DEPARTMENT OF MINES
SOUTH AUSTRALIA

THE INVESTIGATION OF IRON FORMATIONS IN THE MULGATHING DISTRICT

(Tarcoola 4-Mile Sheet)

by

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ABSTRACT

Detailed geological mapping has identified a metamorphosed iron formation thought to be equivalent to the Middleback Group of Eyre Peninsula. Four diamond drill holes have given complete intersections of the Mt. Christie, Fingerpost Hill and George Hill Deposits. District reserves lie in the range 5-15M tons/100'. Grade may approximate 40% Fe. There has been considerable surface enrichment.

The deposits are uneconomic and the reservation can be reduced in area so as to cover only the gold, copper and tin mineralisation at Tarcoola, Earea Dam and Glenloth.

INTRODUCTION

In an attempt to find useful new deposits of iron ore in South Australia, the Department of Mines has carried out an extensive prospecting programme for iron. The publicity resulting from this work encouraged private prospecting. In August 1955 Mr. R.G. Law of Bookabie submitted a sample of iron ore from Mt. Christie for assay and petrological examination. Mt. Christie is on Mulgathing Station 70 air-miles W.N.W. of Tarcoola. In November 1955 a geological reconnaissance of the Mt. Christie area was made in the company of Mr. Law. (Crawford, 1957). While no large high grade deposits were found to exist it was recognised that the province could contain commercial iron orebodies.

An aeromagnetic survey of the Tarcoola District was carried out by Adastra Hunting Pty. Ltd. for the Department in April 1956. As soon as the first sheets were available (February, 1958) geological reconnaissances were initiated (Whitten, 1958). Following publication of the aeromagnetic sheets a more complete inspection was made by the writer in November-December 1959 (Whitten, 1960). This was followed by a visit in September 1960 to collect bulk samples of surface material for metallurgical testing from Mt. Christie, Hill Eleven and Wilgena Hill and to reconnoitre the Tallaringa - Coober Pedy area which had meanwhile been covered by an aeromagnetic survey.

In December 1960 restrictions on the export of iron ore from Australia were lifted. On 9th January 1961 the writer, assisted by G.R. Heath, Geologist, initiated detailed mapping in the Mt. Christie District. This was followed by diamond drilling, metallurgical testing and an appraisal of the whole Tarcoola district which was later summarised in a report for distribution to mining companies (Whitten, 1962). The present report gives details of the deposits and drilling results for that part of the Tarcoola District in the north-west corner of Mulgathing Station.

The assistance of locals in particular the managers of Mulgathing and Commonwealth Hill Stations is gratefully acknowledged. Analytical and Petrological Reports have been provided by officers of the Australian Mineral Development Laboratories.

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LOCATION, ACCESS, TITLE ETC.

The area being considered lies on Christie, Coates, Muckanippie and Mulgathing 1-mile sheets and comprises the northwesterly portion of Mulgathing station. Access is by rail or main road to Malbooma Railway siding 337 miles from Pt. Pirie, thence NNW by an excellently graded station road for 30 miles to Mulgathing Homestead. All the deposits lie near station tracks, now usually graded and suitable for two-wheel-drive vehicles. During the early stages of the investigation access was not easy and four-wheel-drive vehicles were a necessity. The writer personally established tracks through scrub to Mt. Christie, George Hill and Fingerpost Hill. Plan 59-129 shows the geographic distribution of the outcrops discussed.

The climate is severe with long hot summers and short mild winters. The area lies between the 5" and 7" isohets; the evaporation rate is approximately 76". Vegetation is sparse and includes mulga, myall, mallee, saltbush and after rain, desert grasses.

Wool growing is the only industry. Distribution of sheep is dependent on the water supply but averages 20 per square mile. When first visited Mulgathing was the most westerly station along the Transcontinental railway. In recent years a further 1000 s. miles has been taken up to the west and attached to Commonwealth Hill Station.

The Tarcoola District was reserved from operation of the Mining Act in 1956. The area reserved was reduced in 1961.

PREVIOUS INVESTIGATIONS

McDouall Stuart, Ross and Giles crossed the area in 1858, 1874 and 1875 (twice) respectively. Brown (Government Geologist) reported gold from Tarcoola in 1894 and produced the first geological map. He also passed through the area in 1897, 1900, 1901, 1904. Jack in 1930, Ward in 1946 and Anderson in 1949 assessed the water resources of the Tarcoola District. Ridgway and Johns and various Inspectors of Mines reported on mining activities at Tarcoola, Glenloth and Earea Dam. See Whitten (1960) for these references.

Crawford (1957) carried out reconnaissance mapping of Mt. Christie in 1955 but the significance of beneficiation type ore was not then appreciated.

REGIONAL GEOLOGY AND GEOPHYSICS

Geophysics

The first regional information available was on the 1-mile aeromagnetic maps (Webb, 1958) produced by the Exploration Geophysics Section of the Department from the aeromagnetic survey carried out by Adastra Hunting Pty. Ltd. in 1957. On the 4-mile compilation from these maps (Plan 59-402 not appended) the iron formations can be recognised by high intensity anomalies which are elongate. These occur in a background of more moderate magnetic intensity typified by anomalies of large area and more gentle gradients.

Running SW-NE across the Tarcoola 4-mile Sheet are 2, possibly 4 or 5, zones breaking up the regional pattern. These breaks run SW-NE and are 15-20 miles apart. This compares with a periodicity of 15 - 16.7 miles (with harmonics of 4.16 miles) calculated by Horton et al (1964) for one profile 185 miles long in northwestern Canada. Affleck (1963) has found by statistical analysis that there is a marked similarity in magnetic structure all over the earth. His conclusions reveal a periodicity of about 4 miles and a preferred anomaly orientation of N-S, E-W, NW-SE and NE-SW. The writer considers that the 4 mile periodicity is probably minor and due to rock types and builds up into a 15 or 30 mile periodicity as is evident e.g. in the NW-SE trends in the Andamooka - Torrens aeromagnetic survey. It is thought that the 15 or 30-mile periodicity is not due to lithology but is related to systematic tectonic lineaments and to rotational and tidal forces.

Geology

In November - December 1959 the writer carried out a reconnaissance of the district aimed at confirming the cause of the aeromagnetic anomalies. In the course of this and later work a stratigraphic column has been determined in relation to known data on Eyre Peninsula (See Plan 65-98).

Outcrops through the district are scattered and usually of one rock type at each outcrop so that correlation between outcrops is difficult. The oldest known rocks are metasediments which are assumed to rest on an earlier basement. The sediments now consist of quartzites, shales and jaspilites near Tarcoola passing upwards into schists and metajaspilites to the north-west. There is a zone of iron formation outcrops trending north-west from fine grained jaspilites east of and at Wilgena Hill through medium grained varieties near Muckanippie and West Well passing into coarse grained granulitic metajaspilites enclosed in coarse grained gneiss at Mt. Christie. Thus the grade of metamorphism increases as Mt. Christie is approached.

These sediments dip steeply and may rest on or be intruded by granite but no positive evidence of intrusion has been seen. However, age dating of igneous rocks at Warna Well has given an age of 1600 M years approximately the same as that for the Charleston Granite south of the Middleback Ranges. It is not known if the Wynbring or Malbooma granites (15 miles south and 50 miles south-east of Mt. Christie respectively) are of this age.

It must be assumed however that the regional metamorphism and granitisation which has recrystallised the jaspilites at Mt. Christie is of this age or slightly earlier. Such metamorphics could then be correlated with the Gneiss Complex in the Middleback Ranges and the Flinders Group in Southern Eyre Peninsula. (See Plan 65-98). The writer correlates the Wilgena Hill Jaspilites (and hence the Mt. Christie metajaspilites) with the Middleback Jaspilites on lithology.

Unconformably overlying the jaspilite sequence at Wilgena Hill and granite at Tarcoola is the Tarcoola Series. The lowest member is a basal conglomerate or grit made up of fragments of unmetamorphosed jaspilite and quartzite in a ground mass containing abundant coarse grained fresh felspar crystals and angular quartz grains. It passes up through quartzite, slates and graphitic slates. This part of the sequence contains the gold mineralisation of the Tarcoola Mines. Dolomite quarried 3-4 miles west of Tarcoola may belong to this sequence. The dips are generally 45° in contrast to the jaspilite sequence which is uniformly steeply dipping.

Plan 65-98 correlates the Tarcoola Series with the Corunna Conglomerate of the Middleback area on lithology.

The jaspilite sequence and the Tarcoola Series at Wilgena Hill have been intruded by dykes of porphyry. (See description of P 527/60 attached). Large areas of porphyry also occur northwest of Tarcoola (e.g. at Birthday Trig.) and south east of Tarcoola (e.g. N.West Arm Trig) (See Petrological Descriptions P 303, 304/62 attached). Their general lithology (porphyritic rhyolite) suggests close correlation with the Gawler Range Porphyry now renamed Gawler Range Volcanics. Thirty-one miles south of Kingoonya nearer the main mass welded tuff of the same composition outcrops. (P305/62).

Microdiorite, generally similar to this porphyry, intrudes the Tarcoola Series at the Tarcoola Mine and granite at Glenloth. Gold occurs in both localities (in quartz veins at Tarcoola and porphyry at Glenloth) and presumably is related to this age of intrusion.

No evidence of sedimentation equivalent to the Adelaide System has been recognised. Sixty miles north-north-east of Mt. Christie Permian sediments have been identified from 167' to 3140' in the Lake Phillipson Bore. The extent of these Permian basins is not known.

In the northeast of the Tarcoola 4-mile sheet sediments of the Great Australian Artesian Basin blanket bedrock.

Elsewhere they may exist as scattered remnants forming low rises. Near Mt. Christie itself they are not important, the nearest significant outcrop being Coates Hill approximately 10 miles to the east of Mt. Christie.

Water boring on the southern and eastern margins of Mulgathing Station has intersected lignite of presumed Tertiary age. A Departmental drilling programme to assess reserves penetrated lignite, sands, silts and clays but did not extend the known occurrences so that the extent of Tertiary basins is unknown.

Most of the area is covered by poorly consolidated sands and clays. A lateritic or travertine sheet frequently exists a few feet below the surface and persists over wide areas. Salt lakes are common. Recent sand dunes cover an area running NW across the area south of a line joining Tarcoola and Mt. Christie. Frequency varies but may be sufficient to prevent land use. Amplitude varies to 100' and may hamper travel.

MT. CHRISTIE GROUP

This group of iron formation outcrops lies approximately 30 miles west of Mulgathing Homestead in Mt. Christie and Spitfire paddocks of Mulgathing Station and in the adjacent paddock on Commonwealth Hill Station (See Plans 59-129 and 65-99).

The area is sand plains with occasional basement outcrops. Vegetation is mainly mulga with saltbush and blue bush.

Outcrops are scattered and consist mainly of meta-jaspilite. However, gneiss or "granite" with a prominent planar feature forms the largest outcrop in the district one mile south of Mt. Christie as well as a number of minor ones. This material is a metasediment of the almandine-amphibolite facies formed by metamorphism of clastic sediments (See P11/61 attached). A similar rock type with less garnet outcrops along the southern boundary of Mt. Christie paddock and also indicates a metasedimentary origin.

The jaspilite has been recrystallised during this metamorphism. The quartz now averages 500 microns in grain size and the magnetite (partly altered to martite) 100-500 microns. The main outcrops are on noses of folds, less frequently on limbs and usually so separated as to be difficult to integrate into a structural picture.

The area has been covered by 1-mile aeromagnetic plans (Webb, 1958) and the investigation of the anomalies thereon has resulted in the discovery of a large number of smaller outcrops. Because of outcrop there has been no systematic ground geophysics although the writer has run dip needle traverses over all the main outcrops or at their ends to elucidate structure. In the case of Mt. Christie itself the traverses north of the outcrop do not identify iron formation. This suggests that the metajaspilite has reacted to form non-magnetic iron silicates or has been assimilated completely. Similar observations have been made by McPharlin (See Miles, 1954) in reference to discontinuous outcrops of jaspilite surrounded by gneiss in the Camel Hill Line west of the Middlebacks.

The practical aspect of this is that the boundary between the Hutchison Group and the Flinders Group is a metamorphic one and the Middleback Group possibly could be looked upon as an upper (but not necessarily the uppermost) formation in the Gneiss Complex in the Middlebacks. Certainly the granulitic meta-jaspilite at Mt. Christie appears to be the same horizons as Wilgena Hill. Thus a different terminology based on metamorphism is undesirable for the two localities in the Tarcoola District. (See Plan 65-98).

Mt. Christie

Geology

Mt. Christie itself consists of granulitic meta-jaspilite striking 15° magnetic and dipping 75° west. It outcrops over a strike length of 2200' and to a maximum width of 240' in a hill 70'-110' above plain. The area has been mapped on 100 Scale (See Plan 61-318).

Complex folds outcrop near the Trig Station and 300' further north but these appear to be minor folds on a limb structure. On the northern part of the outcrop there are several zones, 10'-20' wide, containing no outcrop. It was thought that these could indicate schist bands or dykes. However later drilling (CD 1) did not intersect such rock types, wider than a foot or two. Consequently these areas are now thought to be higher grade zones of metajaspilite, i.e. bands with insufficient silica to outcrop strongly. Such higher grade material outcrops poorly immediately west of the main outcrop and created difficulties in determining true width during mapping. Immediately east of the main outcrops are small (1' x 1') outcrops of very weathered granitoid rocks. Four hundred feet east of the main outcrop is coarse grained "granite". This is thought to be a metasediment and has been correlated with the main gneiss outcrop one mile to the south.

Crawford (1957) sampled 6 lines across the outcrop with the following results.

Element	Mean %	Range %
Fe	52.4	44.5 - 58.1
Mn	0.04	0.03 - 0.06
SiO_2	19.3	8.44 - 33.1
CaO	0.28	0.12 - 0.52
MgO	0.11	0.06 - 0.17
Al_2O_3	1.86	1.62 - 2.64
P_2O_5	0.28	0.12 - 0.75
TiO_2	0.055	0.03 - 0.08
S	0.035	0.02 - 0.06
H_2O	2.65	1.41 - 3.85
H_2O and 105°C	0.13	0.06 - 0.29

These lines average over 10% higher in iron than the drill core obtained later.

Geophysics

Five reconnaissance dip needle traverses were made, two over the two drill holes, one over the small outcrop to the south and two north of the main outcrop. The first three were duplicated at a later date by C.H. Baget (Geophysicist) using a Jalander magnetometer. The profiles obtained are similar in detail and suggest very approximately a relationship of 200 gammas/1 degree. see Plan 61-318 for details.

Drilling

Two diamond drillholes were laid out to test the main outcrop. Summarised logs are:-

CD 1	CD 2	Log
0 - 71.5'	0 - 143'	Decomposed schist.
71.5'- 150'	-	Medium grained martite and magnetite metajaspilite.
150 - 250'	143'- 259'	Coarse grained magnetite metajaspilite with occasional acid veinlets.
250' - 301'	259'- 348'	Medium and coarse grained magnetite metajaspilite with much chlorite and numerous acidic and one basic dyke.
301' - 349'	348'- 386.5'	Medium to coarse grained pink and grey "granite" with garnets.
End	End	

Plans S 4142, 4143 contain sections on both these holes. The relevant magnetic profiles are plotted on the 100 scale plan 61-318. Drilling has confirmed a horizontal width of 250' approximately compared with 240' as mapped on the surface.

Grade

The core from CD 1 was split in 10' intervals and sent for sampling and metallurgical investigation. See Appendix B. The core from CD 2 has been retained whole.

Summarised Assay results from CD 1 are:-

Footage	Acid Soluble Iron	Insoluble
70' - 150'	40.2%	36.8%
150' - 250'	36.7	43.9

(contd. over)

(contd.)

Footage	Acid Soluble Iron	Insoluble
Average 70 - 250'	38.2	40.7
250 - 300'	18.6	51.5
Average 70 - 300'	33.9	45.7

"Total iron" assays for the zone 250' - 300' averaged 4.2% higher than "acid soluble iron" (See AMDL Reports) whereas for the other zones there is little difference. This results from the higher proportion of ferruginous silicates from 250' to 300'. The average grade of this zone is also lower because of the numerous acidic and basic dykes.

Reserves

Accepting an outcrop length of 2200' and a factor of 10 c.ft./ton, a horizontal width of 250' gives reserves in the range 2½ - 5 million tons/100' depending on continuity. Both CD1 and CD2 ran out of ore at 250' approximately below the surface.

Metallurgy

Testing was carried out on a 15 tons surface sample collected under the supervision of the writer and on drill core from CD1. Whitten (1962) summarises results from Sandman (1961), Moskovits (1961), Bollen (1961-62) and McPheat (1961).

Dry magnetic separation, Humphrey Spirals and Flotation on the 15 ton surface sample produced concentrates with grades ranging from 56.4% to 64.9% Fe and with recoveries ranging from 57.9 to 97.2%. Dry magnetic separation on drill core grouped 70' - 150', 150' - 250', 250' - 300' produced concentrates grading from 55.6 to 64.9% Fe with recoveries from 70.3 to 89.9%. Humphrey Spiral Batch Tests produces concentrates grading from 60.2 to 60.5% Fe with recoveries from 45.8 to 79.2%.

Fingerpost Hill etc

Geology

One and three quarter miles north-north-west of Mt. Christie is an anticline of granulitic metajaspilite plunging north-east at 30°. This forms a hill rising 50-100' above plain level and named Fingerpost Hill. Outcrop conditions for the iron formation are good apart from a narrow zone near the base of the sequence. However no other rock type outcrops. The area is in low scrub. The outcrop has been mapped on 100 scale (See Plan 61-315 attached).

The metajaspilite is approximately 250' thick. It is coarser grained than Mt. Christie. A surface sample reported by Crawford (1957) assayed:-

Fe	52.4	Al_2O_3	1.44
Mn	0.09	P_2O_5	0.20
SiO_2	19.2	TiO_2	0.06
CaO	0.48	S	0.02
MgO	0.12	H_2O	2.56
		H_2O at 105°C	0.08

Geophysics

Apart from the aeromagnetic survey two reconnaissance dip needle traverses were run across the structure (See Plan 61-315). Of these the one over the nose was reread by C.H. Bagot using a Jalander magnetometer with similar results. The high readings suggested a continuation of the jaspilite down the nose of the fold and it was accordingly decided to test this zone by diamond drilling.

Drilling

One hole CD 3 was drilled at -60° S.W. A summarised log is:-

0 - 29'	Kunkar, schist
29 - 57.5	Granitised metasediments.
57.5 - 75	Limonite
75 - 85	Granitised metasediments.
85 - 205	Martite granulitic metajaspilite
205 - 342	Magnetite granulitic metajaspilite, chloritic in places.
342 - 437	Low grade magnetite-chlorite metajaspilite.
437 - 451	Quartz-garnet-chlorite metasediment.

End

Plan S 4144 shows a cross section of this hole (CD 3). The relevant magnetic profile is plotted on Plan 61-315. It is important to note that the dip needle profile suggests that the metajaspilite continues down plunge a horizontal distance of at least 900' i.e. to more than 750' vertically.

Grade

This core has been stored whole and retained for later metallurgical testing. By comparison with Mt. Christie it is thought that the zone from 85'-342' will average approximately 40% acid soluble iron. The grade of the limonite 57.5' to 75' is difficult to estimate but in any case this material may not extend in depth. The zone 342' - 437' contains a significant quantity of chlorite and may be the stratigraphic equivalent of the zone from 250' to 300' in CD 1. As such it could contain say 20-25% acid soluble iron and a significant amount of silicate iron.

Reserves

The outcrop at Fingerpost Hill is 600' x 400' approximately and the metajaspilite has been intersected down plunge to 400' vertical depth. Thus reserves lie in the range 2-2½ M tons/100 ft. with 8-10 M tons indicated. The shape of the body would make it easily amenable to opencutting.

Metallurgy

The ore is slightly coarser than that at Mt. Christie and presumably will have similar beneficiation characteristics. The drill core has been retained whole for testing.

Others near Fingerpost Hill

Fingerpost Hill North: Half a mile north of Fingerpost Hill is a rise with scattered jaspilite outcrop over an area 900' NS by 125' EW (See Plan 65-99). Reserves could approximate 1 million tons to 100 vertical feet. Grade could be 30-35% Fe.

Little Hill lies half a mile southeast of Fingerpost Hill and is crossed on the track from the boundary fence to Fingerpost

Hill. There are four outcrops each in the range 200-300' x 50-100'. This area has been mapped on 100 scale. See Plan 61-317. Reserves possibly lie in the range 0.5 - 1 M tons to 100 vertical feet. One surface sample across the main outcrop assayed 32.7% Fe, 0.05% Mn, 49.9% Insoluble.

One Oak Hill is one mile west of Fingerpost Hill. It is 300' NE-SW by 60' and 20' above plain level. Reserves possibly amount to 150,000 tons to 100' with a grade approximating 30% Fe.

George Hill etc.

Two miles south of Mt. Christie is a syncline of granulitic metajaspilite plunging 40° north-east subparallel to the anticline at Fingerpost Hill. The outcrop forms a hill, George Hill, rising 40' above plain level. There is little scrub. Mapping of this and surrounding hills has been completed at 100 ft. to the inch (See Plan 61-319).

The metajaspilite is approximately 85' in stratigraphic thickness, and covers a roughly semicircular area 300' x 200'. Crawford (1957) sampled two lines, one of which may be along strike:-

Fe	59.9	59.9
Mn	0.04	0.04
SiO_2	5.84	7.20
CaO	0.40	0.20
MgO	0.08	0.04
Al_2O_3	2.82	2.63
P_2O_5	0.12	0.10
TiO_2	0.11	0.17
S	0.04	0.05
H_2O	4.53	3.16
H_2O at $105^{\circ}C$	0.23	0.18

This material is a great deal coarser grained than Mt. Christie.

Geophysics

The area is covered by the aeromagnetic survey. No ground geophysics has been carried out in this vicinity.

Drilling

One diamond drillhole CD 5 was drilled at -50° SW to test the syncline. A summarised log is:-

0 - 50'	Canga
50 - 135'	Martite metajaspilite with minor narrow interbedded clay rock bands.
135 - 278'	Schist, some gneiss, minor jaspilite all somewhat weathered.
End	

See Plan S 4145 for a cross section on this hole.

Grade

This core has been stored whole and retained for metallurgical testing. However all the minerals are secondary or weathered so that assaying the core would not give the grade of the magnetic iron formation. By comparison with Mt. Christie it is thought that the grade in depth would be slightly in excess of 40% acid soluble iron.

Reserves

Reserves to the depth drilled (i.e. 100' vertically) would approximate 400,000 - 500,000 tons.

Others Near George Hill

George Hill Extended: One thousand feet north east of George Hill is another synclinal structure on the same or an overlying bed plunging north at 40°(?). Reserves of oxidized material to 50' could approximate 50,000 tons. (See Plan 61-319).

Blackfellow Hill lies 1000' northwest of George Hill. Here a steeply dipping bed 350' NNE-SSW, approximately 50' thick could supply 50,000 tons of oxidized metajaspilite to 50'. (See P75/61 appended.).

From one surface sample Crawford (1957) quotes a grade of:-

Fe	46.8%	Al_2O_3	1.54
Mn	0.06	P_2O_5	0.09
SiO_2	26.4	TiO_2	0.07
CaO	0.68	S	0.03
MgO	0.11	H_2O	3.41
		H_2O at 105°	0.11

Considering surface enrichment a subsurface grade of 30-35% Fe appears likely. (See Plan 61-319).

Immediately adjacent to this bed is an extremely weathered vesicular rock, essentially quartz and felspar which may be a weathered lava flow. (See P 76/61 appended). It is parallel to the iron formation in strike and is apparently steeply dipping so that it may be interbedded. Its thickness approximates 20'. There are no other known rock types in the iron formation in this district which could be dated and it is thought that this occurrence could be worth sampling for age dating when a drilling plant is in the vicinity. However CD 5 1200' to the SE has intersected only weathered rock so that a hole in excess of 150' may be necessary. The occurrence is mentioned here for record purposes only. The location sampled is shown on Plan 61-319.

<u>Claude Hill</u> : <u>Claude Hill Extended</u>: These hills lie ¼ mile SE of George Hill. They have not been mapped in detail but their location is shown on Plan 65-99 attached. In each case they are flatly dipping jaspilite beds. Reserves lie in the range 0.25 to 0.5 million tons to 50'. Crawford (1957) from surface samples quotes:-

Fe	49.9	Al_2O_3	0.71
Mn	0.02	P_2O_5	0.28
SiO_2	23.9	TiO_2	0.04
CaO	0.64	S	0.05
MgO	0.10	H_2O	2.72
		H_2O at 105°C	0.14

Others near Mt. Christie

1. Approximately 1 mile north of Mt. Christie inside Christie Paddock is a low rise covered by laterite and limonitised metajaspilite. There are a number of 2' x 5' outcrops striking 40° approximately and dipping 30° - 50° west.

2. Spitfire Paddock. One half to one mile south of the northern boundary of Spitfire paddocks are narrow zones of steeply dipping jaspilite forming low ridges. Outcrop conditions are not good, there is much limonite and low grade canga.

OTHER AREAS

West Well Group

Hill Eleven etc.

Hill Eleven is in Hilga South paddock approximately 2 miles northwest of West Well. Medium grained metajaspilite occurs as 10% outcrop in an area 800' NS by 400' EW. The outcrop is 30' above plain level. The area has been mapped on 100' to 1" (See Plan 61-316) and a metallurgical sample has been collected from surface outcrop. A representative sample taken from outcrop assayed 44.8% acid soluble iron and 31.2% insolubles.

This material averages 100 microns in grain size i.e. is intermediate in grain size (and geographic position) between Mt. Christie and Wilgena Hill.

One mile southwest of this point is a small hill of rubbly jaspilite on which has been constructed a stone tank. This forms part of a line of small isolated outcrops running southwesterly across the northwest corner of Merloo Paddock. Dips are generally NW, with grades of 43.4 - 48.2% acid soluble iron and 34.1 - 25.0 insoluble (See Whitten, 1960, for details).

A much smaller outcrop also occurs 2 miles(?) S of West Well.

Durkin Group

Near the southeast corner of Mallee Hen paddock two outcrops occur on the old track to Mt. Christie. The more northeasterly is on a small rubbly rise with no structure discernible. A representative sample assayed 38.8% Fe, 42.0% insoluble. The other is made up of a 10-20' bed of jaspilite outcropping over a strike length of 200 - 250' and forming a cusp shaped anticline plunging 30° SSE. A representative sample assayed 34.2% Fe, 48.0% insoluble.

Aristarchus Tank Group

Near the southwest corner of Aristarchus paddock a medium grained metajaspilite striking $20-60^{\circ}$ and dipping $45-60^{\circ}$ SE outcrops over 1000' SW-NE by 100'? - 200'? wide. The outcrop is a rubbly rise 50-100' above immediate plain level in mallee country. A representative sample assayed 50.0% Fe and 23.9% insoluble.

One mile north-northeast of the above occurs a much smaller, 400' x 120', rubbly rise of similar material.

All the above outcrops are too small to warrant any investigation. Their occurrence is reported as a guide to district structure - See plan, S 2476.

Muckanippie Group

On a low (100') hill, 2000' NS by 300' EW outcrop medium grained jaspilite beds 10' - 30' wide. The beds probably aggregate 80 - 100' width with indeterminate material between. The strike is 15°, dip 80°W.

A representative sample assayed 50.2% Fe, 17.2% insoluble. A bulk sample taken from an outcrop for metallurgical testing suggests that there is much surface enrichment.

Four Jalander magnetometer and dip needle profiles were read over this deposit to indicate the material between outcrop and to compare results of the two methods. Plan S 4146 attached shows the close correlation obtained. A scale factor of 200 gammas/1° is indicated.

OVERALL RESERVES

"SIGNIFICANT OUTCROPS" of iron formation with others "Of Lesser Significance" in the Mulgathing District are:

Outcrop	Reserves/100'	Grade	Drillhole
MT. CHRISTIE GROUP			
MT. CHRISTIE*	2½ - 5M	33.9% Fe	CD 1, 2
FINGERPOST HILL*	2 - 2½M	35% Fe(?)	CD 3
Fingerpost Hill North	1 M	30-35%(?)	
Little Hill etc.*	0.5 - 1 M	32.7%(?)	
One Oak Hill	150,000(?)	30%	
GEORGE HILL*	400,000	35%?	CD 5
George Hill Extended*	50,000	?	
Blackfellow Hill	50,000	?	
Claude Hill	0.25 - 0.5 M	?	
Spitfire Paddock	1 - 2 M	?	
WEST WELL GROUP			
Hill Eleven*	0.5 M ?	?	
Others	not significant		
DURKIN GROUP			
Mallee Hen etc.	Not Significant		
ARISTARCHUS TANK GROUP			
Main Outcrop	0.5 - 1 M	?	

* Indicates mapped on 100 scale.

Summing the above suggests that reserves could lie in the range 5M - 15M tons/100'. Taking totals to the maximum depth tested for the prospects drilled, to 100' for the wider deposits undrilled and to 50' for the narrower deposits, accessible reserves could lie in the range 15 - 25 M tons.

The grade of this is not known. The drilling suggests considerable surface enrichment. Surface samples usually assay over 40% Fe but the unoxidized iron formation is unlikely to have an average grade in excess of 40% Fe. In addition, much of this material will be oxidized, thus severely restricting the choice of beneficiation methods and certainly reducing possible recovery. Accepting this the district appears to have a potential of 5 to 10 M tons of concentrates.

Malbooma is 337 rail miles from Pt. Pirie and Wynbring is 377 miles. Mt. Christie is 50 and 20 miles respectively from these rail points. Considering transport costs in addition to beneficiation and mining costs it is certain that these deposits could not be worked economically at present.

RECOMMENDATION

In view of the above it is recommended that the reservation surrounding the known iron deposits be reduced. It is suggested that the area retained should be the Tarcoola and Wilgena 1-mile sheets surrounding the gold-copper mineralisation at Tarcoola and the gold-tin mineralisation at Earea Dam.

In addition it is thought that the Glenloth Gold field should be assessed for which purpose the Harris 1-mile sheet should be reserved from the Mining Act.

Graham Whitten

G. F. Whitten
Senior Geologist

GFW:AGK
4/3/65

APPENDIX A

Petrological Reports

By: Australian Mineral Development Laboratories

For: S.A. Dept. of Mines.

Reference: 1/2/0 MR 1295

P 527/60 - Wilgena Hill. T.S. 7062.

This is a brick red, massive felspar porphyry of distinctive texture. Phenocrysts of felspar are euhedral and vary in size to a maximum of 0.5 cm length.

The whole rock is stained red because of disseminated limonite which is absorbed in secondary clays and is emplaced along grain boundaries and in cleavages.

The groundmass is an evenly granular aggregate of finer grained felspars and interstitial quartz. Myrmekitic texture between quartz and felspar is pronounced and such textural aggregates are widespread in the matrix and round the edges of both larger and smaller phenocrysts.

The phenocrysts, like the felspar in the matrix are strongly kaolinised. A perthitic texture is preserved within the altered phenocrysts which are exclusively euhedral perthitic orthoclase with carlsbad-type twinning.

Subordinate muscovite and hematite are disseminated through the matrix.

Compared with TW 35 ($3\frac{1}{2}$ m E.N.E. of Konkaby Rockhole) the principal difference noted is that TW 35 contains plagioclase in its groundmass. The presence of myrmekitic texture in the groundmass of both rocks is a specific comparative feature as is also the abundance in both of large perthitic orthoclases with Carlsbad twinning. TW 35 appears to have been modified by contamination whereas P 527/60 is the magma in its pure form.

A.W.G. Whittle,
CHIEF MINERALOGIST & PETROLOGIST

Reference: MP 1/2/0

P304/62: WH1: TS10395 N.W. Arm Trig.

This is a typical porphyritic rhyolite, of a variety very common within the Gawler Range Porphyry.
Phenocrysts of quartz, with characteristic embayments, and of feldspar, are set in a fine-grained groundmass of quartz and feldspar. The feldspar phenocrysts for the most part show no twinning; they are thought to belong to the sanidine-anorthoclase series, and show partial inversion to albite. The groundmass is partly micrographic, partly devitrified glassy material and consists of quartz and feldspar.
Magmatic reddening is a feature of all components except the quartz phenocrysts.

P303/62: WH2: TS10394 Birthday Trig.

This rhyolite is quite similar to the previous one, consisting of embayed phenocrysts of quartz, phenocrysts (sometimes fractured) of albite and ?microcline in a micrographic groundmass of quartz and alkali feldspar. Chlorite pseudomorphs after a ferromagnesian mineral are occasionally present, and traces of fluorite occur.

P305/62: WH3: TS10396 31 miles S of Kingoonya on I.Knob Road

This rock, whilst having the appearance of a porphyritic rhyolite, is in fact an ignimbrite or welded tuff.

Mainly angular fragments and embayed, fractured phenocrysts of potassic feldspar, albite and quartz, together with angular fragments of fine-grained igneous rocks (trachytes and related types), are set in a fine-grained matrix. The matrix consists of devitrified shards of glass, minute cubes of iron-ore, and interstitial sericite. A type of flow-structure or lineation is evident; it is not possible to ascertain whether this is a true flow-phenomenon or a depositional feature, because of alteration.

P306/62: WH4: TS10397 Warna Well Tank, Yerda Turnoff

This rock is a porphyritic rhyolite, with very conspicuous phenocrysts of feldspar.

The phenocrysts of feldspar tend to be glomeroporphyritic, and consist mainly of perthitic orthoclase and microcline, though some albite is also present. Quartz phenocrysts show characteristic embayments.

The groundmass is of a particularly well-developed micrographic texture, consisting of interlocking patches of quartz-feldspar intergrowths.

All four rocks are members of the Gawler Range Volcanic Complex; the welded tuff or ignimbrite is of special interest because of its comparative rarity, though several similar occurrences are known from the southern side of the Gawler Range outcrops.

Investigated by: H.W. Fander

Officer in Charge, Mineralogy Section: H.W. Fander

L. Wallace Coffer
Director

29th November, 1963.

Reference: MP 1/2/0 - 128

P10/61: TH61/1: TS 7516 1 Mile South of Mt. Christie

A microdiorite in which the principle minerals are plagioclase of andesine composition, hornblende and biotite. The texture of the rock is hollocrystalline with the felspars occurring in laths up to 0.2 mm. in length, the hornblende mainly in longitudinal sections with occasional euhedral cross sections, and the biotite as irregular flakes. Much of the hornblende, in particular the larger grains, has been decomposed. Much of the plagioclase shows zoning and minute inclusions are fairly common. Some hornblende contains small inclusions of felspar. Opaques are common, the main one being pyrite which occurs in a band through the rock. Other accessories present are calcite, apatite and quartz; the quartz is apparently secondary filling interstices.

P11/61: TH61/2: TS 7517   1 Mile South of Mt. Christie

The rock is a biotite-garnet gneiss of the almandine-amphibolite facies but because of the complex metamorphic history and possible metasomatism it is not possible to further sub-divide it. The texture of the rock is porphyroblastic, large grains of felspar in a ground mass of quartz and felspar of a finer grain size. The types of felspar present are orthoclase, microcline, all showing sericitization to varying degrees. Inclusions of quartz in the porphyroblasts and intergrowths of quartz and felspar are fairly common. Biotite and garnet are common; the garnets have been fractured and the biotite flakes often bent due to late stage dynamic metamorphism. A second type of biotite of a pale green colour is also present which seems to bear some relationship, either mineralogical or chemical, to the garnet since it occurs in fractures and at the rims of that mineral; the green biotite was probably formed by retrogressive metamorphism from the garnet. Accessory minerals present are rutile and zircon.

The accessory zircons are rounded to well-rounded in shape, thus suggesting that the rock was originally a sediment. Also, the absence of zoning in the felspars could be taken as negative evidence for a sedimentary origin. Metamorphism has occurred in several phases which, along with the metasomatic processes involved (possibly albitisation), would account for the disequilibrium of the rock.

Investigated by: P.J. Sweeney

Officer in Charge Mineralogy & Petrology Section: A.W.G. Whittle

15th March, 1961.

L. Wallace Coffer,
DIRECTOR

Reference MP. 1/2/0/454

P75/61: TW61/5: T.S.7859   Blackfellow Hill

This rock, an itabirite, contains principally two minerals, quartz and martitized magnetite. The quartz is fine to medium grained, heavily fractured in part and contains numerous inclusions. Many of the grains show resorbed boundaries and some show secondary growth. The iron mineral occurs throughout the rock and contains occasional inclusions of quartz.

P76/61: TW61/6: TS 7860   Blackfellow Hill

Originally, this rock was composed of quartz and felspar, the latter having since been leached out leaving vesicules, some of which have been filled with more quartz. The original quartz is of a very fine crystal size while that filling vesicules is somewhat coarser and clearer. Patches of clay minerals (probably kaolinite) occur throughout the rock. Iron minerals have caused staining.

Investigated by: P.J. Sweeney
Officer-in-Charge Mineralogy & Petrology Section: H.W.Fander
11th May, 1961.   L. Wallace Coffer, DIRECTOR.

APPENDIX B

Diamond Drill Hole CD 1

CORE LOG

0.0 - 16.0 ft.	Sheet kunkar.
16.0 - 21.0 ft.	Yellow brown, weathered schist containing quartz grains and a somewhat flaky green mineral.
21.0 - 24.0 ft.	Yellow brown decomposed clay schist.
24.0 - 30.0 ft.	Medium grained brown and white speckled decomposed clay schist. Contains $\frac{1}{4}$ in. quartz veinlets, clay minerals and chlorite after micas. Banding at 60° to core axis.
30.0 - 39.0 ft.	As 24.0 - 30.0 ft., but containing rather more green mineral.
39.0 - 46.8 ft.	As 24.0 - 30.0 ft. At 43 ft., banding at 65° to core axis.
46.8 - 52.5 ft.	Brown and purple speckled decomposed schist. Contains abundant muscovite (but no green mineral).
52.5 - 57.0 ft.	Decomposed brown schist, similar to 46.8 - 52.5 ft.
57.0 - 62.5 ft.	Speckled purple and brown slightly less decomposed muscovite schist. At 62 ft., banding at 55° to core axis.
62.5 - 66.0 ft.	As 46.8 - 52.5 ft.
66.0 - 67.5 ft.	As 46.8 - 52.5 ft., with $\frac{1}{4}$-1 inch martite bands. At 66 ft., banding at 65° to core axis.
67.5 - 71.5 ft.	Decomposed schist containing 50% martite and magnetite bands.
71.5 - 75.5 ft.	Partly decomposed medium grained magnetite and martite metajaspilite with minor limonite. Silica somewhat weathered. At 74 ft., banding at 75° to core axis. Bedding planes are 1/16" to 1/8" thick. This material is typical of the poorly outcropping material west of the Mt. Christie outcrop.
75.5 - 77.5 ft.	Yellow brown schist - very weathered.
77.5 - 81.5 ft.	Medium grained martite metajaspilite with minor magnetite and limonite. At 79 ft., Bedding at 70° to core axis.
81.5 - 88.5 ft.	Martite metajaspilite, with bedding at 70° to core axis.
88.5 - 89.5 ft.	Decomposed felspar rock.
89.5 - 92.0 ft.	As 81.5 - 88.5 ft.
92.0 - 97.0 ft.	Martite and magnetite metajaspilite. Bedding at 60° to core axis.
97.0 - 102.0 ft.	Somewhat leached martite metajaspilite, with occasional narrow schist bands. Contains a fibrous soft yellow-green mineral.
102.0 - 109.0 ft.	Martite metajaspilite with irregular banding averaging 60° to core axis.

109.0 - 109.5 ft.	Schist. Poor recovery.
109.5 - 114.0 ft.	Medium grained magnetite metajaspilite containing some yellow-green mineral. Bedding at 65° to core axis.
114.0 - 115.0 ft.	Dominantly medium grained martite (with minor magnetite) metajaspilite. Yellow green mineral quite coarse grained in places. Bedding at 55° to core axis, at 115 ft.
115.0 - 115.2 ft.	Schist. Poor recovery.
115.2 - 117.3 ft.	As 114.0 - 115.0 ft. Bedding at 80° to core axis at 115.5 ft., and 75° at 117 ft.
117.3 - 121.0 ft.	Martite (with minor magnetite) metajaspilite. Bedding at 60° to core axis.
121.0 - 130.0 ft.	Martite metajaspilite. Bedding at 60° to core axis.
130 - 133.8 ft.	Martite metajaspilite with coarse grained amphiboles.
133.8 - 135 ft.	Mainly coarse grained amphibolite.
135 - 135.3 ft.	Coarse grained orthoclase veinlet, minor biotite.
135.3 - 137.6 ft.	Martite metajaspilite with minor amphibole.
137.6 - 143 ft.	Medium grained martite metajaspilite, bedding mainly 70° to core axis but varying and contorted.
143 - 150 ft.	Medium grained martite metajaspilite with minor residual magnetite and occasional chlorite rich bands.
150 - 160 ft.	Coarse grained martite metajaspilite made up of alternating $\frac{1}{8}$" - $\frac{1}{4}$" beds of iron oxide and "insolubles", similar to the material outcropping on Mt. Christie. Minor magnetite only. Bedding angle 65 - 90°.
160 - 174 ft.	Coarse grained magnetite and martite metajaspilite as 150'-160' but strongly magnetic. Bedding 60° at 165' and 170'.
174 - 182 ft.	Coarse grained magnetite and martite metajaspilite as 160 - 174' but with 1" - 3" chloritic bands at 6 - 12" intervals. Strongly magnetic. Bedding 65°.
182 - 184 ft.	Coarse grained low grade martite metajaspilite plentifully intruded by quartz veinlets. Non magnetic.
184 - 209 ft.	Coarse grained magnetite and martite metajaspilite as 160-174'. Bedding 75° at 190'; 70° at 200'; 65° at 209'. Strongly magnetic.
209 - 210.2 ft.	Metajaspilite with abundant chlorite as 174'-182'.
210.2 - 211 ft.	Quartz-felspar rock with chlorite and garnet as phenocrysts.
211 - 214.5 ft.	Metajaspilite with abundant chlorite as 174-182' and 209-210.2'. Magnetic. Bedding 70°.

214.5 - 215.5 ft.	Quartz felspar "granite" with chlorite and garnet as 210.2 - 211'.
215.5 - 227 ft.	Magnetite metajaspilite with minor chlorite. Strongly magnetic. Bedding contorted but averages 60°. Facings occur at 216.5' and 218.5' in structures too folded to be useful.
227 - 227.7 ft.	Coarse grained "granite".
227.7 - 232.7 ft.	Magnetite metajaspilite with minor chlorite as 215.5 - 227'. Bedding 75°.
232.7 - 235 ft.	Coarse grained quartz orthoclase biotite "granite".
235 - 238.3 ft.	Magnetite metajaspilite. Bedding 75°.
238.3 - 239.7 ft.	Quartz orthoclase "granite" with remnant magnetite.
239.7 - 246 ft.	Magnetite metajaspilite with abundant chlorite, bedding averaging 80° to core axis.
246 - 248.5 ft.	Quartz orthoclase "granite".
248.5 - 249.5 ft.	Magnetite metajaspilite.
249.5 - 250.7 ft.	"Granite".
250.7 - 254.2 ft.	Magnetite metajaspilite.
254.2 - 256 ft.	Coarse grained "granite" with remnant metajaspilite.
256 - 258.6 ft.	Magnetite metajaspilite.
258.6 - 259.6 ft.	Very coarse grained "granite".
259.6 - 265 ft.	Mainly low grade magnetite metajaspilite with approx. 50% chlorite in zones to 6", also minor felspar and quartz felspar veinlets and garnet. Dip 70° to core axis.
265 - 266.5 ft.	Dyke of fine grained basic igneous rock.
266.5 - 269 ft.	Low grade metajaspilite with chlorite and acidic veinlets as 259.6 - 265'. Dip 75°.
269 - 280 ft.	Metajaspilite as 266.5 - 269' but slightly higher grade. Dip 75°.
280 - 301 ft.	Mainly low grade magnetite metajaspilite with much chlorite and with "granite" 282.5 - 283, 291.6 - 292.3; 296.2 - 296.8; 299 - 299.5.
301 - 302 ft.	Very coarse grained pink "granite" with minor garnet and biotite.
302 - 303.1 ft.	Dyke of fine grained basic igneous rock.
303.1 - 306 ft.	Coarse grained pink "granite" grading into
306 - 349 ft.	Medium and coarse grained white and grey granite and granite gneiss containing much garnet.

349' End of hole.

Logged by G.F. Whitten.

ASSAYS

Footage	Acid Soluble Iron (Fe)		Insoluble Matter
70 - 80	44.3 %		34.3 %
80 - 90	49.0		23.4
90 - 100	48.0		26.4
100 - 110	46.4		29.2
110 - 120	42.7		34.3
120 - 130	38.2		40.8
130 - 140	21.9		57.7
140 - 150	30.8		48.3
150 - 160	39.4		37.1
160 - 170	42.8		39.8
170 - 180	39.6		42.3
180 - 190	40.8		36.2
190 - 200	42.2		39.2
200 - 210	40.9		40.4
210 - 220	36.2		38.9
220 - 230	40.6		40.0
230 - 240	25.0		60.1
240 - 250	19.3	Total Fe	64.6
250 - 260	20.8	23.0	64.0
260 - 270	19.9	22.9	59.3
270 - 280	29.5	32.0	54.6
280 - 290	9.1	22.9	68.2
290 - 300	13.9	20.7	71.5

Analysis by: M. Hanckel
Officer in Charge Analytical Section: T.R. Frost.

L. Wallace Coffer,
DIRECTOR

10th August, 1961.

Reference: AN 1/1/32/1390

REPORT OF ANALYSIS

Mark	M8679	M8680	M8681
	70'-150'	150'-250'	250'-300'
Sulphur (S)	0.01 %	0.01 %	0.07 %
Manganese (Mn)	0.08	0.14	0.09
Titanium oxide (TiO_2)	0.09	0.13	0.38
Silica (SiO_2)	30.2	33.7	43.9
Aluminium oxide (Al_2O_3)	1.95	1.98	4.96
Calcium oxide (CaO)	2.1	3.6	4.70
Magnesium oxide (MgO)	1.26	2.02	2.55
Phosphorus pentoxide (P_2O_5)	0.12	0.19	0.17
Total Iron (Fe)	39.8	37.5	24.9

Analysis by: M.R. Hanckel

Officer in Charge Analytical Section: T.R. Frost.

Thomas R. Frost

L. Wallace Coffer,
DIRECTOR

4th December, 1961.

GEOLOGICAL LOG CD 2

Depth (ft.)		
0	5 est.	Kunkar
5	14 est.	Sludge, containing much kunkar but probably representing schist.
14	17 est.	Grey mica schist, possibly dipping 45^o-60^o.
17	19 est.	Sludge as 5 - 14.
19	25	Chloritic schist (light green). Dip?
25	32	Ditto.
32	36	Brown clay schist, Dip 40^o? at 33'.
36	48	Chloritic schist (light green). Dip 60^o at 38'; 60^o at 43'.
48	55.5	Brown clay schist, Dip 40^o at 49'; Broken after 52'.
55.5	61.5	No core.
61.5	63.3	Brown clay schist with much biotite, broken core.
63.3	66	Red clay schist with much muscovite, broken core.
66	71	Chloritic schist, broken core.
71	76	No Core.
76	79	Very decomposed coarse grained biotite "granite".
79	82	Biotite schist, possibly a very weathered finer grained "granite".
82	83	As 76 - 79'.
83	90	Chloritic schist containing much biotite and some muscovite. Dip 60^o at 85'.
90	97	Biotite schist, less weathered than 83' - 90'.
97	98	Coarse grained quartz orthoclase "granite".
98	105	Biotite schist as 90 - 97', dip 65^o.
105	110	No Core.
110	117	2" Core, Medium grained biotite, little else present, a biotite schist.
117	122	1' Core as 110 - 117'.
122	136	Originally core, now disintegrated to "sludge" - biotite schist with minor quartz, chlorite, magnetics etc.
136	143	Schist, mainly biotite but with more felspar and quartz than formerly also magnetics.

Depth (ft.)		
143	181.7	Martite metajaspilite, low grade, with abundant chlorite, narrow beds of biotite, Dips 65° at 144', 65° at 155', 65° at 170', 75° at 180'.
181.7	182.5	Pink felspar veinlet.
182.5	198.5	Coarse grained magnetite and martite, metajaspilite similar to that outcropping on Mt. Christie, with minor chlorite. Bedding 55° at 187 and 197'.
198.5	200	Coarse grained quartz-orthoclase veinlet.
200	210.2	Coarse grained magnetite metajaspilite as 182 - 198.5', Dip at 205' is 65°.
210.2	210.5	Medium grained quartz orthoclase veinlet.
210.5	212.3	As 200 - 210.2 - metajaspilite.
212.3	212.5	As 210.2 - 210.5 - "granite".
212.5	259.2	Coarse grained magnetite metajaspilite as 182.5 to 198.5, minor chlorite only. Bedding 70° at 225'; 75° at 250'.
259.2	259.5	Quartz-grey felspar veinlet.
259.5	348.4	Medium to coarse grained magnetite metajaspilite with minor chlorite and with 1" to 15" (usually 3" - 6") quartz-orthoclase veinlets at 2-5' intervals, occasional quartz grey felspar veinlets. Bedding 65° at 270', 285'; 70° at 300', 325'; 65° at 340'.
348.4	386.6	Very coarse grained quartz felspar garnet rock.

<u>End</u>

GEOLOGICAL LOG CD 3

Depth (feet)		
0	1'6"	Kunkar cementing small fragments of rock.
1'6"	19'8"	Sand sized rock fragments of decomposed sandy schist.
19'8"	29'	Very clayey ditto.
29	62	Decomposed medium grained "granite". Fragmentary core with slight variations in grain size and mineral content "Bedding" generally obscure but possibly 15° at 52' and 35° at 53'.
62	71	Limonite irregularly deposited in clay rock. Recovery at 55% is almost all limonite with clay on irregular faces.

<u>End of Hole</u>

Logged by G.F.W.

LOG OF CD 3A

Depth (feet)	
0 - 30	No Core, See CD 3.
30 - 57.5	Decomposed medium grained granite. "Bedding" 35° at 36'; 25° at 56'.
57.5 - 75	Limonite irregularly deposited in clay rock "granite" and possibly metajaspilite. The core consists of irregular pieces of limonite with traces of rock in cavities.
75 - 85	Clay rock, "granite" and metajaspilite fragments, 2' of core. Dip 25° at 78'.
85 - 97	Limonite metajaspilite with schist bands. Dip 15°-87'; 30°-91'; 30° at 95'.
97 - 136.5	Martite metajaspilite, medium grained, leached, made up of 1/16" to $\frac{1}{2}$" usually $\frac{1}{8}$" bands of martite separated by 1/16 - $\frac{1}{8}$" bands of quartz and with secondary martite veinlets. Dip 50°-106'; 0-110'; 45°-116'; 40-90° at 125'; 80° at 130'.
136.5 - 151	Martite metajaspilite, coarse grained, even dips at 70°.
151 - 155.5	Clay schist, fine and coarse grained, very decomposed, in part possibly a felspar veinlet.
155.5 - 162	Fine grained martite metajaspilite, rounded fragments of core only.
162 - 167	No core.
167 - 176	Fragments of metajaspilite, jaspilite and clay rock 1.3' of core.
176 - 186'	No Core.
186 - 195'	Fine to medium grained martite metajaspilite.
195 - 205'	Medium grained martite with minor magnetite metajaspilite. Dip 40° at 199'; 80 at 204'.
205 - 231	Medium grained magnetite with minor martite metajaspilite made up of $\frac{1}{8}$" magnetite rich bands separated by $\frac{1}{8}$" quartz rich bands, the rock appearing less banded than above. Much chlorite, especially at 214' and 224', a hematite veinlet in schist at 220.2' and a weathered zone from 230-231'. Dips 60° at 207', 55° at 217'; 40° at 222'; 30° at 227'.
231 - 254	Fine grained magnetite metajaspilite bordering on a magnetite jaspilite, made up of 1/16" to 1" bands of magnetite or silica with similar sized bands of chlorite at intervals. A 6" quartz-orthoclase veinlet at 248.5. Dips 60° at 235'; 50° at 240'; 50° at 247'; 65° at 250'.

LOG OF CD 3A

Depth (feet)	
254 - 273.5	Medium grained magnetite metajaspilite as 205-231' with much chlorite and numerous 1" - 4" fine grained quartz-orthoclase bands. Generally low to medium grade: Dips generally 70°.
273.5- 277	Weathered zone of martite metajaspilite and chloritic schist, dips varying from 20° - 70°.
277 - 294	Fine to medium grained magnetite metajaspilite, made up of ¼" magnetite rich bands separated by ¼" - 2" silica rich bands and with numerous chlorite and quartz-orthoclase bands. Dips average 45°.
294 - 313	Medium grained magntite chlorite metajaspilite as 277 - 294'. Dips 45°.
313 - 342	Fine to medium grade magnetite chlorite itabirite as 277 - 294'. Dips mainly contorted but 55° at 330'.
342 - 389	Fine grained quartz magnetite chlorite anthophyllite-cordierite(?) (cf. Cowell) rock, low grade. Dips vary from 40° to 65°.
389 - 390	Coarse grained quartz garnet chlorite veinlet.
390 - 397	Medium grained quartz magnetite chlorite cordierite rock. Dips 45°.
397 - 411	Medium grained quartz magnetite chlorite cordierite(?) rock with occasional clots of magnetite.
411 - 437	Low grade magnetite, chlorite, biotite quartz rock with occasional clots of magnetite.
437 - 451.2	Non magnetic quartz garnet chlorite rock with accessory biotite and cordierite(?).

<u>End</u>

Logged by G.F.W.

LOG OF CD 5

Depth (feet)	
0 - 1'	Canga cemented by kunkar and limonite.
1 - 3'	Canga, mainly buckshot gravel cemented by limonite.
3 - 16	Sludge, fine grained ferruginous soil containing hematite, limonite, minor martite, sand, kunkar.
16 - 24	Canga, as 1 - 3'.
24 - 27	Canga, $\frac{1}{4}$" to 2" usually 1" fragments of iron formation cemented by limonite.
27 - 32	Canga, as 24-27 cemented by limonite and clay.
32 - 36	Canga, as 24-27 cemented mainly by clay.
36 - 50	Either low grade canga (i.e. 2-3' ferruginous zones cemented by clay and separated by 2-3' clay zones) or possibly a clay rock containing narrow bands of iron formation, the whole broken and recemented by clay.
50 - 52	Medium grained martite metajaspilite, dip in core 50°.
52 - 54	Clay rock, no macro structure, appears to be made of fragments. Could possibly be the result of slumping following leaching.
54 - 57	Medium grained martite metajaspilite as 50 - 52', dip in core 75°.
57 - 60	Clay rock as 52 - 54.
60 - 61.5	Medium grained martite metajaspilite.
61.5- 63	Clay rock.
63 - 64.8	Medium grained martite metajaspilite, dip in core 75°.
64.8- 66	Interbedded clay rock and metajaspilite.
66 - 67	Medium grained martite metajaspilite.
67 - 68.7	Clay rock.
68.7- 91.7	Medium grained martite metajaspilite with 3" - 6" clay rock bands at 77', 83', 86', 89'. Dip in core 80° at 70'; 75° at 80'; 70° at 90'.
91.7- 95.8	Clay rock with 2" - 4" metajaspilite bands.
95.8- 97.5	Medium grained martite metajaspilite, dip in core 65°.
97.5- 99	Clay rock.
99 - 102	Medium grained martite metajaspilite.
102 - 106	Interbedded clay rock and medium grained martite metajaspilite.

Depth (feet)	
106 - 134.8	Coarse grained martite metajaspilite has numerous ½" phenocrysts of martite showing multiple twinning. Dip 75° at 110'; 80° at 120'; 60° at 130'.
134.8 - 141.5	Decomposed chloritic schist.
141.5 - 144	Decomposed medium grained biotite gneiss.
144 - 157	Decomposed finer grained chloritic schist with clay zones also 1" - 2" iron oxide bands. A 3" magnetic zone at 147'. Less decomposed after 152' but still oxidized. Dip in core 65° at 155'.
157 - 165	As 144 - 157 but containing numerous ½" serpentine veinlets.
165 - 175	Decomposed chloritic schist as 144 - 157. Dip 60° at 168'.
175 - 182	Broken Core, half low grade jaspilite interbedded with very broken, less siliceous more schistose material. Dip in core, 50° at 177' but contorted.
182 - 185'	Schist, decomposed with serpentine veinlets. Petrological sample at 185'.
185 - 216	Schists, all partly decomposed, some quartzose, some micaceous, some chloritic. Petrological sample at 215. Dip 85° at 215'.
216 - 240	Siliceous schist.
240 - 268.5	Medium grained biotite gneiss, almost completely decomposed.
268.5 - 274	As 240 - 268.5 but with
274 - 278	Decomposed chloritic and siliceous (in parts) rock.

<u>End</u>

Logged by G.F.W.

Reference 1/2/0/1536

MT. CHRISTIE CD 5

PETROLOGICAL DESCRIPTION

RESULTS

P1773/61 CD5 185' (T.S.8691A)

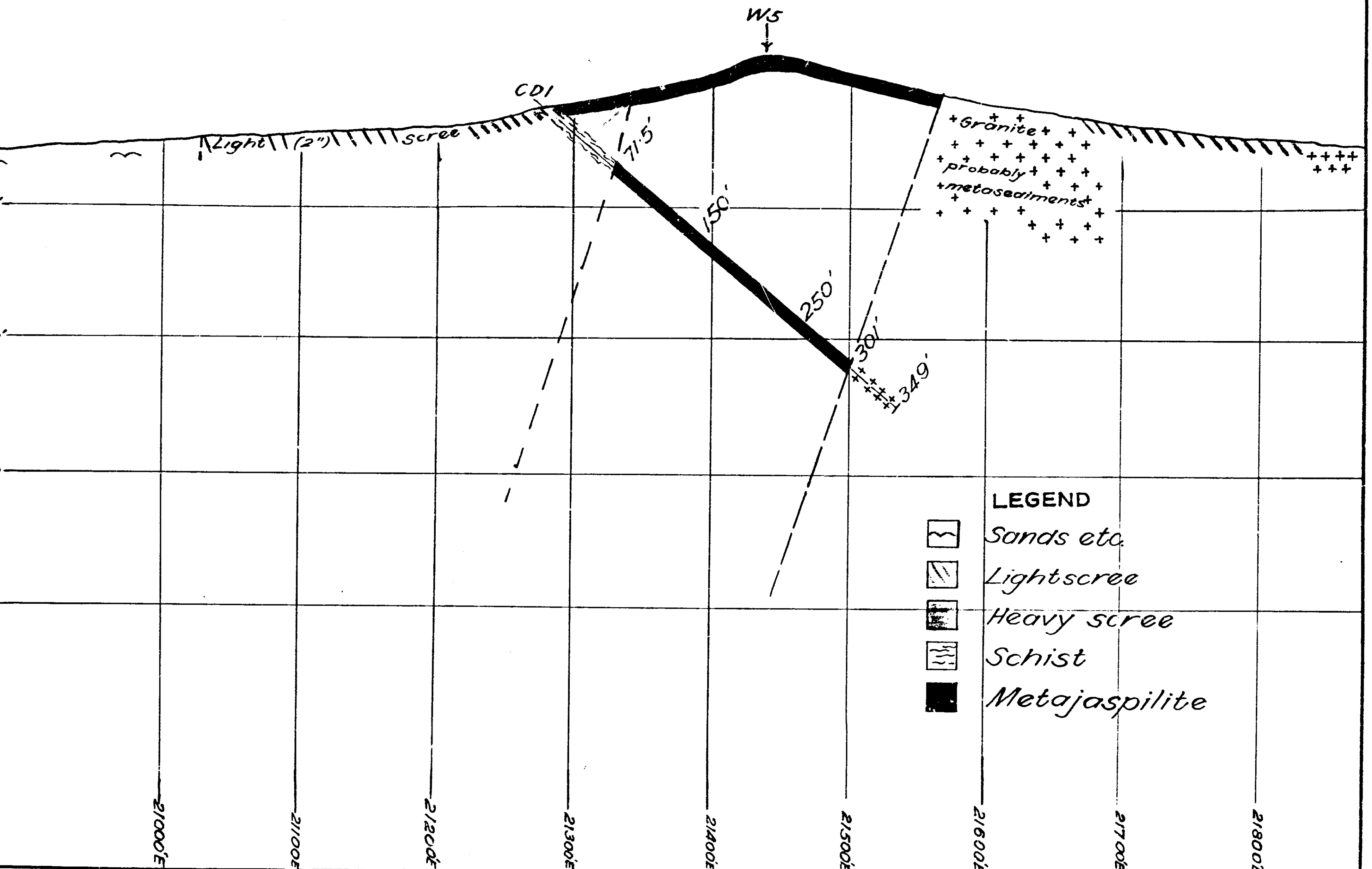
This section of core consists of a mass of flakes of chlorite and green biotite in part showing a tendency towards lineation. Contortion and minor shearing shown by the displacement of some flakes has occurred. Secondary introduction of opaques, mainly ilmenite showing some alteration to leucoxene, has also caused some contortion. Fracturing of the rock as a whole has been extensive; there appears to have been two phases, one before the introduction of the opaques and a minor phase after. Sphene is fairly abundant as an alteration product of the chloritic material and is associated in part with the opaques. Minor rutile is present as small acicular crystals.

T.S.8691B

Another section of the above showed the presence of some microcrystalline silica occurring in concentric bands as a secondarily introduced filling material. Rutile is again present but this time as more rounded grains but obviously not of detrital origin.

P1774/61 CD5 215' (T.S.8692)

This rock, in which the principal minerals are kyanite and plagioclase, can be placed in the kyanite-muscovite-quartz subfacies of the almandine amphibolite facies. The texture is medium to coarse grained granoblastic. The plagioclase, of andesinic composition, often shows corroded boundaries. Biotite is present as truncated flakes which show a better lineation than in the above; it could be described as subparallel. There has been some contortion of the flakes but this is not marked. Fracturing of the kyanite and, to a minor extent the felspar, is pronounced. Chlorite and minor muscovite are present as alteration products of the kyanite; they occur as "rims" around the grains and seem to have occurred in selected bands in the rock.



To accompany report by G.F. Whitten

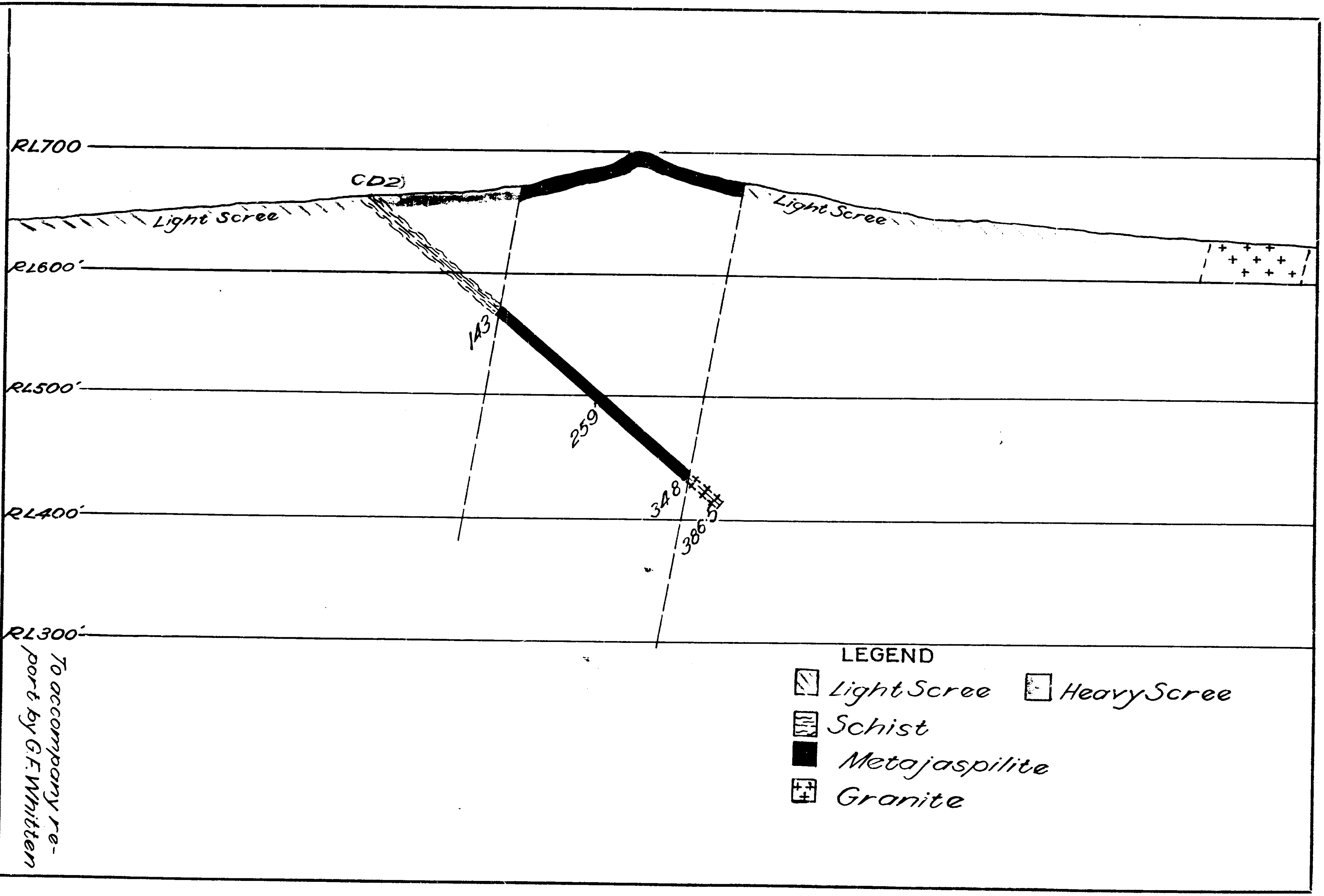
S.A. DEPARTMENT OF MINES

MT CHRISTIE

CROSS SECTION on D.D.H. CD.1

Approved	Director
Passed	
Drn.	
Tcd. G.M.	
Ckd.	
Exd.	
D.M.	
Req.	S 4142 86
Scale 100' to 1"	
Date 1.3.65	

400— 6.63 1423



S.A. DEPARTMENT OF MINES

MT CHRISTIE

CROSS SECTION of D.D.H CD 2

Approved

Director

Passed

Drn.

Tcd. G.M.

Ckd.

Exd.

D.M.

Req.

Scale 100' to 1"

S4/43
Bb

Date 2.3.65

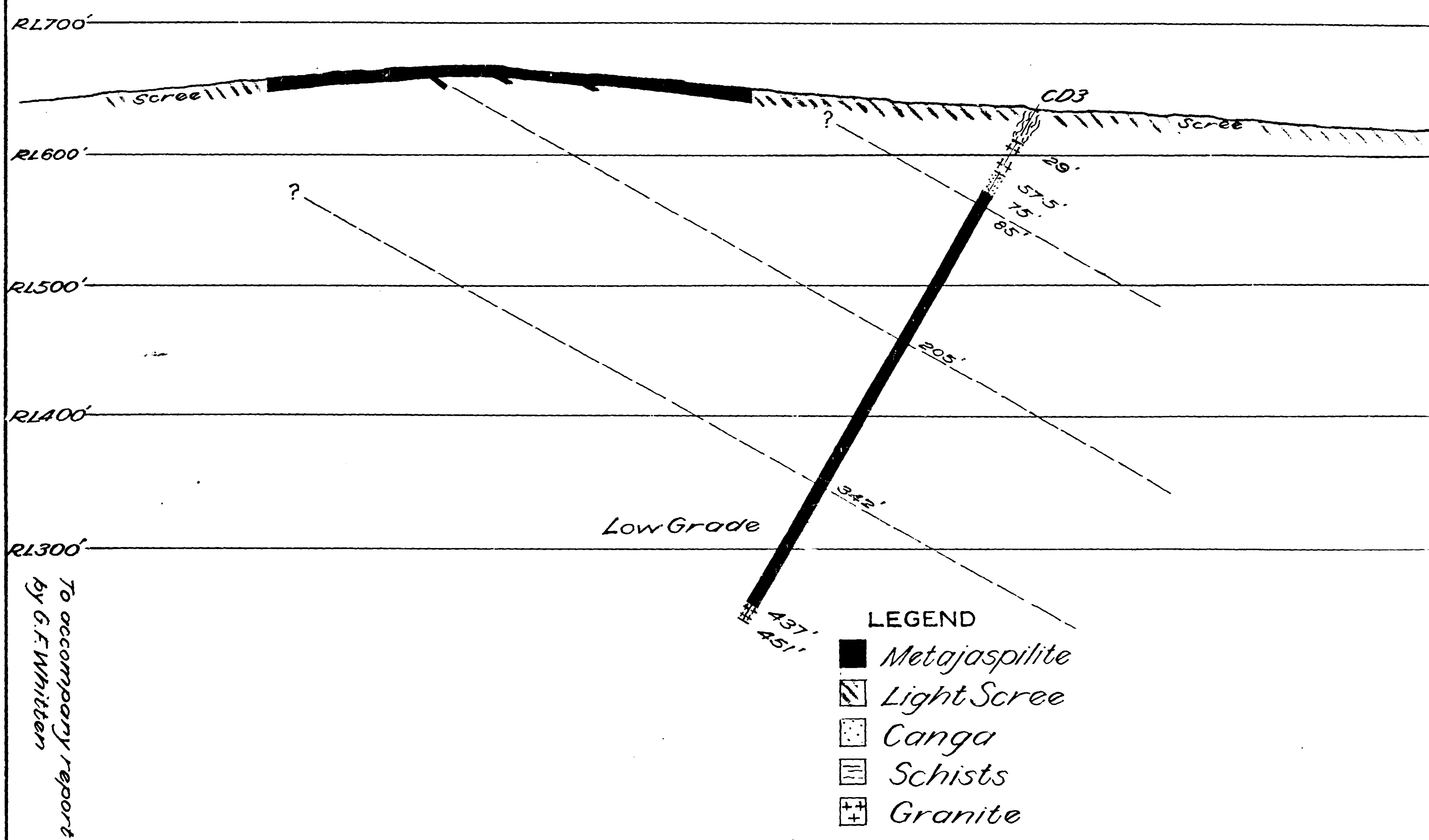
400—6.63 1423

FINGERPOST HILL

CROSS SECTION on DDH CD3

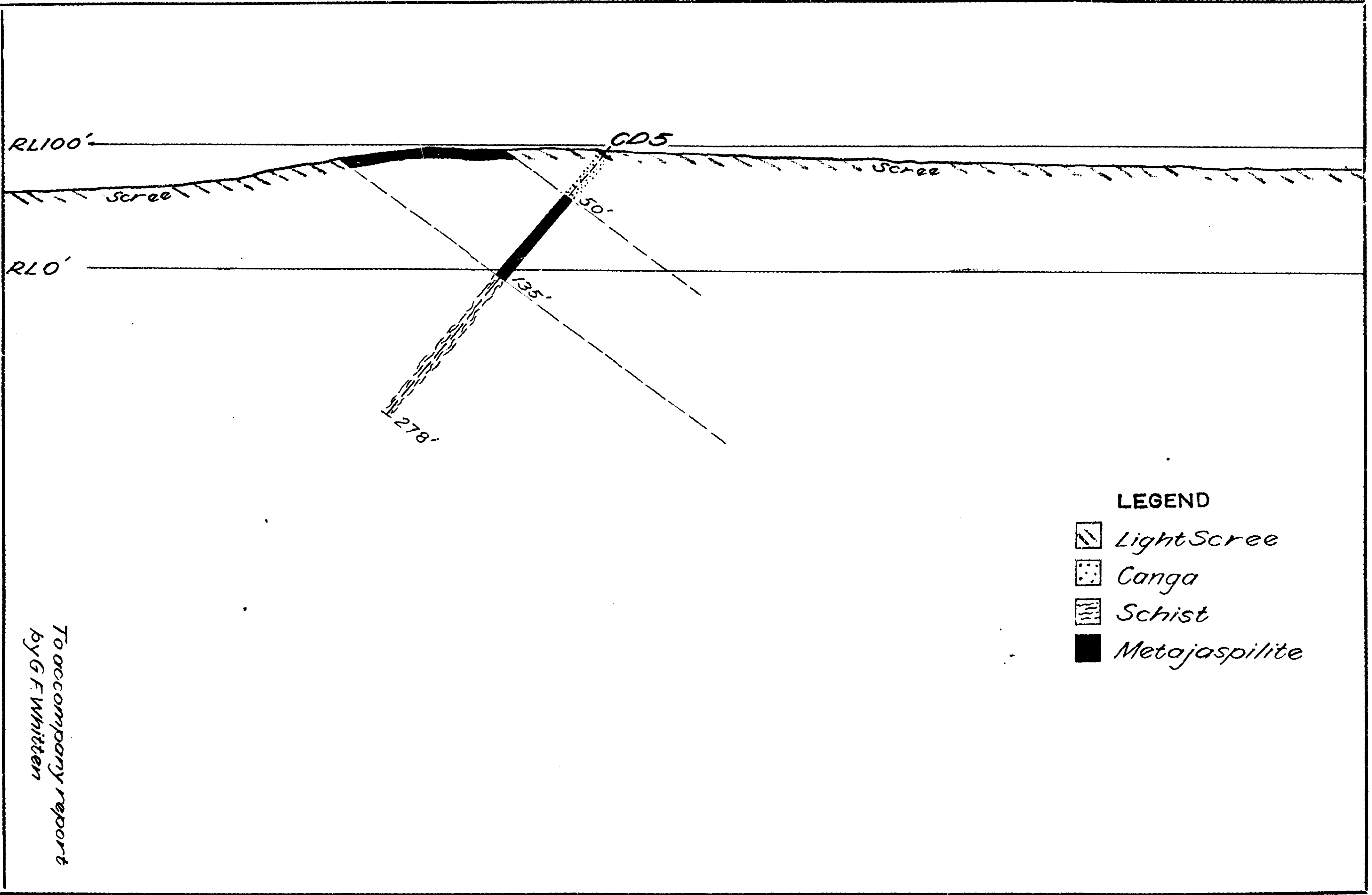
S.A. DEPARTMENT OF MINES

To accompany report by G.F. Whitten



Approved	
Director	
Passed	
Drn.	
Tcd	G.M.
Ckd.	
Exd.	
D.M.	
Req.	
Scale	100' to 1"
	S4/44
	Bb
Date	2.3.65

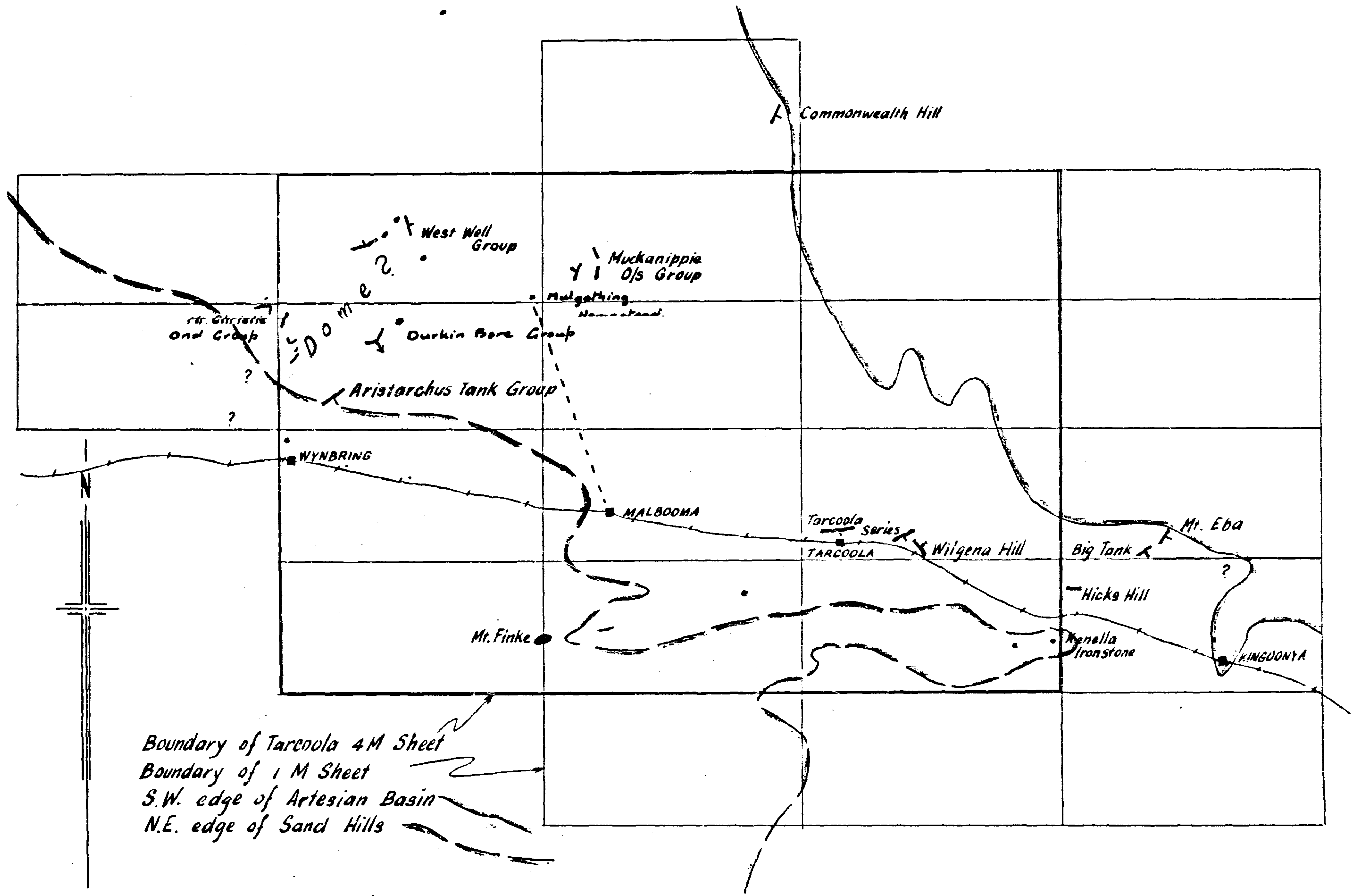
400— 6.63 1423



S.A. DEPARTMENT OF MINES

GEORGE HILL
CROSS SECTION on CD5

Approved	Director
Passed	
Drn.	
Tcd. G.M.	
Ckd.	
Exd.	
D.M.	
Req.	S4/45 8b
Scale 100' to 1"	
Date 2.2.65	



To accompany report by G.F. Whitten.

S.A. DEPARTMENT OF MINES

TARCOOLA DISTRICT
Precambrian Outcrops and Structures.
(Ironstone shown in Red)

Drn. G.F.W.	Passed	Approved	D.M.
Tcd. J.E.			Req.
Ckd.			
Exd.		Director	

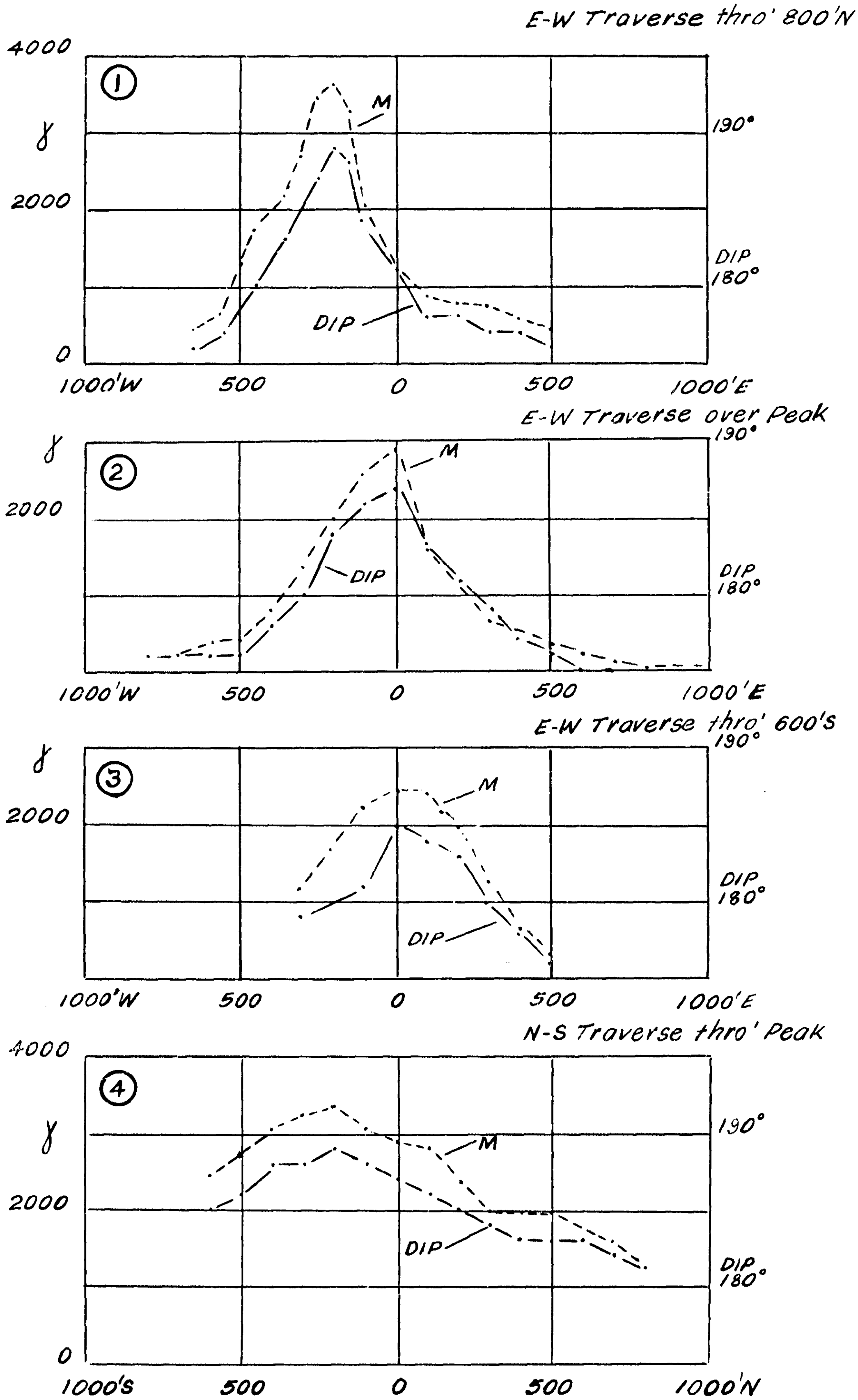
Scale 1" = 16 M approx

S 2476
Bb

Date 8-6-'60

PLATE 4

MUCKANIPPIE HILL (MULGATHING STN.)



M = Jalander Magnetometer Profile

Dip = Dip Needle Profile

To accompany report by G.F. Whitten

S.A. DEPARTMENT OF MINES					
Approved	Passed	Drn.	MUCKANIPPIE JASPILITE MAGNETIC PROFILES	D.M.	Scale
		Tcd. O.W.W.		Req.	8b S4146
		Ckd.			
Director		Exd.			Date 3·3·65

400— 6.63 1423

AGE	ACTIVITY	TARCOOLA MINES	WILGENA HILL	MT CHRISTIE	MIDDLEBACK AREA	SOUTHN EYRE PENA	
Recent	Sand Dunes	—	—	D	D	D	
	Alluvium, Scree etc.	A, S	A, S	A,S	A,S	A,S	
	Laterite, Travertine, Kopi.	T	L	L,T	L,T,K	L,T,K	
Tertiary	Fresh Water Deposits	Lignitic Sands in disconnected Basins			—	?	
Mesozoic	" " etc	Thin remnants of G.A.B Sediments			—	—	
Permian	Glaciation etc	(To North-east at L.Phillipson)		?	?	?	
Upper Proterozoic (Adelaide System)	4 periods of Sedimentation	?	?	?	absent?	absent?	
Middle Proterozoic	Intrusion, Extrusion Mineralization	Microdiorite dykes etc. Au, Cu (?)	Gawler Ra. Volcanics (Dykes) Intruding Tarcoola Series	?	Gawler Ra Volcanics (Dykes, Flows) (1540 M.?)	—	Age Dating in Middleback Area
	Sedimentation	Tarcoola Series Dolomites Slates Quartzites Grits, Basal Conglomerate over granite	— " " " with jaspilite pebbles over jaspilites	?	Corunna Conglomerate Dolomite Quartzite Shale Conglomerate etc	Blue Range ?	Age Dating in Middleback
Middle Precambrian	Granitic Intrusion Granitisation & Metamorphism	Granite?	Granite in vicinity (1600 M.?) Absent?	Wynbring Malbooma Mulgathing Granites { Affects all sediments	Charleston Granite etc. { Mainly below Middleback Gp.	{ Mainly of Flinders "Group"	Age Dating at Warna Well & in Middleback area.
	Sedimentation including iron formations	?	Quartzites Schists, Jaspilites = Grey Shales etc.	Sediments Iron Formation = Sediments	= Middleback Gp =	Hutchison Schists (includes jaspilites)	
	Sedimentation, no iron formations	?	?	Sediments ?	= Gneiss Complex =	Flinders Gp	
Oldest Precambrian	Assumed basement	Granite ?	Granite ?	?	?	?	

S.A. DEPT. of MINES

STRATIGRAPHIC COLUMN — TARCOOLA DISTRICT & EYRE PENINSULA

65-98

B+D

5·3·65

To accompany report by G.F. Whitten

S.A. DEPT. OF MINES

Flight Diagram	59-130				
Aeromagnetic Map	60-28				
Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

PRELIMINARY EDITION SUBJECT TO AMENDMENT

TARCOOLA 4 M.

GEOLOGICAL AND ACCESS PLAN

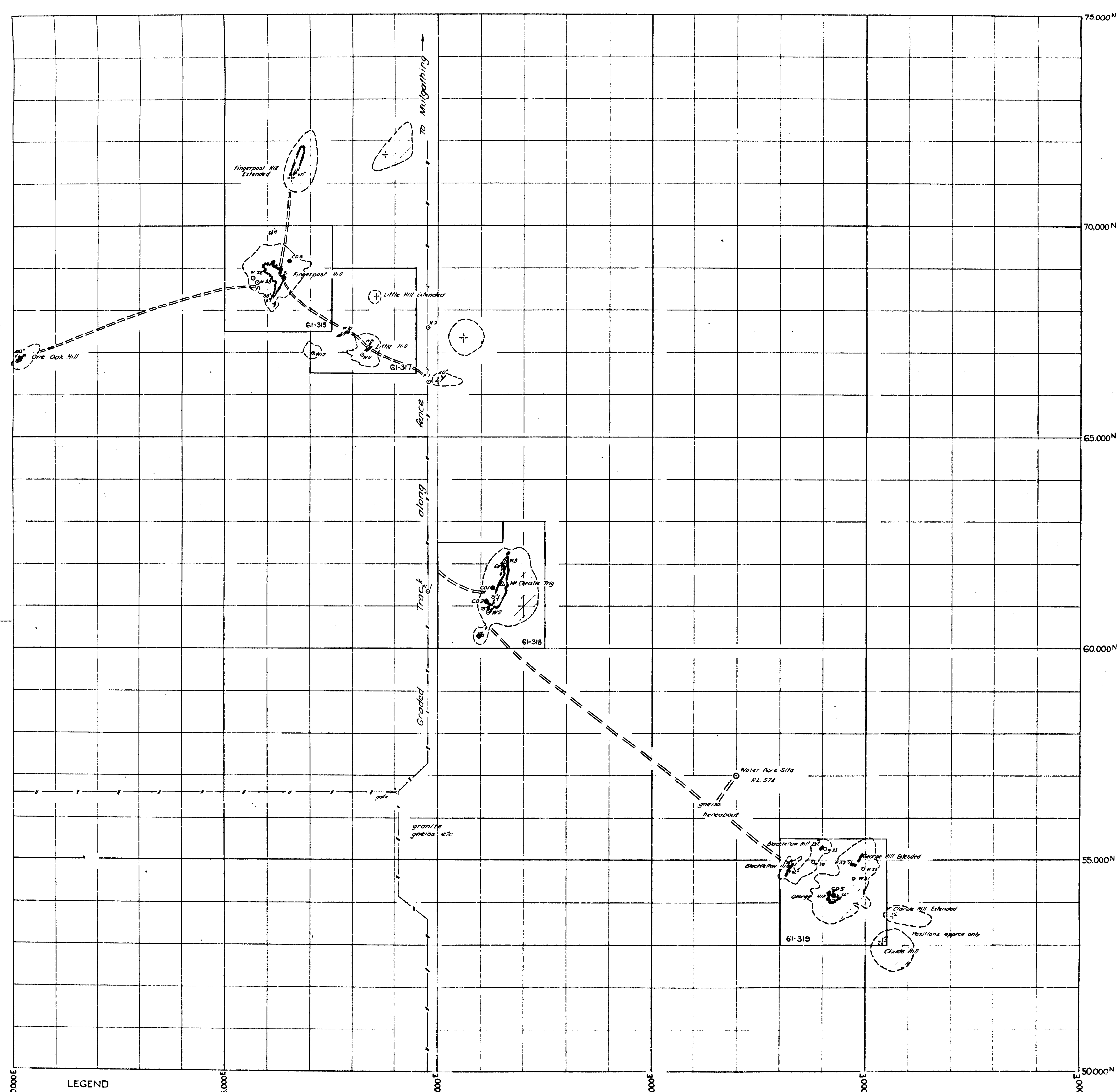
Approved	Passed		
		Drn.	
		Tcd.	
		Ckd.	
Director of Mines		Exd.	

Scale 4 Miles to 1 inch

59-129

Date

1328



LEGEND

Jaspilite { Outcropping / Scree

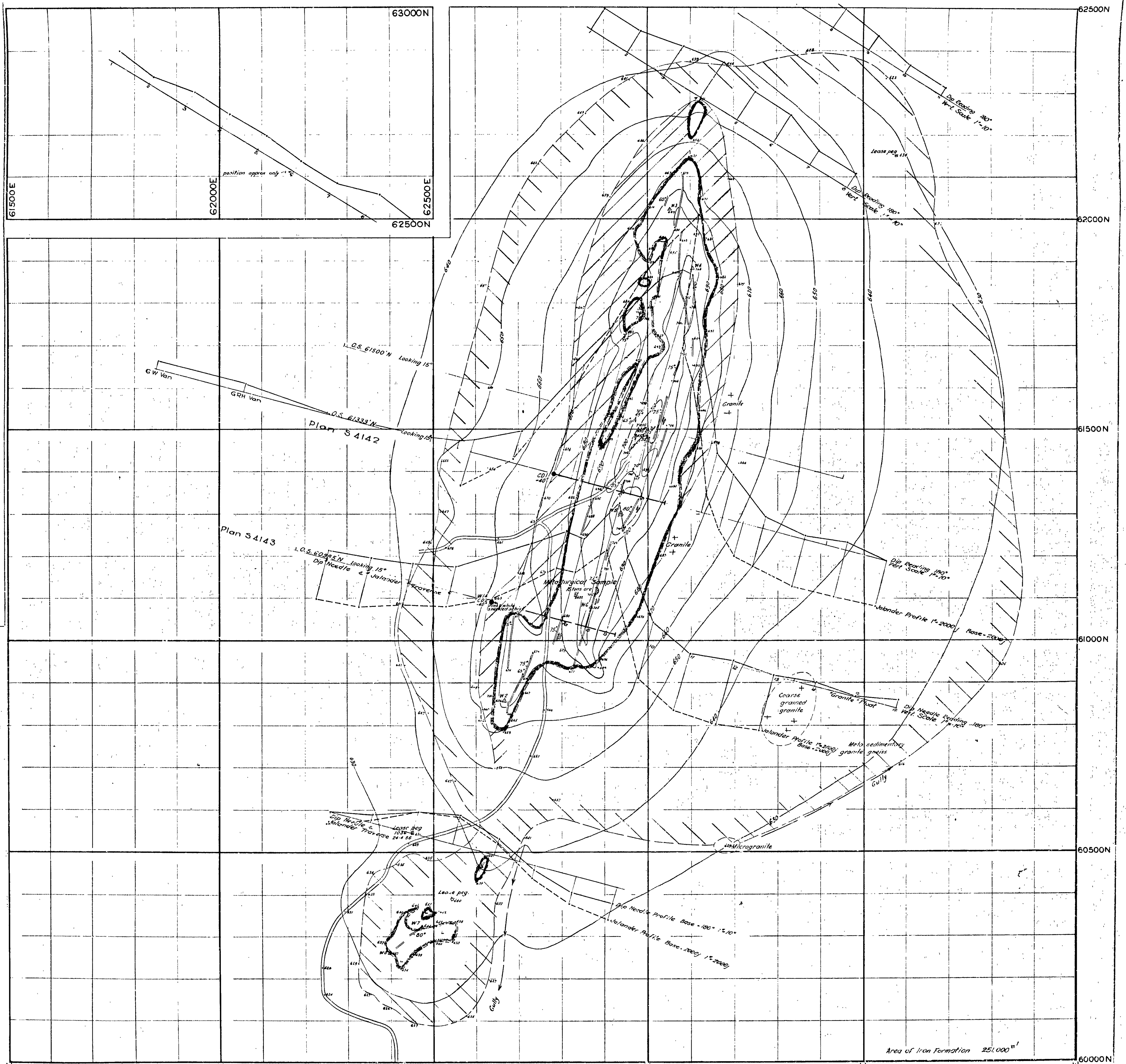
Diamond Drill Holes ● CD1, 2, 3, 5

S.A. DEPT. OF MINES

M^T CHRISTIE AREA
IRON FORMATION OUTCROPS
District Plan

1inch = 1000ft

65-99
Bb



Legend

Jaspilite { Outcrop / Heavy scree / Light scree

Contours (10 ft intervals) —640—

Strike and dip of strata

Drag Folds (showing plunge)

Datum: Sea level

S. A. DEPT. OF MINES

Mt CHRISTIE JASPILITE OCCURRENCE

Geological Plan

Mulgathing Station

Scale 1/10"

61 - 318

10-4-61

To accompany report by G.F. Whitten

LEGEND

Jaspilite { Outcrop / Scree

S. A. DEPT OF MINES

FINGERPOST HILL JASPILITE OCCURRENCE

MT CHRISTIE AREA

Commonwealth Hill Station

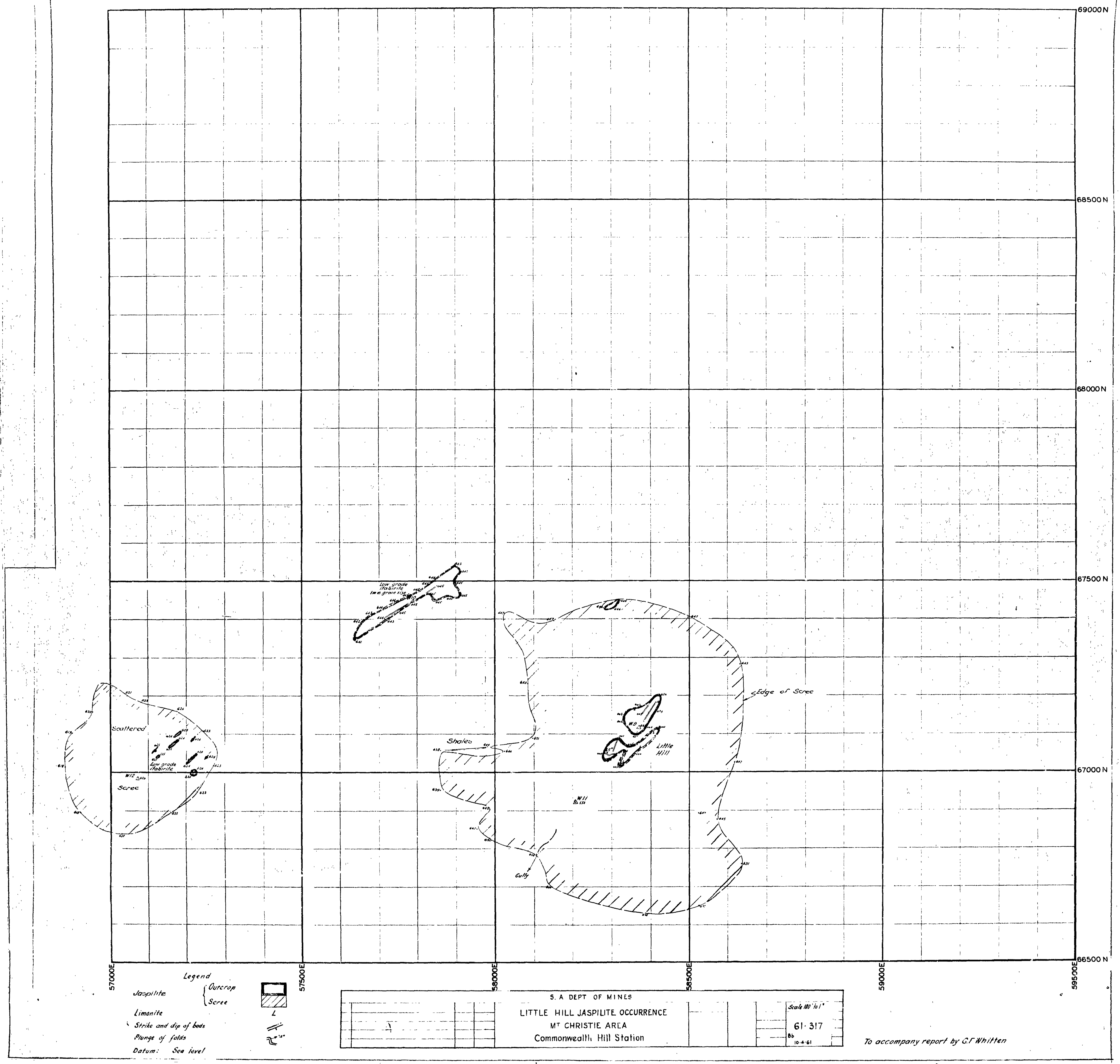
Scale 100 ft. to 1 in

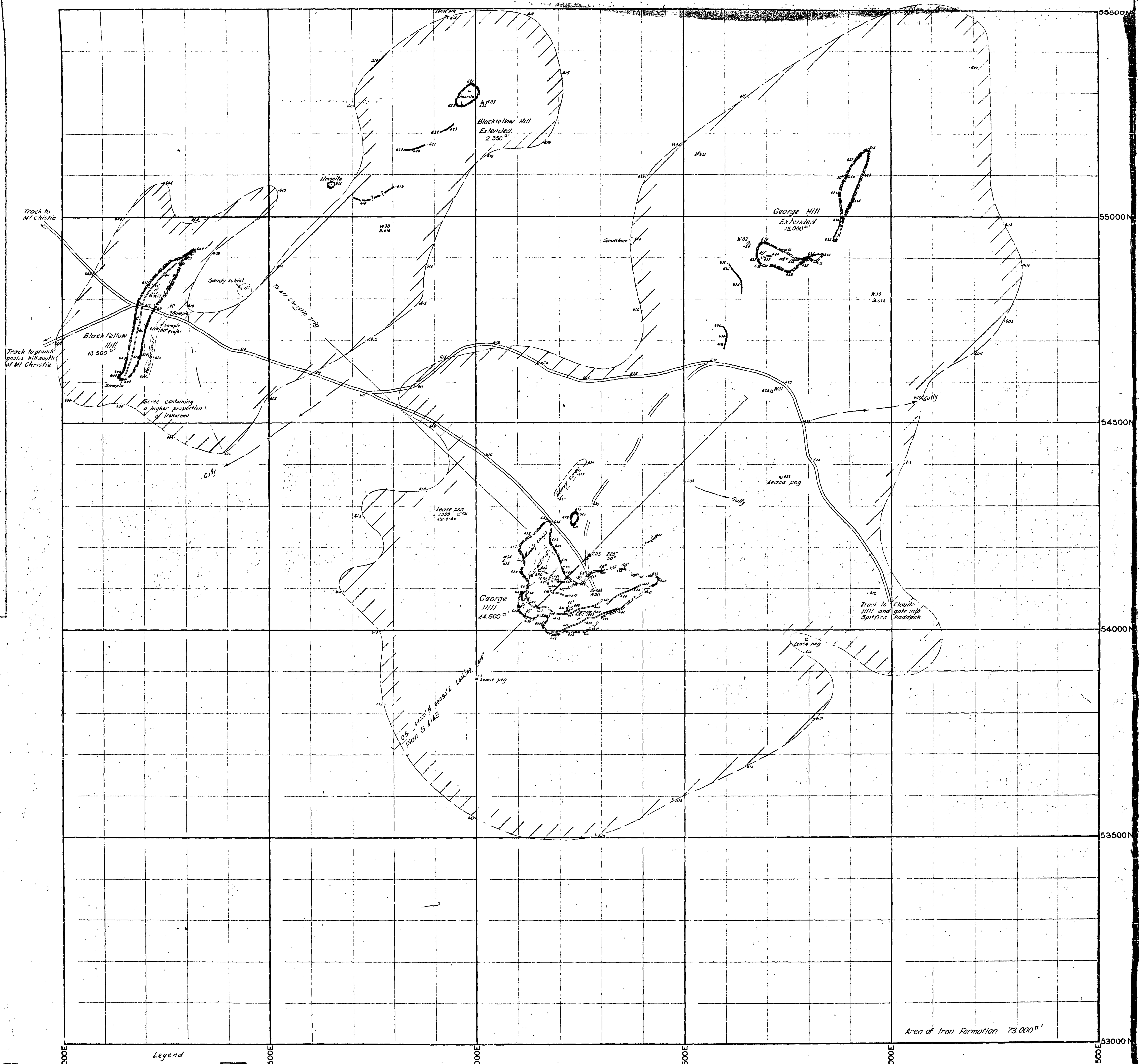
61-315

Bb 10-4-61

To accompany report by G.F. Whitten

61-315 Bb


69000 N
68500 N
68000 N
67500 N
67000 N
66500 N
57000E
57500E
58000E
58500E
59000E
59500E
Low grade itabirite
W10
Scattered
Low grade itabirite
W12
Scree
Shales
Edge of Scree
W9
Little Hill
W11
Gully
Legend
Jaspilite
Outcrop
Scree
Limonite
L
Strike and dip of beds
Plunge of folds
Datum: Sea level
S. A DEPT OF MINES
LITTLE HILL JASPILITE OCCURRENCE
M^T CHRISTIE AREA
Commonwealth Hill Station
Scale 100' to 1"
61-317
Bb
10-4-61
To accompany report by G.F. Whitten



Legend

Jaspilite	Outcrop	
	Heavy scree & conglomerite	
	Light scree	

Limonite L

Strike and dip of strata . . . . 40°

Datum: Sea level

S. A. DEPT. OF MINES.

GEORGE & BLACKFELLOW HILL JASPILITE OCCURRENCES

MT CHRISTIE AREA

Mulgathing Station

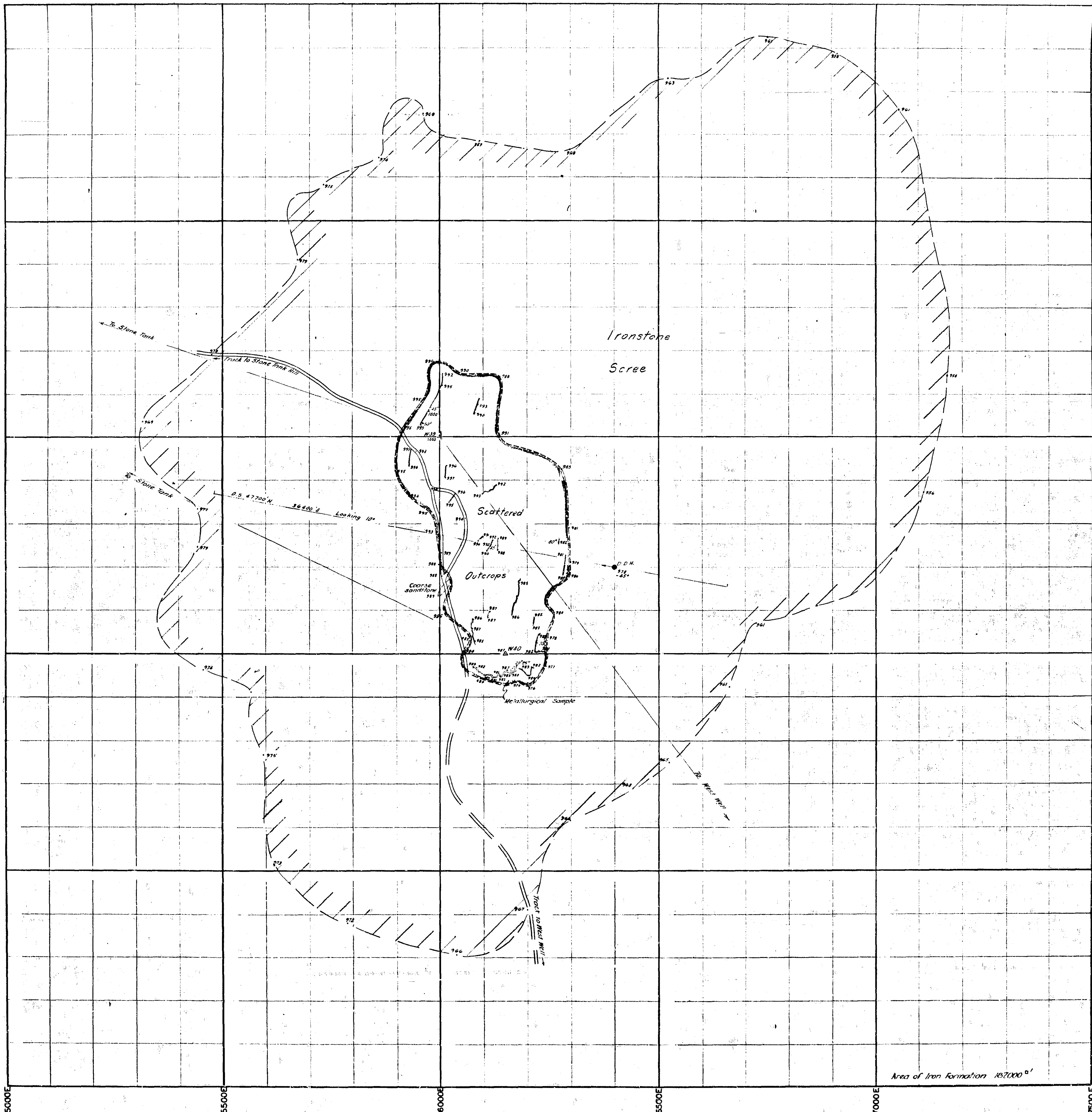
Scale 100' to 1"

G1 - 319

Bb

10.4.61

To accompany report by G.F. Whitten



LEGEND

Jaspilite { Outcrop / Scree

S. A. DEPT. OF MINES

JASPILITE OCCURRENCE TW 11

WEST WELL AREA

Mulgathing Station

scale 100' to 1"

61-316

Bb 10-4-61

To accompany report by G.F. Whitten