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on

REGIONAL GEOLOGY AND NICKEL EXPLORATION IN THE MANN 4 MILE SHEET AND ADJOINING AREAS

by

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GEOCHEMICAL SECTION

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA

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C O N F I D E N T I A L

Preliminary Report

on

REGIONAL GEOLOGY AND NICKEL EXPLORATION

IN THE MANN 4 MILE SHEET AND ADJOINING AREAS

SUMMARY

This report reviews the available information on the region and presents a preliminary appraisal of the data supplied by South Western Mining Co. Ltd. Current field and laboratory information has also been included.

The study shows that the basic and ultrabasic rocks of Giles complex, which are associated with extensive areas of secondarily enriched nickel mineralisation, occupy a regional synclinal structure which has been modified by major fault and shear zones.

This interpretation is being used as a guide for planning the current mapping programme being conducted by the Geochemical Section of the Geological Survey.

New geological and geochemical data is presented which confirms the lateritic origin of the enriched nickel deposits.

Recommendations are made for further exploration of the area.

C O N F I D E N T I A L

REGIONAL GEOLOGY AND NICKEL EXPLORATION IN THE MANN 4 MILE SHEET AND ADJOINING AREAS

PART I

GENERAL

INTRODUCTION:

The discovery of extensive nickel mineralisation in the vicinity of Mt. Davies, Tomkinson Ranges, in 1953 by a Mines Department field party, under R.C. Sprigg, lead to the undertaking of a major exploration campaign in the area between 1955 and 1958 by South Western Mining Ltd., a subsidiary of International Nickel Co.

The company retains Special Mining Lease No. 33 over the area under suspended labour conditions for a 2 year term which commenced 3rd June 1959.

The Geochemical Section of the Geological Survey has commenced an investigation of the nickel mineralisation and regional geology of the Mann 4 mile sheet. The objective is to make an independent appraisal of the economic potential of the area as well as contributing to the knowledge of the geology of the State.

This preliminary report is the result of study of all information available to the authors and of the current Mines Department field and A.M.D.L. laboratory investigations.

ACKNOWLEDGEMENTS:

The bulk of the detailed information shown on the small scale plans comes from confidential reports of South Western Mining Limited, submitted to the Mines Department under the terms of the Lease. Useful information was gained from reports and published papers by Sprigg and Sprigg and B. Wilson, and other papers on the Musgrave Ranges region by A.F. Wilson. Valuable data was obtained in early papers by Basedow, Streich, Talbot & Clarke.

LOCALITY & ACCESS:

The nickel mineralisation is located in the extreme north-western corner of the State in the Davies and Tomkinson 1 mile Sheets.

From Mount Davies air line distance to Adelaide is approximately 800 miles, to Alice Springs 330 miles, and to Laverton, W.A. 400 miles (see fig. 1).

The area is located in the centre of the large central Aboriginal Reserve which extends into the adjoining States. The Reserve is sparsely populated by nomadic natives and the closest settlement to Mount Davies is Giles Meteorological Station, 120 road miles from Mount Davies. Access to Mt. Davies is via Mulga Park Homestead and Kulgera, 167 miles south of Alice Springs, (N.T.). The total distance from the main road at Kulgera to Mount Davies is 280 miles. The track is partly graded and is trafficable to 2 wheel drive vehicles except after heavy rain.

The licensed unsealed airstrip at Mount Davies can be used by aircraft up to DC3 size.

CLIMATE AND WATER SUPPLY:

The area probably has an annual average rainfall in the vicinity of 9 inches, but is capable of great seasonal variations and it decreases rapidly to the south of the ranges. Annual evaporation is probably of the order of 120 inches. The temperature range is extreme, varying from over the century in the summer to below freezing at ground level in the winter.

Limited underground water supplies have already been proved near Mt. Davies and Wingellina but it is doubtful whether this supply could be maintained for a long period. Suitable small reservoir sites could probably be found in the ranges, but it is thought that the high evaporation would greatly restrict their usefulness.

Creeks are restricted to the hilly zone and terminate abruptly in alluvial outwash areas on the margins of the extensive

VEGETATION AND SOIL COVER:

The vegetation is typical of the arid to sub-arid environment. Extensive areas of sparse mulga (Acacia sp.) scrub occur around the foot hills of the ranges. The adjacent plain margins are associated with scattered Corkwoods (Hakea sp.) and Desert Oaks (Casuarina decaisneana). To the south in the sand dune areas, scattered low growth of Cassia and similar shrubs are common with occasional eucalypts around the granite hills which also favor the growth of native pine (Callitris sp.). The ranges themselves are commonly associated with stunted eucalypts, occasional native figs (Ficus platypoda) and spinifex (Triodia sp.). One mallee type eucalypt ("whistling gum") appears to be associated with the ultra basic outcrops.

Current mapping indicates that there is very restricted development of residual soil, which makes geochemical prospecting unsuitable for the large areas which are covered by pediments, drift sand, fixed sand dunes and kunkar.

TOPOGRAPHY:

The Mann-Tomkinson-Blackstone chain of ranges forms a picturesque topography, rising sharply up to 1500 to 2000 feet above the general plain level which itself is of the order of 2000 feet above sea level. The ranges in fact form the topographic backbone of the continent, as they are flanked to the north and south by extensive desert areas. Erosion appears to be still active in the region and there are no high peneplained areas remaining in the Mann 4 mile Sheet typical of a lateritic terrain. The laterite and porcellanite areas farther south and east appear to be small erosion residuals on the flanks of the ranges or in the broad valleys south east of the Musgrave Ranges.

The granitic masses such as form the Birksgate Ranges, and Mt. Harcus in the south of the Mann 4 mile Sheet form impressive rounded tors rising boldly from the southern sandy plain.

HISTORY:

The region is a classic area of central Australian exploration.

The following is a summary of events -

1873 Gosse and party, the first white men in the area arrived at Mount Davies on the 28th August. Giles, one month later reached Mt. Davies and named Champ de Mars and Gosse's Pile.

1874 John and Alexander Forrest made the first successful journey from the west to the overland telegraph line in South Australia and crossed the northern part of the area.

1883-92 Carruthers, surveyor of S.A. Lands Department made a triangulation survey of the area and State Borders.

1891 The Elder Scientific Expedition led by Lindsay and including V. Streich (geologist), crossed the south-western corner of the Mann 4 mile Sheet and reached the Blackstone Range via Mount Sir Thomas and Pernamo Hill.

1900 Cockrum (prospector) pegged gold leases in the vicinity of Mount Davies.

1903 South Australian North West Prospecting expedition, including Wells, George and Basedow, visited the area. Basedow examined the siliceous laterites in the vicinity of Mount Davies.

1917 Talbot and Clarke of the W.A. Geological Survey crossed the western part of the region from Laverton and reached Mount Gosse.

1953 South Australian Mines Department party, Sprigg and Coats visited the Mount Davies area, collected samples.

1954 Special Mining Lease Number 20 pegged by Gold Mineral Exploration and geological mapping commenced.

1955 Special Mining Lease taken over by South Western Mining Limited. Active exploration employing drilling, detailed mapping and geophysics.

November 1959 Inspection of area by Mines Department Geologists.

May 1960 Mines Department field mapping programme commenced.

Although Basedow in 1903 thought the green-stained quartz at Mount Davies was due to the presence of chromium it is interesting to note that H.Y.L. Brown, in his "Catalogue of South Australian Minerals, 1893" reports, (Page 25), "quartz stained with nickel in the Tomkinson Ranges". This report, which was probably based on samples collected by the survey party led by Carruthers, appeared to have been overlooked for 60 years, until it was found that samples collected by the 1953 Mines Department party showed a positive nickel content. The party visited the area to check for possible uranium occurrences. It is interesting to speculate how long this area of nickel mineralisation would have remained untested if it were not for the chance visit of a regional mapping party from an adjoining area.

REGIONAL GEOLOGY AND NICKEL EXPLORATION IN THE MANN 4 MILE SHEET AND ADJOINING AREAS

PART II

REGIONAL GEOLOGY

GENERAL GEOLOGICAL SUCCESSION:

I. ARCHAEAN

A broad subdivision which will be described more fully below can be made as follows:-----

(a) Metasediments: represented by granite gneisses, pyroxene granulites and amphibolites.

(b) Basic intrusives of the Giles Complex.

(c) Intrusive granite and gneissic (?) granite.

(d) Dolerite dykes.

II. PROTEROZOIC

The Tollu Volcanics of Western Australia are possibly of Proterozoic Age and at MacDougalls Bluff are separated from the crystalline basement by a strong angular unconformity marked by a basal conglomerate containing quartz. The volcanics are believed to be associated with copper mineralisation. South Western Mining Ltd. regional maps show that the Tollu Volcanics vary from acid to basic in composition. The area was not inspected on the ground by the writers but recently a low level aerial reconnaissance was made in company with Mr. J. Noldart of the West Australian Geological Survey. A specimen of amygdaloidal basalt from Tollu was obtained from Mr. J. Johnston (formerly of GeoSurveys Ltd.) and submitted for petrological examination. (see Appendix II, Specimen P23/60). Mr. Noldart considered that this rock resembled volcanics associated with the Proterozoic Nullagine Series in W.A.

The Sturtian Glacials of the Adelaide System have been mapped on the Alberga Sheet to the east, and may possibly occur on the Mann 4-mile as a small isolated quartzite outlier (?) on the Bryson Sheet which was observed during the recent aerial reconnaissance.

III. PALAEOZOIC

Sandstones and thin limestones, probably Ordovician Age, flank the southern margin of the region, extending from the Indulkana Range in the east to the vicinity of Skirmish Hill, W.A.

IV. TERTIARY

Laterite and porcellanite.

V. QUATERNARY

Chalcedony, clay pans, clay soils, kunkar, sand dunes, pediment, recent alluvium.

OUTLINE OF ARCHAEAN GEOLOGY:

1. ARCHAEAN META-SEDIMENTS

Information available to date indicates a thickness of many thousands of feet of metasediments were deposited in the area. Lithologically the metasediments indicate that the original sequence probably generally comprised medium to coarse grained clastic sediments, with a higher quartz felspar content. Thinner impure dolomitic members occurred at a number of levels in the succession.

The rocks are remarkably free from hydrous minerals. The sequence was highly metamorphosed to the granulite metamorphic facies and is now represented by a variety of gneisses, granulites and minor quartzites etc. with a composition varying from acid to basic as follows:-

(a) Acid gneisses.

These rocks are well banded and show in places relict cross-bedding structures. Some of the types are clearly meta-arkose, and others are more quartzitic in composition. Their relation to the gneissic granite developed mainly in the southern part of the region appears to be close as a variety of rock types ranging from arkose to granite gneiss to gneissic granite to granite are represented in the region.

(b) Intermediate and basic gneisses and granulites.

These rocks contain less than 10 percent quartz and medium to fine grained rocks well laid commonly contain pyroxene and are garnetiferous in parts of the region.

(c) Basic gneisses and granulites.

These are represented by banded amphibolites and pyroxene rocks, which are clearly of meta-sedimentary origin. Some of these types have been mapped as leucodiorite by South Western Mining geologists.

2. ARCHAEAN, IGNEOUS ROCKS

(a) Granites

Intrusive granites and minor pegmatites occur in the adjoining area of Western Australia and locally in the Nairne Ranges. Intrusive granites appear to be associated with allanite and fleurite. The great mass of granitic rocks forming the Birksgate Ranges Region to the south and extending north-east across the Nairne 4-mile Sheet are, from recent aerial observation folded and foliated rocks probably of sedimentary origin. This is supported by petrological examination of a specimen from the Birksgate Ranges, (see appendix I, Specimen P21/60).

(b) Basic and Ultra-basic Igneous rocks (Giles Complex)

Layered rocks of the Giles Complex occur in the Mount Davies region and extend west over 100 miles into Western Australia (see figs. 7 & 9). These rocks have been mapped in detail by the South Western Mining Limited (see fig. 8) and a study of their maps indicates that the sequence is complex. The authors are of the opinion that the distribution of the ultra basic, basic rocks cannot be used with confidence to give an indication of original facing in terms of gravity-differentiation of the heavy minerals. A large proportion of the rocks are of norite gabbro composition but substantial bodies of olivine and pyroxene rich ultra-basics occur. These are of great genetic significance in the distribution of the nickel minerals.

The following is a summary of the features of the basic and ultra-basic bodies, as obtained from South West Mining geologist's report by H.R. Elves, consultant geologist for South West Mining Limited. Systematic collection of rock specimens for precise petrological identification of the main rock types are being made from these zones. This will supplement the petrological work already carried out at the Parkside laboratories and the earlier work of Robinson (1949).

1955

SUMMARY OF GEOLOGICAL FEATURES OF BASIC AND ULTRABASIC BODIES, MT. DAVIES REGION

	GOSSE'S PILE	MT. DAVIES	WALTER HILL
SIZE	6 miles x 1½ miles	10 miles x 4 miles	10 miles x 3 miles
ULTRABASICS	Bulk	Mainly olivine-rich basics and ultrabasics.	Subordinate ultrabasic development.
PERIDOTITE	Locally in pyroxenites	Narrow bands in northwest (trace chalcopyrite and pyrrhotite)	Irregular bodies cutting norite?
PYROXENITE	Predominantly medium to coarse grained enstatite to bronzitite. Grading to norite.	Medium to coarse grained on northeast side of Greenwood Zone	Thick band on north edge (bronzite?)
SERPENTINITE	Several zones. Grades to peridotite. Original comp. undetermined associated with chrysoprase	Two large laterized serp. zones. Davies 1½ml.x1500' Greenwood 5ml x1000' to 4000'. Grades to Harzburgite with nickel.	Only one exposed locality on scarface (may be largely lateritized) with nickel.
HARZBURGITE	-	Coarse grained enstatite and olivine. Long continuous bands in the north of the intrusive.	-
ENSTATITE	-	Thin bands	-
BASICS	-	-	Mainly norite.-
NORITE	Massive felspathic gabbro (also prob. felspathic gabbro) olivine rare - contains narrow bands of pyroxenite	Thick, massive structureless Olivine norite. Also hypersthene norite with apatite and magnetite. Hypersthene enstatite - norite hypersthene leuco gabbro.	Medium grained layered hypersthene norite dominant. Leuco norite and diorite with magnetite becoming less basic towards west.
DOLERITE	Fine grained with tachylites (in serpentine)	Fine grained and tachylitic with some magnetite.	-
STRUCTURE	Faulted outline, with massive pyroxenite core.	Layering on north side. South half massive.	Layering well developed

	GOSSE'S PILE	MT. DAVIES	WALTER HILL
FACING(?)	Massive. Original outline not known.	North contact basic. Faces south.(?)	Faces south west (?).
TREND	East west, steep south dip.	North south to north east, dip south west.	North west, south east or east west.
SULPHIDES	NONE	Specks chalcopyrite and pyrrhotite at numerous places.	Isolated specks of chalcopyrite in west and north west end.

Although the Giles Complex is broadly concordant with the meta-sediments, particularly in the western part of the region, there is however undoubted evidence that the norite can locally cut across the gneiss banding on the southern margin of the Mount Davies basic mass and around Champ de Mars plug. Similar discordant bodies of norite are known in the Mount Woodroffe region to the east (A.T. Wilson 1960).

The Giles complex however, was apparently largely sill like in character and of very great areal extent, the main sill having a thickness of the order of ten thousand feet (see interpretation cross section fig. 7).

3. DOLERITE DYKES

The entire region from the Everard Ranges to the Blackstones of Western Australia is traversed by numerous swarms of dolerite dykes generally with a north-westerly trend, some swarms persisting for over 150 miles. Minor swarms also trend east-west. The thickness varies from a few tens of feet up to 500 feet or more. Dyke zones are sheared generally with an east block west displacement. Shear zones produce peculiar glassy textured rocks (tachylite). In composition the dyke rocks approach gabbro and norite (Thomson 1911) and may be olivine rich, (A.F. Wilson 1949). The rocks also occur as minor sills. The dyke rocks appear to be genetically related to the Giles Complex. This is suggested also by the occurrence of traces of nickel in the dyke zone in the Anerinna Hills on the Woodroffe 4-mile Sheet and by petrological and geochemical investigations by H.W. Fander (Appendix II), and the recent discovery by the Mines Department party of ultra-basic bodies in a dyke swarm on the Mann and Deering Sheets. The dyke rocks are Pre-Sturtian in age as proved by the mapping of Sprigg, Wilson and Coats on the Alberga 4-mile Sheet. Their age relation to the Tollu Volcanics in Western Australia is not known but are presumed to be older.

4. STRUCTURE

Previous work by A.F. Wilson in the Eastern Musgraves, and Sprigg and B. Wilson in the Alberga region, indicates that there the fold structures are trending meridionally and they assume that east west trends in the western part of the region were younger tectonic features. Sprigg and B. Wilson suggested that a change in trend in the vicinity of Erlywanyawanya Rockhole near Mt. Woodroffe may be due to an unconformity in the Older Precambrian succession.

The writers have visited the locality and agree with A.F. Wilson that this trend-feature is caused by a west-north-west striking shear zone dipping gently south. This shear zone appears to be the eastern extremity of a major shear or fault zone passing along the entire front of the western Musgrave and Mann Ranges and has a strike length of the order of 150 miles.

Compilation of all available evidence from South Western Mining Limited and the recent reconnaissance mapping indicates that the Archaean succession has been folded into a vast synclinorium trending west-north-west beyond the State Boundary (see Figs. 7 & 9). This interpretation is supported by the distribution of the Giles Complex and the western boundary of the gneissic-granite zone.

Although shallow fold structures in the meta-sediments in South Australia and in the western extension of the Mann Range into the Northern Territory plunge both north-south and gently to the east-south-east, a study of the details shows that steep westerly plunging structures also occur. Farther west in Western Australia beyond Mt. Aloysius the regional plunge appears to change to the east. The interpretation of South West Mining Ltd. mapping data suggests that the synclinorium forms a tectonic basin, outlined by the Giles Complex (Fig. 7). This structure shows that the old regional folding in the Tomkinson-Blackstone Range area depart from the meridional trends in the Alberga Sheet.

The large synclinal structure is of fundamental importance in the search for further occurrences of ultra-basic rocks in the region, and suggests that large ultra-basic bodies at this stratigraphic level are unlikely to occur below the younger cover, east of Gosse's Pile. Although local plug-like bodies could be expected along the extension of the Blackstone-Davies Shear Zone, in fact, as mentioned above, small [illegible] recently been found in this zone on the Mann and Deering 1-mile Sheets.

AGE OF STRUCTURES:

1. Older Structures

Archaean meta-sediments were moderately folded prior to the introduction of the Giles Complex probably at the time of regional granitisation which produced the granitic gneisses and gneissic granite. The introduction of the Giles Complex would appear to have occurred while the meta-sediments were still buried to a considerable depth. Further violent folding occurred during or after the emplacement of the large basic and ultra-basic bodies and preceded the introduction of basic dykes along active shear planes and tension openings. It is possible that younger intrusive granites were also emplaced at this stage.

2. Proterozoic Folding

The eastern end of the province is flanked to the north and south by upper Proterozoic rocks. The presence on the Alberga Sheet of tillites resting in places on Archaean rocks indicates that the crystalline basement was exposed at that time. The old mountain belt was probably within a rising geanticlinal belt.

3. Palaeozoic Folding and Tectonics

The marked unconformity between the Ordovician and the Adelaide System in the Indulkana Range and Mount Johns area, indicates that a period of tectonic activity occurred probably in the Cambrian. This is most probably related to the middle Cambrian orogeny of South Australia.

The folding of the Tollu Volcanics into a basin structure was possibly associated with this orogeny. The mild folding of the Ordovician is probably largely due to later Palaeozoic folding which folded Permian-Carboniferous sediments in the Amadeus Basin to the north. Broad arching and uplift of the late

Tertiary laterite surface apparently continued to the present day.

REGIONAL GEOLOGY AND NICKEL EXPLORATION IN THE MANN 4 MILE SHEET AND ADJOINING AREAS

PART III

ECONOMIC GEOLOGY AND EXPLORATION

PREVIOUS WORK:

(a) South Australian North West Prospecting Expedition

Basedow (1905) examined the jasperoid outcrops on the northern foot of Mount Davies, probably Gosse or Scarface zone, which he named Murru Yilyah outcrop and described as follows ......

> '"The deposit consists of a fresh looking highly siliceous rock varying from impure siliceous ironstone, through chalcedonic, and semi-opaline varieties of quartz". ......"The silica has been tinted by mineral salts in solution, the colour ranging from brick red to pale yellow to a bright green (chromium)". ..... "Its origin (the deposit) is doubtful as it can hardly be referred to the 'desert sandstone'*, though in some respects it is not dissimilar to it."'

(b) South Australian Mines Department, 1953

In November, 1953, a party under R.C. Sprigg, Senior Geologist, visited the Tomkinson Ranges to check for possible uranium association with the green stained silica recorded by Basedow. Ultrabasic rocks were discovered to be associated with the green stained formation.

Mr. Sprigg reported these occurrences as follows ....

> 'Green stains have proved to be due both to nickel and chromium, a trace of the latter and 0.2% nickel, (siliceous specimen only). The occurrence is potentially important due to the enormous size of the breccias. Two or three zones were seen to the north with the aid of binoculars. In view of the high degree of leaching of these breccias, the primary nickel mineral could only be sampled by drilling. It is proposed to investigate these breccias fully next season. ......'

* porcellanite or duricrust (BPT).

R.P. Coats visited the area in August, 1954, and reported the occurrence of chromite at Mount Davies (G.S. 168, Rept. Bk. No. 38/77).

(c) Gold and Mineral Exploration, N.L. 1954

R.C. Sprigg, as consultant Geologist, GeoSurveys Australia Limited, returned to the area for three months in 1954.

Results of the work are included in a report in the Mines Department files, (D.M. 1238/54).

The work consisted largely of geological mapping and it is interesting to note Mr. Sprigg's able interpretation of the mineralisation as follows -

> 'To the present no definite indications of sulphide mineralisation have been noted within the dunite intrusive zones and the laterite concentrations appear to be largely surface concentrations of garnierite from the original silicate mineral complex of the ultrabasics themselves. The low copper content of the surface exposures also supports this non-sulphide origin theory for this particular locality.'

(d) South Western Mining Limited

In June, 1955 South Western Mining Limited acquired the Special Mining Lease.

South Western Mining Limited is an Australian Company with the following shareholders:

(i)	Southern Mining and Development Limited, subsidiary of International Nickel Company of Canada Ltd.	51%
(ii)	Nickel Mines of Australia Limited.	49%

This latter group comprises the following interests:

Gold and Mineral Exploration, N.L.	25%
Copper and Alloys Australia Pty. Ltd.	35%
C.H. Smith and Company, GeoSurveys of Australia.	40%

Apart from Gold and Mineral Exploration N.L., the other companies are not listed in the Adelaide Stock Exchange.

SPECIAL MINING LEASE NO. 33:

(a) Area

Area of that piece of land contains about 1060 square miles, bounded by latitude 26°S and 26°30S and Longitude 129°E to 129°30E. The company has a Reservation of comparable size in the adjoining area of Western Australia.

(b) Term

Two years from 3rd June, 1959. (Area was originally acquired by the company as Special Mining Lease No. 21 on June 30 1955), later renewed as No. 25 and again as No. 33. The Company's West Australian Reservation is due for renewal in November 1961.

(c) Rent

£50 per annum.

(d) Mineral Rights

"Right to acquire mineral leases. Exclusive rights only, in respect of nickel minerals and minerals associated or combined therewith, in the area comprised in the special mining lease."

(e) Special Conditions

If agreement not complied with is not remedied, the lease may be cancelled. Three months notice required for surrender of lease.

SOUTH WESTERN MINING ACTIVITIES:

To date South Western Mining Limited have spent approximately £200,000 on exploration in their South Australian Lease. Their total expenditure for the combined South Australian and Western Australian areas exceeds £500,000.

The Company carried out an intensive exploration programme during the first 3½ years of their lease tenure.

The first diamond drill hole A1 was commenced in October 1955 and the last drill hole, Churn Drill 80 was completed in October 1958.

Fourteen geologists and five geophysicists have been engaged at various times, as well as a large number of other personnel.

A large part of the area of the leases was covered by reasonably detailed factual geological mapping on the scale of 1" = 3600 feet, as well as more detailed plans of the nickeliferous area. A large amount of geophysical work was done with the emphasis on the electro magnetic and magnetic methods, both surface and airborne techniques being used. A limited amount of geochemical sampling was done, but the results were not encouraging.

A large footage of diamond drilling was done in the vicinity of the large low grade but impressive looking siliceous nickeliferous outcrops and in a number of electro magnetic anomaly areas.

A considerable amount of percussion and wagon drilling was also carried out during the latter phase of the exploration campaign.

Creek sand samples were collected and studied.

The following tabulation gives details of exploration work accomplished: ---

Geological Mapping - reconnaissance	-	1060 sq.miles
Geological Mapping - detailed	-	96 " "
Geological Sections Mapped	-	20 miles
Creek Sand Samples Collected	-	82 miles
Geochemical traverses	-	4 miles
Resistivity Profiles	-	31 miles
* Magnetometer Traverses (ground)	-	66 sq.miles
* Electromagnetic Surveys (ground)	-	4 sq.miles

* Exclusive on surveys on airborne electromagnetic anomalies.

Electromagnetic Surveys	(Airborne)		- 197.5 sq.miles
Airborne electromagnetic anomalies investigated			- 77
Airborne electromagnetic anomalies drilled			- 5
Diamond Drilling	-	25 holes	- 7021.5'
Percussion Drilling	-	24 holes	- 2255.8'
Wagon Drilling	-	20 holes	- 414.6'

RESULTS OF EXPLORATION CAMPAIGN:

By far the largest proportion of effort was put into testing the siliceous Scarface, Greenwood, Davies and Gosse zones, apparently in an attempt to locate sulphide ore. However, the grade of primary mineralisation tested by drilling is of the order of less than 0.2 per cent nickel. Close surface prospecting located only traces of very weak disseminations of sulphides. Creek sand sampling revealed that precious metals occur only in trace amounts.

Near the close of the campaign it was discovered, apparently accidentally, that the secondary ferruginous ochres contained in places, over 1% nickel in the Claude Hills area,(and in a much more extensive deposit in the Wingellina area in Western Australia, some eighteen miles north-west of Mount Davies). The zone was tested by approximately 500 feet of churn and wagon drilling. The deepest holes, CD 71, reached 150'6" vertical depth. (see figs. 5 & 6). The holes were spaced on a broad grid and no serious attempt was made to test for possible extensions of nickel rich ochre under the concealed area to the west and south-west of the outcrop.

The much larger exposed ochre zone in Wingellina area, Western Australia, some 18 miles to the west was tested by a thorough churn drilling programme and by sinking of prospecting shafts for sampling and underground mapping. The Claude Hills deposit has, according to South Western Mining Limited (personal communication to Director of Mines) a probable tonnage of one million tons of 1.5% nickel.

Also the Wingellina deposit, Western Australia, has a considerably larger tonnage and a grade comparable to the Claude Hills area.

STUDY OF SECONDARY NICKEL ENRICHMENT:

(a) General

Mr. H.A. Laine, in a final report for South Western Mining Limited states that ....

> ..."the ferruginous laterite (ochre) may be enriched in nickel up to several times the original nickel content of the weathered rock, but the enrichment is usually highly erratic in both lateral and vertical distribution." .....

Unfortunately the drill log supplied by South Western Mining in their quarterly reports show generally only the averaged or bulked assays over long lengths of each hole and do not enable a detailed study to be made of the nickel distribution in depth. Such a study is vital to the understanding of the process of secondary enrichment and the accurate delineation of potential ore zones. One hole however, wagon drill hole No. 179, in Claude Hills (see fig. 6), showed an increase in grade with depth. Therefore the need was felt by the authors to obtain more detailed assay information on the drilling intersections, and recently the opportunity was taken to obtain duplicate samples from the Claude Hills drill samples stored at Wingellina. Bores were sampled at approximately 5' intervals. Part of each sample has been kept for laboratory investigation and the remainder of each portion submitted for assay.

(b) Depth of Weathering

In D.D. hole A14, Scarface, "limonitic laterite" was intersected in portion of the hole to a maximum depth of approximately 460 feet vertically below the surface. The deepest Claude Hill hole shows ferruginous ochre associated with siliceous material at 150 feet vertical depth. The authors have been informed that ochres have been proved by churn drilling to extend to at least a vertical depth of 800 feet, in one locality in the

(c) <u>Shape and elevations of the ochre and siliceous laterite bodies</u>

The shape of the bodies appears to be directly controlled by:

(1) Distribution of ultrabasic rocks,

(2) Relationship to a former land surface.

In the main Mount Davies area, the predominatly jasperoid bodies tend to be best developed on the northern side of the ultrabasic and basic areas producing the elongated Scarface Zone and the smaller Gosse zone which is also terminated by faults. Both of these deposits are in the foot hill area on the edge of the alluvial plain. The more highly elevated Greenwood and Davies Zones have been more deeply intersected by erosion, producing a patch work pattern of jasperoid outcrops with local residual ochre pockets. On the other hand the more lowlying Claude Hills body is predominantly of the ochre type, as at Wingellina, Western Australia, where the distribution makes a very complex pattern, probably due to the original distribution of the ultrabasics. The Claude Hills body is simple in shape, being terminated at the north-east end by a zone of jasperiod rock with traces of nickel-stained silica (chrysoprase). The western end is concealed under a thin sand cover, and the drilling results suggest that the deposit may be basin-shaped at the eastern end, and possibly deepens and narrows to the south-west. Apart from the Claude Hills, the only other deposit in the area which is likely to have an extension under the younger cover is the north-west end of the Scarface Zone. Since no survey level data was available, a light aircraft was used recently to determine approximately the relative heights of the various bodies (see fig. 8).

A datum of 2200 feet above sea level was assumed for the air strip (general plain level) and the altimeter readings obtained were as follows:

Strawbridge Laterite	2380 feet
Scarface Zone	2340 to 2400 feet
Claude Hills Ochre	2400 feet
Wingellina (W.A.) Ochre	[illegible]

Gosse Zone	2400 to 2450 feet
Tiezi Laterite	2540 feet
Greenwood Zone	2600 to 2630 feet
Davies Zone	2730 feet

These levels fall within a remarkably restricted range of elevation, when the pronounced topographic relief of the area is considered, e.g. Mount Davies is 3540'.

The recent Mines Department mapping indicates that the relief of the low lying areas can be divided into a number of levels, (i) the lowest being the flat plains area containing recent alluvial material (ii) a slightly higher level which is kunkar covered and in places associated with polished and transported bedrock float material. This level dips under or is truncated by (i). Level (ii) is in turn generally lower than and appears to truncate the more irregular outcrop surface of the ochre and jasperoid bodies.

(d) Geological Profile

The detailed mapping and drilling done by South Western Mining shows clearly that the jasperoid material tends to overlie either serpentine or less altered ultrabasic rock.

Immediately below the jasperoid zone concentrations of magnesite are commonly developed. Unfortunately no diamond drilling has been done in the Claude Hills body to determine the complete geological profile, vertically below the ochre bodies.

Because of the occasional small remnant pockets of ochre material in the larger southern bodies such as Greenwood, it is assumed that the jasperoid material would underlie the ochre in the Claude Hills area. This is borne out (although not revealed in the South Western Mining logs) by examination under a binocular microscope of the cuttings of the Claude Hills churn drill holes which, in the holes examined to date, show a marked increase in jasperoid siliceous material in the deeper sections. Under low power magnification the ochre cuttings in a number of samples show apparent relict textures characteristic of ultrabasic rock.

Samples collected of ochre material from the Wingellina area were submitted for petrological examination, and clearly confirmed (see appendix II, Sample P25/60) that the ochre is the leached and weathered equipment of nearby outcrop ultrabasic rock (picrite). Further samples from the Wingellina area, Claude Hills ochre and Greenwood ochre, showed from X-ray spectrographic analysis that the major constituent is goethite, (see appendix II, Report No. 497). The goethite composition was also checked by differential thermal analyses (D.T.A.) of these three samples, (see appendix II, Report A.M.D.L. 46).

The D.T.A. curves are of particular interest, since they so closely match those of New Caledonian nickel laterite (personal communication, J.D. Hayton, A.M.D.Laboratories). Likewise, they are generally similar to results obtained in the U.S.A. by Fisher & Dressel (1959) from studies of Nicaro (Cuba), nickeliferous laterite ores.

The detailed chemical assays of the three samples are given in Appendix II, (AR 484/60).

Petrological examination confirms that garnierite is present occasionally in the ochre but the large proportion of the nickel is possibly absorbed in clay minerals.

(e) Geochemical Profile

The compilation by the writers of all the available assay information supplied by South Western Mining is shown on fig. 6. Results of resampling by the writers of CD 71 are shown in fig. 2. The assays clearly indicate an overall increase, in nickel content, with a minor fluctuation, to about 1.6% at a depth of 95 feet. This depth coincides also with a maximum of about 46% iron(Fe). Below this depth (from 100 feet to the bottom of the hole, 150 feet), the content both of nickel and iron decreased to rapidly about 0.5% and 10% respectively. Cobalt shows a similar distribution. Magnesite appears to behave inversely to iron.

The detailed log of the hole shows an increase in silica content below 95 feet, indicating that silica contents behave

PLATE II

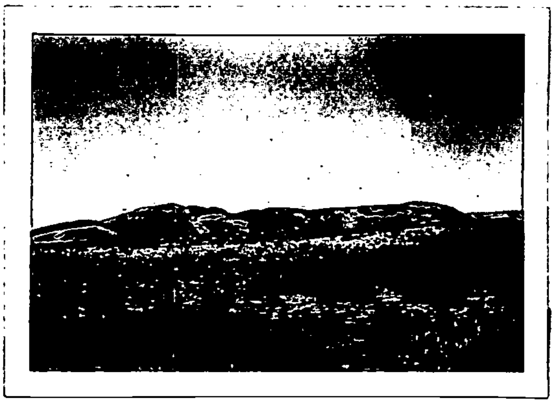


fig. 1

Mount Lindsay, Birksgate Ranges. Rounded gneissic-granite tors. Fixed dune in foreground.

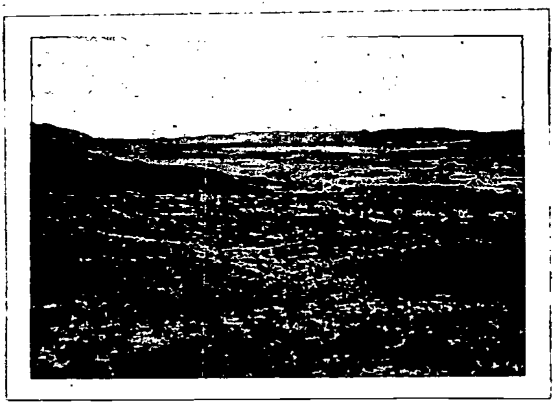


fig. 2

View looking north from Davies Zone. Scarface Zone forms low ridge at edge of scrub covered foothills of norite.

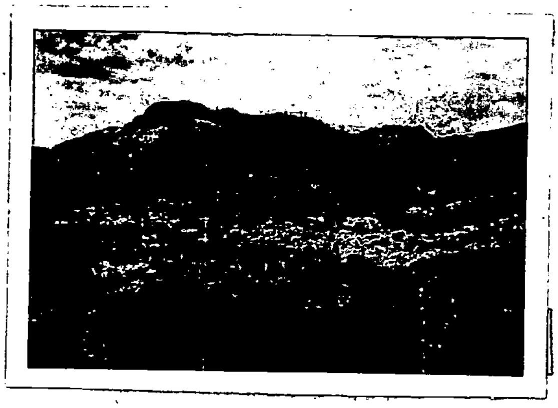


fig. 3

View looking east at western extremity of Davies Zone. Jasperoid capping on hill tops. Train of white magnesite float visible in talus. Light

PLATE III

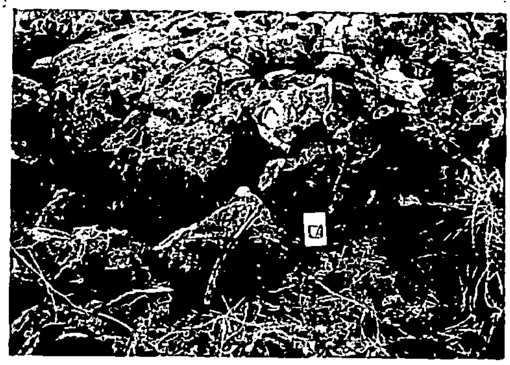


fig. 1

Veinlets of Chrysoprase (Nickeliferous chalcedony) in jasperoid outcrop. Scarface Zone.

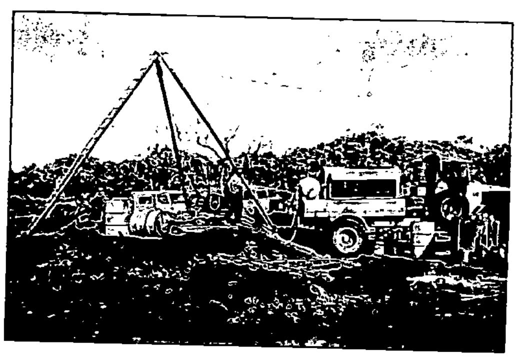


fig. 2

No. 2 Prospecting shaft. Wingellina, W.A. Dump material is mustard-coloured ochre ore. Low rise in background is pyroxenite.

similarly to magnesite. Although they actually occur over a greater vertical interval, these results show a remarkable similarity to those obtained by De Vletter, (1955), from the Ocujal lateritic nickel ore, Cuba (fig. 3). The remaining churn drill holes will be assayed and the results plotted in a similar manner. It is hoped that the higher grade zone, (in the Claude Hills area) can be delineated from the results, and substantial tonnage for higher grade than indicated by the bulk assays available from Southwestern Mining.

There remains a slight possibility that further zones of enrichment may occur in depth. This possibility would require testing by a deep diamond drill hole, which even if the results were negative would provide valuable basic information for the understanding of the enrichment process and enable closer correlations between the Claude Hills deposit and the lower grade southern deposits to be made.

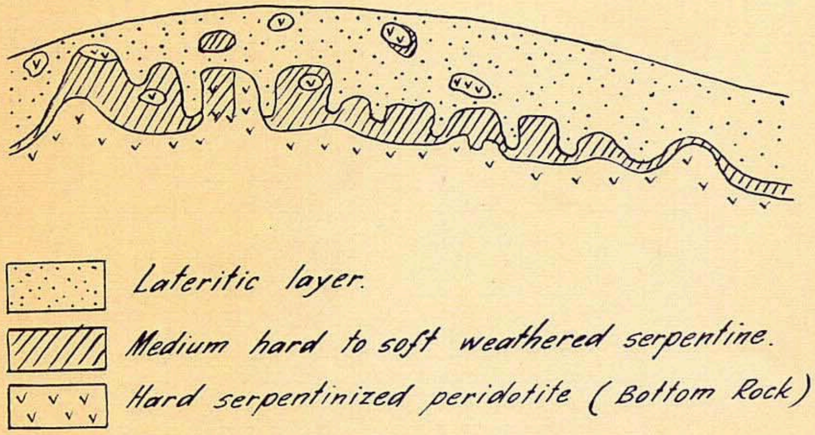
(f) Interpretation of data and genesis of deposits

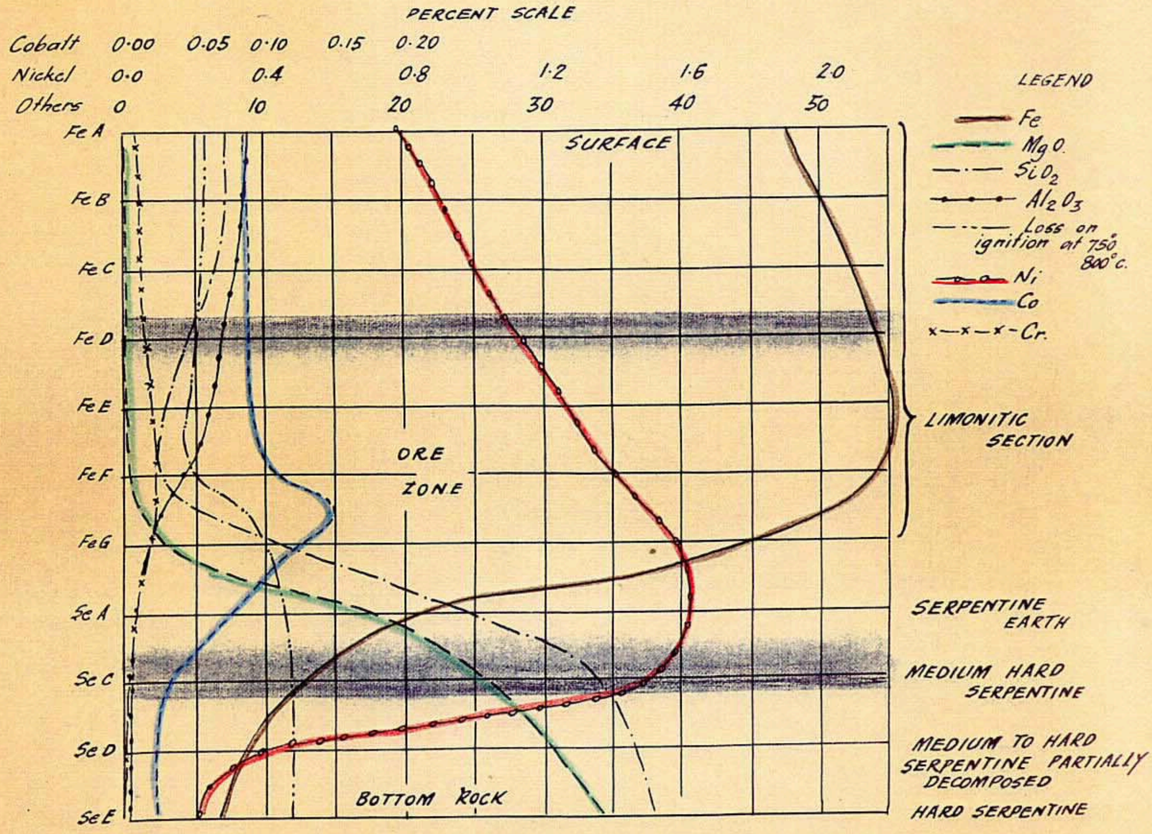
The first impression gained in the area is that a lateritic origin of the nickeliferous bodies is untenable because of the absence of peneplained areas capped by normal pisolitic laterite.

The above geological and geochemical evidence however, indicates that the origin is clearly related to lateritisation. There is another aspect of the field evidence to support this argument.

In the Wingellina area pisolitic laterites occur not far distant from the ochre deposit, (personal communication J. Johnston). It should be noted also that the regional map (fig. 9) shows a broad arc of laterites extending across the south-eastern portion of the Alberga 4-mile Sheet and west along the southern part of the map to the area south of the Birksgate Ranges. This surface may be represented also by the porcellanite capping resting on deeply weathered rocks west of MacDougall's Bluff in Western Australia. Some water bores in the Mount Davies and Wingellina areas are also believed to have intersected well

SCHEMMATIC PROFILE THROUGH NICARO NICKEL ORES



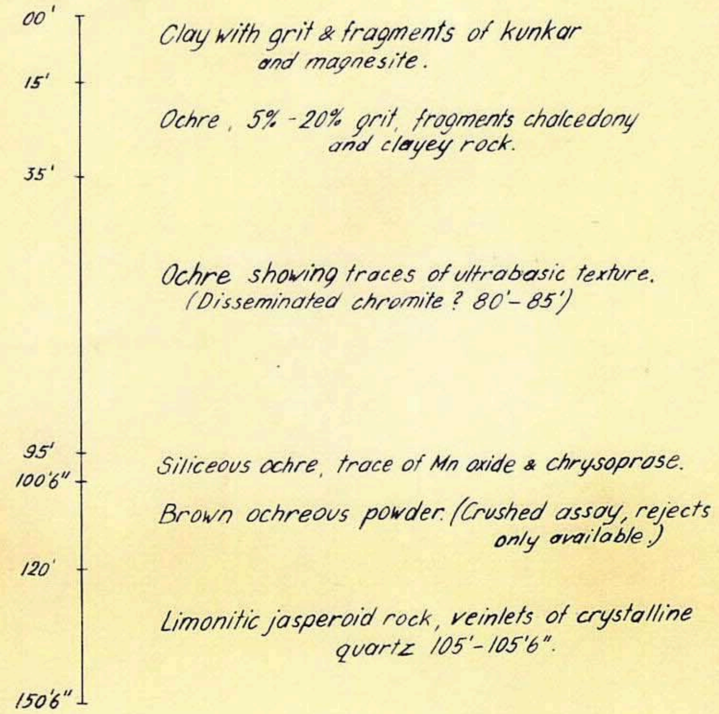


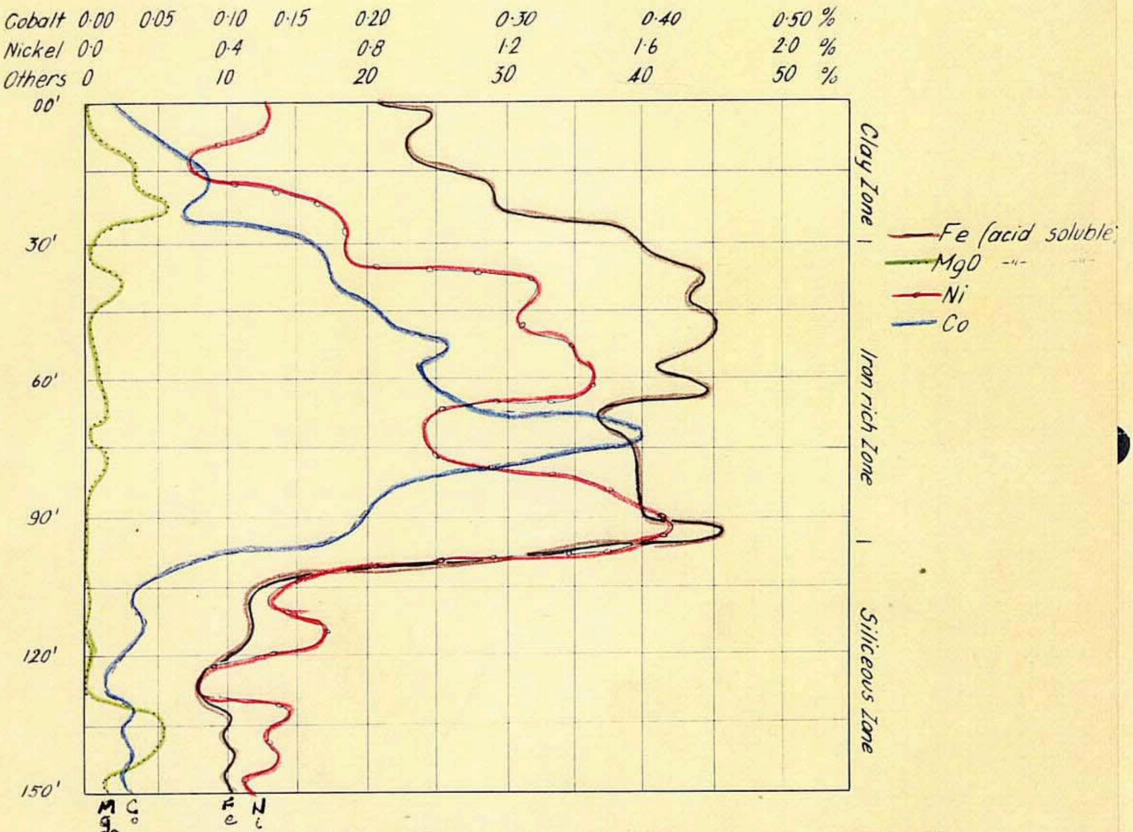
GRAPHICAL REPRESENTATION OF OCUJAL LATERITIC NICKEL ORE, CUBA.

(D.R. De Vletter, 1955 Eng. & Min. Journal Oct. 1955)

S. 2739

Fig 2





GRAPHICAL REPRESENTATION OF CLAUDE HILLS LATERITIC ORE. Based on Dept. of Mines samples & assays of C.D. 71 at 5 ft intervals.

To accompany report by B.P. Thomson & R.C. Mirams

S.A. DEPARTMENT OF MINES

roved	Passed	Drn.	CLAUDE HILLS	D.M.	Scale —
		Tcd. G.S.	LATERITIC NICKEL ORE	Req.	S 2537
		Ckd.			Ad
ector		Exd.	C.D. 71 SECTION		Date 20-7-60

weathered bedrock below the plain areas within the ranges suggesting that concealed remnants of a fossil laterite profile may occur in places.

The relics (described above in Part II) of a complex pre-Recent topography marked by kunkar deposits on slightly elevated surfaces on the plain margins may be of Quaternary Age. It is thought therefore that considerable erosion could have taken place since the time of Tertiary laterite formation, which is presumed to have capped a somewhat undulating topography. This Tertiary surface has been deformed by later tectonic movements along the numerous shear zones in the region.

If it is accepted that the region was originally capped by laterite the cause must still be sought for the anomalous deep weathering of the ultrabasic areas.

The cause of this selective weathering is thought to be both physical and chemical, as many of the jasperoid deposits are close to major shear zones which may have supplied channels for deeply circulating groundwater. Some local breccia structures have been observed in the ochres.

The chemical factors remain unknown at present, but it is hoped that further petrological and geochemical study will reveal the role played by chemical processes in the break down of the minerals constituting the ultrabasic rocks.

ECONOMICS:

(a) General

The world nickel supply and demand situation is outlined in Appendix no. 3. There is an increasing demand for nickel in the Western World which however is being met at present by increased production from the large Canadian deposits. The very large Cuban deposits have recently apparently passed out of the control of the U.S.A. It is understood that active exploration for similar lateritic deposits is being conducted on the South American mainland.

The Claude Hills and Wingellina deposits are however of importance to Australia in that they represent the only potential domestic source of this metal.

(b) Grade Required

A broad comparison can be made with the Cuban laterites which have been closely studied by U.S. Government interests, and have recently been outlined by a number of articles in the Engineering and Mining Journal, (see References, below). The Nicaro (Cuba) deposits were mined to a cut-off grade of 1.1% nickel and the average grade of mined ore was 1.37% nickel. A higher grade of at least 1.5% nickel ore would appear to be required under the more difficult and expensive Australian conditions.

(c) Ore Treatment

The Cuban laterites have been successfully treated by a complex leaching and sintering process requiring expensive treatment plants which were provided by the U.S. Government. Abundant power, water, sulphuric acid and other chemicals are requisite for ore treatment.

An adequate source of water is at present a major obstacle to any future economic exploitation of the Central Australian deposits.

(d) Ore Reserves

Pending further drilling and more detailed assay information the Claude Hills deposit would appear on present information to represent a relatively small tonnage of ore of the grade of 1.5% nickel. The Claude Hills body can, on present information be regarded as a small satellite deposit in comparison with the Wingellina body and it is difficult to see how it could be exploited independently. There is therefore a strong case for further exploration of the possible Claude Hills ore extension to the west.

RECOMMENDATIONS

(a) Geophysical Survey

The Claude Hills area has not been geophysically surveyed except by a broadly spaced airborne electromagnetic traverse , the results of which are difficult to interpret. Little is known therefore about the characteristics of the environment for the application of gravity or magnetic methods.

The ochre however, has an average SG of 1.68 (with 30% moisture), and a large concealed body should therefore show a large marked density contrast with the adjoining dense unweathered ultrabasic and basic rocks. Detailed magnetic traverses may also be useful, as the South Western Mining work indicated that the gneisses and basic rocks are frequently highly magnetic, but the ultrabasics tend to have more subdued magnetic properties as would also be expected with the ochre bodies.

It is recommended therefore that gravity and magnetic survey be made of the Claude Hills area and lines spaced at 1,000 feet intervals west of coordinate 32.00E, (see fig. 5) for at least a distance of 10,000 feet to the west and covering the concealed area south of the base line.

A number of traverses are also recommended in the concealed ground north-west of the Scarface Zone.

(b) Drilling

A minimum of 1,000 feet of churn drilling is required at Claude Hills to more closely delineate the ochre zone, west and southwest of churn drill No. 71. The siting of these holes will be guided by the results of the geophysical survey. At least 200 feet of churn drilling will be required in the extension of the Scarface Zone. A vertical diamond drill hole is recommended in the vicinity of churn drill 71, to test the profile to unweathered bedrock which may be between 200 to even 800 feet below the surface.

(c) Regional Exploration

Prospecting and mapping of the Mann 4-mile region should be continued with emphasis on the search for additional ultrabasic bodies in the eastern extension of the Blackstone-Davies Shear Zone. For this purpose additional geologists are required.

B. Thomson

B. THOMSON
Senior Geologist
GEOCHEMICAL SECTION

BT:AGK
25/7/60

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LIST OF PLANS AND ILLUSTRATIONS

A. PLANS & SECTIONS

CONFIDENTIAL

APPENDIX I

LOGS AND ASSAYS

OF CLAUDE HILLS

CHURN DRILL HOLES 71 & 73

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD 71.

Project: MT. DAVIES REGION | Claude Hills Zone | D.M. 1480/59

Sec. - **Hd.** - | **Co.** - | Bore Ser. No -

Collar Coords 00-00 | **R.L.** 2400' (approx.) | **Grid** Geosurveys

Vertical | **Depth** 150'6" | **Plan Ref** 60-250

Date Bore Commenced | **Completed** | **Driller** Artesian Boring Company

Bore Logged by R.C.M. | **On** 20/6/60 | **Hirer**

OBJECT: Testing Claude Hills ochre deposit in depth

RESULT: Penetrated soft ochre (altered ultra basics) to 100'
" Jasper from 100'-150'6".

LOG comprises Geological Log
Assay Results
Remarks.

GEOLOGICAL LOG

From	To	Description
0	1'	Gritty brown ochreous clay, fragments of travertine, magnesite, decomposed clay rock. (Textures obscure).
1'	5'	Light brown ochreous clay, 10% grit and fragments of jasper, ochreous clay rock, minor travertine (?) and magnesite.
5' 10'	10') 15')	As 1'-5', 20% grit and larger fragments of weathered (to ochre) serpentine rock, magnesite and white chalcedony.
15' 20'	20') 25')	Brown powdery limonite (ochre), 10% fine grit, mainly jasper and fine white chalcedony.
25' 30'	30') 35')	Brown powdery limonite (ochre) less than 5% grit and fragments of weathered ochreous clay rock, (fragments too small to recognize textures) and chalcedony.
35'	40'	Brown powdery limonite (ochre) trace grit only.
40 45' 50' 55' 60' 65' 70' 75'	45) 50') 55') 60') 65') 70') 75') 80')	Brown powdery limonite (ochre), occasional fragments with relict textures indicating ultrabasic origin, some with ochre after olivine, also suggestions of serpentine texture.
80	85'	Brown powdery limonite (ochre) some fragments with layered texture and large inclusions of black opaque mineral, chromite (?).
85'	90'	As 40'-80' 30% fragments, layering rare.
90'	95'	As 40'-80' 5% fragments

From	To	Description
95'	100'	As 40'-80' fragments now containing fine veinlets of sugary quartz.
100'	100'6"	Gritty brown ochreous powder, 10-15% grit and fragments of clay rock with siliceous veinlets containing manganese and trace of nickel (apple-green staining of quartz.)
100'6" 105' 110' 115'	105') 110') 115') 120')	Brown ochreous powder, crushed assay rejects only available.
120' 125' 130'	125') 130') 135')	Lighter brown gritty powder, 20% grit and fragments of brown limonite jasper, sugary texture in part.
135' 140' 145'	140') 145') 150')	Buff gritty powder, fragments of vitreous brown jasper with minor black opaque mineral.
150'	150'6"	As 135'-150' with veinlets of crystalline quartz in fragments.

END OF HOLE.

ASSAYS C.D. 71 CLAUDE HILLS

Sample No.	Footage	Ni %	Co %	Fe % (acid sol)	Mg % (acid sol)	MgO % (acid so
1028/60	0 - 1	0.51	0.022	20.9	0.08	0.12
1029/60	1 - 5	0.52	0.029	24.8	0.10	0.16
1030/60	5 - 10	0.43	0.049	22.6	0.92	1.47
1031/60	10 - 15	0.30	0.075	22.8	2.26	3.62
1032/60	15 - 20	0.42	0.086	28.0	2.28	3.64
1033/60	20 - 25	0.67	0.074	28.3	3.62	5.78
1034/60	25 - 30	0.73	0.140	38.0	1.10	1.76
1035/60	30 - 35	0.74	0.170	40.4	0.39	0.62
1036/60	35 - 40	1.26	0.170	44.8	1.37	2.26
1037/60	40 - 45	1.26	0.20	43.0	1.32	2.19
1038/60	45 - 50	1.23	0.22	45.5	1.32	0.56
1039/60	50 - 55	1.39	0.26	44.3	0.42	0.70
1040/60	55 - 60	1.45	0.23	41.5	0.55	0.91
1041/60	60 - 65	1.45	0.25	44.3	0.66	1.09
1042/60	65 - 70	1.02	0.34	36.6	0.71	1.17
1043/60	70 - 75	0.89	0.40	38.5	0.16	0.26
1044/60	75 - 80	1.02	0.31	38.8	0.79	1.31

Sample No.	Footage	Ni %	Co %	Fe % (acid sol)	Mg % (acid sol)	MgO % (acid sol
1045/60	80 - 85	1.35	0.23	38.6	0.37	0.59
1046/60	85 - 90	1.60	0.20	38.9	0.02	0.03
1047/60	90 - 95	1.67	0.19	45.8	0.02	0.03
1048/60	95 - 100	1.33	0.11	34.6	Nil	Nil
1049/60	101 - 101'6	1.12	0.073	24.2	0.04	0.06
1050/60	101'6-105'	0.63	0.048	14.7	0.02	0.03
1051/60	105' -110'	0.52	0.035	13.0	0.45	0.72
1052/60	110 - 115	0.65	0.042	14.0	0.02	0.03
1053/60	115 - 120	0.63	0.034	12.8	0.34	0.55
1054/60	120 - 125	0.37	0.023	8.5	0.32	0.51
1055/60	125 - 130	0.31	0.012	6.9	0.24	0.38
1056/60	120 - 135	0.57	0.030	10.7	2.81	4.49
1057/60	135 - 140	0.50	0.025	9.4	3.18	5.07
1058/60	140 - 145	0.54	0.028	10.7	2.47	3.95
1059/60	145 - 150	0.44	0.023	9,8	0.97	1.55
1060/60	150 - 150'7	0.48	0.028	10.7	1.21	1.93

Department of Mines, South Australia

GEOCHEMICAL SECTION

LOG OF PERCUSSION BORE NO. CD 73.

Project: MT. DAVIES REGION	Claude Hills Zone	D.M. 1480/59	
Sec. Hd.	Co.	Bore Ser. No.	
Collar Coords 00'N 1600'E	R.L.	Grid Geosurveys	
Vertical	Depth 87'7"	Plan Ref. 60-250	
Date Bore Commenced	Completed	Driller Artesian Boring Company	
Bore Logged by R.C.M.	On 21/6/60	Hirer	

OBJECT: To test in depth ochre outcropping at the above coordinates.

RESULT: Penetrated soft ochre (altered ultra-basics) to 85' then jasper from 85' to 87'7".

LOG comprises: Geological Log
Assay Results
Remarks.

GEOLOGICAL LOG

From	To	Description
0' 1'	1' 5'	Brown ochreous powder. Crushed rejects from assay samples only available.
5'	70'	As 0'-5' samples every 5 feet.
70'	75'	Brown powdery limonite (ochre) grit and fragments of ochreous clay rock showing relict ultra basic (?) textures and containing specks of black opaque mineral (chromite?).
75' 80' 83'	80' 83 85'	As 0 - 70'
85'	87'7"	Gritty ochreous powder. Crushed rejects from assay sample only but containing hard grit.

END OF HOLE

CONFIDENTIAL

APPENDIX II

LABORATORY REPORTS, MINERALOGY & PETROLOGY SECTION AND AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

APPENDIX II

LABORATORY REPORTS, MINERALOGY & PETROLOGY SECTION AND AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

1. Portion of Petrological Report dated 19/11/54 "Rocks of Mann, Tomkinson & Musgrave Ranges" by A.J. Marlow & A.W.G. Whittle.

2. Petrological Report on ultrabasics in Mt. Davies area collected by Geosurveys Ltd. by A.W.G. Whittle, dated 20/10/54.

3. Petrological Report on siliceous nickel laterite and creek sand, Mt. Davies area, collected by Geosurveys Ltd., by A.W.G. Whittle, dated 20/10/54.

4. Portion of Report No. M.R.56. (A.M.D.L.) by H.W. Fander, dated 25th February, 1960.

5. Report No. M.R.61. (A.M.D.L.) by H.W. Fander, dated 26th February, 1960.

6. Petrological Report No. M.R.497 (A.M.D.L.) by H.W. Fander, dated 22nd June, 1960.

7. Report No. 497, A.M.D.L. X-Ray Spectrograph and X-Ray Diffraction analysis of 3 ochre samples. by A.E. Tynan, dated 22nd June, 1960.

8. Mineralogical Report No. 1.3.0/797, A.M.D.L. by H.W. Fander, dated 6th July, 1960.

9. Differential Thermal Analysis, Nickel Ore, Mt. Davies Confidential Report. A.M.D.L. 46, Project 1/1/16. by M.J. O'Connor, dated July 1960.

10. Assays of the three ochres examined in reports 6, 7, & 9.

11. Unpublished laboratory investigations by H.W. Fander on Minor Elements in Musgrave Ranges Rocks.

PORTION OF PETROLOGICAL REPORT DATED 19/11/54.

by A.J. Marlow and A.W.G. Whittle.

Description of Samples: Rocks from Mann - Tomkinson - Musgrave Ranges.

Locality, etc. : Mann - Tomkinson - Musgrave Ranges.

Submitted by : R. P. Coats, Department of Mines, Exhibition Buildings, North Terrace.

P.252/54 - Mann Ranges.

R.C. 493

This rock is a greyish coloured, coarse grained adamellite, with a gneissic structure.

Important constituent minerals are andesine, orthoclase, quartz, hornblende and biotite. Magnetite, garnet, apatite and zircon occur as abundant accessory minerals.

Andesine has a composition ranging from $Ab_{64}An_{36}$ to $Ab_{68}An_{34}$ and occurs as large anhedral crystals. The plagioclase is riddled with minute inclusions of apatite, which occur as tiny colourless rods. The plagioclase shows selective alteration along some twin planes.

Orthoclase occurs as large anhedral crystals which contain perthite. The perthite occurs as minute strings and is not very plentiful. The orthoclase is traversed in parts by minute veins of quartz and also has inclusions of quartz. Along the plagioclase-orthoclase boundary, lobate patches of myrmekite are formed.

Quartz occurs as large anhedral crystals which exhibit undulatory extinction due to strain. Quartz also occurs as re-crystallined quartz of a finer grain size, which occurs in the interstices of other minerals and also as fine veins intruding the other minerals.

Green, pleochroic hornblende occurs as large anhedral crystals which have been intruded, along cracks, by magnetite and quartz. Magnetite also occurs as fine crystals along the cleavage planes of the hornblende. The hornblende is corroded. The hornblende is a variety of green hornblende with z - 1.68±.

Biotite forms large reddish brown and pleochroic plates. Some of the biotite occurs as large broad plates, some as long narrow flakes and some as small anhedral flakes in the groundmass of the gneiss.

Magnetite is the most prominant accessory mineral. Associated with it is garnet, apatite, zircon and a little tourmaline. These appear to have entered the rock during the period of crushing. The magnetite has penetrated the hornblende and also occurs infilling cracks in the felspar. The magnetite occurs as anhedral masses.

Almandite garnet occurs as pink euhedral and subhedral crystals. It is very extensive in the rock and is usually associated with the magnetite. This garnet was possibly formed as a primary constituent or may have formed when the adamellite was metamorphosed under pressure at depth.

Rounded, subhedral crystals of apatite are quite abundant. The apatite appears associated with the magnetite and seems to be of late formation in the rock. Apatite also occurs as numerous small inclusions in the plagioclase felspar.

Zircon occurs as subhedral and anhedral crystals which are extensively cracked. The zircon crystals show slight zoning.

A little brown pleochroic tourmaline is also present.

This rock has a grain size varying from fine in parts to coarse in others and has a gneissic texture.

This rock appears to have been a granitic rock of adamellite composition which has been submitted to regional metamorphism. During this metamorphism, magnetite, plus apatite and zircon has penetrated the rock. Garnet has also been formed during this period. The regional metamorphism has given the rock a gneissic structure.

P. 260/54 - Tomkinson Ranges.

This rock is a greyish, medium to coarse grained hypersthene diorite.

Important constituents are andesine, hypersthene and diallage. Magnetite and hematite are the main accessories.

Andesine ranges in composition from $Ab_{60}An_{40}$ to $An_{64}An_{36}$. In the hand specimen, the andesine has a pale blue appearance which is caused by myriads of minute magnetite crystals which are included in the felspar. The andesine occurs as large anhedral crystals containing antiperthite. The plagioclase twinning is largely in the form of broad discontinuous twins and in some crystals only incipient twinning is seen on the edge of the crystal.

Hypersthene occurs as large anhedral crystals. It is pale green in colour and shows strong pleochroism. Hypersthene has inclusions of magnetite - as fine prismatic crystals and as coarser anhedral masses. Inclusions of pale brown rods, which may possibly be hematite, also occur situated parallel to the cleavage planes of the hypersthene.

Diallage forms large, green, slightly pleochroic, anhedral crystals associated with the hypersthene. Diopside also has inclusions of magnetite and a reddish brown mineral. The inclusions occur as fine rods, as prismatic and anhedral crystals.

Magnetite forms subhedral and anhedral crystals. It occurs as large crystals associated with the pyroxenes and also as inclusions in the pyroxenes. Fine crystals of magnetite also occur around the boundaries of the pyroxene crystals. Magnetite inclusions are also present in andesine. Magnetite has formed later than the plagioclase and pyroxene.

The rock is a coarse grained, intermediate igneous rock - a hypersthene diorite, with a xenomorphic granular texture.

R.C. 506

This rock is a pale grey, coarse grained andesinite composed almost completely of andesine. Minor accessory minerals include diopside, magnetite, zoisite and biotite.

Andesine, which has an approximate composition of $Ab_{62}An_{38}$, occurs as coarse, irregular, anhedral crystals. The plagioclase has irregular and patchy twinning and some crystals show undulatory extinction. A few plagioclase crystals are slightly folded.

Andesine contains antiperthitic material as irregular inclusions. Some of these inclusions are oriented parallel to cleavage and twin planes, but the inclusions are more prevalent near the interstices of the andesine crystals and near cracks through the mineral.

The andesine also contains minute inclusions of magnetite along twin and cleavage planes. These magnetite inclusions give the andesine a bluish-grey appearance in the hand specimen.

Diopside occurs as an accessory mineral. It occurs as pale green anhedral crystals of various sizes, in the interstices of andesine crystals.

Magnetite is a relatively prominent accessory mineral. It occurs as subhedral and anhedral crystals situated in the interstices of the andesine crystals. Magnetite also is found as inclusions in andesine.

Surrounding magnetite crystals and also along the interstices of andesine crystals is zoisite. This zoisite occurs as fibrous aggregates which show abnormal interference colours.

Biotite is also a minor accessory mineral. It forms greenish-brown anhedral flakes, associated with magnetite and zoisite.

This andesinite is holocrystalline and xenomorphic in texture.

<u>P. 253/54 - Tomkinson Ranges.</u>

<u>R.C. 507</u>

This rock is a dark grey, medium to coarse grained <u>hypersthene</u> diorite.

Hypersthene is the most prominent constituent. Diallage, andesine and a minor amount of hornblende are also important minerals. Magnetite is an abundant accessory.

Hypersthene occurs as large anhedral crystals which show intense pleochroism. Hypersthene has abundant inclusions of magnetite which occur along the cleavage and twin planes as minute prisms or disseminated grains and also as large anhedral masses. Some cleavage and twin planes are completely infilled with magnetite. Small elongated inclusions of a reddish brown mineral, which is possibly hematite, also occur along cleavage and twin planes.

Pale green slightly pleochroic diallage also occurs in this rock but is subordinate to hypersthene. Diallage forms large anhedral crystals which also have inclusions of magnetite along cleavage planes.

Basic andesine occurs as anhedral crystals which show very irregular and patchy twinning due to strain. The plagioclase also exhibits undulatory extinction and some crystals are slightly folded. A small amount of antiperthite is found in some andesine crystals. The percentage of pyroxenes in this rock is far greater than the percentage of felspar.

Hornblende occurs as small, olive green and pleochroic, anhedral crystals associated with magnetite. It is only a very minor constituent of the rock.

Magnetite is a very abundant accessory mineral. It occurs as large anhedral masses in the interstices of the other minerals; as prismatic crystals along the cleavage and twin planes of the pyroxenes; and as disseminated grains. Some crystals of hypersthene are almost completely infilled with magnetite. The magnetite has been altered to hematite and limonite in places.

This rock is of medium to coarse grain and is composed of holocrystalline, anhedral crystals of various minerals - that is, this rock has an xenomorphic texture.

P. 254/54 - Tomkinson Ranges.

R.C. 512.

This rock is a coarse grained peridotite. In the hand specimen it is leek green in colour and dotted with pale brown crystals of olivine which has been altered in places to reddish-brown ferruginous material.

This rock is composed of ferriferous diallage and olivine. Diallage occurs as large anhedral crystals, which are pale green and pleochroic. Diallage encloses the anhedral crystals of olivine. The crystals of olivine are cracked and along these cracks, the mineral has been altered to ferruginous material - limonite and hematite.

This rock is a pyroxene-peridotite, with ferriferous diallage the most abundant mineral.

P. 255/54 - Tomkinson Ranges.

R.C. 514.

This rock is a greenish-grey, coarse grained diallage diorite. It is composed principally of ferriferous diallage and very basic andesine. A little hypersthene is also present. Magnetite occurs as a minor accessory.

The diallage occurs as large anhedral crystals. It is green in colour and pleochroic, and shows the parting parallel to (100) which is typical of diallage. Along cracks and cleavage planes, diallage has been coated with ferruginous material. Diallage is the most abundant mineral.

Andesine, which has an approximate composition of $Ab_{52}An_{48}$, occurs as irregular anhedral crystals. Some crystals show undulatory extinction.

Hypersthene occurs in very minor quantities. Small anhedral crystals occur between diallage crystals.

Magnetite is a minor accessory mineral. It occurs as anhedral crystals which are altered to limonite on the edges.

This rock is coarse grained with an xenomorphic texture.

P. 256/54 - Tomkinson Ranges.

R.C. 515.

This rock is a dark grey to black, medium to coarse grained andesinite. This is composed almost completely of andesine, apart from small shreds of diopside in the interstices of the felspar crystals.

The andesine has a composition of $Ab_{61}An_{39}$. It occurs as very large anhedral crystals interlocking with one another. In the hand specimen, the felspar appears to be bluish-black in colour. This is due to the presence of numerous minute dark coloured inclusions. These inclusions can just be seen individually under high power on the microscope, so are really very fine

Small shreds and anhedral crystals of almost colourless diopside occur in the interstices of the andesine crystals. Diopside occurs in very minor amounts. This rock belongs to the diorite clan. Johannsen calls this type of rock a leucodiorite.

P. 257/54 - Tomkinson Ranges.

R.C. 517.

This rock is a medium grained, yellow-green altered dunite. The rock is spotted with grains of chromite.

The original olivine has been altered to serpentine - consisting of pale yellow-green, massive serphophite and chrysotile in cross-fibre veinlets. Ferruginous material-limonite, is also present in the altered olivine.

Chromite occurs as large anhedral crystals dotted through the rock. A carbonate is also present in considerable quantities.

P. 258/54 - Tomkinson Ranges.

R.C. 518.

This rock is a diallage diorite very similar to R.C. 514. Constituent minerals are diallage, andesine, hypersthene and magnetite as in R.C. 514. The two rocks differ because the plagioclase is slightly less basic in R.C. 518 and the percentage of magnetite present is greater.

Diallage is the most abundant mineral. Andesine forms large anhedral crystals in the interstices of diallage crystals. Andesine shows interrupted and patchy twinning and has undulatory extinction. Hypersthene occurs in minor quantities.

This rock is coarse grained and has an xenomorphic texture.

R.C. 518A.

This rock is a reddish coloured, fine grained, very altered dunite.

Most of the original minerals have been altered and replaced. Olivine was altered to serpentine which has been replaced by fine grained quartz and silica.

This rock is now composed of chromite, crysotile, quartz, silica and ferruginous material.

Chromite occurs as cracked anhedral and subhedral crystals and in anhedral masses. Chromite, on the basis of chemical analysis, makes up 16% of the total rock.

Crysotile is still present as remnant cross fibre veinlets. Ferruginous material outlining the original serpentine structure is all that remains of most of the serpentine. The serpentine has been replaced by recrystallised quartz and silica.

This rock is valuable because of the high percentage of chromite present.

P. 261/54 - Tomkinson Ranges.

R.C. 522.

This rock is a dark grey, coarse grained diopside-olivine gabbro. Diopside, olivine, labradorite and hypersthene are the main constituents of the rock. Magnetite and biotite are accessory minerals. Chlorite and serpentine are present as second-

Olivine occurs as large anhedral crystals which are extensively cracked. Along these cracks are disseminated grains of magnetite and ferruginous material due to alteration of olivine. Magnetite is also enclosed by the olivine in the form of elongate prisms and as anhedral masses. A reaction rim of pale green serpentine has been formed on the outside of the olivine crystals in places.

Diopside forms large anhedral crystals which are nearly colourless and which have extensive fine partings that have been differentially altered. Magnetite has intruded along these partings as minute elongated crystals. Chlorite and biotite have been produced by alteration along these partings. Some diopside is also present in the finer grained, granular aggregates of pyroxene. Some diopside exhibits gentle folding.

Hypersthene occurs as small anhedral crystals which interlock with one another and also as occasional long lobate masses. The small hypersthene crystals contain numerous inclusions of magnetite grains and anhedral masses.

Acid labradorite occurs as very large anhedral crystals. The plagioclase has very irregular and patchy twinning and also shows undulatory extinction. The plagioclase is slightly folded.

Magnetite is a prominent accessory mineral and occurs as small anhedral masses, as disseminated and elongated inclusions in the pyroxenes.

Red-brown, pleochroic biotite occurs as a minor accessory. It is in the form of small anhedral flakes associated with the pyroxenes.

This rock is medium to coarse grained and has an xenomorphic-granular texture.

P. 262/54 - Tomkinson Ranges.

R.C. 529.

This rock is a light grey, coarse grained gabbro which has been extensively sheared. The minerals, due to this shearing are in a bad state of preservation. The plagioclase, labradorite, has been very altered. The pyroxene present is probably diopside and minor amounts of olivine and hypersthene may be present.

Magnetite and biotite are the main accessories. Magnetite and chlorite have been produced due to alteration of the pyroxenes.

This rock is coarse grained and constituent minerals have been strongly stressed, so that in thin section, they show a marked undulose extinction.

P. 263/54 - Tomkinson Ranges.

R.C. 530.

This rock is a grey coloured, coarse grained perthitic-biotite granite. Important constituents are orthoclase, quartz, biotite and albite. Magnetite, apatite and zircon and a little anatase occur as accessory minerals.

Orthoclase occurs as large, irregular, anhedral crystals. The orthoclase contains strings and braids of perthite which in places make up between 30 — 50 percent of the mineral. Most of the strings are parallel to one another and the individual strings extinguish simultaneously. In some crystals of orthoclase, anhedral masses of this sodic felspar are seen on the edge of the crystal. From these, strings of perthite are projecting. Peculiar textural features are present in the orthoclase. Some quartz inclusions are rimmed by sodic felspar. Many of the quartz inclusions have a scolloped outline due to corrosion caused by a heat reaction with the orthoclase. Some quartz inclusions are rimmed by possibly a very siliceous felspar with a composition between quartz and orthoclase. Patches are found in the orthoclase where tiny crystals of quartz are surrounded by a richly pertitic felspar which differs slightly in composition from the rest of the orthoclase. In places, no quartz remains only zones of slightly different composition from the orthoclase. These zones contain broader perthite strings.

This rock seems to have several stages in its cooling history. It apparently cooled normally for the first stages, then rapid cooling followed so that the plagioclase and orthoclase did not form as separate crystals. Instead, the plagioclase components were held in an unstable orthoclase. Later this sodic plagioclase exsolved as perthitic material within the orthoclase. Apparently, some of the quartz crystallised simultaneously with the orthoclase and a heat reaction has resulted between them, thus giving the scalloped effect and the plagioclase rims around the quartz inclusions. The larger anhedral crystals of quartz apparently crystallised at a later stage and thus no reaction with the orthoclase.

Quartz occurs as large anhedral crystals and as smaller rounded and lobate inclusions within the orthoclase. Some lobate patches of quartz are seen in small patches of myrmekite. The larger crystals of quartz show undulatory extinction due to strain.

Biotite is the ferro-magnesium mineral present. It occurs as red-brown, pleochroic, anhedral lathes and flakes. Biotite alters, in places, to an olive green chlorite. Biotite contains inclusions of apatite and a little zircon. The small zircon inclusions are surrounded by pleochroic halos. Some magnetite has been intruded into the lathes of biotite.

A minor amount of plagioclase felspar is present as anhedral crystals of albite showing albite twinning. It has an average composition of $Ab_{96}An_4$. Only a very few plagioclase crystals crystallised out during cooling. But the overall percentage of plagioclase is very high and is found in perthite strings making up to 30 - 50% of the orthoclase crystal.

Magnetite is the most abundant accessory present. It occurs as large anhedral crystals and is also intruded along cracks in the other minerals. Associated with magnetite is apatite, zircon and a minor amount of anatase. Apatite occurs as small subhedral crystals associated with magnetite and biotite. Zircon forms small euhedral and subhedral crystals. Anatase forms small euhedral buish crystals.

This rock is a coarse grained perthitic-biotite granite with a hypautomorphic, inequigranular texture.

Dept. Samples Nos.P.293/54 to
P.297/54.

- PETROLOGICAL REPORT -

Description of Samples: Rock samples.

Marks or Nos.: As listed.

Locality, etc.: Musgrave 8 M. Military Sheet.
Mt. Davies Grid Reference 211-742.
Native Reserve. Grid A.1.

Submitted by: Geosurveys of Australia Limited,
17 Currie St., Adelaide, S.A.

Rock (No.1)

P.293/54 Main Lode (N. side) in W. side No.1 Creek.

This pale green rock is a thoroughly decomposed olivine rock (dunite) of fine evenly grained texture. The principal constituents of the rock are antigorite, calcite and bowlingite which represent the end products of weathered olivine.

The rock contains disseminated 0.1 - 0.5 mm. subhedra of chromite associated with haematite containing some exsolved rutile. Chromite forms a nucleus to aggregates, the shell of which is the haematite-rutile complex.

The rock is an ultrabasic intrusive.

Rock (No.2)

P.294/54 Rock Hole Creek. 7½ miles W. of Mt. Davies.

This rock is a medium grained olivine gabbro with affinities towards olivine norite. It consists of a xenomorphic granular mosaic of labradorite and pale green augite as the principal constituents, with lesser bronzite and altered olivine.

Rock (No.3)

P.295/54 Northern side of Mt. Davies.

The rock is a medium grained dark coloured olivine gabbro. It consists of labradorite, diallage and olivine. Felspar is dominant hence the rock is less basic than those above.

Rock (No.4)

P.296/54 Southern edge, north lode, W. end, 6 miles W. of Mt. Davies.

This is a rare type of ultrabasic coarse grained intrusive rock which is monomineralic in composition. It consists entirely of enstatite and may be classed as an enstatitite, a species of the pyroxenite group of ultrabasics.

Rock (No.5)

P.297/54. Western end of Mt. Scarface. 7¾ miles W. of Mt. Davies.

This is a mesocratic basic igneous rock containing dominant basic labradorite. Diallage, olivine, hypersthene and dark brown hornblende are other constituents. Olivine, pyroxene and amphibole are frequently closely associated in accordance with the "reaction principle".

20.10.54

(A.W.G. Whittle)
PETROLOGIST.

Dept. Samples No. P.298/54
to P.301/54.

- PETROLOGICAL REPORT -

Description of Samples: Mineral Samples.

Marks or Nos.: As listed.

Locality, etc.: Musgrave 8 M. Military Sheet.
Mt. Davies Grid Reference 211-742.
Native Reserve. Grid A.1.

Submitted by: Geosurveys of Australia Limited,
17 Currie Street, Adelaide, S.A.

MINERAL (No.1)

P.298/54 Above Rock Hole Creek. 7½ miles W. of Mt. Davies.

The rocks are siliceous boxworks and ferruginous gossan. The silica is mostly chalcedonic but there are small radial quartz aggregates. Quartz and chalcedony are stained green by untramicroscopic particles of green nickel silicate. Within the boxworks there are minute 0.1 - 1.0mm. spherulitic aggregates of garnierite. The boxworks indicate leached primary nickel mineral.

MINERAL (No.2)

P.299/54 General sample north lode.

This sample is generally similar to that described under P.298/54.

MINERAL (No.3)

P.300/54 Goss's Pile Lode. 5 miles E. Mt. Davies.

This is a greasy rock which can be regarded as made up of microcrystalline aggregates of clays of the beidellite and montmorillonite group stained green by the presence of ultramicroscopic garnierite. The latter mineral is not distinguishable optically, but its presence is manifest by the green colour and positive nickel microchemical tests.

MINERAL (No.4)

P.301/54 Above No.1 Sand sample. No.1 Creek.

This is another siliceous and ferruginous gossan rock containing wide veins of bright green chalcedony. The chalcedony contains disseminated ultramicroscopic green garnierite.

SUMMARY. In order to ascertain the nature of any primary minerals which may be present in these samples, polished sections were made.

No primary nickel minerals were found, but primary chromite was found in three of the samples.

Chromite is abundant in sample P.293/54 and is present in traces as 0.01 - 0.1mm. crystals in P.300/54 and P.301/54.

An analysis of a representative mixture of samples P.298/54 - P.301/54 gave the following results.

Nickel (Ni)	1.3%
Copper (Cu)	less than 0.01%
Chromic oxide (Cr_2O_3)	0.04%.

20.10.54

(A.W.G. Whittle)
PETROLOGIST.

MINERALOGY & PETROLOGY SECTION:

PORTION OF REPORT NO. M.R. 56.

MATERIAL:	Rock samples.
SUBMITTED BY:	B.P. Thomson.
DATE RECEIVED:	20th January, 1960.
MARKS or NOS:	P16/60 - P20/60.
SOURCE OF LOCALITY:	Various as under.
INFORMATION REQUIRED:	Petrological.
METHODS OF EXAMINATION:	Immersion. Thin Section.

RESULTS OF EXAMINATION: -

P18/60 T.S. 6023 Woodroffe 1 mile sheet, ½ ml. N.E. Erlywanjawanja Rockhole.

A pyroxene granulite. The bulk of the rock consists of highly stressed quartz andesine, and microcline; The latter is often crowded with very fine ocicular colourless crystals, with square terminations and straight extinction, and are probably sillimanite. Hypersthene occurs in bands; it shows strong pink or purplish pleochroism and shows extensive reaction rims.

These consist of an inner shell of quartz and feldspar (?) and an outer shell of brown garnet. Opaques and occasional biotite are similarly surrounded by reaction tims of garnet. A few well rounded grains of zircon and xenotime are present.

P19/60 T.S. 6024 Woodroffe 1 mile sheet. 5 miles S.W. of Erlywanjawanja.

A highly altered and completely kaolinized quartzo - feldspathic rock. From its structure and the presence of rounded zircon, and sphene, it is likely that the rock was a metasediment. The quartz grains are highly irregular, embayed and corroded; this probably occurred during kaolinization.

P20/60 T.S. 6025 Davies 1 mile sheet, Tiezi Waterhole.

This consists of an even-grained mosaic of microperthite and stained quartz, the feldspar predominating. Very occasional rounded zircon is seen. The rock could be termed a pseudo-aplite, i.e. of aplitic texture but probably of sedimentary origin. Owing t the stable nature of the constituents over a wide range of conditions, the metamorphic grade cannot be determined.

The presence of microperthite could indicate a temperature of about 600°C at which it was homogeneous, but this depends on many factors.

Examined by H.W. Fander.

A.W.G. WHITTLE.

CHIEF MINERALOGIST & PETROLOGIST.

MINERALOGY & PETROLOGY SECTION:

REPORT NO. M.R.61.

MATERIAL: Rock samples.

SUBMITTED BY: B.P. Thomson, Mines Dept. Head Office.

DATE RECEIVED: 21st January, 1960.

MARKS or NOS: P21/60 - P27/60.

SOURCE or LOCALITY: Nth. West of S.A. and adjoining W.A.

INFORMATION REQUIRED: Petrological.

METHODS OF EXAMINATION: Thin sections; Immersion.

RESULTS OF EXAMINATION:-

P21/60 T.S. 6026 Mt. Lindsay, Birksgate Ranges.

A medium grained, pseudogranitic gneiss. Quartz is strained, and contains regularly orientated inclusions of opaque rods and small biotite laths.

Feldspars are mainly micro- and cryptoperthite, with some oligoclase and oligoclase - antiperthite.

Some myrmekite occurs. Poikiloblastic green hornblende and brown biotite occur sparingly.

Anhedral patches of opaques have reaction rims of sphene.

Rounded grains of zircon, apatite and sphene are very conspicuous.

P22/60 T.S. 6027 Wingellina area. (W.A.) 3 miles N.W. of camp.

The bulk of the rock consists of mosaics of andesine-labradorite plagioclase. These are anhedral inclusions of pleonaste.

Reaction rims of vermicular pyroxene partly surround olivine in contact with plagioclase. This rock could be classed as a hypersthene - troctolite, but it may be a granulite or "charnockite".

P23/60 T.S. 6028 Tollu Blackstone Range. (W.A.)

The rock consists mainly of felted laths of altered plagioclase, fine grained opaques, chlorite and other secondary minerals. There are microphenocrysts of pigeonite; pseudomorphs of epidote-aggregates after olivine and pyroxene are conspicuous.

A few patches of chlorite represent altered pyroxene. Vesicles are lined with epidote, quartz and potassic feldspar.

May be termed a vesicular pigeonite basalt.

P24/60 T.S. 6029 Bilbring Waterhole. (W.A.)

A fine grained quartzo - feldspathic gneiss. The streaky appearance is due to alternating bands of quartz, feldspars and heavy minerals. The feldspars are microcline and microperthite, reddened with limonite along boundaries and cleavages.

Quartz occurs as subhedral mosaics. There are thin layers of heavy minerals - opaques, zircon, sphene, and re-crystallised apatite.

P25/60 T.S. 6030 South Side of Picrite Hill 1½ miles ESE of Wingellina camp. W.A.

Coarse patches of limonite and opaques are pseudomorphs after pyroxene (as indicated by relict cleavage) and some olivine

22nd June, 1960.

MINERALOGY & PETROLOGY SECTION.

REPORT No. M.R. 497.

MATERIAL:	Ochres.
SUBMITTED BY:	B.P. Thomson, Mines Department.
DATE RECEIVED:	27th April, 1960.
MARKS or NOS:	P 381 - 383/60.
SOURCE or LOCALITY:	Mt. Davies Area, Claude Hills, & Wingellina (W.A.)
INFORMATION REQUIRED:	Mineralogical, petrographic.
METHODS OF EXAMINATION:	Thin Sections etc.

RESULTS OF EXAMINATION:-

P 381 - 383/60. T.S. 6423 - 25

All the rocks consist of networks and colloform bands of limonite, with some opaque, black material also present as small veinlets. In P 382/60, many cavities and interstices are filled with clear dolomite. In most specimens, some indication of relict minerals is seen; P381/60 in particular, shows limonite pseudomorphs after olivine and pyroxene, and is similar to P25/60 and its unweathered equivalent, P26/60. A separate X-ray report is enclosed.

H.W. Fander.
MINERALOGIST.

Interstitial patches of comparatively fresh andesine occur. The relict structure is of a coarse-grained ultrabasic rock. Some of the rock was crushed and submitted for spectrographic analysis for nickel. The results of this analysis will be forwarded in due course.

P26/60 T.S. 6031 Picrite Hill, 1½ miles ESE Wingellina Camp W.A.

The rock consists mainly of coarse sub- to anhedral crystals of forsterite, with large areas of poikilitic bronzite. Some interstitial labradorite occurs.

Small amounts of green spinel and biotite are present. The bronzite is crowded with rodlike inclusions except for clear margins. Olivine shows typical network structure, with veinlets of serpentine.

A few blebs of chromite (?) are seen. According to Hatch, Wells & Well, 10th edition, page 337, this rock is a bronzite-picrite; the small amount of plagioclase is an essential constituent.

It is in all probability the unweathered equivalent of P25/60.

P27/60 T.S. 6032. 1½ miles WNW of Wingellina Camp W.A.

Blebs of hypersthene, augite, brown hornblende and sphene, set in granular matrix of quartz and microperthite. Grains of opaques and zircon occur.

This is pyroxene - granulite. The presence of hornblende indicated that it is near the transition of amphibolite/pyroxene-granulite facies.

Examined by: H.W. Fander

A.W.G. WHITTLE

CHIEF MINERALOGIST & PETROLOGIST.

22nd June, 1960.

MINERALOGY AND PETROLOGY SECTION

REPORT No. 497.

(Project No. 1/3/0).

MATERIAL:	Three Ochres.
SUBMITTED BY:	B. Thomson. (S.A. Mines Dept. Geochemical Section).
DATE RECEIVED:	27.4.60
MARKS or NOS & LOCALITY:	P381/60 Wingellina Ochre, Picrite Hill P382/60 Mt. Davies Area, Claude Hills Ochre P383/60 Mt. Davies Area, Greenwood Ochre.
INFORMATION REQUIRED:	Mineral composition by X-ray analysis.
METHODS OF EXAMINATION:	X-ray diffraction and X-ray spectrograph.

RESULTS OF EXAMINATION:-

The above samples were all examined by X-ray diffraction techniques using filtered iron radiation to determine the mineral composition of each. X-ray spectrographic analyses were also made to determine elements heavier than scandium (A.N. 21).

P381/60

The major constituent is goethite (Fe_2O_3) together with a small amount of calcite. In addition the diffractograph contained a few broad peaks of low intensity. These are probably due to small amounts of chlorite and mica.

From the spectrograph the following elements were present:-

Major	:	Fe
Heavy Trace	:	Cr, Ni
Faint Trace	:	Zn, Mn.

P382/60

Major minerals present are goethite with lesser amounts of calcite and dolomite. Quartz occurs in trace amounts.

Elements present :-

Major : Fe

Minor	:	Mn
Heavy Trace	:	Ni, Cr
Faint Trace	:	Zn, Co, Cu.

P383/60.

Goethite is again the major constituent together with a probable minor amount of hydrohematite.

Elements present:-

Major	:	Fe
Heavy Trace	:	Cr, Ni
Trace	:	Mn
Faint Trace	:	Zn, Co, Cu.

A.E. Tynan,
MINERALOGIST.

MINERALOGY & PETROLOGY SECTION 6th July, 1960

REPORT No. 1.3.0/797

MATERIAL:	Nickel Mineral.
SUBMITTED BY:	B.P. Thomson.
DATE RECEIVED:	4th July, 1960
SOURCE or LOCALITY:	Wingellina, W.A.
INFORMATION REQUIRED:	Identification.
METHODS OF EXAMINATION:	Immersion.
RESULTS OF EXAMINATION:-	P430/60.

This mineral is garnierite.

From its optical properties the estimated nickel content is about 20%.

A quantitative analysis for nickel is being carried out and will be reported separately.

H.W. Pander.
MINERALOGIST.

C O N F I D E N T I A L

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

AMDL 46

PROJECT 1/1/16

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MINES

NICKEL ORE, MOUNT DAVIES.

DIFFERENTIAL THERMAL ANALYSIS

by

M.J. O'CONNOR.

This report describes work undertaken at the request of the S.A. Department of Mines. The experimental work was carried out under the general supervision of J. D. Hayton, Chief Research Chemist.

Issued by: L. Wallace Coffer.
Director.

Investigation commenced : June 1960.
Investigation completed : June 1960.

Report Issued : July 1960.

Copy No: 2

1. Summary.

Three samples of nickel ore from Mount Davies were submitted by the South Australian Department of Mines for differential thermal analysis.

Each sample gave a differential trace corresponding to goethite.

One of the samples contained some form of limestone as shown by the endothermic peak (at 885°C) characteristic of the reaction $CaCO_3$ $CaO + CO_2$. Another of the samples probably contained magnesite since a small endothermic peak appeared at 753°C on the differential trace.

2. Material Examined.

Three samples designated A462/60, A463/60 and A464/60 were received. The samples had previously been ground to approximately minus 100 mesh for chemical analysis.

3. Experimental Procedure and Results.

A steatite cell, contained in a stainless-steel block with close-fitting lid, was used as the sample container. Platinum-platinum + 10 per cent rhodium thermocouples were used with the temperature recording couple in the sample. Calcined alumina was used as the inert reference material. A heating rate of 400°C per hour was maintained. Chart speed on both recorders was 16 centimetres per hour.

The weight of sample used and the differential trace obtained are shown in Fig.1. The difference in temperature between the sample and the inert material (T), is plotted against temperature. A peak on the negative side of the zero or base-line represents an endothermic reaction.

4. Discussion.

(i) Sample A462/60.

There are three endothermic peaks - at 135°C, 340°C and 753°C. These peaks correspond to evolution of adsorbed water, loss of water of crystallization from goethite, and loss of carbon dioxide from magnesite respectively.

(ii) Sample A463/60

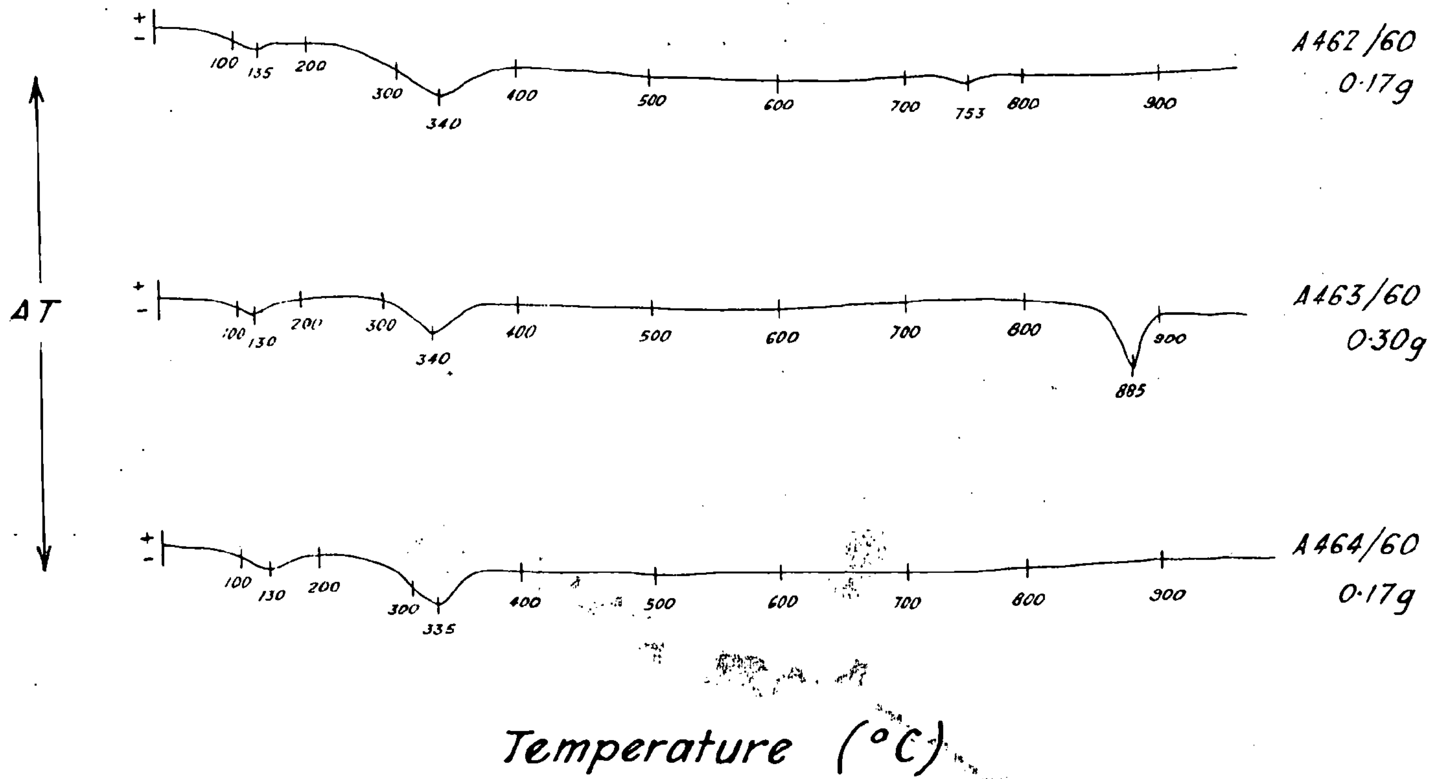
Three endothermic peaks at 135°C, 340°C and 885°C corresponding to loss of adsorbed water, loss of water of crystallization from goethite and the evolution of carbon dioxide from limestone respectively.

(iii) Sample A464/60)

The first part of the curve is similar to that of the other two samples. The endothermic peaks at 135°C and 335°C represent loss of adsorbed water and loss of water of crystallization from goethite respectively.

FIGURE 1

DIFFERENTIAL TRACES



S2540
M

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

6th May, 1960.

AR484/60

1/3/0

Director of Mines
Rundle Street,
ADELAIDE.

Samples marked as under, yielded on analysis:-

Mark	Nickel (Ni)	Cobalt (Co)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)
A462/60	0.62%	0.11%	38.6%	4.75%	0.65%
A463/60	0.52	0.14	25.7	14.0	2.35
A464/60	0.84	0.04	46.4	0.65	0.95

Type of Material:- Rock.

Locality:- B. Thomson, Geochemical Section, Dept. of Mines

A462/60 (portion of sample P381/60) Wingellina Ochre, Picrite Hill W.A.

A463/60 (" " " P382/60) Clande Hills Ochre.

A464/60 (" " " P383/60) Greenwood Ochre.

T.F. Frost.
CHIEF ANALYST.

UNPUBLISHED LABORATORY INVESTIGATIONS BY H. W. FANDER

ON MINOR ELEMENTS IN MUSGRAVE RANGES ROCKS

(HEAVY MINERAL CONCENTRATES)

Rock Type (H. W. Fander)	Sample No.	% of total	Cr %	Ni %	Pb %	V %	Mn %	Co %	
Microdiorite - micro gabbro	BW 15	24.8	0.01- 0.1	0.01- 0.1	.0001- .001	0.01- 0.1	0.1- 1.0	.001- 0.01	
dolerite - c̄ pigeonite	BW 24	23.25	0.1- 1.0	0.01- 0.1	.0001- .001	0.01- 0.1	0.1- 1.0	.001- .01	
" " "	BW 30	8.5	.01- .1	.01- .1	.0001- .001	.01- .1	0.1- 1.0	.001- .01	
" " "	BW 35	10.25	.01- .1	.01- .1	.0001- .001	.01- .1	0.1- 1.0	.01- .1	
hypersthene micro-gabbrp	BW 40	16.0	0.1- 1.0	0.1- 1.0	.0001- .DD1	0.01- 0.1	0.1- 1.0	.001- .01	
octhonorite	BW 47	10.6	.01- .1	.01- .1	.0001- .001	.01- .1	0.1- 1.0	.001- .01	
olivine dolerite or microgabbro	BW 53	16.6	0.1- 1.0	0.1- 1.0	.0001- .001	.01- .1	0.1- 1.0	.001- .01	
uralite-gabbro or dolerite	BW 57	1.35	.001- .01	.01- .1	- -	.01- [illegible]	0.1- 1.0	.001- .01	
olivine-gabbro	BW 75	15.1	0.1- 1.0	0.1- 1.0	.0001- .001	.01- .1	0.1- 1.0	.001- .01	
augite-pegmatite?	BW 62	59.0	0.1	.05	.01	.02	.2	.007	
meta-diorite	BW208	33.5	.003	.004	.005	.03	.3	.003	AMPHIBOLITES
hornblende-gneiss	BW217	62.0	.07	.02	.01	.05	.35	.004	
" "	BW224	55.0	.05	.01	.005	.03	.2	.003	
" "	BW227	26.0	.02	.01	.02	.05	.35	.001	
" "	BW234	59.0	.03	.01	.002	.06	.3	.004	
" "	BW242	34.0	.02	.01	.07	.03	.35	.002	
" "	BW250	35.0	.05	.025	.07	.05	.3	.003	
quartz gabbro	JJ161	3.1	.03	.02	-	.05	.2	.005	
orthpyroxene microgabbro	JJ170	3.75	.06	.05	0.15	.02	.2	.003	
gabbro	JJ177	11.25	.01	.003	-	.07	.3	.003	
hypersthene-micro-gabbro	JJ185	2.85	.07	.05	-	.04	.2	.007	
basic or ultra basic rock	JJ187	7.6	.05	.04	-	.04	.25	.003	
gabbro	JJ203	2.5	.04	.03	-	.06	.2	.003	
"	JJ216	57.0	.1	.04	.002	.02	.25	.003	
altered gabbro	JJ217	17.0	.2	.06	.07	.02	.35	.003	
gabbro	JJ237	56.5	.05	.015	.002	.05	.35	.005	
"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Rock Type (H. W. Fander)	Sample No.	% of total	Cr %	Ni %	Pb %	V %	Mn %	C
olivine gabbro	JJ251	69.0	.2	.1	.1	.01	.1	.0
amphibolite	JJ563	76.5	.1	.02	.1	.05	.15	.0
gabbro	JJ581	58.0	.35	.1	.1	.02	.25	.00
pyroxene-granulite	JJ738	12.5	.02	.002	.1	.06	.2	.00
dolerite ?	JJ756	98.0	.05	.01	.05	.02	.3	.00
pyroxene-gneiss	JJ767	10.5	.007	.002	.1	.07	.2	.00

APPENDIX III.

REVIEW OF WORLD NICKEL PRODUCTION By J.F. Thomson,

(INTERNATIONAL NICKEL COMPANY OF CANADA.)

APPENDIX 111

METALS AND MINERALS
REVIEW AND FORECAST

(MINING WORLD. April 25, 1960).

N I C K E L

by

Dr. John F. Thompson,
Chairman of the Board,
International Nickel Company of Canada Limited.

Free world consumption of nickel in 1959 exceeded 400,000,000 pounds or about 25 percent over the 320,000,000 pounds consumed in the previous year.

Despite the prolonged steel strike in the United States, nickel consumption in 1959 registered an increase of about 35 per cent over 1958. Marked gains in nickel consumption were also recorded in the United Kingdom and other European markets. The United States, as in the past, was again the world's largest consumer of nickel. The year saw one of the sharpest and swiftest recoveries in demand for nickel in history.

Free world capacity for nickel production in 1959 was at an annual rate of about 550,000,000 pounds from all sources. This capacity, based on presently planned programs, is expected to increase by more than 100,000,000 pounds, at 18 percent, in the next two years. During the latter part of 1959 the changed political situation in Cuba introduced an element of confusion in that country's nickel industry which has not been entirely resolved and the forecast for increased capacity is made with this fact in mind. International Nickel's new mining project at Thompson, Manitoba, will contribute 75,000,000 pounds to this annual increase in capacity. The Thompson project takes on added significance in light of the current situation in Cuba.

Canada continues to be by far the largest supplier of nickel to the United States, the United Kingdom and other Free World markets. Of the Free World's present operating capacity for nickel production, Canada accounts for over 70 percent; Cuba 10 percent; United States 4 percent; and New Caledonia, Japan and other sources the remainder.

During September, the General Services Administration of the United States government announced that it would offer for sale its Nicaro nickel plant in Cuba, and would receive purchase proposals up to December 1, 1959. The GSA said the plant is capable of producing nickel at an annual rate in excess of 50,000,000 pounds (metal content in the form of nickel oxide powder and sinter. Early in December, it announced that it had received responses from private industry and that an interest in acquiring the plant had been expressed by the Cuban Government. The GSA said that a considerable period of time may be required to determine whether a sale acceptable to the United States Government can be concluded. Also in Cuba, the Freeport Nickel Company continued mine development and plant erection at Moa Bay to produce a nickel concentrate slurry for shipment to Louisiana for refining.

The development of the new mining project of International Nickel at Thompson, Manitoba, proceeded on schedule. It is expected to come into full production in 1961 at an annual rate of 75,000,000 pounds of nickel and will constitute the biggest nickel-producing operation in the world next to International Nickel's operations in the Sudbury district of Ontario.

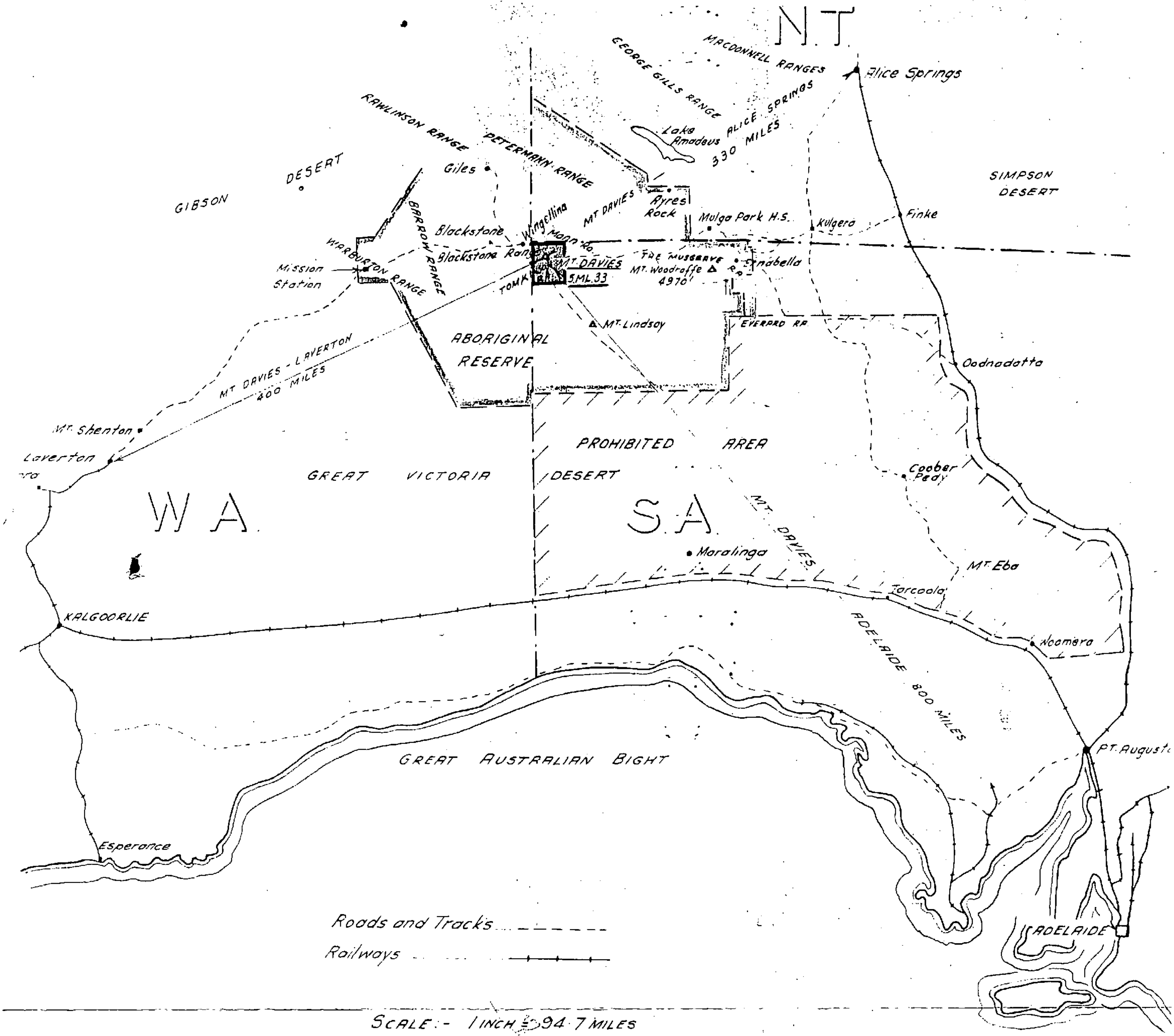
The world's second largest producer - Falconbridge Nickel Mines Ltd. - operated its Canadian mines and smelter at capacity of about 60,000,000 pounds in 1959. The company continued exploration for lateritic ores in the Dominican Republic and plans a pilot plant there.

Japan's nickel refining companies continued to furnace imported New Caledonian lateritic ores.

Societe Le Nickel completed expansion at its New Caledonian plants and reportedly plans additional facilities.

Russian production, largely from the Petsamo district in what was formerly part of Finland totalled about 115,000,000 pounds. Russia was a large buyer of nickel alloys and fabricated parts during the year, particularly in Europe, but would buy wherever obtainable.

Hanna Mining Company, the only United States producer, maintained normal operations furnacing blended grade ores for maximum economic long range output. The Company uses the Perrin electrothermic process to treat nickel silicates.



To accompany report by B.P. Thomson and R.C. Mirams

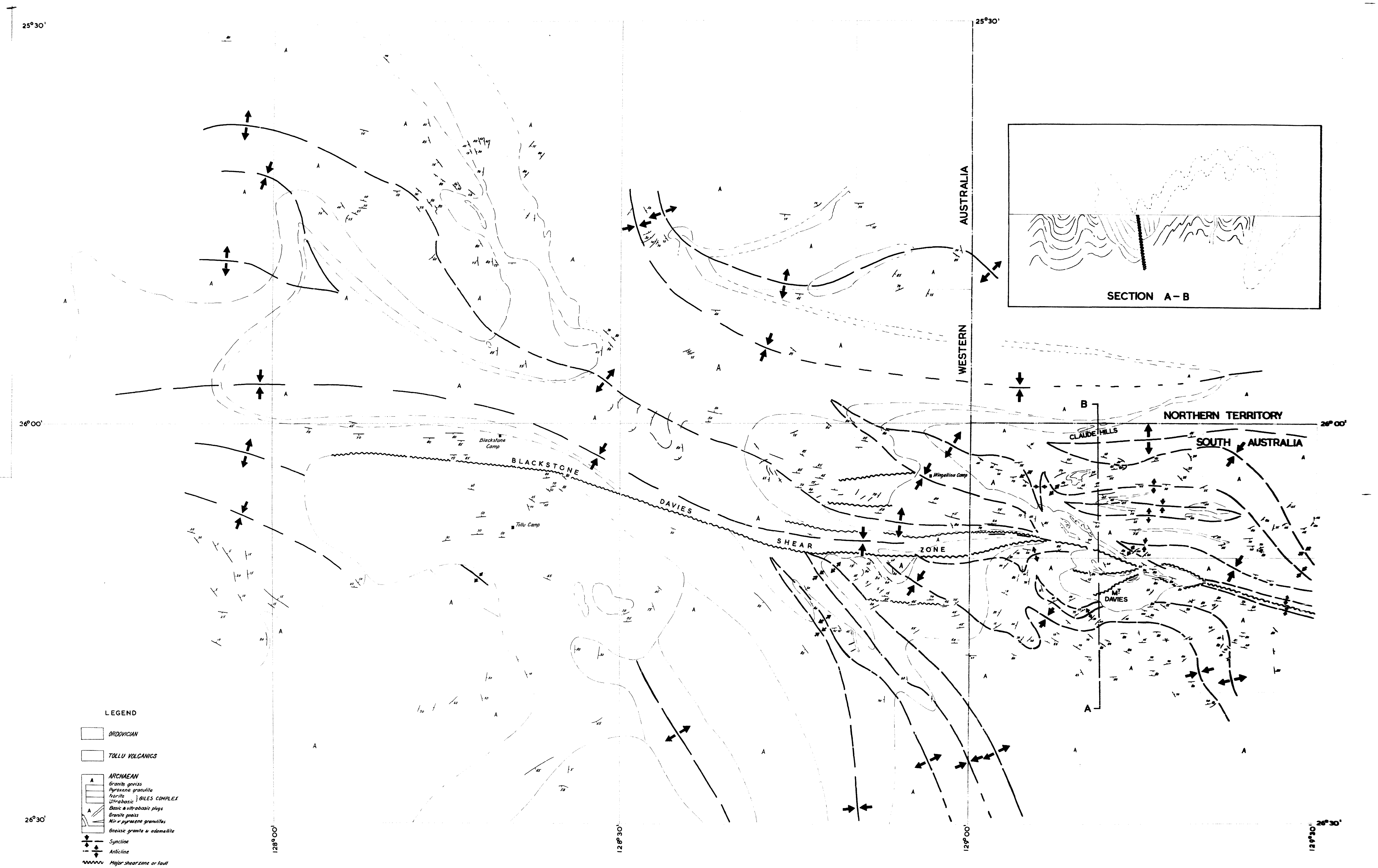
S.A. DEPARTMENT OF MINES

LOCALITY MAP
S.M.L. 33
TOMKINSON RANGES

Dn. T.A.W.

60-252

Date 9-5-60



To accompany report by B.P. Thomson & R.C. Mirams.

S.A. DEPT. OF MINES

INTERPRETATION OF REGIONAL STRUCTURE IN NORTHWEST OF S.A. & PORTION OF W.A. & N.T.

Req. No.
D.M.
Compiled from

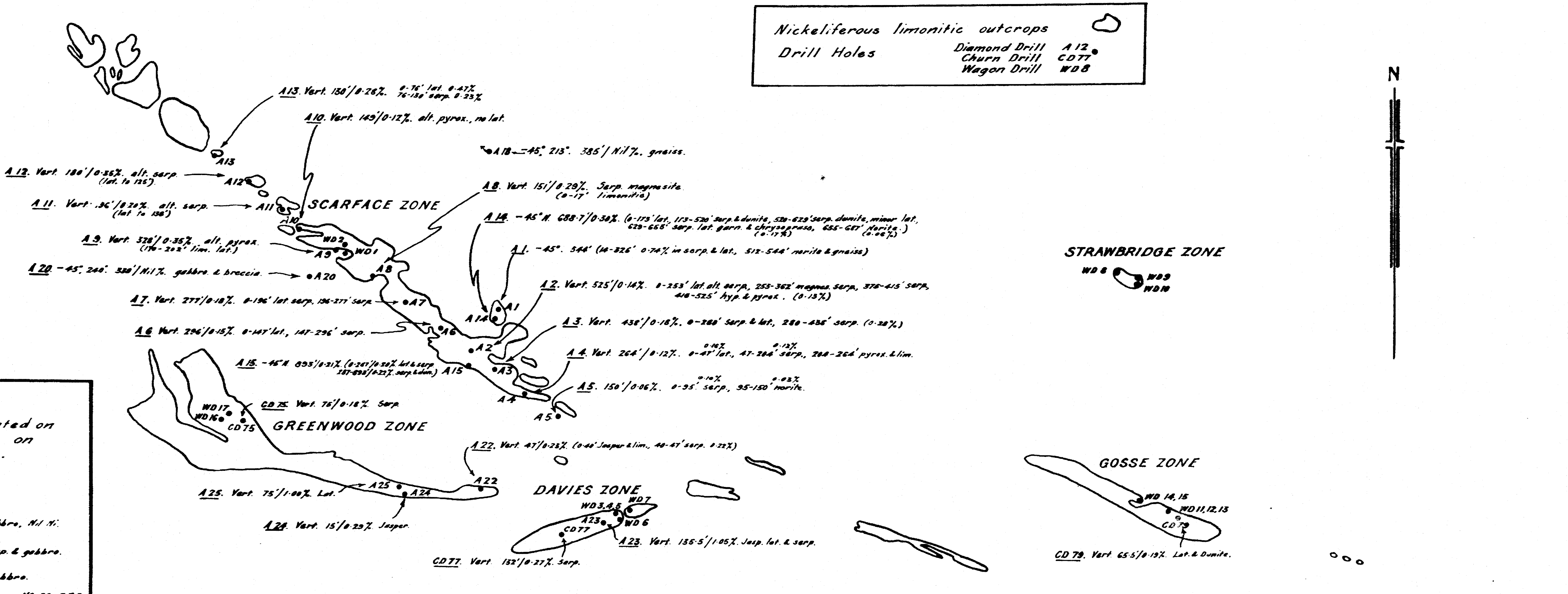
Associated Drawing	No.	No.	Amendment	Exd.	Date

Approved — Passed
Director of Mines

Drn. B.P.T.
Tcd. G.S.
Ckd.
Exd.

60-416
994-1/2+81
Date 24-7-68

ADD 1" (TRIM)



NOTE:
Diamond Drill holes not located on plan, drilled west of area on electromagnetic anomalies.
Results are as follows:

A 19. -45°. 195°. Anom. 328. 355'/Nil %

A 21. -45°. 180°. Anom. 335. 105'/Nil %. Gabbro, Nil Ni.

A 29. -45°. 180°. " 335. 209'/Nil %. Serp. & gabbro.

A 30. -45°. 180°. " 335. 175'/Nil %. Gabbro.

For bores in Claude Hills Area see Plan Nº 60-250
For detail of Wagon Drill holes see report.

To accompany report by B. P. Thomson and R. C. Mirams. Confidential.

S.A. DEPT. OF MINES

MT. DAVIES REGION
SOUTH WESTERN MINING LTD.
DRILL HOLE LOCATION PLAN

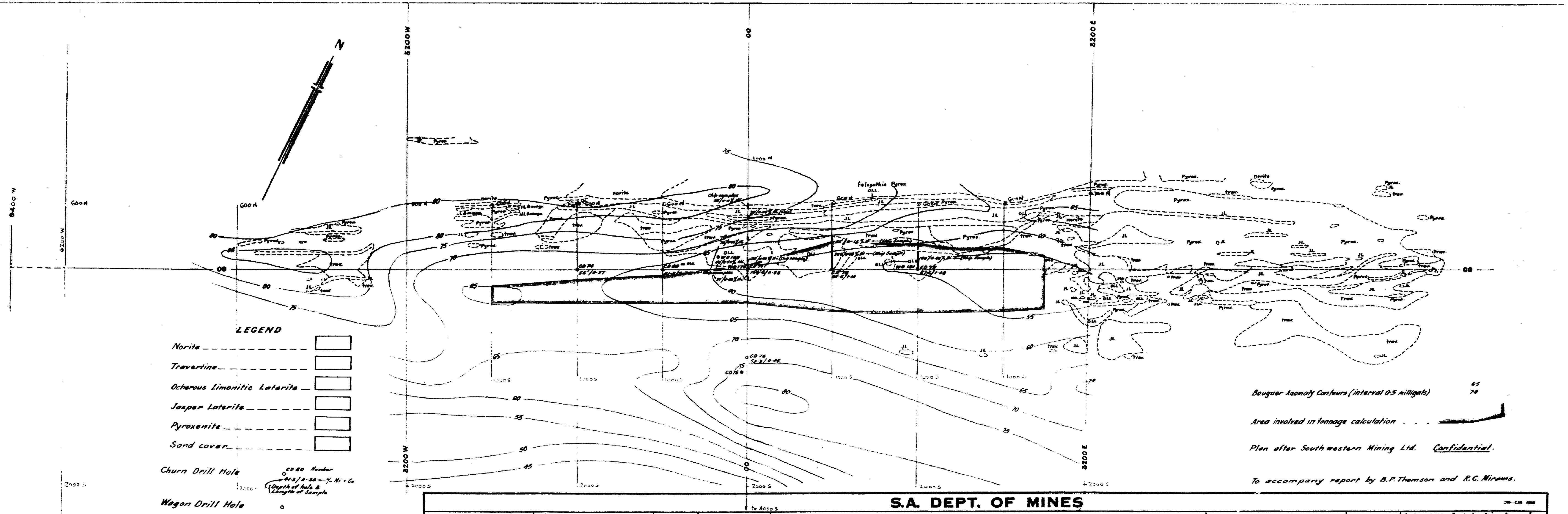
Req. No.
D.M.
Compiled from

Associated Drawing	No.	No.	Amendment	Exd.	Date

Approved | Passed
Director of Mines

Drn.
Tcd. R.R.
Ckd.
Exd.

Scale: 3600 feet to 1 inch.
60 - 251
Ad.
Date



S.A. DEPT. OF MINES

MT. DAVIES REGION
CLAUDE HILLS ZONE
GEOLOGICAL PLAN

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

Approved | Passed

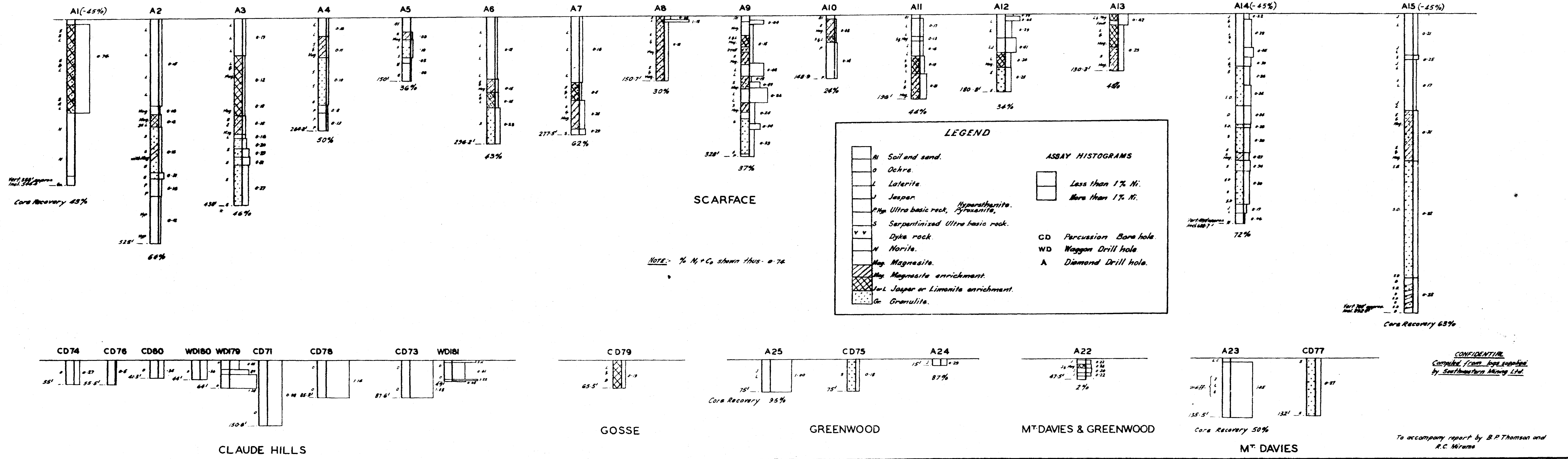
Director of Mines

Drn.
Tcd. R.R.
Ckd.
Exd.

Scale: 400 feet to 1 inch.

60-250
Ad

Date 6 · 5 · 60



S.A. DEPT. OF MINES

Mt DAVIES REGION
DRILL HOLE SECTIONS

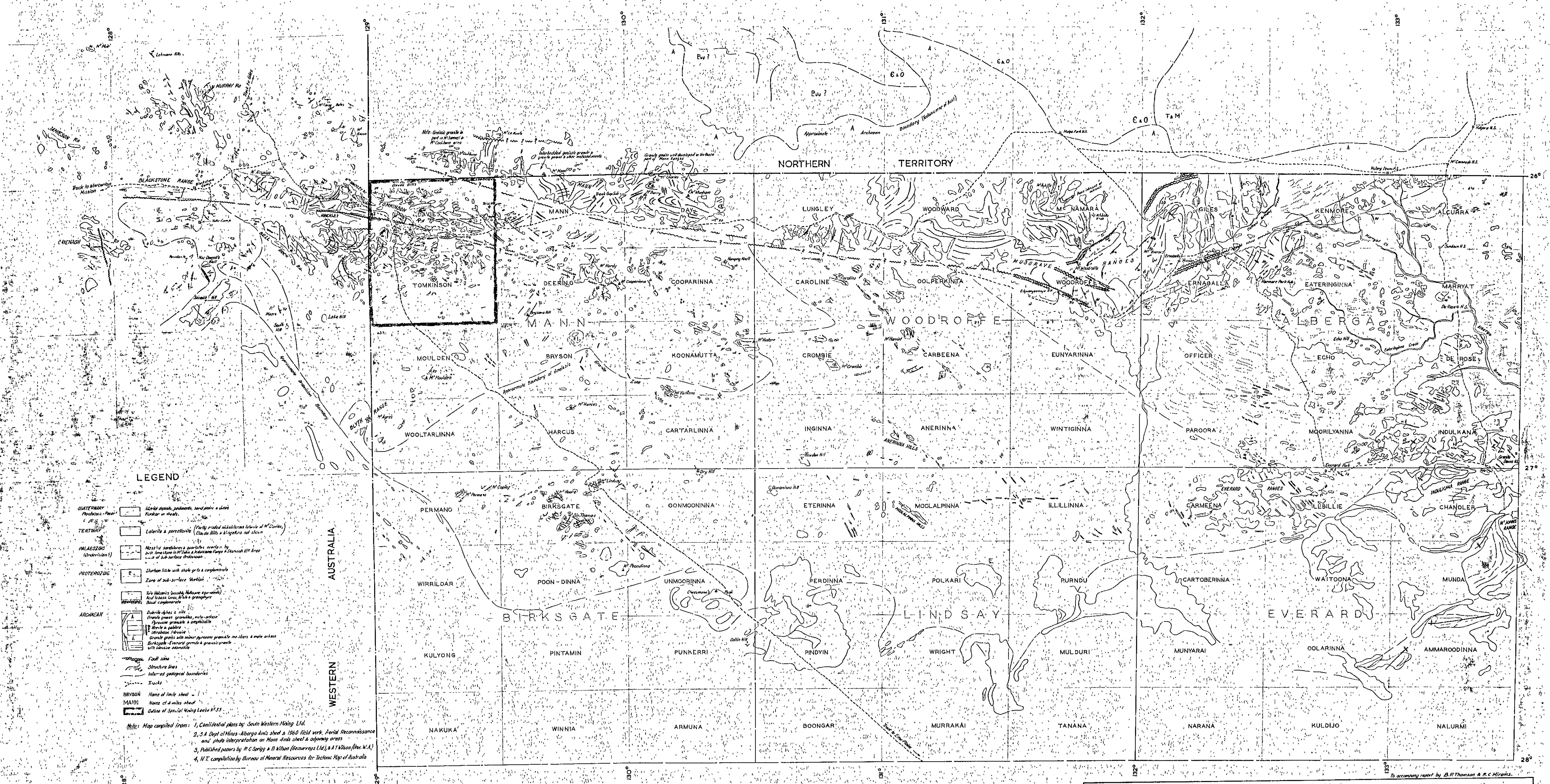
Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

Approved	Passed
Director of Mines	

Drn.
Tcd. R.O.W.
Ckd. R.R.
Exd.

Scale: 100' TO 1"
60-248
Date 5-5-60

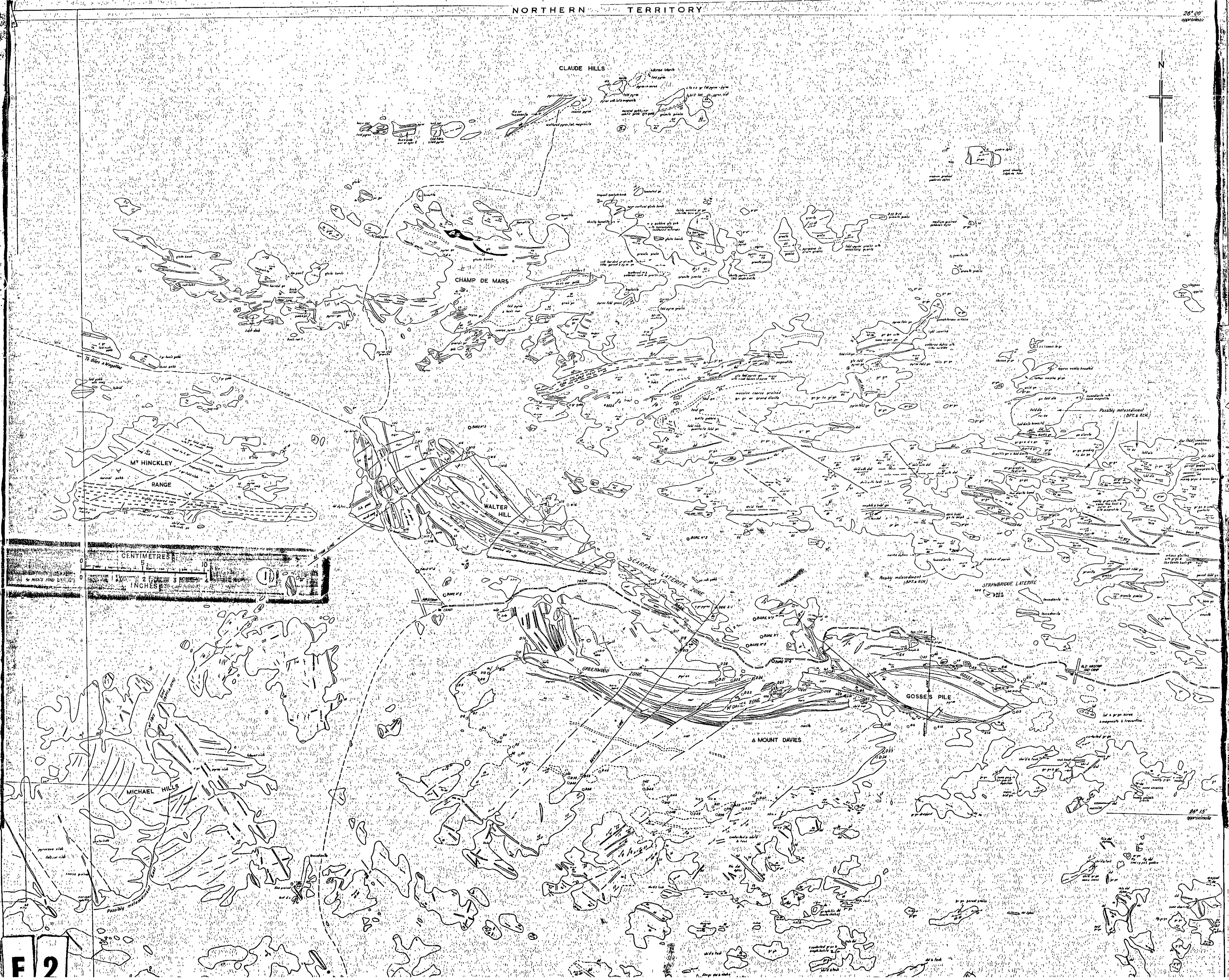


To accompany report by B.R.Thomson & R.C Mirams.

CONFIDENTIAL

S.A. DEPT. OF MINES.		
Amendements	REGIONAL GEOLOGY OF NORTHWESTERN PROVINCE OF S.A. AND ADJOINING AREAS IN N.T. & W.A.	Scale: 8 mls to 1 inch; Approved; Passed; Drn; Tcd G.S.; Ckd; Exd; L-60-102; 994 1/2 + 81; Date: 15-7-60

CHAMP DE MARS
Mt HINCKLEY
RANGE
WALTER
HILL
SECTION LINE
SCARFACE LATERITE ZONE
STRAWBRIDGE LATERITE
GREENWOOD ZONE
Mt DAVIES ZONE
GOSSE'S PILE
GOSSE ZONE
Δ MOUNT DAVIES
MICHAEL HILLS
26° 15' approximate
WESTERN AUSTRALIA
SOUTH AUSTRALIA
129° 00' approximate
CENTIMETRES
INCHES
LEGEND
Giles Complex
Basic gabbro, diorite etc.
Ultrabasics
Dolerite
Granite, syenite
Quartzite
Acid gneisses
Basic gneisses
Laterite
Ochre
See note below
Quartz
Bedding
Schistosity, gneissosity
Foliation, banding
Faults, shears
Creek sample
"Davies" 6
"Gosses" 4
"Walter" 3
Wagon Drill No 5
Western portion of "Davies" 1 mile sheet
and
North Western portion of "Tomkinson" 1 mile sheet
After plan by South Western Mining Ltd.
CONFIDENTIAL
F 1
To accompany report by B.P. Thomson & R.C. Mirams
S.A. DEPT. OF MINES
Mt DAVIES REGION
GEOLOGICAL PLAN
AND
LOCATION OF CREEK SAMPLES
Approved
Passed
Scale: 1inch to 3600ft
L-60-42
A
Date 11-5-60
Amendment



NORTHERN TERRITORY
26° 00' approximate
N
CLAUDE HILLS
CHAMP DE MARS
Mt HINCKLEY RANGE
WALTER HILL
CENTIMETRES
INCHES
SCARFACE LATERITE ZONE
STRAWBRIDGE LATERITE
Possibly metasediment (BPT & RCH)
GREENWOOD ZONE
GOSSE'S PILE
GOSSE ZONE
MOUNT DAVIES
MICHAEL HILLS
26° 15' approximate
Possibly metasediment
TRACK
OLD AIRSTRIP AND CAMP

F 2

Report, April 1961

on

NICKEL EXPLORATION, SPECIAL MINING LEASE, NO. 33
TOMKINSON RANGES

by

Brendan P. Thomson, M. Sc.

&

R. C. Mirams, B.Sc

GEOCHEMICAL SECTION

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA

R.B. 659A
GS. 1782
S.R. 11/2/87

17th April, 1961

1 Copy complete with folder of plans. £2.10.0

INDEX

PART I. GENERAL

PART II. REGIONAL GEOLOGY

INDEX (Cont.)

PART III ECONOMIC GEOLOGY AND EXPLORATION

LIST OF PLANS AND ILLUSTRATIONS

A. PLANS & SECTIONS

*NOTE Mann 1:250,000 Geological sheet prepared subsequently to text of Report.

B. PLATES

PLATE I.

Fig. 1. Pyroxene gneiss outcrop, Tiezi.

Fig. 2. Meta-arkose, Tiezi.

Fig. 3. Sedimentary structure in pyroxene gneiss.

PLATE II.

Fig. 1. View of Scarface Zone.

Fig. 2. Davies Zone.

Fig. 3. Chrysoprase veinlets.

Report

on

NICKEL EXPLORATION. SPECIAL MINING LEASE NO. 33

TOMKINSON RANGES

SUMMARY

This report reviews the available information on the region and presents a preliminary appraisal of the data supplied by South Western Mining Co. Ltd. Current field and laboratory information has also been included.

New geological and geochemical data is presented which confirms the lateritic origin of the enriched nickel deposits. Results of recent gravity survey of the Claude Hills area and regional aeromagnetic survey are discussed.

Recommendations are made for further exploration of the area.

C O N F I D E N T I A L

NICKEL EXPLORATION. SPECIAL MINING LEASE NO. 33
TOMKINSON RANGES

PART 1

GENERAL

INTRODUCTION:

The discovery of extensive nickel mineralisation in the vicinity of Mt. Davies, Tomkinson Ranges, in 1953 by a Mines Department field party, under R.C. Sprigg, led to the undertaking of a major exploration campaign in the area between 1955 and 1958 by South Western Mining Ltd. a subsidiary of International Nickel Company.

The company retains Special Mining Lease No. 33 over the area under suspended labour conditions for a 2 year term which commenced 3rd. June, 1959. The lease covers the Mann and Davies 1-mile Sheet.

Officers of the Geological Survey made a preliminary inspection of the Mt. Davies nickel mineralisation in November 1959. Between May and December 1960, 22 weeks were spent in the field on investigation of the nickel mineralisation and the regional geology of the Mann 4-Mile Sheet.

During the period a low level aerial reconnaissance was made of the 4-Mile sheet on east-west traverses about 2 miles apart. The Bureau of Mineral Resources also flew the Mann 4-Mile on north-south aeromagnetic traverses.

This report is the result of study of all information available to the authors and of the Mines Department field and Australian Mineral Development Laboratory investigations.

ACKNOWLEDGEMENTS:

The bulk of the detailed information shown on the small scale plans comes from reports of South Western Mining Limited, submitted to the Mines Department under the terms of the Lease. Useful information was gained from reports and published papers by Sprigg and Sprigg and B. Wilson, and other papers on the Musgrave Ranges region by A.F. Wilson. Valuable data was obtained from early papers by Basedow, Streich, Talbot and Clarke.

LOCALITY & ACCESS:

The nickel mineralisation is located in the extreme north-western corner of the State in the Davies and Tomkinson 1-mile sheets.

From Mount Davies air line distance to Adelaide is approx-mately 800 miles, to Alice Springs 330 miles, and to Laverton, W.A. 400 miles (see fig. 1).

The area is located in the centre of the large central Aboriginal Reserve which extends into the adjoining States. The Reserve is sparsely populated by nomadic natives and the closest settlement to Mount Davies is Giles Meteorological Station, 120 road miles from Mt. Davies. Access to Mt. Davies is via Mulga Park Homestead and Kulgera, 167 miles south of Alice Springs, (N.T.) The total distance from the main road at Kulgera to Mount Davies is 280 miles. The track is partly graded and is trafficable to 2 wheel drive vehicles except after heavy rain.

CLIMATIC AND WATER SUPPLY:

The area probably has an annual average rainfall in the vicinity of 9 inches, but is subject to great seasonal variations and it decreases rapidly to the south of the ranges. Annual evaporation is probably of the order of 120 inches. The tempera-ture range is extreme, varying from over the century in the summer to below freezing at ground level in the winter.

Limited underground water supplies have been proved near Mt. Davies and Wingellina but it is doubtful whether this supply could be maintained for a long period. Suitable small reservoir sites could probably be found in the ranges, but the high evaporation would greatly restrict their usefulness.

Creeks are restricted to the hilly zone and terminate abruptly in alluvial outwash areas on the margins of the extensive flats between the hills.

VEGETATION AND SOIL COVER:

Vegetation is typical of the arid to sub-arid environment. Patches of mulga occur around the foothills of the range elsewhere are scattered corkwoods and desert oaks and spinifex. One mallee type eucalypt appears to be associated with the ultrabasic outcrops.

The mapping by the Mines Department included a study of the Recent and Quaternary cover. Residual soil appears to be restricted to the immediate vicinity of outcrop areas. Elsewhere a cover of transported material such as stream wash, talus, aeolian sand and kunkar sheets appear to offer little hope of detection of concealed nickel deposits in soil covered or alluviated areas.

TOPOGRAPHY:

The Mann - Tomkinson-Blackstone chain of ranges forms a picturesque topography, rising sharply up to 1500 to 2000 feet above the general plain level which itself is of the order of 2000 feet above sea level. The ranges in fact form the topographic backbone of the continent, as they are flanked to the north and south by extensive desert areas. The laterite and porcellanite areas farther south and east appear to be small erosion residuals on the flanks of the ranges or in the broad valleys southeast of the Musgrave Ranges.

PART II

REGIONAL GEOLOGY

GENERAL GEOLOGICAL SUCCESSION:

1. ARCHAEAN

A broad subdivision which will be described more fully below can be made as follows:-

(a) Metasediments: represented by granite gneisses, pyroxene granulites and amphibolites.

(b) Basic intrusives of the Giles Complex.

(c) Intrusive granite and gneissic (?) granite.

(d) Dolerite dykes.

2. TERITARY

Laterite residuals at Tiezi and possibly ochre and jasper zones in Mt. Davies and Claude Hills area.

3. QUATERNARY

Chalcedony, clay pans, clay soils, kunkar, sand dunes, pediment, recent alluvium.

OUTLINE OF ARCHAEAN GEOLOGY:

1. ARCHAEAN META-SEDIMENTS

Information available to date indicates a thickness of many thousands of feet of metasediments in the area. Lithologically the metasediments indicate that the original sequence generally comprised medium to coarse grained clastic sediments, with a higher quartz-felspar content. Thinner impure dolomitic members occurred at a number of levels in the succession.

The rocks are remarkably free from hydrous minerals. The sequence was highly metamorphosed to the granulite metamorphic facies and is now represented by a variety of gneisses, granulites. and minor quartzites etc. with a composition varying from acid to basic as follows:-

(a) Acid gneisses and granulites

These rocks are well banded and show in places relict cross-bedding structures. Some of the types are clearly meta-arkose, and others are more quartzitic in composition. Their relation to the gneissic granite developed mainly in the southern part of the region appears to be close as a variety of rock types ranging from arkose to granite gneiss to gneissic granite to granite are represented in the region.

(b) Intermediate gneisses and granulites.

These rocks contain less than 10 per cent quartz and are medium to fine grained rocks. They commonly contain pyroxene and are garnetiferous in parts of the region.

(c) Basic gneisses and granulites.

These are represented by banded amphibolites and pyroxene granulites, which are clearly of meta-sedimentary origin.

Some of the intermediate to basic types have been mapped as leudodiorite by Company geologists.

2. ARCHAEAN, IGNEOUS ROCKS

(a) Basic and Ultra-basic Igneous rocks (Giles Complex)

Layered rocks of the Giles Complex occur in the Mount Davies region and extend west over 100 miles into Western Australia. These rocks have been mapped in detail by South Western Mining Limited and a study of their maps indicates that the sequence is complex. A large proportion of the rocks are of norite gabbro composition but substantial bodies of olivine and pyroxene rich ultra-basics occur. These are of genetic significance in the distribution of the nickel minerals.

The following table is a summary of the features of the basic and ultra-basic bodies, as obtained from a report by H.R. Elves, consultant geologist for South Western Mining Limited. Systematic collection of rock specimens for precise petrological identification of the main rock types has been made by us from these zones. This will supplement the petrological work already carried out by Australian Mineral Development Laboratories and the earlier work of Robinson (1949).

Although the Giles Complex is broadly concordant with the meta-sediments, particularly in the western part of the region, there is undoubted evidence that the norite can locally cut across

1955

SUMMARY OF GEOLOGICAL FEATURES OF BASIC AND ULTRABASIC BODIES, MT. DAVIES REGION

	GOSSE'S PILE	MT. DAVIES	WALTER HILL
SIZE	6 miles x 1½ miles	10 miles x 4 miles	10 miles x 3 miles
ULTRABASICS	Bulk	Mainly olivine-rich basics and ultra-basics.	Subordinate ultrabasic development.
PERIDOTITE	Locally in pyroxenites	Narrow bands in northwest (trace chalcopyrite and pyrrhotite.)	Irregular bodies cutting norites?
PYTOXENITE	Predominantly medium to coarse grained enstatitite to bronzitite. Grading to norite.	Medium to coarse grained on north-east side of Greenwood Zone.	Thick band on north edge (bronzite?).
SERPENTINITE	Several zones. Grades to peridotite. Original comp. undetermined. Associated with chrysoprase.	Two large laterized serp. zones Davies 1½ml.x1500' Greenwood 5m.x1000' to 4000'. Grades to Harzburgite.	Only one exposed locality on Scarface (may be largely lateritized) with nickel.
HARZBURGITE	-	Coarse grained enstatite and olivine. Long continuous bands in the north of the intrusive.	-
ENSTATITE	-	Thin bands	-
BASICS	-	-	Mainly norite.
NORITE	Massive felspathic gabbro (also prob. felspathic gabbro) olivine rare - contains narrow bands of pyroxenite.	Thick, massive structureless Olivine norite. Also hyperathene norite with apatite and magnetite. Hypershthene enstatite - norite hypersthene leuco gabbro	Medium grained layered hypersthene norite dominant. Leuco norite and diorite with magnetitebecoming less basic towards west.
FACING(?)	Massive. Original outline not known.	North contact basic. Faces south (?)	Faces south west (?)
TREND	East west, steep south dip	North south to north east, dip south west	North west, south east or east west.

	GOSSE'S PILE	MT. DAVIES	WALTER HILL
SULPHIDES	NONE	Specks chalcopyrite and pyrrhotite at numerous places	Isolated specks of chalcopyrite in west and north west end.
DOLERITE	Fine grained with tachylites (in serpentine.)	Fine grained and tachylitic with some magnetite	-
STRUCTURE	Faulted outline, with massive pyroxenite core.	Layering on north side. South half massive.	Layering well developed.

the gneiss banding on the southern margin of the Mount Davies basic mass and around the intrusive Champ de Mars plug. Similar discordant bodies of norite are known in the Mount Woodroffe region to the east (A.T. Wilson 1960).

The Giles complex however, was apparently largely sill-like in character and of very great areal extent, the main sill probably ha ing a thickness of the order of ten thousand feet.

(b) DOLERITE DYKES

The entire region from the Everard Ranges to the Blackstones of Western Australia is traversed by numerous swarms of dolerite dykes generally with a north-westerly trend, some swarms persisting for over 150 miles. Minor swarms also trend east-west. The thickness varies from a few tens of feet up to 500 feet or more. Dyke zones are sheared generally with an east block west displacement. Shear zones produce peculiar glass textured rocks (tachylite). In composition the dyke rocks approach gabbro and norite (Thomson 1911) and may be olivine rich, (A.F. Wilson 1949). The rocks also occur as minor sills. Although they are the younger intrusives in the region, the dyke rocks may be genetically related to the Giles Complex. This is also suggested by the recent discovery by a Mines Department party of ultra-basic bodies in a dyke swarm on the Mann and Deering Sheets. The basic dyke rocks are Pre-Sturtian in age as proved by the mapping of Sprigg, Wilsoh and Coats on the Alberga 4-Mile Sheet.

3. STRUCTURE

Metasediments

The metasediments are folded into a succession of relatively open anticlines and synclines plunging both east and west. Further mapping of marker beds in the metasediments is required to decipher the details of folding. In the area between Mt. Davies and the Northern Territory border the fold axes trend east-west, The contact between the sediments and Giles Complex is generally concealed by talus or drift sand on the north side of the Hinkley Range - Mt. Davies zone. Near Gosses Pile and Walter Hill however outcrops near the contact indicate that the fold axes in these areas trend northwest. The resultant S shaped pattern of folding in the northern part of the region may be attributed to the influence of a clockwise regional shear couple.

South of Mt. Davies the fold pattern is more obscure than in the northern sheet. Fold axes vary in strike from north south to east west and are truncated by the lobe of Giles complex forming the Mt. Davies-Greenwood ridge. Fold structure in the area between Mt. Davies and the West Australian border appear to be severely buckled and dragged on the shear zone on the southern margin of the Mt. Hinkley Range.

Giles Complex

The location of ultrabasic rocks on the northern flank of the Gosses Pile-Mt. Davies-Scarface Zone suggests that the Giles Complex faces south. By the same argument the Claude Hill zone would face north. This difference in facing between the two zones is in agreement with the anticlinorial character of the folding in the metasediments separating the two zones.

The Giles Complex has been strongly folded and in the regional sense tends to be broadly concordant with the stratigraphy Although plug-like bodies occur (e.g. Champ de Mars) it is thought that the intrusives were in part originally sill-like.

Faults and Shears

A major fault appears to extend along the southern flank of the Musgrave & Mann Ranges for a distance of at least 160 miles along a WNW strike. It extends into the Northern Territory crossing the northeast corner of the Davies 1-Mile sheet. The structure appears to be a wrench (strike-slip) fault, dipping south. The long strip of concealed ground along the northern flank of the Mt. Hinkley Range-Gosses's Pile zone is parallel to this major fault and may indicate a parallel fault structure which with a clockwise north block east movement could account for the fold pattern. This hypothetical fault zone would link with the observed Hinkley-Range-Gosses's Pile shear zone which has been followed 50 miles into Western Australia and may have played a roll in the emplacemen of the ultrabasic bodies.

Minor faults strike east to north-east and west-north-west to north-west.

No sheared or faulted contacts have been observed in the Claude Hills area.

AGE OF STRUCTURES:

1. Older Structures:

Archaean meta-sediments were moderately folded prior to the introduction of the Giles Complex and probably at the time of regional granitisation which produced the granitic gneisses and gneissic granite. The introduction of the Giles Complex would appear to have occurred while the meta-sediments were still buried to a considerable depth. Further violent folding occurred during or after the emplacement of the large basic and ultrabasic bodies and preceded the introduction of basic dykes along active shear planes and tension openings. It is possible that younger intrusive granites were also emplaced at this stage.

2. Proterozoic Folding

The eastern end of the province is flanked to the north and south by Upper Proterozoic rocks. The presence on the Alberga Sheet of tillites resting in places on Archaean rocks indicates that the crystalline basement was exposed at that time. The old mountain belt was probably within a rising geanticlinal zone.

3. Palaeozoic Folding and Tectonics:

The marked unconformity between the Ordovician and the Adelaide System in the Indulkana Range and Mount Johns area to the south of the Alberga Sheet, indicates that a period of tectonic activity occurred probably in the Cambrian.

4. Tertiary and Quaternary Tectonic Activity

Broad arching and uplift of the late Tertiary laterite surface apparently continued to the present day.

PLATE 1

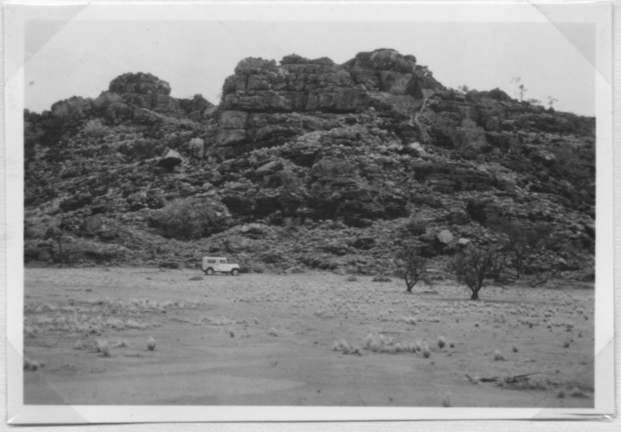


Fig. 1

Pyroxene gneiss near Tiezi waterhole showing rectangular blocky joint pattern, gneiss is "case-hardened" by surface silicification.

Fig. 2

Steep dipping meta-arkose near Tiezi waterhole. Pen in B Lineation direction plunging at low angle to east.

Fig. 3

Relict sedimentary structure (Cross Bedding?) in pyroxene gneiss, 5 miles east of Walter Hill.

PLATE II

Fig. 1

View looking north from Davies Zone, Scarface Zone forms low ridge at edge of scrub covered foothills of norite.

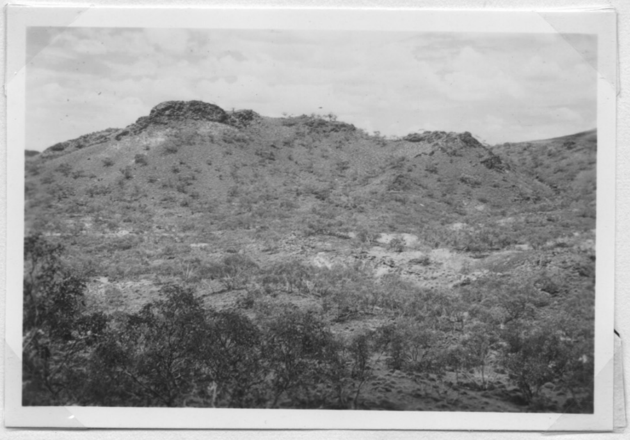


Fig. 2

View looking east at western extremity of Davies Zone. Jasperoid capping on hill tops. Train of white magnesite float visible in talus. Light coloured area in foreground covered with mallee scrub is exposed serpentine horizon.

Fig. 3

Veinlets of Chrysoprase (Nickeliferous chalcedony) in jasperoid outcrop. Scarface Zone.

PART III

ECONOMIC GEOLOGY AND EXPLORATION

PREVIOUS WORK

(a) South Australian North West Prospecting Expedition 1903

Basedow (1905) examined the jasperoid outcrops on the northern foot of Mount Davies, probably Gosse or Scarface zone, which he named Murru Yilyah outcrop and described as follows.....

> '"The deposit consists of a fresh looking highly siliceous rock varying from impure siliceous ironstone, through chalcedonic, and semi-opaline varieties of quartz".... "The silica has been tinted by mineral salts in solution the colour ranging from brick red to pale yellow to a bright green (chromium)".... "Its origin (the deposit) is doubtful as it can hardly be referred to the 'desert sandstone'*, though in some respects it is not dissimilar to it."'

Although Basedow in 1903 thought the green-stained quartz at Mount Davies was due to the presence of chromium it is interesting to note that H.Y.L. Brown, in his "Catalogue of South Australian Minerals, 1893" reports, Page 25), "Quartz stained with nickel in the Tomkinson Ranges". This report, which was probably based on samples collected by the survey party led by Carruthers, appeared to have been overlooked for 60 years.

(b) South Australian Mines Department, 1953

In November, 1953, a party under R.C. Sprigg, Senior Geologist, visited the Tomkinson Ranges to check for possible uranium association with the green stained silica recorded by Basedow. Ultrabasic rocks were discovered to be associated with the green stained formation.

Mr. Sprigg reported these occurrences as follows ....

> 'Green stains have proved to be due both to nickel and chromium, a trace of the latter and 0.2% nickel, (siliceous specimen only). The occurrence is potentially important due to the enormous size of the breccias. Two or three zones were seen to the north with the aid of binoculars. In view of the high degree of leaching of these breccias, the primary nickel mineral could only be sampled by drilling. It is proposed to investigate these breccias fully next season. ...'

* porcellanite or duricrust (BPT)

R.P. Coats visited the area in August, 1954, and reported the occurrence of chromite at Mount Davies (G.S.168, Rept. Bk. No. 38/77).

(c) Gold and Mineral Exploration, N.L. 1954

R.C. Sprigg, as consultant Geologist, Geosurveys Australia Limited, returned to the area for three months in 1954.

Results of the work are included in a report in the Mines Department files, (D.M. 1238/54).

The work consisted largely of geological mapping and it is interesting to note Mr. Sprigg's able interpretation of the mineralisation as follows -

> "To the present no definite indications of sulphide mineralization have been noted within the dunite intrusive zones and the laterite concentrations appear to be largely surface concentrations of garnierite from the original silicate mineral complex of the ultrabasics themselves. The low copper content of the surface exposures also supports this non-sulphide origin theory for this particular locality."

(d) South Western Mining Limited

In June, 1955 South Western Mining Limited acquired the Special Mining Lease.

SPECIAL MINING LEASE NO. 33

(a) Area

Area of that piece of land contains about 1060 square miles, bounded by latitude 26°S and 26°30S and Longitude 129°E to 129°30E. The company has a Reservation of comparable size in the adjoining area of Western Australia.

(b) Term

Two years from 3rd June, 1959. (Area was originally acquired by the company as Special Mining Lease No. 21 on June 30 1955), later renewed as No. 25 and again as No. 33. The Company's West Australian Reservation is due for renewal in November 1961.

(c) Rent

£50 per annum.

(d) Mineral Rights.

"Right to acquire mineral leases. Exclusive rights only, in respect of nickel minerals and minerals associated or combined therewith, in the area comprised in the special mining lease".

SOUTH WESTERN MINING ACTIVITIES

To date South Western Mining Limited have spent approximately £200,000 on exploration in their South Australian Lease. Their total expenditure for the combined South Australian and Western Australian areas exceeds £500,000.

The Company carried out an extensive exploration programme during the first 3½ years of their lease tenure.

The first diamond drill hole A1 was commenced in October 1955 and the last drill hole, Churn Drill 80 was completed in October 1959.

Fourteen geologists and five geophysicists have been engaged at various times, as well as a large number of other personnel.

A large part of the area of the leases was covered by reasonably detailed factual geological mapping on the scale of 1" = 3600 feet, as well as more detailed plans of the nickeliferous areas. A large amount of electro magnetic and magnetic geophysical traversing, both surface and airborne was done. A limited amount of geochemical sampling was done, but the results were not encouraging.

A large footage of diamond drilling was carried out in the vicinity of the large low grade but impressive looking siliceous nickeliferous outcrops and in a number of electro magnetic anomaly areas.

A considerable amount of percussion and wagon drilling was also done during the latter phase of the exploration campaign.

Creek sand samples were collected and studied.

The following tabulation gives details of exploration work accomplished:-

Geological Mapping - reconnaissance	- 1060 sq.miles
Geological Mapping - detailed	- 96 " "
Geological Sections Mapped	- 20 miles
Creek Sand Samples Collected	- 82 miles
Geochemical traverses	- 4 "
Resistivity Profiles	- 31 "

* Magnetometer Traverses (ground)	-	66 sq.miles
* Electromagnetic Surveys (ground)	-	4 " "
Electromagnetic Surveys (airborne)	-	197.5 " "
Airborne electromagnetic anomalies investigated	-	77
Airborne electromagnetic anomalies drilled	-	5
Diamond Drilling - 25 holes	-	7021.5 feet
Percussion Drilling - 24 holes	-	2255.8 "
Wagon Drilling - 20 holes	-	414.6 "

RESULTS OF EXPLORATION CAMPAIGN:

By far the largest proportion of effort was put into testing the siliceous Scarface, Greenwood, Davies and Gosse zones, apparently in an attempt to locate sulphide ore. However, the grade of primary mineralisation tested by drilling is of the order or less than 0.2 per cent nickel (see figs. 8 & 9). Close surface prospecting located only traces of very weak disseminations of sulphides. Creek sand sampling revealed that precious metals occur only in trace amounts.

The high nickel values in D.D. holes A25 and A23 (see fig. 9) in the Davies and Greenwood zones are suspected to be confined to narrow deep zones of enrichment in or below the jasperoid zone. These two localities have not yet been studied in detail. By comparison with the Claude Hills profile it appears that in the Davies, Greenwood and Scarface zones a nickeliferous ochre horizon above the jasper has been removed by recent erosion.

Near the close of the campaign the nickeliferous ochre area of Claude Hills was tested by approximately 500 feet of churn and wagon drilling. The deepest hole, Cd, 71, reached 150'6" vertical depth (see figs. 5 & 6). The holes were spaced on a broad grid and no serious attempt was made to test for possible extensions of nickel rich ochre under the concealed area to the west and southwest of the outcrop.

According to South Western Mining Limited (personal communication to Director of Mines) the Claude Hills deposit has a probable

* Exclusive of surveys of airborne electromagnetic anomalies.

tonnage of one million tons of 1.5% nickel. The Wingellina deposit, Western Australia, has a considerably larger tonnage and a grade comparable to the Claude Hills area.

STUDY OF SECONDARY NICKEL ENRICHMENT:

(a) General

Mr. H.A. Laine, in a final report for South Western Mining Limited states that....

> ..."the ferruginous laterite (ochre) may be enriched in nickel up to several times the original nickel content of weathered rock, but the enrichment is usually highly erratic in both lateral and vertical distribution"...

Unfortunately the drill log supplied by South Western Mining in their quarterly reports gave generally only the averaged or bulked assays over long lengths of each hole and do not enable a detailed study to be made of the nickel distribution in depth. Such a study is vital to the understanding of the process of secondary enrichment and the accurate delineation of potential ore zones. The assays of wagon drill hole No.179, in Claude Hills (see fig. 6) however, showed an increase in grade with depth. Therefore the need was felt by the authors to obtain more detailed assay information on the drilling intersections, and in 1960 the opportunity was taken to obtain duplicate samples from the Claude Hills samples stored at Wingellina. The Claude Hills bores were sampled at approximately 5 feet intervals. Part of each sample was kept for laboratory investigation and the remainder of each portion submitted for assay. The results of this sampling proved that in the ochre zone the nickel and iron values have a very distinct vertical distribution analogous to nickiliferous laterites elsewhere in the world.

(b) Depth of Weathering

Locally, weathering of the basic and ultrabasic rocks can extend to surprising depths. In D.D. hole A14, Scarface, "limonitic laterite" with 0.17% Ni-Co was intersected in portion of the hole at a maximum depth of approximately 460 feet vertically below the surface. The deepest Claude Hill hole bottomed in limonitic jasperoid rock at 150 feet vertical depth.

(c) Shape and Elevations of the Ochre and Siliceous Laterite Bodies

The shape of the bodies appears to be directly controlled by:

(1) Distribution of ultrabasic rocks,

(2) Relationship to a former land surface,

(3) Proximity to shear zones,

In the Mount Davies area, the predominantly jasperoid bodies tend to be best developed on the northern side of the ultra-basic and basic areas producing the elongated Scarface Zone and the smaller Gosse zone which is also terminated by faults. Both of these deposits are in the foot hill area on the edge of the alluvial plain. The more highly elevated Greenwood and Davies Zones have been more deeply intersected by erosion, producing a patch work pattern of jasperoid outcrops with local residual ochre pockets. On the other hand the more low lying Claude Hills body is predominantly of the ochre type, as is the Wingellina deposit in Western Australia. The Claude Hills zone of nickel enrichment is simple in shape, being terminated at the north-east and by a zone of jasperoid rock with traces of nickel-stained silica (chrysoprase) the western end is concealed under a thin sand cover. However, drilling and gravity survey results indicate that the bottom of the zone is less than 100' deep and 5200 feet long and 200 to 700 feet wide. Apart from the Claude Hills, the northeast end of the Scarface Zone is the only other deposit in the area which appears likely to have an extension under the younger cover and develop a nickeliferous ochre profile. A light aircraft was used in 1960 to determine approximately the relative heights of the various bodies. A datum of 2200 feet above sea level was assumed for the air strip (general plain level) and the altimeter readings obtained were as follows:

Strawbridge Laterite	2380 feet
Scarface Zone	2340 to 2400 feet
Claude Hills Ochre	2400 feet
Wingellina (W.A.) Ochre	2400 feet
Gosse Zone	2400 to 2450 feet

Tiezi Laterite	2540 feet
Greenwood Zone	2600 to 2630 feet
Davies Zone	2730 feet

These levels fall within a remarkably restricted range of elevation, when the pronounced topographic relief of the area is considered, e.g. Mount Davies is 3540 feet.

The recent Mines Department mapping of the Cainozoic deposits indicates that the relief of the low lying areas can be divided into a number of levels, (i) the lowest being the flat plains area containing recent alluvial material (Qrs Art) (ii) a slightly higher level (Qpk) which is kunkar covered and in places associated with polished and transported bedrock float material. This level dips under or is truncated by (i). Level (ii) is in turn generally lower than an appears to truncate the more irregular outcrop surface of the ochre and jasperoid bodies.

(d) Geological Profile

The detailed mapping and drilling done by South Western Mining shows clearly that the jasperoid material tends to overlie either serpentine or less altered ultrabasic rock.

Immediately below the jasperoid zone concentrations of magnesite are commonly developed. (see Plate II fig. 3). Unfortunately no diamond drilling has been done in the Claude Hills body to determine the complete geological profile, vertically below the ochre bodies.

Because of the occasional small remnant pockets of ochre material in the larger southern bodies such as Greenwood, it was assumed that the jasperoid material would underlie the ochre in the Claude Hills area. This was borne out (although not revealed in the South Western Mining logs) by examination under a binocular microscope of the cuttings of the Claude Hills churn drill holes which showed a marked increase in jasperoid siliceous material in the deeper sections. Under low power magnification the ochre cuttings in a number of samples show apparent relict textures characteristic of ultrabasic rock. Samples collected of ochre material from the Wingellina area were submitted for petrological examination, and clearly confirmed (see appendix II, Sample P.25/60) that the ochre is the leached and weathered equivalent of ultrabasic rock (picrite) outcropping nearby. Further samples from the Wingellina area, Claude Hills ochre and Greenwood ochre, showed frommX-ray diffracting analysis that the major constituent is goethite, (see appendix II, Report No. 497). The goethite composition was also checked by differential thermal analyses (D.T.A.) of these three samples, (see appendix II Report A.M.D.L. 46).

The D.T.A. curves are of particular interest, since they so closely match those of New Caledonian nickel laterite (personal communication, J.D. Hayton, A.M.D.Laboratories). Likewise, they are generally similar to results obtained in the U.S.A. by Fisher and Dressel (1959) from studies of Nicaro (Cuba) nickeliferous laterite ores.

The detailed chemical assays of the three samples are given in Appendix II, (AR.484/60).

Petrological examination confirms that garnierite is present occasionally in the ochre but a large proportion of the nickel is possibly absorbed in clay minerals.

(e) Geochemical Profile

The compilation by the writers of all the available assay information supplied by South Western Mining is shown on fig. 9. Results of resampling by the writers of the Claude Hills percussion drill holes are shown in figs. 2 & 10. Three of the holes intersected an ochre layer containing more than 1.5% Ni and more than 40% Fe between 60 and 95 feet below depth limits. The following table shows average values.

TABLE 1. CLAUDE HILLS, C.D. 71, 78, 73, AVERAGE Ni, Fe ASSAYS

C.D. 71			C.D. 78			C.D. 73			
Depth Ft.	Ni.%	Fe.%	Depth Ft.	Ni.%	Fe.%	Depth Ft.	Ni.%	Fe.%	Grade Range
0-35	0.45	29.7	0-40	0.63	24	0-20	0.54	19.3	1% Ni
35-85	1.23	41.6	40-60	1.26	43.2	20-70	1.17	38.6	1 to 1.5% Ni
85-95	1.63	42.3	60-83	1.79	42.8	70-83	1.65	44.0	1.5% Ni
95-101'6	1.28	32.0							1 to 1.5% Ni
101'6-150'7"	0.53	10.2	83-85'3	0.5	10.7	83-87'7	0.58	13.8	1% Ni

The sharp fall in Fe and Ni values at 83 feet depth in two of the holes and 95 feet C.D. 71 is clearly related to an old weathering profile and secondary enrichment process. Silica shows very clearly an inverse relationship with Fe and Ni (fig.2) indicating a downward leaching of silica into the jasperoid zone.

The detailed log of the hole shows an increase in silica content below 95 feet, indicating that silica contents behave similarly to magnesite. Although they actually occur over a greater vertical interval, these results show a remarkable similarity to those obtained by De Vletter, (1955), from the Ocujal lateritic nickel ore, Cuba, (fig.3) and also by the Phillipines Bureau of Mines at Surigao (fig.4).

There remains a possibility that further zones of enrichment may occur in depth, below the jasperoid zone as may be the case in D.D.H. A23 and A25 in the Greenwood and Davies Zones. This possibility would require testing by a deep diamond drill hole, which even if the results were negative would provide valuable basic information for the understanding of the enrichment process and enable closer correlations between the Claude Hills deposit and the lower grade southern deposits to be made.

(f) Interpretation of data and genesis of deposits.

The first impression gained in the area is that a lateritic origin of the nickeliferous bodies is untenable because of the absence of peneplaned areas capped by normal isolitic laterite.

The above geological and geochemical evidence however, indicates that the origin is clearly related to a weathering process akin to lateritisation.

There is another aspect of the field evidence to support this argument. At Tiezi waterhole, ferruginous and siliceous lateritic cappings rest on weathered and kaolinised gneiss. The writers have been told that in the Wingellina area pisolitic laterites occur not far distant from the ochre deposit. It should be noted also that in the north-western province of South Australia a broad arc of laterites extending across the south-eastern portion of the Alberga 4-Mile Sheet and west along the southern part of the province to the area south of the Birksgate Ranges suggesting that an old peneplaned surface may have existed not far above the present level of Mount Davies. Some water bores in the Mount Davies and Wingellina areas are also believed to have intersected well weathered bedrock below the plain areas within the ranges, suggesting that concealed remnants of a fossil laterite profile may occur in places.

The kunkar deposits on slightly elevated surfaces on the plain margins are relics (described above in Part II) of a complex pre-Recent topography. These surfaces may be of Quaternary Age. It is thought therefore that considerable erosion could have taken place since the time of Tertiary laterite formation, which is presumed to have capped a somewhat undulating topography. This Tertiary surface has been deformed by later tectonic movements along the numerous shear zones in the region.

If it is accepted that the region was originally capped by laterite the cause must still be sought for the anomalous deep weathering of the ultrabasic areas.

The cause of this selective weathering is thought to be both physical and chemical, as many of the jasperoid deposits are close to major shear zones which may have supplied channels for deeply circulating groundwater during a climatic cycle of relatively high rainfall. Some local breccia structures have been observed in the ochres.

The chemical factors remain unknown at present, but it is hoped that further petrological and geochemical study will reveal the role played by chemical processes in the break-down of the minerals constituting the ultrabasic rocks.

ECONOMICS:

(a) General

There is an increasing demand for nickel in the Western World which however is being met at present by increased production from the large Canadian deposits. The very large Cuban deposits have recently apparently passed out of the control of the U.S.A. Hannah Mining Company is mining 1 m. tons per year 1.5% Ni Laterite in Douglas Co. Oregon.

The Claude Hills and Wingellina deposits are however of importance to Australia in that they represent the only potential domestic source of this metal.

(b) Grade Required

A broad comparison can be made with the Cuban laterites which have been closely studied by U.S. Government interests, and have recently been outlined by a number of articles in the Engineering and Mining Journal, (see References, below). The Nicaro (Cuba) deposits were mined to a cut-off grade of 1.1% nickel and the average grade of mined ore was 1.37% nickel. A higher grade of at least 1.5% nickel ore would appear to be required under the more difficult and expensive Australian conditions.

(c) Ore Treatment.

The Cuban laterites have been successfully treated by a complex leaching and sintering process requiring expensive treatment plants which were provided by the U.S. Government. Abundant power, water, sulphuric acid and other chemicals are requisite for ore treatment. Hannah Mining Company in Oregon use the French Ugine smelting process with electric furnaces and silicon reductant.

An adequate source of water is at present a major obstacle to any future economic exploitation of the Central Australian deposits.

(d) Ore Reserves, Claude Hills

The three churn drill holes, C.D. 71, 73, 78 intersected grade greater than 1.5% Ni.

00' — *Clay with grit & fragments of kunkar and magnesite.*

15' — *Ochre, 5% - 20% grit, fragments chalcedony and clayey rock.*

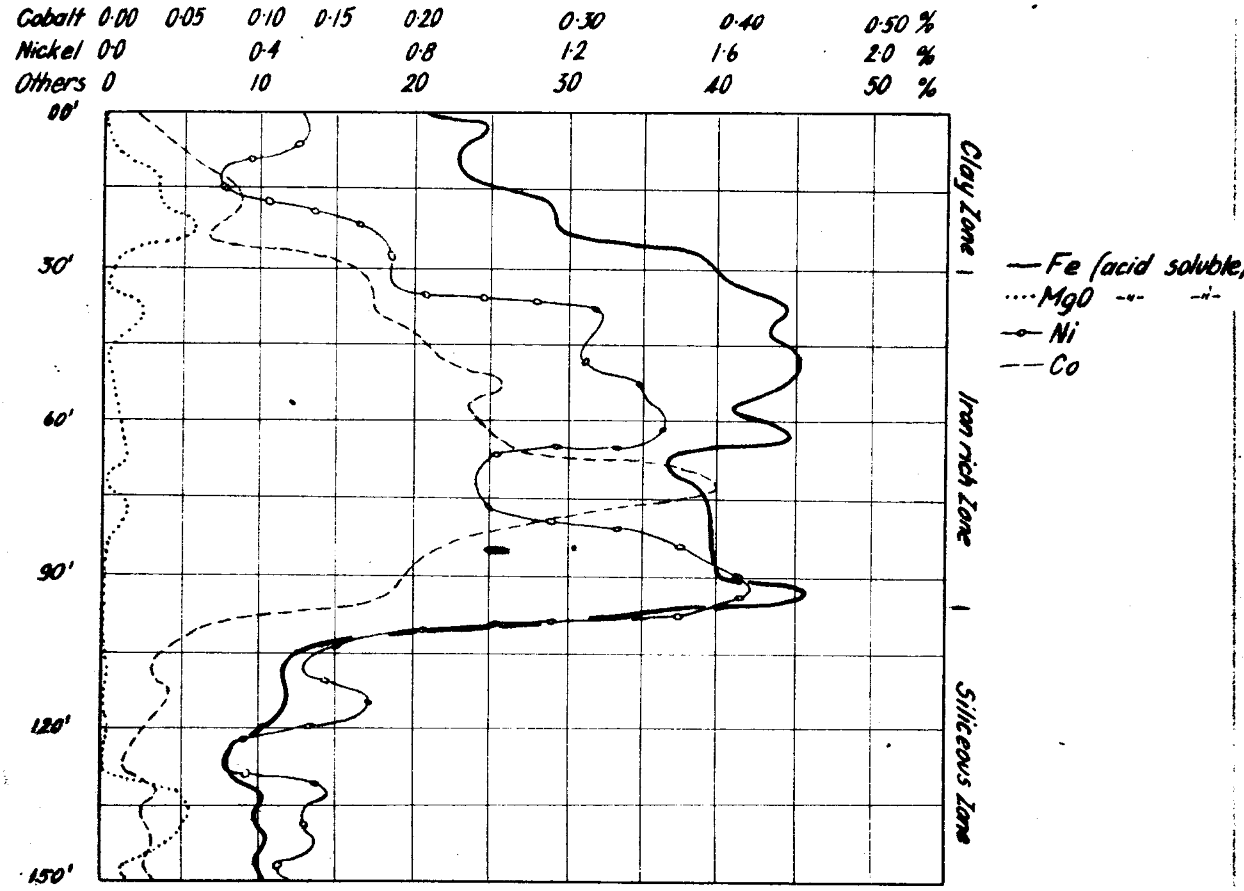
35' — *Ochre showing traces of ultrabasic texture. (Disseminated chromite ? 80'-85')*

95' — *Siliceous ochre, trace of Mn oxide & chrysoprase.*

100'6" — *Brown ochreous powder. (Crushed assay, rejects only available.)*

120' — *Limonitic jasperoid rock, veinlets of crystalline quartz 105'-105'6".*

150'6"

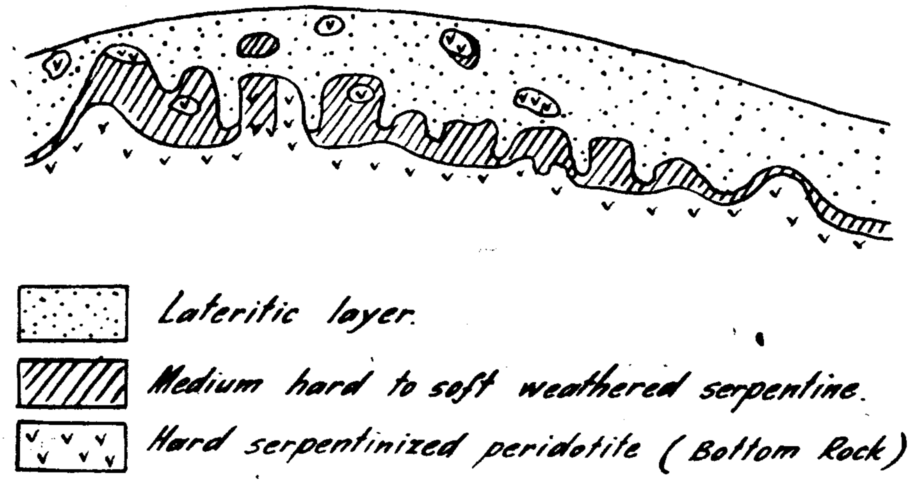


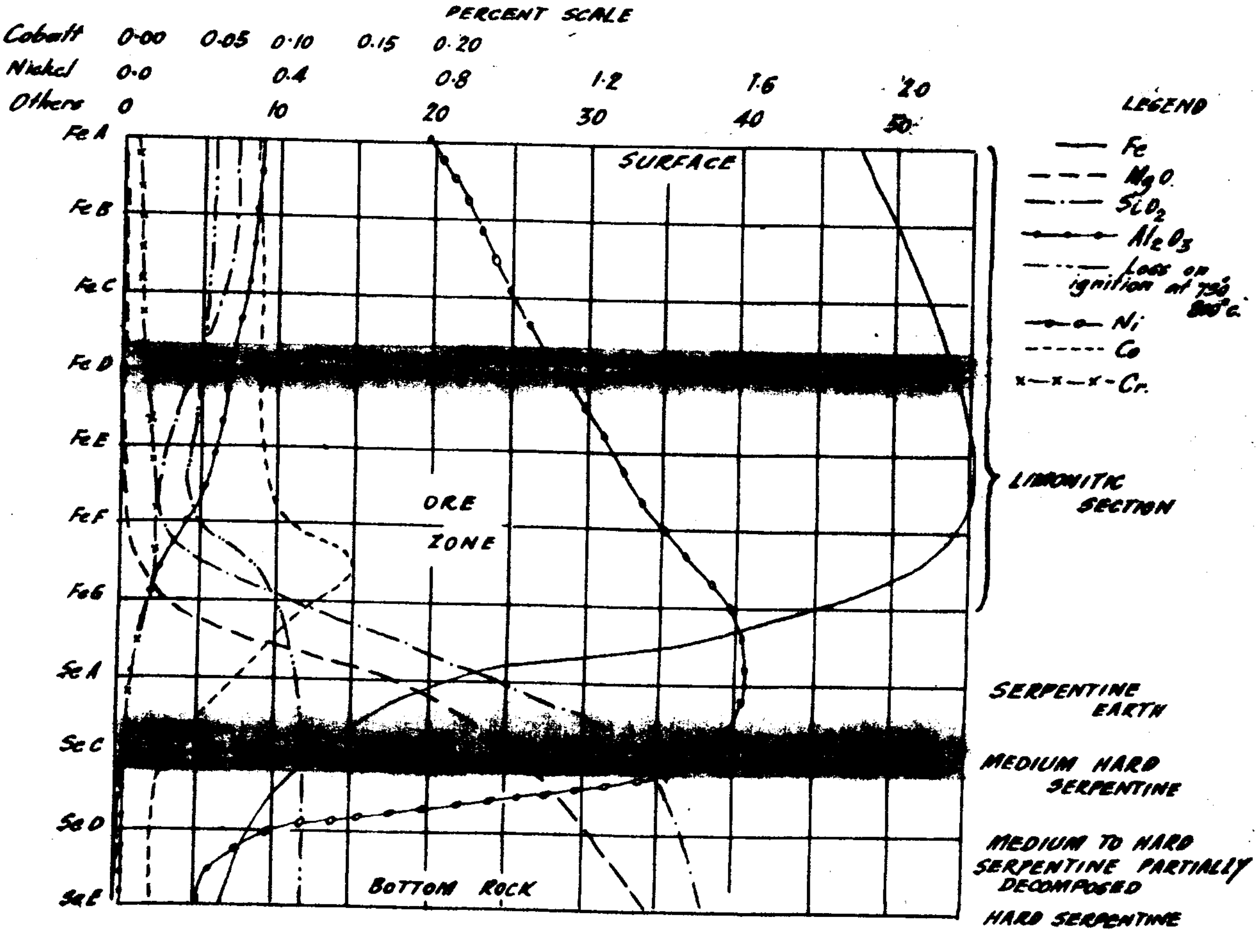
GRAPHICAL REPRESENTATION OF CLAUDE HILLS LATERITIC ORE. Based on Dept. of Mines samples & assays of C.D. 71 at 5 ft intervals.

To accompany report by B.P. Thomson & R.C. Mirams

S.A. DEPARTMENT OF MINES					CONFIDENTIAL
Approved	Passed	Drn.	CLAUDE HILLS LATERITIC NICKEL ORE	D.M.	Scale —
		Tcd. G.S.		Req.	S 2538
		Ckd.	C.D. 71 SECTION		A4
Director		Exd.			Date 20-7-60

SCHEMMATIC PROFILE THROUGH NICARO NICKEL ORES





GRAPHICAL REPRESENTATION OF OCUJAL LATERITIC NICKEL ORE, CUBA.

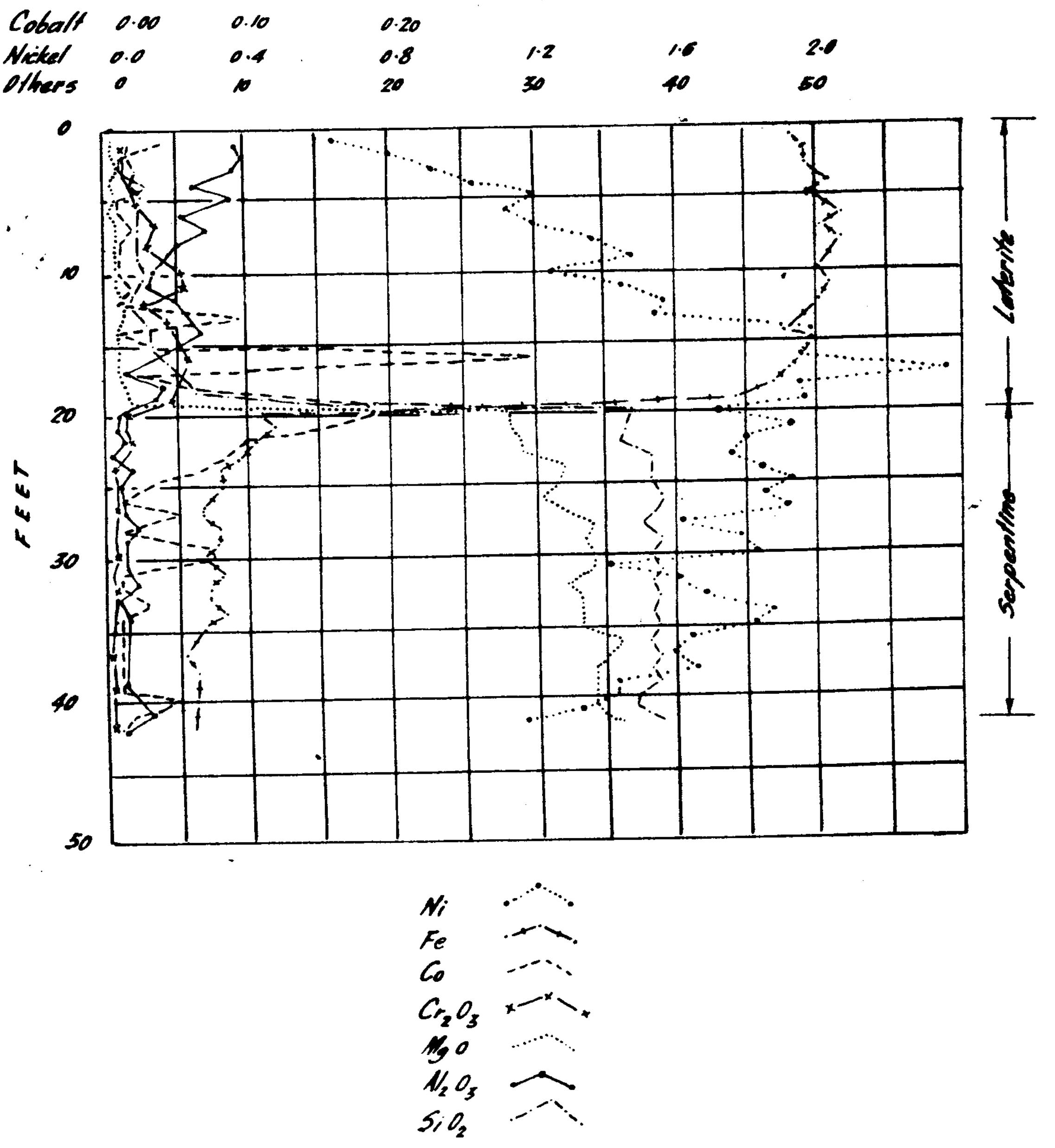
(D.R. De Vletter, 1955 Eng. & Min. Journal Oct. 1955)

fig. 3

NONOC ISLAND, MINDANAO, PHILLIPINES.

Table showing Laterite Profile & relation to S.G. & Co, Ni %

	ZONE	Av. % Co.	Av. % Ni.	% Moisture	dry Av. S.G.
1.	Dark brown laterite.	0·05	0·75	29·30	1·29
2.	Moderate to light brown " .	0·107	1·02	29·25	1·16
3	Yellow brown mottled "	0·153	1·50	46·71	0·96
4	Decomposed Serpentine.	0·043	1·70	30·40	1·20



From

Special Project Series
Publication 17, Iron-Nickel 1958
Bureau of Mines, Republic of Phillipines.

S.A. DEPARTMENT OF MINES					
Approved	Passed	Drn.	GRAPHICAL REPRESENTATION OF SURIGAO LATERITIC NICKEL ORE — MINDANAO	D.M.	Scale -
		Tcd.		Req.	S·2743
		Ckd.			931·4
Director		Exd.			Date 12·4·61

fig. 4

300—6.60 6649

The gravity survey (see appendix III for details) showed a distinct trough of low density ochre extending from at least Section 2800E to 2400W (see figs. 6 [redacted]). Surface sampling along 00 section indicated a decline in nickel values about 60 feet north of C.D. 71. This point was assumed to be on the northern boundary of the underlying zone of nickel enrichment and the zone was assumed to follow the gravity contours in more or less symmetrical fashion.

The S.G. of 1.68 with 30% moisture is equivalent to 26 cubic feet of dry ochre ore per ton. 1.5% Ni assumed cut-off grade and calculations made in grade blocks 1% Ni to 1.5 and greater than 1.5% Ni. vertically above plan ore outline.

Probable ore is located between 00 and 2800E.

Possible ore is located between 00 and 2400W.

TABLE II. ORE RESERVES

	1.5%Ni			1 to 1.5%Ni		
	Tons	%Ni	%Fe	Tons	%Ni	%Fe
Probable Ore (00 to 2800E)	1,000,000	1.73	42.5	2,600,000	1.18	39.5
Possible Ore (00 to 2400W)	400,000	1.6	42	1,300,000	1.2	40
Total	1,400,000	1.65	42	3,900,000	1.2	40

Overburden 2,500,000 tons o.57%Ni, 27%Fe

2400W to 2800E

RECOMMENDATIONS

(a) Geophysical Survey

The only geophysical survey made by South Western Mining Limited in the Claude Hills area was by a widely spaced coverage by airborne electromagnetic traverses.

The successful use of the gravity survey by the Mines Department in outlining the concealed nickeliferous ochre on the western end of the Claude Hills Zone shows the need for further traversing between Claude Hills and the West Australian border.

The recent Survey extended to line 6400W measured from datum (C.D. 71) (see fig. 6). The gravity contours and trends shown by aeromagnetic profiles suggest that the subsurface strikes may be approximately east-west in the concealed area in the vicinity of

Claude Hills and in the drift sand covered area to the west extending some 50,000 feet west to the West Australian border.

It is recommended that 25 gravity profiles 7000 feet long and spaced at 2000 feet intervals be run between Claude Hills and the West Australian border. The lines to be oriented north-south to commence at the Northern Territory-South Australian border. To test the concealed area north-west of the Scarface Zone, 10 lines 6000 feet long, spaced at 2000 feet intervals are required.

(b) Drilling

At least 5 percussion holes 100 feet deep are required to confirm the western extension of the Claude Hills ochre body between line 00 and 3200W. A vertical diamond drill hole in the vicinity of C.D. 71 is required to test the profile to unweathered bedrock which may be from 200 to even 800 feet below the surface.

BPT:PAL
17/4/61

B.P. THOMSON
SENIOR GEOLOGIST
GEOCHEMICAL SECTION

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

CONFIDENTIAL

APPENDIX I

LOGS AND ASSAYS

OF CLAUDE HILLS

CHURN DRILL HOLES 71, 73, 74, 76, 78, 80

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Geochemical Section

LOG OF PERCUSSION BORE NO. CD 71

Project: MT. DAVIES REGION	Claude Hills Zone.	D.M. 1480/59
Sec. - Hd.	Co.	Bore Serial No. -
Collar Coords C0-00	R.L. 2400' (approx.)	Grid Geosurveys
Vertical	Depth 150'6"	Plan Ref. 60-250
Date Bore Commenced	Completed	Driller Artesian Boring Co.
Bore Logged by R.C.M.	On 20/6/60	Hirer

OBJECT: Testing Claude Hills ochre deposit in depth

RESULT: Penetrated soft ochre (altered ultra basics) up to 100'
" jasper from 100'-150'6"

LOG comprises Geological Log
Assay Results
Remarks

GEOLOGICAL LOG

From	To	Description
0'	1'	Gritty brown ochreous clay, fragments of travertine magnesite, decomposed clay rock. (Texture obscure).
1'	5'	Light brown ochreous clay, 10% grit and fragments of Jasper, ochreous clay rock, minor travertine (?) and magnesite.
5' 10'	10') 15')	As 1'-5', 20% grit and larger fragments of weathered (to ochre) serpentine rock, magnesite and white chalcedony.
15' 20'	20') 25')	Brown powdery limonite (ochre), 10% fine grit, mainly jasper and fine white chalcedony.
25' 30'	30') 35')	Brown powdery limonite (ochre) less than 5% grit and fragments of weathered ochreous clay rock, (fragments too small to recognize textures) and chalcedony.
35'	40'	Brown powdery limonite (ochre) trace grit only.
40' 45' 50' 55' 60' 65' 70' 75'	45') 50') 55') 60') 65') 70') 75') 80')	Brown powdery limonite (ochre)l occasional fragments with relict textures indicating ultrabasic origin, some with ochre after olivine, also suggestions of serpentine texture.
80'	85'	Brown powdery limonite (ochre) some fragments with layered texture and large inclusions of black opaque mineral, chromite (?).
85'	90'	As 40'-80' 30% fragments, layering rare.
90'	95'	As 40'-80' 5% fragments.
95'	100'	As 40'-80' fragments now containing fine veinlets of sugary quartz.

From	To	Description
100'	100'6"	Gritty brown ochreous powder, 10-15% grit and fragments of clay rock with siliceous veinlets containing manganese and trace of nickel (apple-green staining of quartz)
100'6	105'	Brown ochreous powder, <u>crushed assay rejects only available</u>.
105'	110'	
110'	115'	
115'	120'	
120'	125'	Lighter brown gritty powder, 20% grit and fragments of brown limonite jasper, sugary texture in part.
125'	130'	
130'	135'	
135'	140'	Buff gritty powder, fragments of vitreous brown jasper with minor black opaque mineral.
140'	145'	
145'	150'	
150'	150'6"	As 135'-150' with veinlets of crystalline quartz in fragments.

END OF HOLE

ASSAY RESULTS

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)	SiO_2%
1028/60	0 - 1	0.51	0.022	20.9	0.08	37.6
1029/60	1 5	0.52	0.029	24.8	0.10	21.1
1030/60	5 - 10	0.43	0.049	22.6	0.92	15.1
1031/60	10 - 15	0.30	0.075	22.8	2.26	22.0
1032/60	15 - 20	0.42	0.086	28.0	2.28	11.7
1033/60	20 - 25	0.67	0.074	28.3	3.62	7.85
1034/60	25 - 30	0.73	0.140	38.0	1.10	7.70
1035/60	30 - 35	0.74	0.170	40.4	0.39	8.00
1036/60	35 - 40	1.26	0.170	44.8	1.37	8.33
1037/60	40 - 45	1.26	0.20	43.0	1.32	9.29
1038/60	45 - 50	1.23	0.22	45.5	1.32	9.65
1039/60	50 - 55	1.39	0.26	44.3	0.42	9.63
1040/60	55 - 60	1.45	0.23	41.5	0.55	11.1
1041/60	60 - 65	1.45	0.25	44.3	0.66	10.6
1042/60	65 - 70	1.02	0.34	36.6	0.71	16.7
1043/60	70 - 75	0.89	0.40	38.5	0.16	14.2
1044/60	75 - 80	1.02	0.31	38.8	0.79	12.3
1045/60	80 - 85	1.35	0.23	38.6	0.37	16.3
1046/60	85 - 90	1.60	0.20	38.9	0.02	8.50
1047/60	90 - 95	1.67	0.19	45.8	0.02	10.2
1048/60	95 - 100	1.33	0.11	34.6	nil	32.7

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (Acid sol)	SiO_2%
1049/60	100' - 101'6"	1.12	0.073	24.2	0.04	51.6
1050/60	101'6 - 105'	0.63	0.048	14.7	0.02	66.4
1051/60	105' - 110'	0.52	0.035	13.0	0.45	67.8
1052/60	110' - 115'	0.65	0.042	14.0	0.02	67.5
1053/60	115' - 120'	0.63	0.034	12.8	0.34	71.3
1054/60	120' - 125'	0.37	0.023	8.5	0.32	80.6
1055/60	125' - 130'	0.31	0.012	6.9	0.24	81.8
1056/60	150' - 135'	0.57	0.030	10.7	2.81	68.4
1057/60	135' - 140'	0.50	0.025	9.4	3.18	72.1
1058/60	140' - 145'	0.54	0.028	10.7	2.47	69.6
1059/60	145' - 150'	0.44	0.023	9.8	0.97	75.1
1060/60	150' - 150'7"	0.48	0.028	10.7	1.21	73.0

AVERAGES

0 - 35	0.54	29.7
35 - 85	1.23	41.6
85 - 95	1.63	42.3
95 - 101'6"	1.28	32.0
101.6" -150'7"	0.53	10.2

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD 73

Project MT. DAVIES REGION	Claude Hills Zone		D.M. 1480/59
Sec.	Hd.	Co.	Bore Ser. No.
Collar Coords 00'N 1500'E	R.L.		Grid Geosurveys
Vertical	Depth 87'7"		Plan Ref. 60-250
Date Bore Commenced	Completed		Driller Artesian Boring Co.
Bore Logged by R.C.M.	On 21/6/60		Hirer

OBJECT: To test in depth ochre outcropping at the above coordinates.

RESULT: Penetrated soft ochre (altered ultra-basics) to 85' then jasper from 85' to 87'7".

LOG comprises: Geological Log
Assay Results
Remarks

GEOLOGICAL LOG

From	To	Description
0' 1'	1' 5'	Brown ochreous powder. Crushed rejects from assay samples only available.
5'	70'	As 0-5' samples every 5 feet.
70'	75'	Brown powdery limonite (ochre) grit and fragments of ochreous clay rock showing relict ultra basic (?) textures and containing specks of black opaque mineral (chromite?).
75' 80' 83'	80' 83' 85'	As 0-70'.
85'	87'7"	Gritty ochreous powder. Crushed rejects from assay sample only but containing hard grit.

END OF HOLE

ASSAY RESULTS

Sample No.	Footage			Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)	SiO_2%
A.1061/60	0'	-	1'	0.31	0.044	15.0	1.55	
1062/60	1	-	5	0.51	0.040	19.7	1.37	
1063/60	5	-	10	0.47	0.053	16.7	1.29	
1064/60	10	-	15	0.62	0.060	21.3	1.53	
1065/60	15	-	20	0.78	0.051	20.6	2.03	
1066/60	20	-	25	1.00	0.082	26.4	3.39	
1067/60	25	-	30	1.14	0.086	33.6	3.50	
1068/60	30	-	35	1.04	0.087	29.6	3.76	
1069/60	35	-	40	1.08	0.09	37.7	1.53	
1070/60	40	-	45	1.30	0.11	43.0	1.00	
1071/60	45	-	50	1.21	0.11	43.0	1.10	
1072/60	50	-	55	1.37	0.11	44.0	0.79	
1073/60	55	-	60	1.33	0.15	42.2	0.68	
1074/60	60	-	65	1.01	0.13	43.6	0.60	
1075/60	65	-	70	1.17	0.14	43.1	0.81	
1076/60	70	-	75	1.57	0.13	44.4	0.45	
1077/60	75	-	80	1.77	0.13	43.9	0.45	
1078/60	80	-	83	1.63	0.13	43.7	0.45	
1079/60	83	-	85	0.55	0.038	13.5	0.63	
1080/60	85	-	87'7"	0.60	0.039	14.1	0.45	

AVERAGES

0	-	20'	0.54	19.3
20'	-	70'	1.17	38.6
70'	-	83'	1.65	44.0
83'	-	87'7	0.58	13.8

LOG COMPLETED

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD. 74

Project MT. DAVIES REGION	Claude Hills Zone		D.M. 1480/59
Sec. HD.	Co.		Bore Hole Ser.No.PB
Collar Coords: S0000, W1600	R.L. 2400' (approx.)		Grid. Geosurveys
Vertical	Depth 55 ft.		Plan Ref. 60-250
Date Bore commenced	Completed		Driller Artesian Boring Co.
Bore Logged by J.E.J.	On. 11/8/1960		Hirer

OBJECT: Testing Claude Hills ochre deposit in depth

RESILT: Penetrated altered pyroxenite from surface to 40 ft.
" nickeliferous ochre from 40 ft. to 45 ft.
" serpentine from 45 ft. to 47 ft.
" pyroxenite from 47 ft. to 55 ft.

LOG comprises: Geologic Log
Assay Results
Remarks.

GEOLOGICAL LOG

From	To	Description
0	2'	Wind blown red sand with sub-angular grains, 90% quartz and 10% magnetite.
2'	5'	Greyish-fawn coloured gritty powder from drill sludge. Contains about 50% of unctuous clay minerals and 15% magnesite chips, with about 10% of contaminating quartz and magnetite sand.
5'	10'	Sample as above, but with considerable decrease in clay minerals and increase in magnesite.
10'	15'	Olive green to drab grey gritty powder from drill sludge. Contains small amount of unctuous clay minerals, about 30% magnesite chips, 30% fragments of tough caponite stained green by hydrated ferrous silicates, rare crystal fragments of enstatite and 10% of contaminating quartz and magnetite sand.
15'	20'	Drab olive-grey powder from drill sludge, very gritty and containing about 50% of crystalline fragments of enstatite, 20% magnesite, 10% fragments of green saponite and 5% contaminating quartz sand.
20'	25'	As above
25'	30'	Sample as above
30'	35'	" " "
35'	40'	Sample as above, but coloured drab grey-brown. Contaminating sand is not present and magnesite content has dropped to 5%. Rare plagioclase and chromite grains observed.
40'	45'	Chocolate brown ochre with fine granular texture and few clots of soft, dark green serpentine. Contains about 1% chromite grains and 5% magnesite fragments.

From	To	Description
45'	47'	Light green, soft serpentine with granular texture and about 10% of clots of chocolate brown ochre, 10% of fragments of magnesite and about 1% of chromite grains.
47'	50'	Drab, pale grey-brown gritty powder from drill sludge. Contains about 50% of crystalline fragments of green enstatite, 10% magnesite fragments, 5% clost of chocolate brown ochre, 5% of light green saponite, and rare chips of plagioclase.
50'	55'	Sample as above.

END OF HOLE

ASSAY RESULTS

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)
A1092/60	0 - 2	0.02	*0.01	5.8	0.74
1093/60	2 - 5	0.10	*0.01	2.8	2.0
1094/60	5 - 10	0.09	0.01	2.6	7.8
1095/60	10 - 15	0.31	0.02	6.3	6.3
1096/60	15 - 20	0.14	*0.01	3.7	3.9
1097/60	20 - 25	0.26	0.02	8.9	6.1
1098/60	25 - 30	0.25	0.03	11.0	9.1
1099/60	30 - 35	0.24	0.03	13.2	9.5
1100/60	35 - 40	0.38	0.030	12.4	5.2
1101/60	40 - 45	0.51	0.045	17.6	3.6
1102/60	45 - 47	0.42	0.030	11.2	3.8
1103/60	47 - 50	0.20	0.015	4.9	2.7
1104/60	50 - 55	0.05	*0.010	2.2	1.6

* = less than

AVERAGES

0 - 25'	0.17	5.5
25 - 47'	0.37	13.4
47 - 55'	0.11	3.2

LOG COMPLETED

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD. 76

Project MT. DAVIES REGION	Claude Hills Zone	D.M. 1480/59
Sec. Hd.	Co.	Bore Ser.No. PB. -
Collar Coords S0800 E.0000	R.L. 2400' (approx)	Grid. Geosurveys
Vertical	Depth 55'5"	Plan Ref. 60-250
Date Bore Commenced	Completed	Driller Artesian Boring Co.
Bore Logged by J.E.J.	On 10/8/60	Hirer

OBJECT: Testing Claude Hills ochre deposit in depth.

RESULT: Penetrated leached soil horizon to 45 ft.
" altered serpentine from 45 ft. to 55.5 ft.

LOG comprises Geolcgic Log
Assay results
Remarks

GEOLOGICAL LOG

From	To	Description
0'	3'	Sample consists of fawn coloured, gritty, siliceous powder containing few small lumps of soft, brick red sandstone, which is composed of angular to rounded grains of quartz, and magnetite, cemented by hematite and clay. Sample appears to be a drill sludge from a leached and recemented residual soil.
3'	5'	Sample as above.
5'	10'	Sample as above, but containing few fragments of chalcedony and granules of magnesite.
10'	15'	Pale fawn coloured gritty powder from drill sludge with soft lumps. Contains abundant rounded grains of magnesite and about 20% of angular chips of clear silica and white chalcedony, with about 5% of angular magnetite grains.
15'	20'	Sample as above.
20'	25'	Pale pinkish gritty powder from drill sludge, with about 40% as angular chips of jasper and clear silica and about 10% of chips and grains of magnesite, and 10% as fragments of soft white saponite.
25'	30'	Sample as above, but one crystal fragment of grass green enstatite observed.
30'	35'	Sample as above, but enstatite not observed, and magnesite rare, while saponite fragments from 20% of whole.
35'	40'	Sample as above.
40'	45'	Sample as above.
45'	50'	Grey-brown, slightly gritty, clay powder from drill sludge. Contains abundant fragments of varicoloured saponite, which is an almost completely altered serpentine. Saponite fragments are mottled red, white and brown, and contain blebs of bright yellow ochre, minute veinlets of opaline silica, scales of talc, and rarely grains of chromite and of olive green serpentine.

From	To	Description
50'	52'	Sample as above, but saponite is dominantly brownish in colour, and shows granular textures inherited from serpentine.
52'	55'	Grey-brown gritty powder from drill sludge, containing abundant angular chippings of clear silica, and about 3% of chromite grains. Clay minerals seem rare.
55'	55'5"	Sample as above.

END OF BORE

ASSAY RESULTS

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)
1105/60	0 - 3	0.02	*0.01	5.4	0.75
1106/60	3 - 5	0.02	*0.01	5.8	0.55
1107/60	5 - 10	0.02	*0.01	5.4	0.95
1108/60	10 - 15	0.01	*0.01	4.9	1.0
1109/60	15 - 20	0.01	*0.01	3.3	2.1
1110/60	20 - 25	0.01	*0.01	3.5	2.0
1111/60	25 - 30	0.02	*0.01	2.7	1.5
1112/60	30 - 35	*0.01	*0.01	3.7	1.2
1113/60	35 - 40	0.01	*0.01	6.9	1.6
1114/60	40 - 45	0.01	*0.01	9.2	1.0
1115/60	45 - 50	0.01	*0.01	8.0	0.76
1116/60	50 - 52	0.01	*0.01	11.5	0.45
1117/60	52 - 55	0.01	*0.01	6.9	0.55
1118/60	55 - 55'5"	0.02	0.01	6.9	0.45

* = less than

AVERAGES

0 - 55'5" 0.01 5.6

LOG COMPLETED

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD. 78

Project MT. DAVIES REGION.		Claude Hills Zone	D.M. 1480/59
Sec.	Hd.	Co.	Bore Ser. No.PB
Collar Coords S0000, E0800		R.L. 2400' (approx.)	Grid Geosurveys
Vertical		Depth 85.25 ft.	Plan Ref. 60-250
Date Bore commenced		Completed	Driller Artesian Boring Co.
Bore Logged by J.E.J.		On 10/8/60	Hirer

OBJECT: Testing of Claude Hills Ochre deposit in depth

RESULT: Penetrated jasper from surface to 48.5 ft.
" nickel bearing ochre from 48.5 ft. to 83 ft.
" jasper from 83 ft. to 85.25 ft.

LOG comprises: Geologic log
Assay result
Remarks

From	To	Description
0'	1'	Buff loamy soil with few quartz sand grains and occasional fragments of yellow limonite ochre, which contains granules and streaks of calcite? and of hard, blackish brown limonite.
1	5'	Bright yellow, gritty powder from drill sludge. Contains about 30% angular chips of jasper and chalcedony, rare grains of magnesite and 5-10% grains of quartz sand.
5'	10'	Sample as above.
10'	15'	" " "
15'	20'	Chocolate brown gritty powder from drill sludge with about 50% angular chips of jasper and chalcedony, from 5 to 10% grains of quartz sand, and about 10% fragments of bright yellow, structureless ochre.
20'	25'	Sample as above.
25'	30'	" " "
30'	35'	" " "
35'	40'	Sample as above, but quartz sand grains rare.
40'	45'	Sample as above.
45'	48.5"	" " "
48'5"	50'	Soft, bright yellow ochre with fine granular texture and vague banding, and showing marked microscopic laminar texture within individual grains. Contains about 10% angular granules of sooty wad and rare specks of white saponite. Texture has been inherited from an ultra basic rock rich in orthopyroxenes.
50'	55'	Sample as above.
55'	60'	" " "

From	To	Description
60'	65'	Sample as above.
65'	70'	" " "
70'	75'	" " "
75'	80'	Sample as above, but ochre contains network of minute veinlets of white saponite, as well as occasional fragments of jasper.
80'	83'	Sample as above.
83'	85'3"	Yellow brown gritty powder from drill sludge, consisting almost entirely of coarse and fine chips of jasper, with about 10% of colloidal yellow ochres.

END OF HOLE

ASSAY RESULTS

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)
A1119/60	0 - 1	0.10	*0.01	7.4	0.39
1120/60	1 - 5	0.58	0.03	20.6	4.50
1121/60	5 - 10	0.63	0.05	25.4	3.95
1122/60	10 - 15	0.55	0.12	22.8	1.37
1123/60	15 - 20	0.50	0.10	17.1	2.00
1124/60	20 - 25	0.56	0.11	19.1	3.52
1125/60	25 - 30	0.72	0.13	28.4	3.97
1126/60	30 - 35	0.75	0.16	28.7	5.42
1127/60	35 - 40	0.80	0.22	32.9	3.66
1128/60	40 - 45	1.32	0.15	40.3	1.84
1129/60	45 - 48'5"	1.31	0.12	40.0	2.16
1130/60	48'5" 50	1.30	0.16	45.1	0.53
1131/60	50 - 55	1.04	0.17	45.7	0.45
1132/60	55 - 60	1.4	0.17	47.2	0.37
1133/60	60 - 65	1.7	0.16	48.3	0.37
1134/60	65 - 70	1.7	0.14	43.2	0.37
1135/60	70 - 75	1.9	0.13	44.0	0.29
1136/60	75 - 80	2.0	0.11	43.5	0.34
1137/60	80 - 83	1.5	0.07	28.4	0.34
1138/60	83 - 85'3"	0.52	0.03	10.7	

AVERAGES

0'	-	15'	0.58	22.[illegible]
15'	-	40'	0.66	25.2
40'	-	60'	1.26	43.2
60'	-	83'	1.79	42.8
83'	-	85'3"	0.52	10.7

Department of Mines, South Australia

Geochemical Section

LOG OF PERCUSSION BORE NO. CD. 80

Project:	MT. DAVIES REGION	Claude Hills Zone	D.M. 1480/59
Sec.	Hd.	Co.	Bore Ser.No. PB
Collar Coords	S0000, W0800	R.L.	Grid. Geosurveys
Vertical		Depth 41.25 ft.	Plan Ref. 60-250
Date Bore Commenced		Completed	Driller Artesian Boring Co.
Bore Logged by	J.E.J.	On 11/8/60	Hirer

OBJECT: Testing Claude Hills ochre deposit in depth.

RESULT: Penetrated brown ochre from surface to 35 ft.
" jasper from 35 ft. to 41.25 ft.

LOG comprises Geologic Log
Assay Results
Remarks

From	To	Description
0'	2'	Sample consists in part of red, wind blown quartz and magnetic sand, and in part of pulverized assay rejects.
2'	5'	Dark brown, gritty powder from drill sludge. Contains about 50% of red, wind blown sand, the remainder being colloidal brown ochre with small lumps of yellow brown ochre, about 10% of sample, which shows white saponite specks, fine talcose scales, and a mesh texture inherited from a serpentine.
5'	10'	Sample as above, but with quartz sand reduced to 5%, ochre much reduced and grains of white, red and purple saponite forming about 40% of sample.
10'	15'	Sample as above
15'	20'	" " "
20'	25'	Chocolate brown, very gritty powder from drill sludge. Contains about 30% chips of jasper and chalcedony, 10% magnesite, 5% varicoloured saponite and 5% as lumps of hard, yellow ochre, plus a good deal of colloidal ochre.
25'	30'	Sample as above.
30'	35'	" " "
35'	40'	" " " but with jasper chips forming 60% of sample, and colloidal ochre much reduced.
40'	41.25	Sample as above.

END OF HOLE

ASSAY RESULTS

Sample No.	Footage	Ni%	Co%	Fe% (acid sol)	Mg% (acid sol)
A1139/60	0 - 2	0.03	*0.01	4.0	0.18
1140/60	2 - 5	0.05	0.01	8.7	0.66
1141/60	5 - 10	0.10	0.02	14.3	2.5
1142/60	10 - 15	0.12	0.03	18.3	2.2
1143/60	15 - 20	0.12	0.02	18.4	2.0
1144/60	20 - 25	0.23	0.08	10.2	3.3
1145/60	25 - 30	0.54	0.13	25.6	4.8
1146/60	30 - 35	0.51	0.18	15.1	3.5
1147/60	35 - 40	0.37	0.13	9.7	1.7
1148/60	40 - 41'5	0.39	0.13	10.3	0.71

* = less than

AVERAGES

0 - 25'	0.12	13.6
25 - 41'4"	0.47	16.4

LOG COMPLETED

CONFIDENTIAL

APPENDIX II

LABORATORY REPORTS, MINERALOGY & PETROLOGY

SECTION OF AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

APPENDIX II

LABORATORY REPORTS, MINERALOGY & PETROLOGY

SECTION OF AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

1. Petrological Report No. M.R. 497 (A.M.D.L.)
   by H.W. Fander, dated 22nd June, 1960.

2. Report No. 497, (A.M.D.L.)
   X-ray Spectrograph and X-ray Diffraction
   analysis of 3 ochre samples.
   by A.E. Tynan, dated 22rd June, 1960.

3. Differential Thermal Analysis, Nickel Ore,
   Mt. Davies. Confidential Report (A.M.D.L. 46).
   Project 1/1/16.
   by M.J. O'Connor, dated July 1960.

4. Assays of the three ochres examined in reports
   6, 7, and 9.

22nd June, 1960.

MINERALOGY & PETROLOGY SECTION

REPORT NO. M.R. 497

MATERIAL: Ochres

SUBMITTED BY: B.P. Thomson, Mines Department

DATE RECEIVED: 27th April, 1960

MARKS OR NOS.: P 381 - 383/60

SOURCE OR LOCALITY: Mt. Davies Area, Claude Hills, and Wingellina (W.A.)

INFORMATION REQUIRED: Mineralogical, petrographic

METHOD OF EXAMINATION: Thin Sections etc.

RESULTS OF EXAMINATION:-

P 381 - 383/60. T.S. 6423 - 25

All the rocks consist of networks and colloform bands of limonite, with some opaque, black material also present as small veinlets. In P 382/60, many cavities and interstices are filled with clear dolomite. In most specimens, some indication of relict minerals is seen; P 381/60 in particular, shows limonite pseudomorphs after olivine and pyroxene, and is similar to P25/60 and its unweathered equivalent, P26/60. A separate X-ray report is enclosed.

H.W. FANDER
MINERALOGIST

22nd June, 1960

MINERALOGY AND PETROLOGY SECTION

REPORT NO. 497

(Project No. 1/3/60)

MATERIAL:	Three Ochres.
SUBMITTED BY:	B. Thomson (S.A. Mines Dept. Geochemical Section)
DATE RECEIVED:	27/4/60
MARKS OR NOS. & LOCALITY:	P381/60 Wingellina Ochre, Picrite Hill P382/60 Mt. Davies Area, Claude Hills Ochre P383/60 Mt. Davies Area, Greenwood Ochre.
INFORMATION REQUIRED:	Mineral composition by X-ray analysis
METHOD OF EXAMINATION:	X-ray diffraction and X-ray spectrograph

RESULTS OF EXAMINATION:

The above samples were all examined by X-ray diffraction techniques using filtered iron radiation to determine the mineral composition of each. X-ray spectrographic analyses were also made to determine elements heavier than scandium (A.N. 21).

P381/60

The major constituent is goethite (Fe_2O_3) together with a small amount of calcite. In addition the diffractograph contained a few broad peaks of low intensity. These are probably due to small amounts of chlorite and mica.

From the spectrograph the following elements were present:-

Major	:	Fe
Heavy Trace	:	Cr, Ni
Faint Trace	:	Zn, Mn

P382/60

Major minerals present are goethite with less amounts of calcite and dolomite. Quartz occurs in trace amounts.

Elements present:-

Major	:	Fe
Minor	:	Mn
Heavy Trace	:	Ni, Cr
Faint Trace	:	Zn, Co, Cu

P383/60

Goethite is again the major constituent together with a probably minor amount of hydrohematite.

Elements present:-

Major	:	Fe
Heavy Trace	:	Cr, Ni
Trace	:	Mn
Faint Trace	:	Zn, Co, Cu.

A.E. TYNAN
MINERALOGIST

C O N F I D E N T I A L

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

AMDL 46

PROJECT 1/1/16

SOUTH AUSTRALIAN GOVERNMENT

DEPARTMENT OF MINES

NICKEL ORE, MOUNT DAVIES

DIFFERENTIAL THERMAL ANALYSIS

by

M. J. O'CONNOR

This report describes work undertaken at the request of the S.A. Department of Mines. The experimental work was carried out under the general supervision of J.D. Hayton, Chief Research Chemist.

Issued by: L. Wallace Coffer.
Director.

Investigation commenced: June 1960
Investigation completed: June 1960

Report issued: July 1960

Summary.

Three samples of nickel ore from Mount Davies were submitted by the South Australian Department of Mines for differential thermal analysis.

Each sample gave a differential trace corresponding to goethite.

One of the samples contained some form of limestone as shown by the endothermic peak (at 885°C) characteristic of the reaction $CaCO_3 = CaO + CO_2$. Another of the samples probably contained magnesite since a small endothermic peak appeared at 753°C on the differential trace.

Material Examined

Three samples designated A462/60, A463/60, and A464/60 were received. The samples had previously been ground to approximately minus 100 mesh for chemical analysis.

Experimental Procedure and Results

A steatite cell, contained in a stainless-steel block with close-fitting lid was used as the sample container. Platinum-platinum + 10 per cent rhodium thermocouples were used with the temperature recording couple in the sample. Calcined alumina was used as the inert reference material. A heating rate of 400°C per hour was maintained. Chart speed on both recorders was 16 centimetres per hour.

The weight of sample used and the differential trace obtained are shown in Fig. 1. The difference in temperature between the sample and the inert material (T), is plotted against temperature. A peak on the negative side of the zero or base-line represents an endothermic reaction.

Discussion

(1) Sample A462/60

There are three endothermic peaks - at 135°C, 340°C and 753°C. These peaks correspond to evolution of absorbed water, loss of water of crystallization from goethite, and loss of carbon dioxide from magnesite respectively.

(11) Sample A463/60

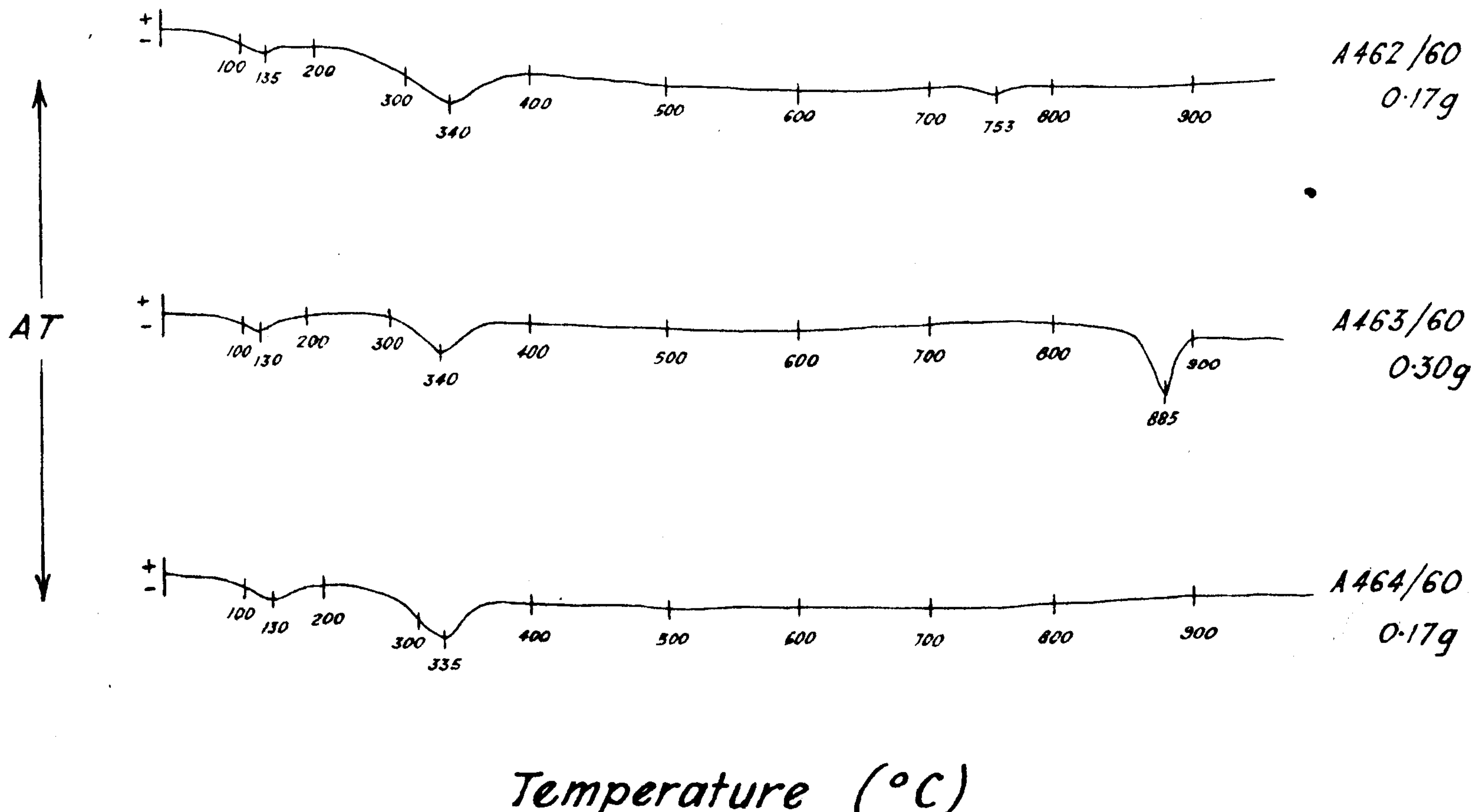
Three endothermic peaks at 135°C, 340°C and 885°C corresponding to loss of absorbed water, loss of water of crystallization from goethite and the evolution of carbon dioxide from limestone respectively.

(111) Sample A464/60

The first part of the curve is similar to that of the other two samples. The endothermic peaks at 135°C and 335°C represent loss of absorbed water and loss of water of crystallization from goethite respectively.

FIGURE 1

DIFFERENTIAL TRACES



S2540 M

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

6th May, 1960

AR484/60

1/3/0

Director of Mines,
Rundle Street,
ADELAIDE.

Samples marked as under, yielded on analysis:-

Mark	Nickel (Ni)	Cobalt (Co)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)
A462/60	0.62%	0.11%	38.6%	4.75%	0.65%
A463/60	0.52	0.14	25.7	14.0	2.35
A464/60	0.84	0.04	46.4	6.65	0.95

Type of Material:- Rock

Locality:- B. Thomson, Geochemical Section, Dept. of Mines

A462/60 (portion of sample P381/60) Wingellina Ochre
Picrite Hill W.A.

A463/60 (" " " P382/60) Claude Hills Ochre.

A464/60 (" " " P383/60) Greenwood Ochre.

T.F. Frost
CHIEF ANALYST

APPENDIX III

GRAVITY INVESTIGATIONS IN THE MOUNT DAVIES REGION OF SOUTH AUSTRALIA

(Extracts As from Geophysical Report GS. 1952)

by

D.M. Pegum

METHODS USED AND RESULTS:

Gravity surveys were made over both Scarface Zone and the Claude Hills area, to find out if the gravity method is useful in tracing possible extensions of these bodies under younger cover.

The following approximate average densities were determined for the rocks of the region.

Pyroxenite	3.2
Norite	3.0
Siliceous laterite	2.7
Ferruginous laterite	1.7

Scarface Zone:

A traverse was run over Scarface Zone with stations located every 100 feet by chaining and levelled by observation of the vertical angle. The bearing of the traverse was obtained from an uncontrolled photomosaic of the area. The Bouguer gravity anomaly was computed for each station to an arbitrary datum, using an elevation correction of 0.060 milligals per foot corresponding to a density of 2.7 as almost all of the relief on the traverse line was caused by hills of siliceous laterite. No topographic correction was applied as it was considered it would be negligible.

The survey indicated a strong regional gradient positive to the southward of over 10 milligals per mile and superimposed on this a small negative residual anomaly of less than one milligal over the outcrop of siliceous laterite.

It is considered that the regional anomaly is caused by the dense rocks of the Giles Complex which in this area are thickening very rapidly to the south. It is considered that the residual anomaly of less than one milligal is too small to trace the silicified laterite in this area with strong regional gradient. The laterite is overlain by unknown thicknesses of light overburden and underlain by basic and ultrabasic rocks of varying densities. The density contrast between the laterite and basic rocks (0.5) is too small for the successful use of gravity surveys on this problem.

Claude Hills Zone:

A similar traverse was run over the claude hills body but as in this area almost all the topographic relief is caused by hills of ultrabasic rock an elevation correction of 0.053 milligals per foot was used corresponding to a density of 3.2

A broad positive anomaly corresponds to the area underlain by basic and ultrabasic rocks and superimposed on this a negative anomaly of over 2 milligals over the outcrop of the ferruginous laterite. A grid of gravity stations was established using the old baseline established by South Western Mining Ltd. Stations were located by chaining at 100 feet intervals on traverse lines 800 feet apart and levelled by observation of the vertical angle. The bearing of the baseline was determined by solar observation. The Bouguer gravity anomaly was computed to an arbitrary datum for each station. No topographic corrections were applied as they were considered negligible.

The gravity stations and values were plotted on a geological map of the area and contours of the Bouguer gravity anomaly were drawn.

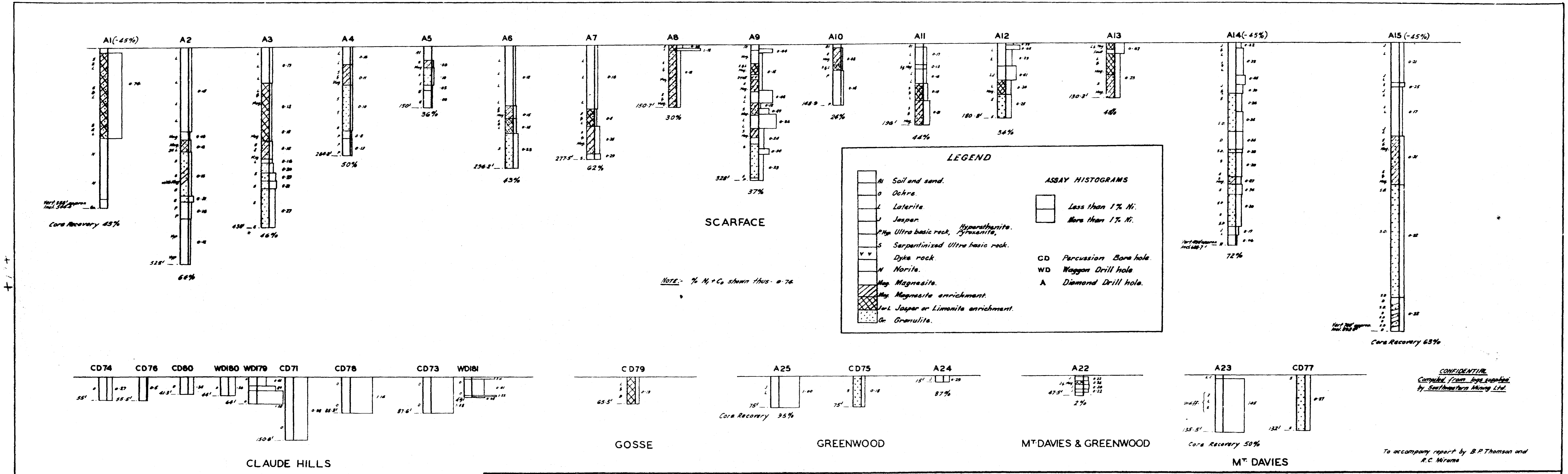
The survey indicated the ultrabasic rock outcrops of Claude Hills to be located on a regional gravity high as is to be expected because of the high density of the ultrabasic rocks. Superimposed on this broad gravity high is a gravity low which coincides with the area underlain by ferruginous laterite. The negative anomaly covers an area 6,000 feet by 1,000 feet which would appear to be the area underlain by ferruginous laterite. This result is to be expected from the low density of the ferruginous laterite overlying basic and ultrabasic rocks of high density. The survey also indicates by the steep gravity gradient that the margin of the Giles complex to the south of Claude Hills is within 2,000 feet of the baseline.

CONCLUSIONS AND RECOMMENDATIONS

The work done has indicated that geophysical gravity surveys can be of great use in determining the extent of deposits of ferruginous laterite but could only be used under exceptionally favourable conditions to trace deposits of siliceous laterite. The gravity method would also appear to be of considerable use in tracing the basic and ultrabasic rocks of the Giles complex under more recent cover.

The survey has apparently dilineated the extent of the Claude Hills body and should be of considerable value in any project to test the body by drilling.

If it is considered from further geological work that there are any areas with any likelihood of ferruginous laterite deposits concealed by younger cover a gravity survey should normally be successful in locating any such body. Gravity surveys should also be useful to determine if any area is underlain by rocks of the Giles complex.



S.A. DEPT. OF MINES

MT. DAVIES REGION
DRILL HOLE SECTIONS

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

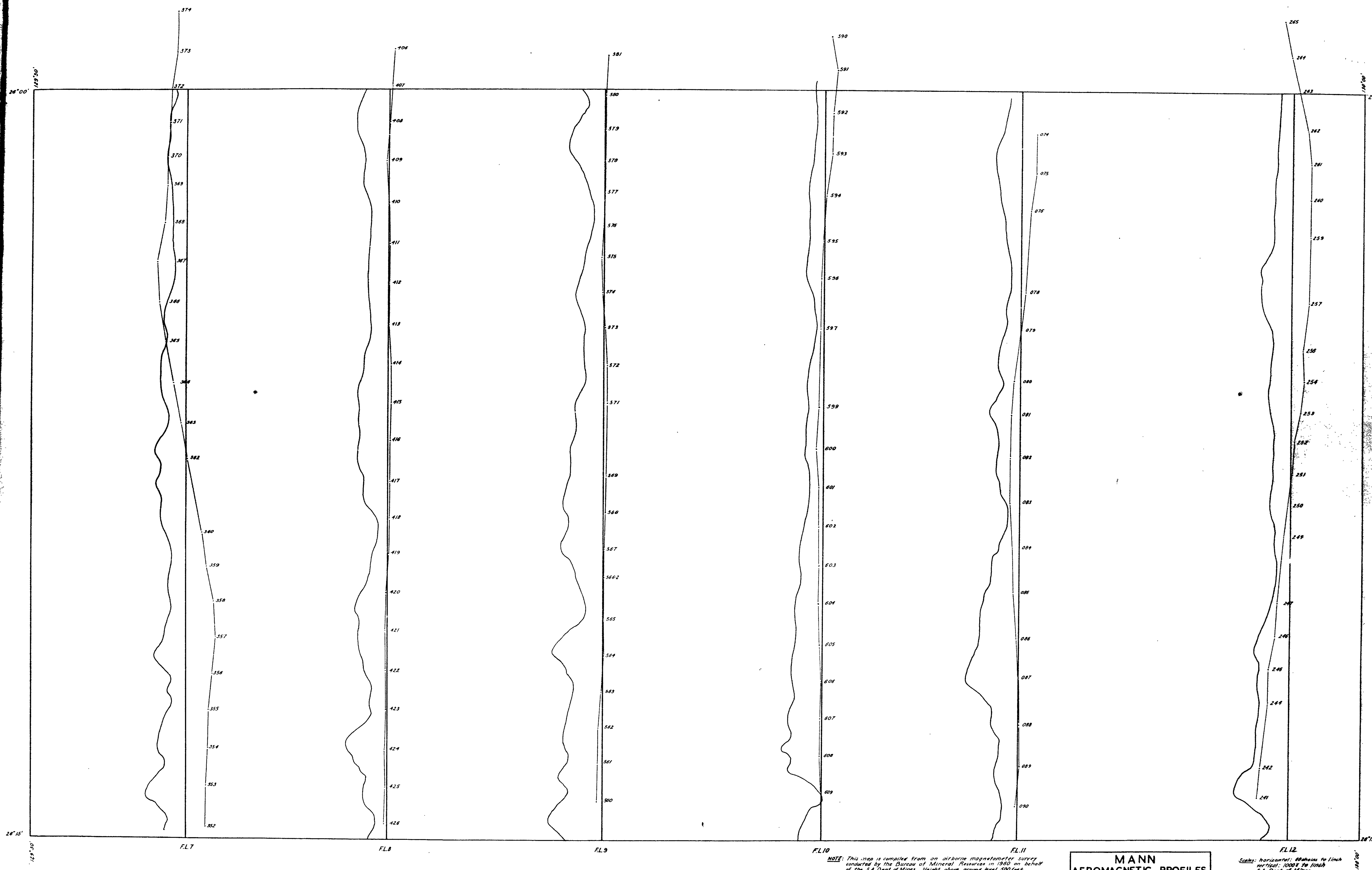
Approved	Passed	
		Drn.
		Tcd. R.O.W.
		Ckd. R.R.
Director of Mines		Exd.

Scale: 100' TO 1"

60-248

Rd.

Date 5-5-60



NOTE: This map is compiled from an airborne magnetometer survey conducted by the Bureau of Mineral Resources in 1960 on behalf of the S.A. Dept of Mines. Height above ground level 500 feet. Results reduced by Geophysical Section, Dept of Mines.

MANN
AEROMAGNETIC PROFILES OF TOTAL INTENSITY

Scales: horizontal: 80 chains to 1 inch
vertical: 1000γ to 1 inch
S.A. Dept of Mines.

L 61-81

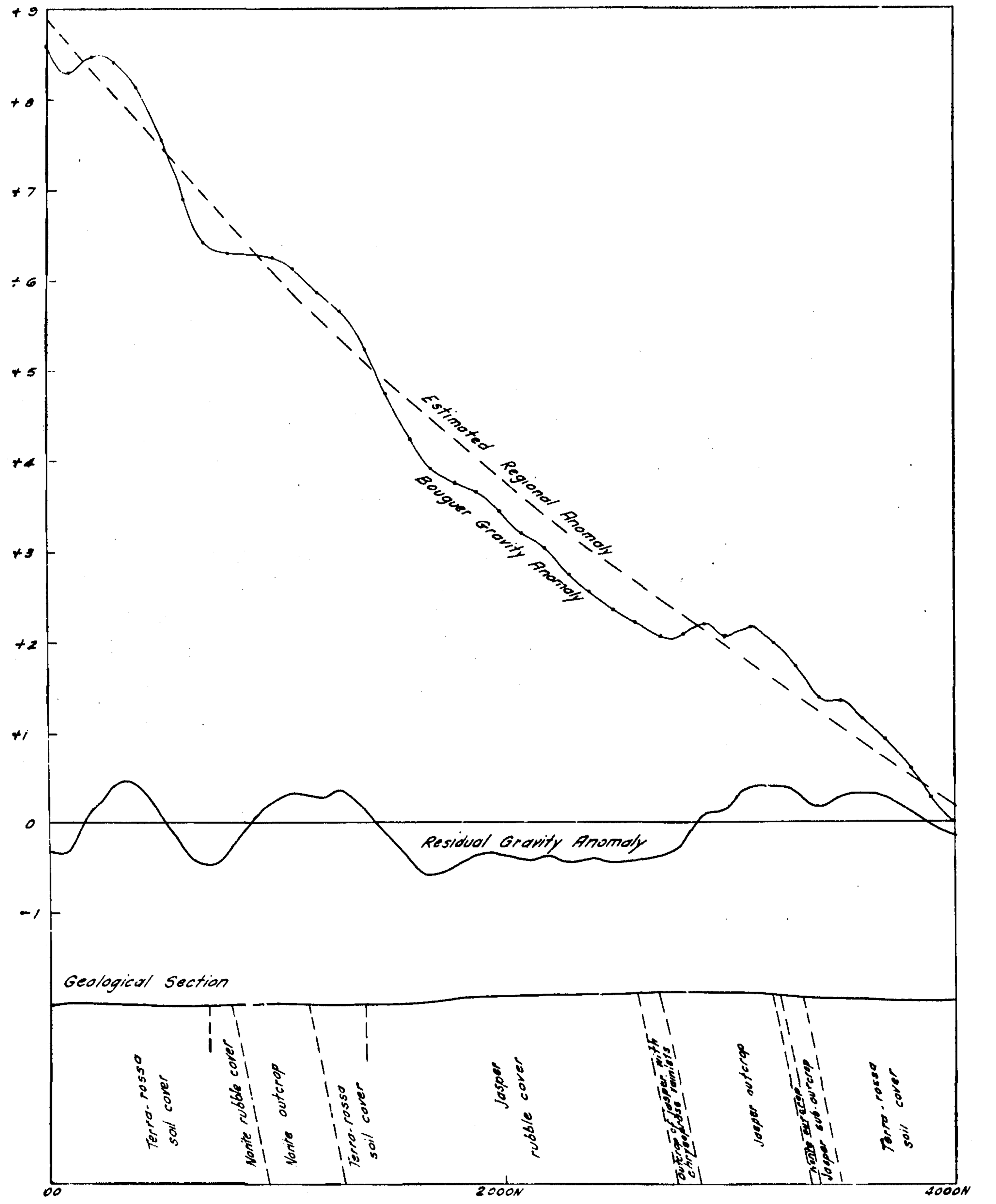
NOTE:
This map is compiled from an airborne magnetometer survey conducted by the Bureau of Mineral Resources in 1960 on behalf of the S.A. Dept of Mines.
Height above ground level 500 feet
Results reduced by Geophysical Section of S.A. Dept of Mines.

TOMKINSON
AEROMAGNETIC PROFILES OF
TOTAL INTENSITY
PRELIMINARY PRINT

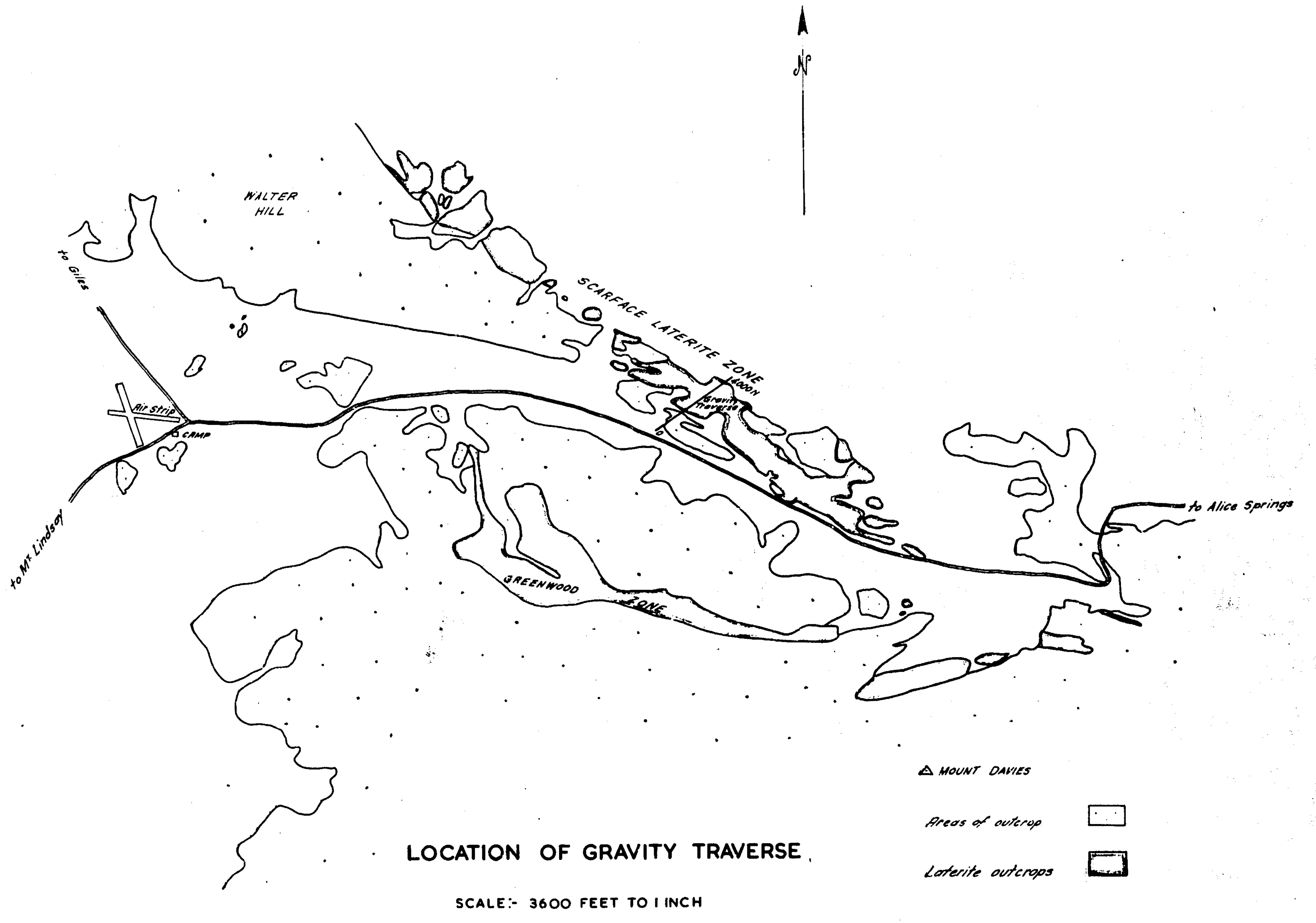
Scale 60 chns to one inch
1000 γ to 1" vertical

S.A. DEPT. OF MINES
L Ad 61 - 33


F.L.1
F.L.2
F.L.3
F.L.4
F.L.5
F.L.6
T.L.I
NOTE
This map is compiled from an airborne magnetometer survey conducted by the Bureau of Mineral Resources in 1960 on behalf of the S.A. Dept. of Mines
Height above ground level 500 feet
Results reduced by Geophysical Section S.A. Dept of Mines
DAVIES
AEROMAGNETIC PROFILES OF TOTAL INTENSITY
PRELIMINARY PRINT
Scale: 60 chains to 1 inch horizontal
1000 γ to 1 inch vertical
S.A. DEPT OF MINES
L 61-32
SCALE IN CHAINS
SCALE IN METRES
17



SCALE:- 400 FEET TO 1 INCH
1 MILLIGAL TO 1 INCH



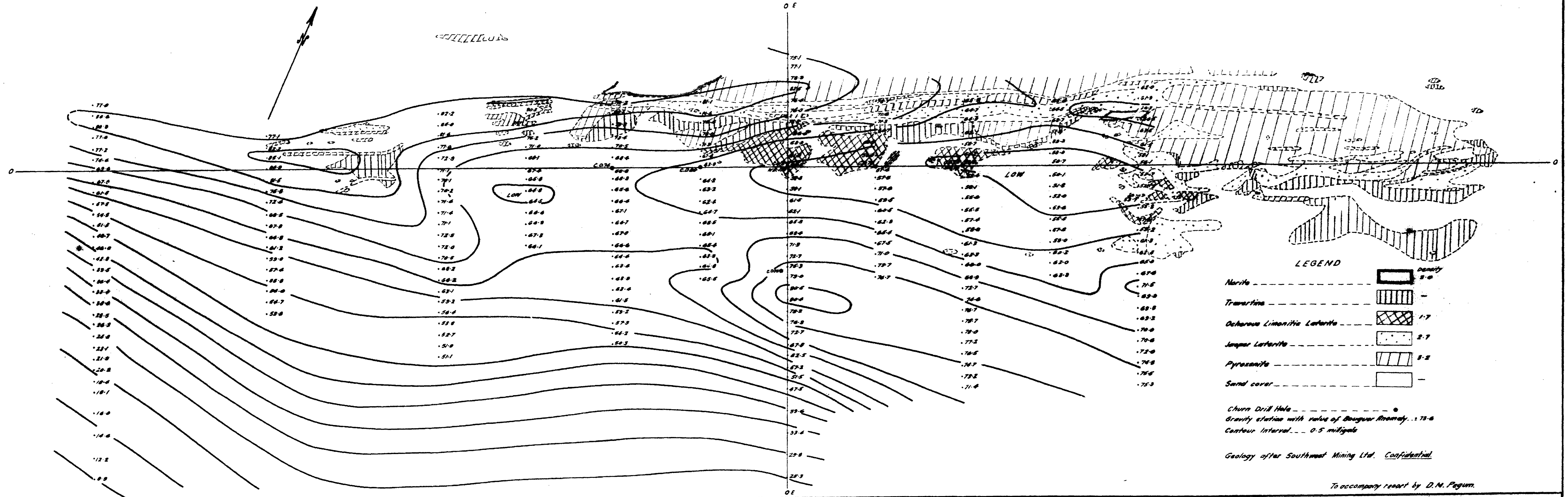
LOCATION OF GRAVITY TRAVERSE.

SCALE:- 3600 FEET TO 1 INCH

To accompany report by D. Pegum

S.A. DEPT. OF MINES

Associated Drawing	No.	No.	Amendment	Exd.	Date	Reg. No. / D.M. / Compiled from	MOUNT DAVIES REGION SCARFACE ZONE BOUGUER GRAVITY ANOMALY	Approved / Director of Mines	Passed	Drn. D.P. Tcd. A.O.W. Ckd. Exd.	Scale: 61 − 30 Ad Date 27-1-61



To accompany report by D.M. Pegum.

S.A. DEPT. OF MINES

MOUNT DAVIES REGION
CLAUDE HILLS ZONE
BOUGUER GRAVITY ANOMALY

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

Approved | Passed

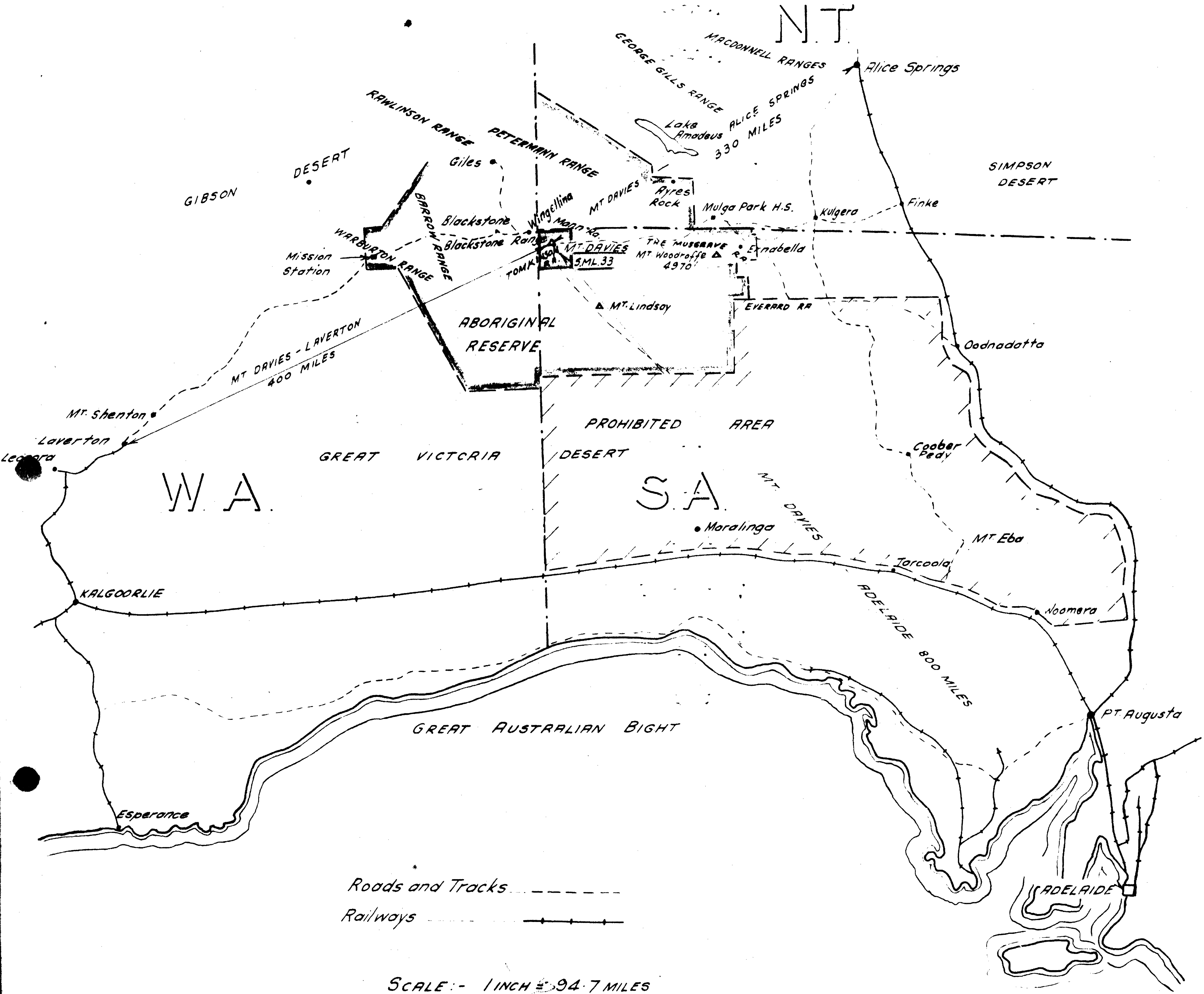
Director of Mines

Drn.
Tcd. R.G.W.
Ckd.
Exd.

Scale: 400' to 1"

60-638

Date 22-12-60



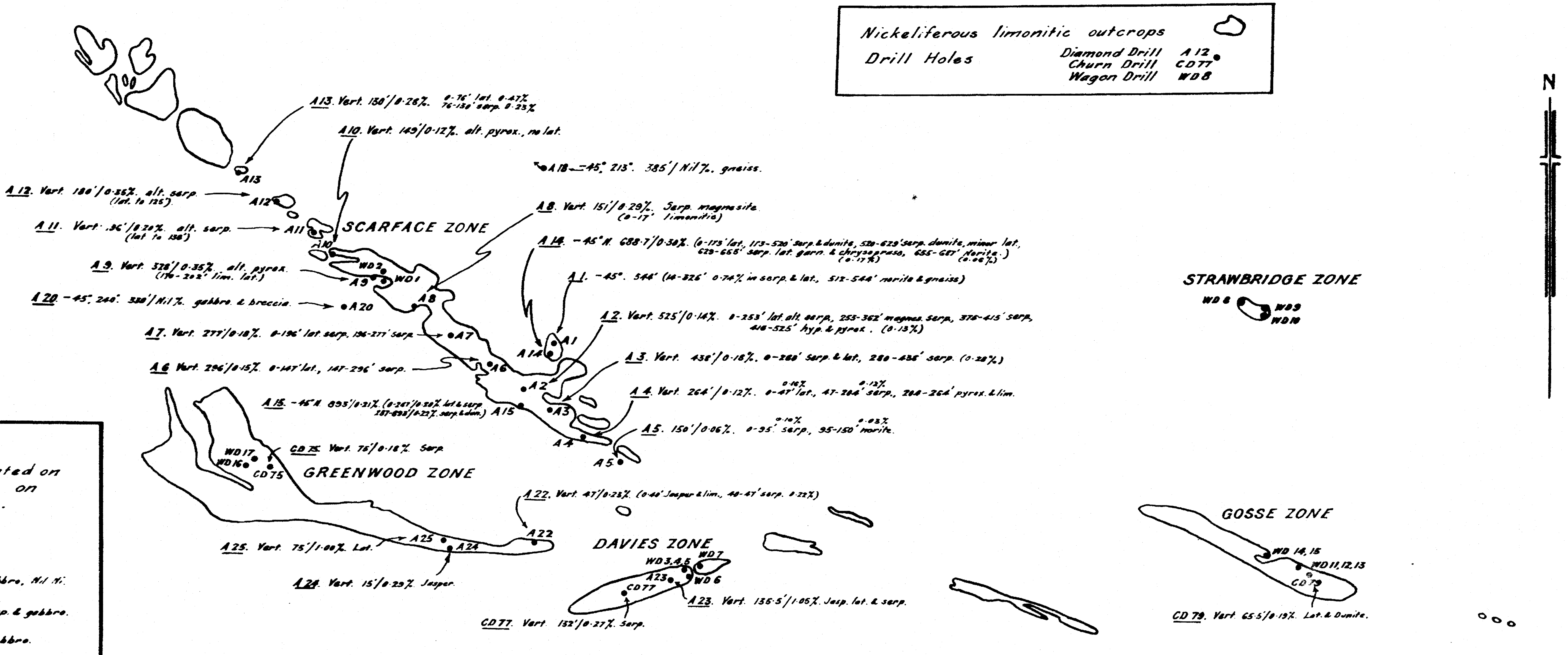
To accompany report by B.P. Thomson and R.C. Mirams

S.A. DEPARTMENT OF MINES

LOCALITY MAP S.M.L. 33 TOMKINSON RANGES	A.W.	60-252 Ad

9-5-60

A3D1" (TRIM)



NOTE:

Diamond Drill holes not located on plan, drilled west of area on electromagnetic anomalies.

Results are as follows:

A 19. -45°. 195°. Anom. 328. 335'/Nil%

A 21. -45°. 180°. Anom. 335. 105'/Nil%. Gabbro, Nil Ni.

A 29. -45°. 180°. " 335. 209'/Nil%. Serp. & gabbro.

A 30. -45°. 180°. " 335. 175'/Nil%. Gabbro.

For bores in Claude Hills Area see Plan Nº 60-250

For detail of Wagon Drill holes see report.

To accompany report by B. P. Thomson and R. C. Mirams. Confidential.

S.A. DEPT. OF MINES

400—7.58 2917

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

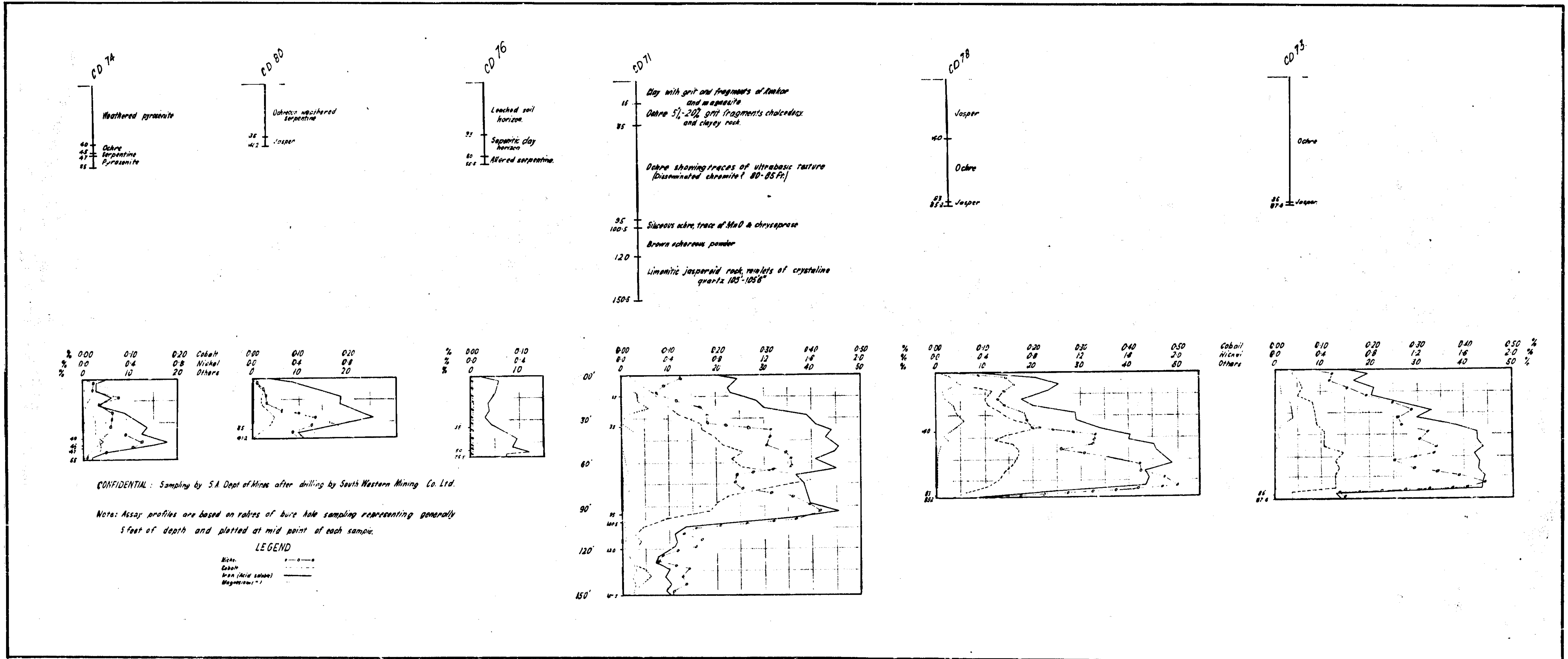
MT. DAVIES REGION
SOUTH WESTERN MINING LTD.
DRILL HOLE LOCATION PLAN

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

Scale: 3600 feet to 1 inch.

60 - 251
Ad.

Date



S.A. DEPARTMENT OF MINES

CLAUDE HILLS
PERCUSSION DRILLING & ASSAY PROFILES

J.M.
Compiled from

Approved | Passed
Director of Mines

Drn.
Tcd. G.K.W.
Ckd.
Exd.

Scale VERT: 40 Ft. to lin.

61-119
Ad.

Date 15-3-61