	90,984·66	7,165·19						
Yalgoo	....	....	....	....	....	....	....	1·23	....	....	....	1·23	....
Mt. Margaret	Mt. Morgans	34·28	8·65	106·00	4·57	47·50	....						
	Mt. Malcolm	56·93	12·80	140,429·00	33,966·15	34,035·88	3,138·62	109·23	21·45	140,698·00	33,975·07	34,105·75	3,138·62
	Mt. Margaret	18·02	....	163·00	4·35	22·37	....						
North Coolgardie	Menzies	....	31·92	32,740·75	16,503·92	16,535·84	548·34						
	Ularring	....	....	1,223·50	1,165·28	1,165·28	....	....	31·92	37,672·00	20,218·17	20,250·09	900·20
	Niagara	....	....	659·75	422·56	422·56	....						
	Yerilla	....	....	3,048·00	2,126·41	2,126·41	351·86						
Broad Arrow	....	....	....	....	....	....	....	·12	254·45	4,113·10	1,288·83	1,543·40	18·33
North-East Coolgardie	Kanowna	....	....	545·50	140·60	140·60	....						
	Kurnalpi	....	....	....	....	....	....	....	....	545·50	140·60	140·60	....
East Coolgardie	East Coolgardie	5·30	39·69	2,068,778·20	531,901·38	531,946·37	117,602·26						
	Bulong	....	....	386·25	34·62	34·62	....	5·30	39·69	2,069,164·45	531,936·00	531,980·99	117,602·26
Coolgardie	Coolgardie	1·67	344·61	17,579·25	11,861·85	12,208·13	302·98						
	Kunanalling	·19	....	315·00	133·42	133·61	4·30	1·86	344·61	17,894·25	11,995·27	12,341·74	307·28
Yilgarn	....	....	....	....	....	....	....	4·36	285·23	413,806·00	70,399·58	70,689·17	12,059·19
Dundas	....	....	....	....	....	....	....	....	....	191,537·50	101,554·73	101,554·73	49,115·51
Phillips River	....	....	....	....	....	....	....	....	....	166·25	1,331·38	1,331·38	4,983·21
Outside Proclaimed Goldfield	....	....	....	....	....	....	....	16·37	34·53	8·75	15·34	66·24	1,360·44
Total	....	....	....	....	....	....	....	**208·04**	**1,059·54**	**3,056,444·53**	**868,698·82**	**869,966·40**	**196,755·54**

TABLE III.

Return showing total production reported to the Mines Department, and respective Districts and Goldfields from whence derived, to 31st December, 1960.

Goldfield	District	District: Alluvial	District: Dollied and Specimens	District: Ore Treated	District: Gold Therefrom	District: Total Gold	District: Silver	Goldfield: Alluvial	Goldfield: Dollied and Specimens	Goldfield: Ore Treated	Goldfield: Gold Therefrom	Goldfield: Total Gold	Goldfield: 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	2,918·92	22,751·90	17,240·32	29,155·71	128·76
West Kimberley	....	....	....	....	....	....	....	1·30	24·68	1·00	2·49	28·47	13,575·29
Pilbara	Marble Bar	15,257·26	4,568·60	336,455·47	327,485·96	347,311·82	32,536·96	25,673·76	7,470·61	477,745·76	458,095·13	491,239·50	33,604·26
	Nullagine	10,416·50	2,902·01	141,290·29	130,609·17	143,927·68	1,067·30						
West Pilbara	....	....	....	....	....	....	....	6,339·37	374·74	24,769·96	24,303·97	31,018·08	1,910·06
Ashburton	....	....	....	....	....	....	....	9,267·37	482·46	6,807·10	2,913·43	12,663·26	41,971·38
Gascoyne	....	....	....	....	....	....	....	693·61	113·55	424·00	657·33	1,464·49	26·92
Peak Hill	....	....	....	....	....	....	....	3,384·35	5,300·33	775,095·73	322,007·92	330,692·60	3,768·47
East Murchison	Lawlers	7,069·11	2,343·19	2,012,155·42	822,897·00	832,309·30	27,184·22	8,972·28	22,205·14	12,616,542·08	3,649,982·30	3,681,159·72	60,195·14
	Wiluna	232·63	1,254·11	8,873,578·19	1,872,184·97	1,873,671·71	10,298·63						
	Black Range	1,670·54	18,607·84	1,730,808·47	954,900·33	975,178·71	22,712·29						
Murchison	Cue	5,101·16	9,104·99	6,811,817·31	1,401,634·88	1,415,841·03	274,093·80	25,570·13	59,135·33	13,827,583·72	5,459,372·41	5,544,077·87	477,786·27
	Meekatharra	14,629·56	18,254·55	2,303,722·81	1,307,455·57	1,340,339·68	5,145·85						
	Day Dawn	3,241·76	11,341·63	2,037,218·88	1,375,521·32	1,390,104·71	169,434·20						
	Mt. Magnet	2,597·65	20,434·16	2,674,824·72	1,374,760·64	1,397,792·45	29,112·42						
Yalgoo	....	....	....	....	....	....	....	1,801·76	3,223·19	442,508·08	263,703·11	268,728·06	1,503·16
Mt. Margaret	Mt. Morgans	3,536·25	9,398·51	1,217,427·31	717,672·57	730,607·33	5,812·32	11,691·20	35,417·30	11,068,706·02	4,867,471·09	4,914,579·49	254,249·12
	Mt. Malcolm	4,021·57	16,664·44	7,323,105·47	2,975,754·96	2,996,440·97	182,246·10						
	Mt. Margaret	4,133·38	9,354·35	2,528,173·24	1,174,043·56	1,187,531·29	66,190·70						
North Coolgardie	Menzies	1,685·00	7,014·92	1,772,253·43	1,349,337·46	1,358,037·38	31,859·29	4,844·79	19,856·93	3,534,197·18	2,491,131·89	2,515,833·61	64,020·91
	Ularring	129·52	7,203·12	532,681·70	442,319·95	449,652·56	21,928·23						
	Niagara	1,718·36	1,821·77	941,173·52	527,507·95	531,048·08	5,686·69						
	Yerilla	1,311·91	3,817·12	288,088·53	171,966·53	177,095·56	4,546·70						
Broad Arrow	....	....	....	....	....	....	....	21,981·82	27,729·75	1,356,837·42	739,454·10	789,165·67	5,324·21
North-East Coolgardie	Kanowna	106,530·67	13,526·67	1,008,175·26	626,951·34	747,008·68	3,039·73	119,366·16	21,825·58	1,021,842·58	645,780·05	786,971·79	3,052·44
	Kurnalpi	12,835·49	8,298·91	13,667·32	18,828·71	39,963·11	12·71						
East Coolgardie	East Coolgardie	33,680·20	41,138·13	77,471,466·70	33,906,712·78	33,981,531·11	5,184,177·79	61,085·42	57,172·70	77,659,064·75	34,038,986·77	34,157,244·89	5,184,190·71
	Bulong	27,405·22	16,034·57	187,598·05	132,273·99	175,713·78	12·92						
Coolgardie	Coolgardie	17,018·36	17,973·23	2,896,348·60	1,499,039·87	1,534,031·46	37,096·68	18,539·06	23,611·60	3,260,453·80	1,752,036·62	1,794,187·28	37,852·37
	Kunanalling	1,520·70	5,638·37	364,105·20	252,996·75	260,155·82	755·69						
Yilgarn	....	....	....	....	....	....	....	2,197·92	5,785·99	7,340,174·39	2,285,513·35	2,293,497·26	188,207·85
Dundas	....	....	....	....	....	....	....	2,250·77	16,328·56	5,091,401·62	2,316,708·99	2,335,288·32	1,337,252·22
Phillips River	....	....	....	....	....	....	....	607·11	821·02	130,659·24	107,900·16	109,328·29	33,474·55
Outside Proclaimed Goldfield	....	....	....	....	....	....	....	1,494·87	1,144·84	4,368·08	11,960·03	14,599·74	37,362·30
Total	....	....	....	....	....	....	....	334,759·52	310,943·22	138661934·41	59,455,221·46	60,100,924·20	7,779,456·39

TABLE IV.

Total output of Gold (Bullion and Concentrates entered for Export and Gold reviewed at the Perth Branch of the Royal Mint) from 1st January, 1886, to 31st December, 1960; Showing in Fine Ounces the quantity credited to respective Goldfields.

Year	Export	Mint	Total	Export	Mint	Total
	Kimberley			**Pilbara**		
	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.	Fine ozs.
Prior to 1957	22,422·06	17,026·73	39,448·79	175,464·75	388,012·09	563,476·84
1957	....	69·13	69·13	13·28	787·95	801·23
1958	....	91·82	91·82	21·41	965·91	987·32
1959	....	35·87	35·87	....	1,080·25	1,080·25
1960	....	23·37	23·37	....	3,542·19	3,542·19
Total	22,422·06	17,246·92	39,668·98	175,499·44	394,388·39	569,887·83
	(*a*) **West Pilbara**			**Ashburton**		
Prior to 1957	4,351·11	26,916·02	31,267·13	4,104·96	6,366·23	10,471·19
1957	56·96	....	56·96	....	0·91	0·91
1958	....	15·71	15·71	....	....	....
1959	....	6·88	6·88	....	....	....
1960	....	15·22	15·22	....	0·55	0·55
Total	4,408·07	26,953·83	31,361·90	4,104·96	6,367·69	10,472·65
	(*b*) **Gascoyne**			(*c*) **Peak Hill**		
Prior to 1957	304·55	1,089·57	1,394·12	41,102·76	229,142·77	270,245·53
1957	....	0·60	0·60	....	272·50	272·50
1958	....	5·81	5·81	....	491·05	491·05
1959	....	18·68	18·68	....	448·61	448·61
1960	....	143·37	143·37	....	423·05	423·05
Total	304·55	1,258·03	1,562·58	41,102·76	230,777·98	271,880·74
	East Murchison			**Murchison**		
Prior to 1957	259,726·99	3,024,651·39	3,284,378·38	1,577,518·64	3,865,870·51	5,443,389·15
1957	13·40	228·44	241·84	25·02	89,012·11	89,037·13
1958	6·96	386·84	393·80	31·40	81,793·32	81,824·72
1959	4·85	635·57	640·42	46·30	95,327·82	95,374·12
1960	....	204·93	204·93	130·93	91,880·20	92,011·13
Total	259,752·20	3,026,107·17	3,285,859·37	1,577,752·29	4,223,883·96	5,801,636·25
	(*d*) **Yalgoo**			(*e*) **Mt. Margaret**		
Prior to 1957	13,650·56	197,235·99	210,886·55	695,020·08	3,917,592·42	4,612,612·50
1957	....	108·58	108·58	124·30	32,622·75	32,747·05
1958	....	9·89	9·89	63·50	30,487·16	30,550·66
1959	....	41·51	41·51	78·09	33,821·01	33,899·10
1960	....	3·36	3·36	230·82	33,926·98	34,157·80
Total	13,650·56	197,399·33	211,049·89	695,516·79	4,048,450·32	4,743,967·11
	(*f*) **North Coolgardie**			(*g*) **Broad Arrow**		
Prior to 1957	263,667·84	2,122,064·01	2,385,731·85	122,919·72	447,453·91	570,373·63
1957	....	24,178·72	24,178·72	....	2,548·36	2,548·36
1958	67·08	20,335·49	20,402·57	....	2,203·97	2,203·97
1959	....	21,728·32	21,728·32	....	1,513·24	1,513·24
1960	....	19,931·76	19,931·76	....	1,267·75	1,267·75
Total	263,734·92	2,208,238·30	2,471,973·22	122,919·72	454,987·23	577,906·95
	(*f*) **North-East Coolgardie**			(*f*) **East Coolgardie**		
Prior to 1957	235,893·69	459,850·99	695,744·68	7,035,851·48	26,693,465·64	33,729,317·12
1957	....	105·58	105·58	1,529·11	542,866·97	544,396·08
1958	....	143·84	143·84	688·12	522,852·26	523,540·38
1959	....	193·12	193·12	860·10	512,226·88	513,086·98
1960	....	66·69	66·69	245·03	521,186·91	521,431·94
Total	235,893·69	460,360·22	696,253·91	7,039,173·84	28,792,598·66	35,831,772·50
	(*h*) **Coolgardie**			**Yilgarn**		
Prior to 1957	663,583·18	1,427,561·96	2,091,145·14	220,618·27	1,825,962·17	2,046,580·44
1957	1·05	20,344·33	20,345·38	12·40	84,765·72	84,778·12
1958	21·36	14,512·28	14,533·64	8·63	81,832·96	81,841·59
1959	1·09	17,956·23	17,957·32	....	76,246·91	76,246·91
1960	149·76	12,520·76	12,670·52	....	70,448·45	70,448·45
Total	663,756·44	1,492,895·56	2,156,652·00	220,639·30	2,139,256·21	2,359,895·51
	(*i*) **Dundas**			(*j*) **Phillips River**		
Prior to 1957	170,787·39	1,819,401·08	1,990,188·47	40,651·34	64,373·65	105,024·99
1957	....	95,726·05	95,726·05	266·75	92·49	359·24
1958	....	108,365·64	108,365·64	811·37	1·09	812·46
1959	....	101,623·28	101,623·28	1,331·56	29·90	1,361·46
1960	....	97,340·16	97,340·16	1,312·12	16·34	1,328·46
Total	170,787·39	2,222,456·21	2,393,243·60	44,373·14	64,513·47	108,886·61
				Outside Proclaimed Goldfields		
Prior to 1957				23,139·62	44,217·47	67,357·09
1957				....	907·52	907·52
1958				90·86	881·76	972·62
1959				....	1,352·79	1,352·79
1960				....	747·98	747·98
Total				23,230·48	48,107·52	71,338·00

(*a*) Prior to 1st May, 1898, included with Pilbara, and from 12th July, 1929, to 16th September, 1949, included in Outside Proclaimed Goldfields.
(*b*) Prior to March, 1899, included with Ashburton. (*c*) From 1st August, 1897. (*d*) Prior to 1st April, 1897, included with Murchison.
(*e*) From 1st August, 1897. (*f*) Prior to 1st May, 1896, included with Coolgardie. (*g*) From 1st September, 1897. (*h*) Declared 5th April, 1894, to which date included with Yilgarn. (*i*) Prior to 1893, included with Yilgarn. (*j*) Prior to 1902, included in Outside Proclaimed Goldfields.

TABLE V.

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	1,697,553·59	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	3,598,931
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	842,005·23	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
Total	11,579,022·60	50,056,247·00	61,635,269·60	443,672,124

	1959 £A	1960 £A
Estimated total par value of above production	258,174,663	261,809,692
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	1,203,773	1,204,206
Exchange Premium paid by Mint above par value, 1930–1960 (approximate)	168,332,425	178,068,624
Estimated Total	£A430,300,463	£A443,672,124
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	2,455,981	3,154,223
Gross estimated value of gold won	£A432,917,892	£A446,987,795

TABLE VI.—MINERALS OTHER THAN GOLD

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 1960 and previous years.

Period	Abrasive Silica Stone		Alunite (Crude Potash)		Arsenic*		Antimony†		
	Murchison Goldfield (Mt. Magnet District)		Yilgarn Goldfield		East Murchison Goldfield (Wiluna District)		East Murchison Goldfield		
	Quantity	Value	Quantity	Value	Quantity	Value	Conc.	Metal	Value
	tons	£	tons	£	tons	£	tons	tons	£
Prior to 1957	1·50	9	9,073·05	215,865	‡38,674·08	747,205	7,883·66	3,870·93	157,298
1957	....	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....	....
Total	**1·50**	**9**	**9,073·05**	**215,865**	**38,674·08**	**747,205**	**7,883·66**	**3,870·93**	**157,298**

* By-product by Wiluna G.M.'s Ltd. † By-product of Gold Mining. ‡ Includes 1·13 tons Arsenic valued at £24 from Yilgarn Goldfield.

Period	Antimony*						Asbestos	
	Pilbara Goldfield			Total			Ashburton Goldfield	
	Conc.	Metal	Value	Conc.	Metal	Value	Quantity	Value
	tons	tons	£	tons	tons	£	tons	£
Prior to 1957	1,919·80	796·44	84,599	†9,829·69	4,680·63	242,497	10·10	959
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**1,919·80**	**796·14**	**84,599**	**9,829·69**	**4,680·63**	**242,497**	**10·10**	**959**

* By-product of Gold Mining. † Includes 26·23 tons Conc. containing 13·56 tons metal valued at £600 from West Pilbara Goldfield.

Period	Asbestos—*continued*							
	Pilbara Goldfield		West Pilbara Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	2,279·81	76,624	33,709·93	3,875,070	501·10	6,732	36,509·19	3,959,426
1957	360·52	8,031	12,133·66	1,229,670	....	....	12,494·18	1,237,701
1958	170·02	3,743	13,094·89	1,339,633	....	....	13,264·91	1,343,376
1959	34·35	721	15,277·48	1,627,821	....	....	15,311·83	1,628,542
1960	....	....	12,982·85	1,420,369	....	....	12,982·85	1,420,369
Total	**2,844·70**	**89,119**	**87,198·81**	**9,492,563**	**501·10**	**6,732**	**90,562·96**	**9,589,414**

* Includes 8·25 tons valued at £41 from East Coolgardie Goldfield.

Period	Barytes							
	Murchison Goldfield		North-East Coolgardie Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	546·84	2,695	52·22	430	1,633·65	11,726	2,232·71	14,851
1957	....	....	....	....	140·00	910	140·00	910
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**546·84**	**2,695**	**52·22**	**430**	**1,773·65**	**12,636**	**2,372·71**	**15,761**

Period	Bauxite		Bentonite		Beryl Ore			
	Outside Proclaimed Goldfield		Outside Proclaimed Goldfield		Pilbara Goldfield		Ashburton Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	....	....	5,810·91	20,225	1,610·58	156,265	0·14	25
1957	....	....	741·79	2,982	284·05	52,129	....	....
1958	....	....	37·00	153	130·40	23,942	....	....
1959	....	....	133·00	532	199·09	35,636	5·24	964
1960	26,892·00	*	382·00	1,533	73·75	13,143	0·33	63
Total	**26,892·00**	*	**7,104·70**	**25,425**	**2,297·87**	**281,115**	**6·71**	**1,052**

* Not available for publication.

Table VI.—*Minerals other than Gold*—continued.

Period	Beryl—*continued*							
	Gascoyne Goldfield		West Kimberley Goldfield		West Pilbara Goldfield		Murchison Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	191·57	19,928	3·50	297	....	....	25·14	1,027
1957	22·73	4,399	....	....	....	....	....	....
1958	18·34	3,827	....	....	....	....	....	....
1959	45·51	8,470	....	....	....	....	....	....
1960	95·41	17,833	0·98	190	2·33	409	0·44	85
Total	**373·56**	**54,457**	**4·48**	**487**	**2·33**	**409**	**25·58**	**1,112**

Period	Beryl Ore—*continued*							
	Yalgoo Goldfield		Coolgardie Goldfield		Phillip's River Goldfield		Outside Proclaimed Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	13·81	2,376	165·13	17,369	....	....	10·00	92
1957	·58	109	42·40	7,469	....	....	0·61	127
1958	1·06	197	20·23	3,834	....	....	....	....
1959	2·60	488	14·04	2,454	....	....	·23	40
1960	1·25	223	0·75	121	5·93	957	....	....
Total	**19·20**	**3,393**	**242·55**	**31,247**	**5·93**	**957**	**10·84**	**259**

Period	Beryl—*continued*		Bismuth		Building Stone		Calcite	
	Total		Gascoyne Goldfield		Outside Proclaimed Goldfield		Mt. Margaret Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	lb.	£	tons	£	tons	£
Prior to 1957	2,019·87	197,379	7,982	1,884	....	....	5·00	25
1957	350·37	64,233	....	....	....	....	....	....
1958	170·03	31,801	3,310	1,475	....	....	....	....
1959	266·71	48,052	....	....	....	....	....	....
1960	181·17	33,024	....	....	40·00	1,300	....	....
Total	**2,988·15**	**374,489**	**11,292**	**3,359**	**40·00**	**1,300**	**5·00**	**25**

Period	Chromite		Clays (Various)					
	Peak Hill Goldfield		Murchison Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	13,106·75	187,300	41·75	207	234,118·50	187,850	*235,211·05	188,795
1957	1,312·30	20,996	....	....	29,400·70	34,171	29,400·70	34,171
1958	....	....	....	....	33,796·96	39,269	33,796·96	39,269
1959	....	....	....	....	52,011·10	61,950	52,011·10	61,950
1960	....	....	....	....	58,357·50	60,244	58,357·50	60,244
Total	**14,419·05**	**208,296**	**41·75**	**207**	**407,684·76**	**383,484**	**408,777·31**	**384,429**

* Includes 1,050·80 tons valued at £738 from Collie Mineral Field.

Period	Coal		Copper Ore					
	Collie Coalfield		Pilbara Goldfield		West Pilbara Goldfield		Ashburton Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	26733171·56	33,726,361	131·85	5,653	82,758·77	749,156	378·07	6,937
1957	838,660·53	2,552,657	459·10	21,013	381·75	8,966	4·59	325
1958	870,882·45	2,280,649	....	....	6·75	210	....	....
1959	911,434·52	2,356,534	....	....	....	....	....	....
1960	922,393·50	2,439,195	....	....	....	....	....	....
Total	**30276542·56**	**43,355,396**	**590·95**	**26,666**	**83,147·27**	**758,332**	**382·66**	**7,262**

Table VI.—*Minerals other than Gold*—continued.

Period	Copper Ore—*continued*							
	Mt. Margaret Goldfield		Phillips River Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	47,861·82	231,003	95,935·93	590,237	184·09	2,386	254,105·57	1,768,810
1957	19·92	404	558·83	13,189	....	....	1,803·97	58,564
1958	....	....	1,726·71	53,265	....	....	*1,801·95	54,424
1959	....	....	4,408·75	230,078	....	....	4,408·75	230,078
1960	....	....	3,552·13	199,007	....	....	3,552·13	199,007
Total	**47,881·74**	**231,407**	**106,182·35**	**1,085,776**	**184·09**	**2,386**	†265,671·84	**2,310,883**

* Including 264·83 tons valued at £6,906 from East Murchison Goldfield, 68·49 tons valued at £949 from Peak Hill Goldfield, 9·35 tons valued at £193 from Yalgoo Goldfield, and 9·44 tons valued at £201 from Northampton Mineral Field. †Including 109·52 tons valued at £1,709 from West Kimberley Goldfield, 649·73 tons valued at £14,089 from East Murchison Goldfield, 91·70 tons valued at £1,004 from Yalgoo Goldfield, 6·12 tons valued at £51 from North Coolgardie Goldfield, 50·67 tons valued at £379 from East Coolgardie Goldfield, 16·00 tons valued at £77 from Yilgarn Goldfield, 1,295·27 tons valued at £49,888 from Peak Hill Goldfield, 24,035·69 tons valued at £119,698 from Northampton Mineral Field, 1,053·61 tons valued at £12,157 from Murchison Goldfield.

Period	Copper (Metallic By-product)		Corundum		Cupreous Ore (Fertiliser)			
	Coolgardie Goldfield		East Murchison Goldfield		West Pilbara Goldfield		Pilbara Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	....	....	‡63·15	655	12,266·46	92,523	3,020·87	76,040
1957	....	....	....	....	629·86	5,380	1,859·93	41,814
1958	....	....	....	....	225·25	4,985	1,713·98	37,892
1959	....	....	....	....	263·71	5,141	4,902·72	96,086
1960	4·72	731	....	....	1·85	64	2,573·86	71,763
Total	**4·72**	**731**	**63·15**	**655**	**13,387·13**	**108,093**	**14,071·36**	**323,595**

‡ Includes 9·15 tons valued at £275 from West Kimberley Goldfield.

Period	Cupreous Ore (Fertiliser)—*continued*							
	Ashburton Goldfield		Peak Hill Goldfield		East Murchison Goldfield		Murchison Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	67·90	840	6,366·43	94,200	3,161·12	52,635	1,638·46	15,075
1957	....	....	1,464·37	20,352	575·54	10,504	....	....
1958	....	....	4,624·54	51,875	737·79	9,161	85·80	1,768
1959	....	....	6,187·47	73,923	155·15	1,745	152·10	1,808
1960	54·15	1,947	4,258·94	51,889	....	....	218·00	2,302
Total	**122·05**	**2,787**	**22,901·75**	**292,239**	**4,629·60**	**74,045**	**2,094·36**	**20,953**

Period	Cupreous Ore (Fertiliser)—*continued*							
	Yalgoo Goldfield		Mt. Margaret Goldfield		Broad Arrow Goldfield		East Coolgardie Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	57·29	390	325·64	2,422	34·59	379	29·00	100
1957	....	....	9·60	163	....	....	....	....
1958	43·09	637	....	....	....	....	....	....
1959	112·56	2,221	20·66	178	....	....	....	....
1960	419·78	7,415	24·54	183	51·79	549	....	....
Total	**732·72**	**10,663**	**370·44**	**2,946**	**86·38**	**928**	**29·00**	**100**

Period	Cupreous Ore (Fertiliser—*continued*)							
	Dundas Goldfield		Phillips River Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	12·69	117	368·47	8,422	57·79	524	27,687·38	344,221
1957	....	....	99·39	3,913	1·19	22	4,638·69	82,127
1958	....	....	211·17	8,337	....	....	7,643·72	114,670
1959	....	....	64·43	2,904	....	....	11,858·80	184,006
1960	....	....	122·90	4,140	....	....	7,726·81	140,252
Total	**12·69**	**117**	**866·36**	**27,716**	**58·98**	**546**	*59,555·40	**865,276**

* Includes 64·97 tons valued at £345 from Yilgarn Goldfield; 21·79 tons valued at £186 from Northampton Mineral Field; and 2·10 tons valued at £16 from Gascoyne Goldfield.

Table VI.—*Minerals other than Gold*—continued.

Period	Diamonds		Diatomaceous Earth		Dolomite		Emerald	
	Pilbara Goldfield		Outside Proclaimed Goldfield		Murchison Goldfield		Murchison Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	carats	£	tons	£	tons	£	carats (cut and rough)	£
Prior to 1957	*	24	411·00	5,861	2,007·90	8,884	22,123·00	1,609
1957	....	....	....	....	60·00	239	....	....
1958	....	....	....	....	196·00	786	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	403·92	1,616	....	....
Total	....	**24**	**411·00**	**5,861**	**2,667·82**	**11,525**	**22,123·00**	**1,609**

* Not recorded.

Period	Emerald—*continued*				Emery		Felspar	
	Pilbara Goldfield		Total		West Kimberley Goldfield		Goolgardie Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	carats (cut and rough)	£	carats (cut and rough)	£	tons	£	tons	£
Prior to 1957	8·68	313	22,131·68	1,922	21·15	375	55,905·80	179,625
1957	....	....	....	....	....	....	995·00	4,611
1958	....	....	....	....	....	....	673·00	3,062
1959	....	....	....	....	....	....	1,393·00	6,338
1960	....	....	....	....	....	....	1,942·00	8,283
Total	**8·68**	**313**	**22,131·68**	**1,922**	**21·15**	**375**	**60,908·80**	**201,919**

Period	Felspar—*continued*				Fergusonite		Fuller's Earth	
	Outside Proclaimed Goldfield		Total		Pilbara Goldfield		Outside Proclaimed Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	628·41	1,427	56,542·21	181,084	0·30	391	*81·51	344
1957	....	....	995·00	4,611	....	....	40·13	201
1958	7·60	30	680·60	3,092	....	....	....	....
1959	2·80	14	1,395·80	6,352	....	....	....	....
1960	....	....	1,942·00	8,283	....	....	....	....
Total	**646·81**	**1,503**	**61,555·61**	**203,422**	**0·30**	**391**	**121·64**	**545**

* Including 30 tons valued at £86 from Broad Arrow Goldfield.

Period	Gadolinite		Glass Sand		Glauconite		Graphite	
	Pilbara Goldfield		Outside Proclaimed Goldfield		Outside Proclaimed Goldfield		Outside Proclaimed Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	1·00	112	50,668·36	37,085	6,016·00	129,101	148·10	1,267
1957	....	....	5,692·86	3,914	126·00	5,040	5·10	37
1958	....	....	6,420·41	4,267	112·00	5,590	....	....
1959	....	....	6,827·54	4,555	102·00	5,103	....	....
1960	....	....	8,636·95	6,102	111·00	5,550	....	....
Total	**1·00**	**112**	**78,246·12**	**55,923**	**6,467·00**	**150,384**	**153·20**	**1,304**

Period	Gypsum							
	Yilgarn Goldfield		Dundas Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	297,744·00	231,712	2,078·00	1,336	222,425·00	234,218	522,247·00	467,267
1957	27,843·00	21,234	....	....	5,510·40	4,733	33,353·00	25,967
1958	21,953·00	16,544	4,984·00	14,894	8,578·00	8,696	35,515·00	40,134
1959	23,553·00	17,733	11,169·00	33,495	3,009·00	2,979	37,731·00	54,207
1960	25,386·00	19,222	....	....	5,488·00	5,703	44,216·00	55,628
Total	**396,479·00**	**306,445**	**18,231·00**	**49,725**	**245,010·00**	**256,329**	**673,062·00**	**643,203**

Table VI.—*Minerals other than Gold*—continued.

Period	* Iron Ore (for Pig Iron)						Iron Ore (exported)	
	Yilgarn Goldfield		Outside Proclaimed Goldfield		Total		West Kimberley Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	96,265·25	1,215,826	47,508·57	296,734	143,773·82	1,512,560	2,362,435·00	2,341,686
1957	21,838·50	324,646	....	....	21,838·50	324,646	389,686·00	386,440
1958	30,075·00	458,561	....	....	30,075·00	458,561	536,713·00	532,355
1959	57,206·00	808,644	....	....	57,206·00	808,644	672,239·00	666,601
1960	79,085·00	1,098,825	....	....	79,085·00	1,098,825	837,147·00	830,124
Total	**284,469·75**	**3,906,502**	**47,508·57**	**296,734**	**331,978·32**	**4,203,236**	**4,798,220·00**	**4,757,206**

* Excludes Iron Ore used as Flux :—Yilgarn Goldfield, 84·35 tons valued at £128 ; West Pilbara Goldfield, 100·00 tons valued at £300 ; East Coolgardie Goldfield, 450·00 tons valued at £247 ; West Kimberley Goldfield, 10·50 tons valued at £12 ; Greenbushes Mineral Field, 7,481·00 tons valued at £4,629 ; and Outside Proclaimed Goldfields, 49,938·50 tons valued at £31,732.

Period	Jarasite		Kyanite		Lead Ore and Concentrates		Silver Lead Ore and Concentrates	
	Phillips River Goldfield		Outside Proclaimed Goldfield		Northampton Mineral Field		Ashburton Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	9·45	37	4,215·69	21,781	*442,958·57	3,449,722	7,073·14	343,360
1957	....	....	....	....	3,322·51	256,214	197·43	15,965
1958	....	....	....	....	2,312·92	131,612	109·45	7,553
1959	....	....	....	....	1,440·52	69,899	41·50	2,492
1960	....	....	....	....	2,259·86	119,139	....	....
Total	**9·45**	**37**	**4,215·69**	**21,781**	**452,294·38**	**4,026,586**	**7,421·52**	**369,370**

* Includes 12·19 tons valued at £13 from State generally.

Period	Silver Lead Ore and Concentrates—*continued*							
	Kimberley Goldfield		Pilbara Goldfield		West Pilbara Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	9·26	652	3,611·79	239,997	178·42	7,754	10,885·71	592,716
1957	....	....	657·62	44,161	1·63	126	856·68	60,252
1958	....	....	70·06	734	....	....	179·51	8,287
1959	....	....	420·87	17,039	....	....	462·37	19,531
1960	....	....	....	....	....	....	3·83	153
Total	**9·26**	**652**	**4,760·34**	**301,931**	**180·05**	**7,880**	***12,388·10**	**680,939**

* Includes 5·50 tons valued at £295 from Peak Hill Goldfield and 11·43 tons valued at £221 from Gascoyne Goldfield.

Period	Silver Lead Zinc Ore and Concentrates—*continued*							
	West Kimberley Goldfield		Pilbara Goldfield		Northampton Mineral Field		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	1,844·14	46,734	94·42	5,488	105·36	3,983	2,043·92	56,205
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**1,844·14**	**46,734**	**94·42**	**5,488**	**105·36**	**3,983**	**2,043·92**	**56,205**

	Limestone							
	Murchison Goldfield		Yilgarn Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	298·00	772	2,548·00	1,607	90,859·00	15,911	93,705·00	18,290
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	11,327·75	14,935	11,327·75	14,935
Total	**298·00**	**772**	**2,548·00**	**1,607**	**102,186·75**	**30,846**	**105,032·75**	**33,225**

Table VI.—*Minerals other than Gold*—continued.

Period	Magnesite							
	East Coolgardie Goldfield		Coolgardie Goldfield		Outside Proclaimed Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	1,831·26	3,268	2,789·37	7,534	4,269·82	9,718	8,890·45	20,520
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	*18·50	74
1960	....	....	....	....	....	....	....	....
Total	**1,831·26**	**3,268**	**2,789·37**	**7,534**	**4,269·82**	**9,718**	**8,908·95**	**20,594**

* From Phillips River Goldfield.

Period	Manganese (Metallurgical, Battery and Low Grades)						Mica	
	Pilbara Goldfield		Peak Hill Goldfield		Total		Outside Proclaimed Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	lb.	£
Prior to 1957	24,101·25	360,778	160,977·56	1,672,970	185,123·66	2,034,040	†32,930·00	3,984
1957	13,496·14	227,329	50,440·92	702,491	63,937·06	929,820	....	....
1958	22,372·52	389,482	39,400·91	570,834	61,809·43	960,474	....	....
1959	39,266·84	662,219	30,705·80	358,573	69,980·24	1,020,824	....	....
1960	42,411·09	616,898	11,377·75	136,107	53,788·84	753,005	....	....
Total	**141,647·84**	**2,256,706**	**292,902·94**	**3,440,975**	***434,639·23**	**5,698,163**	**32,930·00**	**3,984**

* Includes 20 tons valued at £180 from Mt. Margaret Goldfield and 24·85 tons valued at £112 from Outside Proclaimed Goldfield, and 43·60 tons valued at £190 from East Coolgardie Goldfield. † Includes 7,868 lb. Crude Mica. Also includes 31·25 lb. Mica valued at £5 from West Kimberley Goldfield.

Period	* Mineral Beach Sands—Outside Proclaimed Goldfield							
	Ilmenite Concentrates		Monazite Concentrates		Rutile Concentrates		Zircon Concentrates	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	3,293·40	15,150	....	....	....	....	....	....
1957	40,931·99	233,475	....	....	....	....	....	....
1958	82,926·27	448,218	....	....	....	....	....	....
1959	73,627·67	353,076	109·55	7,210	297·45	8,423	4,068·34	41,129
1960	114,661·72	485,562	241·96	9,319	621·41	15,686	4,624·45	49,270
Total	**315,441·05**	**1,535,481**	**351·51**	**16,529**	**918·96**	**24,109**	**8,692·79**	**90,399**

* Excluding 155·95 tons of mixed concentrates valued at £776.

Period	Mineral Beach Sands—Outside Proclaimed Goldfield		Ochre					
	Leucoxene Concentrates		West Pilbara Goldfield		Murchison Goldfield		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	....	....	3,800·45	47,931	4,440·30	44,186	*8,386·71	93,027
1957	....	....	....	....	27·30	273	27·30	273
1958	....	....	....	....	189·30	1,893	189·30	1,893
1959	276·25	3,930	....	....	104·00	1,040	104·00	1,040
1960	20·10	392	....	....	104·00	1,040	104·00	1,040
Total	**296·35**	**4,322**	**3,800·45**	**47,931**	**4,864·90**	**48,432**	**8,811·31**	**97,273**

* Includes 20·61 tons valued at £330 from Kimberley Goldfield ; 2·10 tons valued at £15 from Pilbara Goldfield ; 11·00 tons valued at £66 from Yalgoo Goldfield ; 10·40 tons valued at £83 from North-East Coolgardie Goldfield ; 65·85 tons valued at £308 from East Coolgardie Goldfield ; and 36·00 tons valued at £108 from Outside Proclaimed Goldfield.

Period	Petallite		Phosphatic Guano		Pyrites			
	Coolgardie Goldfield		Outside Proclaimed Goldfield		Dundas Goldfield		East Coolgardie Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	20·19	121	10,799·73	59,174	567,799·00	3,349,209	12,542·98	57,103
1957	....	....	586·89	8,974	45,342·00	327,761	12,575·72	54,806
1958	67·77	293	169·65	1,827	38,915·00	303,340	10,473·64	48,507
1959	....	....	....	....	38,909·00	302,719	14,121·39	69,270
1960	....	....	86·79	938	39,003·00	294,120	14,295·79	72,619
Total	**87·96**	**414**	**11,643·06**	**70,913**	**729,968·00**	**4,577,149**	**64,009·52**	**302,305**

Table VI.—*Minerals other than Gold*—continued.

Period	Pyrites—*continued*		Quartz Grit		Semi-Precious Stones			
	Total		Collie Coalfield		Chrysoprase East Coolgardie Goldfield		Opaline East Coolgardie Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	lb.	£	lb.	£
Prior to 1957	†654,389·54	3,451,808	....	....	....	....	....	....
1957	57,917·72	382,567	....	....	....	....	....	....
1958	49,388·64	351,847	90·00	75	5·00	5	25·00	4
1959	53,030·39	371,989	312·00	260	....	....	....	....
1960	53,298·79	366,739	288·00	243	....	....	....	....
Total	**868,025·08**	**4,924,950**	**690·00**	**578**	**5·00**	**5**	**25·00**	**4**

† Includes 74,047·56 tons values at £45,496 from Mt. Margaret Goldfield.

Period	Semi-Precious Stones—*continued*				Sillimanite		Soapstone	
	Prase Coolgardie Goldfield		Tiger Eye Opal Gascoyne Goldfield		Outside Proclaimed Goldfield		Greenbushes Mineral Field	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	lb.	£	lb.	£	tons	£	tons	£
Prior to 1957	....	....	....	....	2·00	13	517·00	1,778
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	2,240·00	40	120·00	97	....	....	....	....
Total	**2,240·00**	**40**	**120·00**	**97**	**2·00**	**13**	**517·00**	**1,778**

Period	Soapstone—*continued*		Spodumene		Talc			
	Total		Phillips River Goldfield		East Coolgardie Goldfield		Outside Proclaimed Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	*565·40	1,928	3·89	57	1,213·56	5,148	14,073·66	194,532
1957	....	....	....	....	175·45	877	3,478·20	49,029
1958	....	....	....	....	....	....	2,500·67	35,304
1959	....	....	....	....	....	....	4,047·69	58,085
1960	....	....	....	....	....	....	5,470·39	69,114
Total	**565·40**	**1,928**	**3·89**	**57**	**1,389·01**	**6,025**	**29,570·61**	**406,064**

* Including 48·40 tons valued at £150 from Outside Proclaimed Goldfields.

Period	Talc—*continued*		Tanto/Columbite					
	Total		Pilbara Goldfield		Greenbushes Mineral field		Gascoyne Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	15,287·22	199,680	361·98	317,206	65·70	70,460	0·80	1,038
1957	3,653·65	49,906	5·55	4,662	16·50	6,546	....	....
1958	2,500·67	35,304	4·03	6,923	2·00	1,628	....	....
1959	4,047·69	58,085	3·10	4,343	5·36	5,489	....	....
1960	5,470·39	69,114	6·03	12,848	4·54	4,134	....	....
Total	**30,959·62**	**412,089**	**380·69**	**345,982**	**94·10**	**88,257**	**0·80**	**1,038**

Period	Tanto/Columbite—*continued*						Tin	
	Coolgardie Goldfield		Phillips River Goldfield		Total		Greenbushes Mineral Field	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	8·03	14,014	0·84	3,420	437·35	406,138	11,806·57	1,246,617
1957	....	....	0·23	622	22·28	11,330	49·09	29,749
1958	....	....	....	....	6·03	8,551	14·24	6,434
1959	....	....	....	....	8·46	9,832	22·95	12,818
1960	....	....	....	....	10·57	16,982	20·14	11,411
Total	**8·03**	**14,014**	**1·07**	**4,042**	**484·69**	**453,333**	**11,912·99**	**1,307,029**

Table VI.—*Minerals other than Gold*—continued

Period	Tin—*continued*							
	Kimberley Goldfield		West Kimberley Goldfield		Pilbara Goldfield		West Pilbara Goldfield	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	0·83	302	0·43	314	6,590·14	908,192	2·48	1,615
1957	....	....	....	....	221·16	125,330	....	....
1958	....	....	....	....	123·96	70,886	....	....
1959	....	....	....	....	226·75	141,911	....	....
1960	....	....	....	....	260·68	157,364	....	....
Total	**0·83**	**302**	**0·43**	**314**	**7,422·69**	**1,403,683**	**2·48**	**1,615**

Period	Tin—*continued*				Tungsten (Scheelite)			
	East Murchison Goldfield		Total		Pilbara Goldfield		East Murchison Goldfield	
	Quantity	Value	Quantity	Value	Conc.	Value	Conc.	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	0·69	225	18,406·67	2,157,722	1·68	1,867	0·06	52
1957	....	....	270·25	155,079	0·19	138	....	....
1958	....	....	138·20	77,319	....	....	....	....
1959	....	....	249·70	154,729	....	....	....	....
1960	....	....	280·82	168,775	....	....	....	....
Total	**0·69**	**225**	***19,345·64**	**2,713,624**	**1·87**	**2,005**	**0·06**	**52**

* Includes 4·78 tons valued at £395, 0·15 tons valued at £15, and 0·60 tons valued at £46 from Murchison, Coolgardie and Yilgarn Goldfields, respectively.

Period	Tungsten (Scheelite)—*continued*							
	Yalgoo Goldfield		Mt. Margaret Goldfield		North Coolgardie Goldfield		Coolgardie Goldfield	
	Conc.	Value	Conc.	Value	Conc.	Value	Conc.	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	3·02	1,093	2·95	3,730	15·48	10,104	24·30	8,479
1957	....	....	....	....	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**30·2**	**1,093**	**2·95**	**3,730**	**15·48**	**10,104**	**24·30**	**8,479**

Period	Tungsten (Scheelite)—*continued*				Tungsten (Wolfram)			
	Yilgarn Goldfield		Total		Pilbara Goldfield		Murchison Goldfield	
	Conc.	Value	Conc.	Value	Ore and Conc.	Value	Ore and Conc.	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	106·79	39,125	*155·51	64,702	24·61	45,078	248·82	14,740
1957	....	....	0·19	138	....	....	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**106·79**	**39,125**	**155·70**	**64,840**	**24·61**	**45,078**	**248·82**	**14,740**

* Includes 0·16 tons valued at £59 from Murchison Goldfield, 1·01 tons valued at £175 from Broad Arrow Goldfield and 0·08 tons valued at £19 from Dundas Goldfield.

Period	Tungsten (Wolfram)—*continued*				Vermiculite		Zinc Ore (Fertiliser)	
	Yalgoo Goldfield		Total		Outside Proclaimed Goldfield		Pilbara Goldfield	
	Ore and Conc.	Value	Ore and Conc.	Value	Quantity	Value	Quantity	Value
	tons	£	tons	£	tons	£	tons	£
Prior to 1957	1·74	1,522	*303·93	61,759	1,831·92	11,822	20·00	100
1957	....	....	....	....	1·04	9	....	....
1958	....	....	....	....	....	....	....	....
1959	....	....	....	....	....	....	....	....
1960	....	....	....	....	....	....	....	....
Total	**1·74**	**1,522**	**303·93**	**61,759**	**†1,832,96**	**11,831**	**20·00**	**100**

* Includes 28·48 tons valued at £331 from West Kimberley Goldfield and 0·28 tons valued at £88 from Board Arrow Goldfield. † Includes 127·16 tons valued at £882 from East Coolgardie Goldfield and 20 tons valued at £60 from Yilgarn Goldfield.

TABLE VII.

Quantity and Value of Minerals, other than Gold, reported during the year 1960

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer.	Quantity.	Metallic Content.	Value.
		ASBESTOS (Chrysotile)	Tons		£A
M.C. 48, etc.	West Pilbara	Hancock, L. G.	61·26	....	(*b*) 1,602·10
		ASBESTOS (Crocidolite)			
M.C. 22, etc.	West Pilbara	Australian Blue Asbestos Ltd.	12,921·59	....	1,418,767·18 (*b*)
		BAUXITE (*f*)			
M.L. 385H, etc.	O.P.G. (Dwellingup, etc.)	Western Aluminium, No Liability	26,892·00	See	Footnote
	Footnote.—Assay Al_2O_3 and Value not available for publication.				
		BENTONITE			
M.C. 437H, etc.	O.P.G. (Marchagee)	Noonan, E. J.	382·00	....	(*a*) 1,533·00
		BERYL (*f*) (*g*)		BeO Units	
Crown Lands	West Kimberley	Sundry Persons	0·98	11·74	190·20
Crown Lands	Pilbara	Sundry Persons	62·55	695·09	11,160·11
M.C. 614	Pilbara	Butterfield, D. J.	2·84	33·12	511·85
M.C. 304	Pilbara	White, A. L.	4·09	50·55	780·85
M.L. 370	Pilbara	Stein, L. C. and S. K.	0·34	4·48	69·20
M.C. 116	Pilbara	Tabba Tabba Mining Syndicate	1·97	19·65	303·60
M.C. 312	Pilbara	Hall, Walkerden and Crawford	1·96	19·65	316·90
Crown Lands	West Pilbara	Sundry Persons	2·33	25·37	409·00
Crown Lands	Ashburton	Sundry Persons	0·33	4·09	63·30
P.A. 35	Gascoyne	Lee, E.	1·00	10·31	166·30
P.A. 36	Gascoyne	Poland, W. C.	10·15	119·98	1,933·25
P.A. 38	Gascoyne	Williams, R.	0·33	4·43	71·40
P.A. 40	Gascoyne	Kempton, T. L.	0·34	4·04	65·15
P.A. 41	Gascoyne	Kempton Bros.	21·17	266·12	3,847·05
Crown Lands	Gascoyne	Sundry Persons	62·42	737·58	11,749·50
Crown Lands	Murchison	Sundry Persons	0·44	5·26	84·80
P.A. 3645	Yalgoo	Little, C., and Todd, D.	1·25	14·46	223·45
M.L. 80, etc.	Coolgardie	Australian Glass Mnfrs. Co. Pty. Ltd.	0·75	8·97	121·05
P.A. 839	Phillips River	Beavis, R. J.	5·93	66·37	956·60
			181·17	2,101·26	(*b*) 33,023·56
		BUILDING STONE			
M.C. 677H	O.P.G. (Jerramungup)	Crawford Quarries Pty. Ltd.	30·00	....	1,000·00
M.C. 680H	O.P.G. (Karlgarin)	Crawford Quarries Pty. Ltd.	10·00	....	300·00
			40·00	....	(*c*) 1,300·00
		CLAYS (Cement Clay)			
Freehold Land	O.P.G. (Maida Vale)	D. F. D. Rhodes Pty. Ltd.	7,923·00	....	4,479·00
M.C. 492	O.P.G. (Gosnells	Cockburn Cement Ltd.	5,092·00	....	6,365·00
			13,015·00	....	(*c*) 10,844·00
		CLAYS (Fireclay)			
M.C. 685H	O.P.G. (Byford)	Kargotich, T., J., P., and S.	6,000·00	....	9,000·00
M.C. 304H, etc.	O.P.G. (Clackline)	Clackline Refractories Ltd.	1,614·00	....	1,614·00
Loc. 84	O.P.G. (Glen Forrest)	Darling Range Firebrick Co. Pty. Ltd.	752·50	....	714·85
M.C. 522H, etc.	O.P.G. (Byford)	Bridge, J. S., and T. D.	9,415·00	....	13,259·45
M.C. 585H	O.P.G. (Glen Forrest)	Le Vaux, M. L.	2,565·00	....	1,923·75
			20,346·50	....	(*c*) 26,512·05
		CLAYS (*Brick, Pipe and Tile Clay)			
M.C. 690H	O.P.G. (Byford)	Swaby, F. W.	6,000·00	....	7,500·00
M.C. 672H, etc.	O.P.G. (Caversham)	Stoneware Pipes and Tiles Pty. Ltd.	4,034·00	....	4,034·00
Lots 169, etc.	O.P.G. (Greenmount)	Stoneware Pipes and Tiles Pty. Ltd.	1,293·00	....	1,745·00
Lot 137	O.P.G. (Red Hill)	Stoneware Pipes and Tiles Pty. Ltd.	8,255·00	....	8,255·00
M.C. 584H	O.P.G. (Bickley)	Orange Grove Bricks Pty. Ltd.	5,414·00	....	1,354·00
			24,996·00	....	(*c*) 22,888·00

* Incomplete.—Figures relate only to production reported from holdings under the Mining Act.

Table VII.—*Minerals other than Gold*—continued

Quantity and Value of Minerals, other than Gold, reported during the year 1960

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer	Quantity	Metallic Content	Value
		COAL	Tons		£A
M.L. 292, etc.	Collie	Amalgamated Collieries of W.A. Ltd.	610,894·40	....	1,669,126·55
M.L. 314, etc.	Collie	Griffin Coal Mining Co.	148,092·70	....	322,101·70
M.L. 437, etc.	Collie	Western Collieries Ltd.	163,406·40	....	447,966·90
			922,393·50	....	2,439,195·15 (*e*)
		COPPER ORE AND CONCENTRATES (*f*) (*g*)		Copper Units	
M.C. 35, etc.	Phillips River	Ravensthorpe Copper Mines, N.L.	3,552·13	90,596·00	(*b*) 199,007·40
		Silver and Gold content transferred to respective items.			
		COPPER ORE (Metallic by-product) (*f*) (*g*) (*j*)		Copper Tons	
G.M.L. 5873, etc.	Coolgardie	Northern Mineral Syndicate	....	*4·72	(*b*) 731·30
		* From Gold/Concentrates exported.			
		Silver and Gold content transferred to respective items.			
		CUPREOUS ORE AND CONCENTRATES (Fertilizer)		Av. Assay Cu%	
P.A. 2614	Pilbara	Henderson, J. M.	28·46	13·84	747·70
G.M.L. 314L	Pilbara	Copper Hills Copper Mine	2,499·41	12·69	68,566·95
P.A. 803L	Pilbara	Napier, G. A.	11·92	21·77	599·25
P.A. 794L	Pilbara	Clark, J.	34·07	22·76	1,848·70
P.A. 257	West Pilbara	Watkins, D. C.	1·85	11·80	63·85
P.A. 323	Ashburton	Devenish, G., and Cumming, C.	12·00	13·97	320·95
Crown Lands	Ashburton	Sundry Persons	2·52	17·40	91·05
P.A. 322	Ashburton	Yaksich, A.	39·63	17·73	1,535·00
P.A. 3651	Murchison	Seivwright, K.	6·85	6·10	50·50
P.A. 3507N	Murchison	Grylls, West, Vicini, and Facer	30·45	5·82	193·40
M.C. 15N	Murchison	Cawse, L. W., and Rixon, K. D.	15·77	9·35	239·85
G.M.L. 1990N	Murchison	Motter, Z.	164·93	7·65	1,818·65
M.C. 63P	Peak Hill	Parkinson, L. T.	447·25	15·80	19,277·45
M.L. 68P	Peak Hill	Thaduna Copper Mining Co.	3,520·43	6·75	29,651·95
P.A. 883P	Peak Hill	Rooney, J. P.	21·34	6·45	182·50
M.C. 65P	Peak Hill	Ricci, A.	269·92	7·55	2,776·80
M.C. 14	Yalgoo	O'Callaghan and Howlett	414·05	10·15	7,333·70
P.A. 2565	Yalgoo	Todd and Hodder	5·73	8·90	81·50
P.A. 1661F	Mt. Margaret	Marion, J. S.	25·54	6·23	182·95
P.A. 5240W	Broad Arrow	Burkett, R. C.	51·79	7·79	549·15
M.C. 35, etc.	Phillips River	Ravensthorpe Copper Mines, N.L.	77·40	9·14	2,041·65
M.L. 410	Phillips River	New Surprise Copper Mine	41·10	16·07	1,980·55
M.C. 41	Phillips River	Kuzmins, W.	4·40	13·80	118·30
			7,726·81	9·70	140,252·35 (*a*) (*b*)
		DOLOMITE			
M.L. 9, etc.	Murchison	Westralian Ores Pty. Ltd.	403·92	....	(*a*)(*b*) 1,615·80
		FELSPAR			
M.L. 80, etc.	Coolgardie	Australian Glass Mnfrs. Co. Pty. Ltd.	1,942·00	....	(*a*) 8,283·42
		GLASS SAND			
M.C. 417H, etc.	O.P.G. (Lake Gnangara)	Australian Glass Mnfrs. Co. Pty. Ltd.	8,018·45	....	5,212·00
M.C. 365H, etc.	O.P.G. (Lake Gnangara)	Leach, R. J.	542·50	....	813·75
M.C. 161H, etc.	O.P.G. (Lake Gnangara)	Leach, L. J.	76·00	....	76·00
			8,636·95	....	(*c*) 6,101·75
		GLAUCONITE	Greensand Treated	Glauconite Recovered Tons	
Private Property	O.P.G. (Gingin)	Brook, G. E.	555·00	111·00	(*b*)(*d*) 5,550·00

Table VII.—*Minerals other than Gold*—continued

Quantity and Value of Minerals, other than Gold, reported during the year 1960

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer	Quantity	Metallic Content	Value
		GYPSUM	Tons		£A
M.C. 30, etc.	Yilgarn	Ajax Plaster Co. Pty. Ltd.	6,161·00	....	5,082·00
M.C. 51, etc.	Yilgarn	H. B. Brady & Co. Pty. Ltd.	8,051·00	....	6,038·25
M.C. 9, etc.	Yilgarn	Perth Modelling Works	11,174·00	....	8,101·15
M.C. 126H, etc.	O.P.G. (Baandee)	Perth Modelling Works	674·00	....	606·60
M.C. 612H, etc.	O.P.G. (Lake Cowcowing)	Hewitt, B.	3,639·00	....	4,127·00
M.C. 485H	O.P.G. (Nukarni)	Fitzgerald, E. J.	1,175·05	....	969·35
M.C. 25, etc.	Dundas	Garrick Agnew Pty. Ltd.	13,342·30	....	30,703·39
			44,216·35	....	55,627·74 (*a*) (*b*)

Includes 13,342·30 tons for Export.
Plaster of Paris reported as Manufactured during the year being 20,236·00 tons from 27,671·00 tons of Gypsum.

		IRON ORE (for Pig)			
Temp. Res. 1258H	Yilgarn	Charcoal Iron and Steel Industry	79,085·00	Pig Iron Recovered 52,325·00	1,098,825·00 (*c*) (*d*)

Average Assay of Ore Used = 61·90% Fe.

		IRON ORE (for Export)			
M.L. 10, etc.	West Kimberley	Australian Iron and Steel Ltd.	837,147·00	Av. Assay Fe% 63·29	(*b*) 830,124·00

Number of Lease, Claim or Area	Goldfield or Mineral Field	Registered Name of Producer	Ore and Conc. Tons	Lead		Silver	
				Tons	Value £A	Fine ozs.	Value £A
		LEAD ORE AND CONCENTRATES (*f*) (*g*)					
M.L. 256, etc.	Northampton	Gurkha Lead Mine Pty. Ltd.	1,539·62	1,201·59	82,998·25	1,009·41	398·75
Vic. Loc. 436	Northampton	Wheel of Fortune Extended Lead Mine	582·83	433·20	29,583·15	277·86	111·70
M.L. 234	Northampton	Mary Springs Lead Mine	137·41	101·23	6,557·35	73·17	29·00
			2,259·86	1,736·02	(*b*) 119,138·75	1,360·44	539·45

Silver :—Quantity and Value transferred to Silver Item.

				SILVER/LEAD ORE AND CONCENTRATES (*f*) (*g*)						
M.C. 4	Gascoyne	McDonald, A.	3·83	2·61	(*b*)	153·05	26·92	10·45

Silver :—Quantity and Value transferred to Silver Item.

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer	Quantity	Metallic Content	Value
		LIMESTONE *	Tons		£A
M.C. 432H	O.P.G. (Wanneroo)	Anticich, J.	390·15	....	390·15
M.C. 461H	O.P.G. (Forrestdale)	Lime Fertilizers (W.A.)	57·10	....	47·25
M.C. 532H	O.P.G. (Wanneroo)	Gibbs, C. E. and A. J.	851·00	....	1,063·75
M.C. 575H, etc.	O.P.G. (Wanneroo)	Susac, F. and Y.	2,580·00	....	3,225·00
M.C. 684H	O.P.G. (Wanneroo)	Cooper, D. B.	3,847·50	....	4,809·35
M.C. 692H, etc.	O.P.G. (Wanneroo)	Franconi, D. and S.	3,080·00	....	4,401·00
M.C. 702H	O.P.G. (Wanneroo)	Makrides, J.	461·00	....	922·00
M.C. 728H	O.P.G. (Wanneroo)	Llewellyn, A. W.	61·00	....	76·25
			11,327·75	....	(*c*) 14,934·75

* Incomplete :—Figures relate only to production reported from holdings under the Mining Act.

		MANGANESE (METALLURGICAL GRADE) (*f*)			
M.C. 268, etc.	Pilbara	Northern Mineral Syndicate	29,425·14	Av. Assay Mn% 51·32	448,761·70
M.L. 194L, etc.	Pilbara	D. F. D. Rhodes Pty. Ltd.	8,230·00	51·69	118,688·00
M.L. 244L, etc.	Pilbara	Westralian Ores Pty. Ltd.	21·00	44·05	520·00
M.C. 517, etc.	Pilbara	Pindan Pty. Ltd.	4,734·95	46·23	48,928·50
M.C. 24P, etc.	Peak Hill	Westralian Ores Pty. Ltd.	10,264·00	44·24	125,908·00
			52,675·09	49·54	(*b*) 742,806·20

Table VII.—*Minerals other than Gold*—continued

Quantity and Value of Minerals, other than Gold, reported during the year 1960

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer	Quantity	Metallic Content	Value
MANGANESE (BATTERY GRADE)					
			Tons	Assay MnO_2%	£A
M.L. 61P	Peak Hill	Westralian Ores Pty. Ltd.	11·00	78·18	(*b*) 228·00
MANGANESE (LOW GRADE)					
				Av. Assay Mn%	
M.C. 24P, etc.	Peak Hill	Westralian Ores Pty. Ltd.	1,102·75	Not known	(*a*) 9,970·35
MINERAL BEACH SANDS (ILMENITE) (*f*)					
				TiO_2 Assay	
M.C. 516H, etc.	O.P.G. (Capel)	Western Titanium, N.L.	62,727·68	55·01	See Footnote
D.C. 56H	O.P.G. (Bunbury)....	Cable (1956) Ltd.	19,857·95	55·22	
D.C. 13H, etc.	O.P.G. (Wonnerup)	Ilmenite Pty. Ltd.	22,757·00	53·86	
M.C. 619H, etc.	O.P.G. (Yoganup)....	Westralian Oil Ltd.	9,319·09	59·67	
			114,661·72	55·20	(*b*)485,562·25
Footnote :—Current Values for separate Companies not available for publication.					
MINERAL BEACH SANDS (MONAZITE) (*f*) (*g*)					
				ThO_2 Units	
M.C. 516H, etc.	O.P.G. (Capel)	Western Titanium, N.L.	241·96	1,553·05	(*b*) 9,319·20
MINERAL BEACH SANDS (RUTILE) (*f*) (*g*)					
				TiO_2 Tons	
M.C. 516H, etc.	O.P.G. (Capel)	Western Titanium, N.L.	621·41	599·77	(*b*)15,686·05
MINERAL BEACH SANDS (LEUCOXENE) (*f*) (*g*)					
M.C. 516H, etc.	O.P.G. (Capel)	Western Titanium, N.L.	20·10	18·46	(*b*) 391·80
MINERAL BEACH SANDS (ZIRCON) (*f*) (*g*)					
				ZrO_2 Tons	
M.C. 516H, etc.	O.P.G. (Capel)	Western Titanium, N.L.	4,624·45	3,037·07	(*b*) 49,269·55
OCHRE—RED					
M.C. 26, etc.	Murchison	Zadow, J. C.	104·00	....	(*a*) 1,040·00
PHOSPHATIC GUANO					
M.C. 486H	O.P.G. (Jurien Bay)	Smith, B. D.	53·29	....	639·50
M.C. 714H	O.P.G. (Jurien Bay)	Ward, R. J.	33·50	....	298·45
			86·79	....	(*a*)(*c*) 937·95
PYRITES ORE AND CONCENTRATES (*g*)					
				Sulphur Content—Tons	
G.M.L. 5345, etc.	East Coolgardie	Gold Mines of Kalgoorlie (Aust.) Ltd.	14,295·79	5,809·55	72,619·39
G.M.L. 1460, etc.	Dundas	Norseman Gold Mines, N.L.	39,003·00	18,430·50	294,120·00
			53,298·79	24,240·05	(*a*)366,739·39
QUARTZ GRIT					
Q.A. 2	Collie	Rowden, E.	288·00	....	(*c*) 243·00
SEMI-PRECIOUS STONES (PRASE)					
			Lb.		
P.A. 7431	Coolgardie	Evans, B. H.	2,240·00	....	(*a*) 40·00
SEMI-PRECIOUS STONES (TIGER EYE OPAL)					
M.C. 22	Gascoyne	McNamara, P. O.	120·00	....	(*b*) 97·00
SILVER					
			Fine ozs.		
		By-product of Gold Mining	187,451·06	....	78,018·55
		By-product of Copper Mining	4,983·21	....	2,044·35
		By-product of Lead Mining	1,360·44	....	539·45
		By-product of Silver/Lead Mining	26·92	....	10·45
			193,821·63	....	80,612·80

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Table VII.—*Minerals other than Gold*—continued

Quantity and Value of Minerals, other than Gold, reported during the year 1960

Number of Lease, Claim, or Area	Goldfield or Mineral Field	Registered Name of Producer	Quantity	Metallic Content	Value
		TALC			
			Tons		£A
Loc. M839	O.P.G. (Three Springs)	Three Springs Talc Pty. Ltd.	5,470·39	....	(*c*) 69,113·85
		TANTO/COLUMBITE ORES AND CONCENTRATES (*f*) (*g*)			
				Assayed Ta_2O_5 Content—Units	
M.C. 290	Pilbara	Pinchin, F. A. D.	1·49	75·47	2,428·20
M.C. 116	Pilbara	Tabba Tabba Mining Syndicate	2·93	186·98	7,645·30
Crown Lands	Pilbara	Sundry Persons	1·61	78·94	2,774·95
M.C. 69, etc.	Greenbushes	Austin Bros.	(*k*) 2·40	101·28	2,609·80
L.T.T. 1399H	Greenbushes	Coghlan, R. J.	(*k*) 2·14	70·71	1,524·10
			10·57	513·38	(*b*) 16,982·35
		TIN (*f*) (*g*)			
			Tons	Tons	£A
D.C. 43, etc.	Pilbara	Northern Mineral Syndicate	98·69	66·52	57,853·00
D.C. 201, etc.	Pilbara	Mineral Concentrates Pty. Ltd.	44·22	30·63	27,623·90
D.C. 254	Pilbara	Johnston, J. A.	49·42	33·19	29,834·50
D.C. 48, etc.	Pilbara	Pilbara Exploration, N.L.	24·57	15·77	14,045·35
D.C. 16, etc.	Pilbara	Leonard, H. V.	27·94	19·72	17,896·92
P.A. 2611	Pilbara	McLeod, D. W.	0·55	0·37	324·40
Crown Lands	Pilbara	Sundry Persons	15·29	10·78	9,786·15
M.C. 69, etc.	Greenbushes	Austin Bros.	17·22	10·65	9,604·20
L.T.T. 1399H	Greenbushes	Coghlan, R. J.	0·49	0·33	293·45
Crown Lands	Greenbushes	Sundry Persons	2·43	1·57	1,513·00
			280·82	189·53	(*b*) 168,774·87

REFERENCES

O.P.G. Denotes 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 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 VIII.

SHOWING AVERAGE NUMBER OF MEN EMPLOYED ABOVE AND UNDER GROUND IN THE LARGER GOLDMINING COMPANIES OPERATING IN WESTERN AUSTRALIA DURING THE YEARS FROM 1951 TO 1960 INCLUSIVE.

COMPANY	1951			1952			1953			1954			1955			1956			1957			1958			1959			1960		
	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 Mng. Pty.	....	....	....	47	4	51	37	5	42	28	6	34	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
†Boulder Perseverance, Ltd.	115	119	274	151	115	266	155	112	267	152	114	266	171	114	285	181	113	294	....	....	....	....	....	....	....	....	....	....	....	....
Broken Hill Pty. Co., Ltd.	13	12	25	6	....	6	4	....	4	2	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Blue Spec Gold Mines, Ltd.	33	21	54	36	21	57	33	15	48	30	15	45	17	9	26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Big Bell Mines, Ltd.	230	240	470	203	205	408	200	215	415	179	167	346	44	16	60	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Burbidge Gold Mines, N.L.	2	....	2	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consolidated Gold Area, N.L.	3	1	4	1	....	1	1	1	2	1	2	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Comet Gold Mines, Ltd.	13	11	24	10	8	18	10	6	16	4	2	6	3	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Central Norseman Gold Corporation, N.L.	148	226	374	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
Eclipse Gold Mines, N.L.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	27	8	35	17	10	27	17	15	32
Golden Horseshoe (New), Ltd.	39	....	39	38	....	38	42	....	42	42	....	42	39	....	39	35	....	35	6	....	6	....	....	....	....	....	....	....	....	....
Gold Mines of Kalgoorlie, Ltd.	181	191	372	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
Great Boulder Pty., Ltd.	311	354	665	344	339	683	349	359	708	342	372	714	350	379	729	349	380	729	330	400	730	323	387	710	308	399	707	290	385	675
*Great Western Consolidated	125	72	197	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
Hill 50 Gold Mine, N.L.	62	41	103	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
†Kalgoorlie Enterprise, Ltd.	8	85	93	8	93	101	8	98	106	8	89	97	7	101	108	8	100	108	....	....	....	....	....	....	....	....	....	....	....	....
§Kalgurli Ore Treatment Co., Ltd.	77	....	77	81	....	81	77	....	77	78	....	78	65	....	65	40	....	40	33	....	33	28	....	28	....	....	....	....	....	....
Lake View and Star, Ltd.	492	517	1,009	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
Moonlight Wiluna Gold Mines, Ltd. (Timoni)	42	42	84	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
Mountain View Gold, N.L.	13	7	20	5	3	8	4	6	10	3	6	9	3	1	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mt. Charlotte (Kalgoorlie) Gold Mines, N.L.	2	....	2	2	3	5	3	6	9	3	2	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
North Kalgurli (1912), Ltd.	133	348	481	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
Northern Minerals Syndicate Ltd. (Paris Mine)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6	4	10	15	11	26
Gold Mines of Kalgoorlie (Aust.), Ltd. (Barbara and Bayleys Leases)	73	120	193	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
New Coolgardie Gold Mines, N.L. (Callion Leases)	6	21	27	6	29	35	7	34	41	9	42	51	8	35	43	3	11	14	....	....	....	....	....	....	....	....	....	....	....	....
Ora Banda Amalgamated, Ltd.	1	....	1	1	....	1	3	2	5	1	2	3	....	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Paringa Mining and Exploration Co., Ltd.	47	46	93	10	6	16	2	2	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Porphyry (1939) Gold Mines, Ltd.	6	1	7	1	....	1	3	3	6	2	2	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Radio Gold Mines	5	3	8	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
†South Kalgurli Consolidated	124	110	234	67	102	169	67	107	174	64	106	170	53	99	152	13	84	97	....	....	....	....	....	....	....	....	....	....	....	....
Sons of Gwalia, Ltd.	121	129	250	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
Sunshine Reward Amalgamated Leases	10	7	17	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
Wiluna Gold Mines, Ltd.	20	....	20	13	....	13	2	1	3	1	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
All other Operators	883	664	1,547	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
State Average (incl. Diggers)	3,378	3,388	6,766	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

* 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.

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