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PROGRESS REPORT

EXPLORATION LICENCE 1/63

FOR THE PERIOD

JANUARY 14, 1981 - AUGUST 11, 1981

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AUGUST, 1981

81-1577 (1)

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NB TRANSPARENCIES HELD IN VERTIPLAN.

1. SUMMARY

* On Magnet Range, previously anomalous geochemical results on the preliminary lines were resampled and intermediate 125m interval lines have been cut and surveyed ready for later geology and geochemistry.

* A stratigraphic diamond drill to test Hall's Formation south of the mine was abandoned due to uncontrollable deviation.

* A new geological interpretation for the entire licence was prepared at 1:10,000.

* A DIGHEM survey was carried out over the entire E.L., showing very little of interest.

2. INTRODUCTION

Exploration licence E.L. 1/63 is situated in the north-west of Tasmania, 98 kilometres from Burnie at 41°28'S, 145°24'E.

This exploration licence surrounding the Cleveland Tin Limited Mining Lease (M.L. 27M/71 formerly M.L. 43/66) was granted to Aberfoyle Tin Development Partnership in August, 1963. It has been held by subsidiaries of the Aberfoyle Group of companies since 1963 and is presently held by Cleveland Tin Limited.

A. PREVIOUS EXPLORATION

Original reconnaissance geological mapping on E.L. 1/63 was undertaken by Cox (1967) and Glasson and Cox (1969). This work involved stream sediment sampling and analysis, ground magnetometer traverses and some self potential evaluation. On completion of this preliminary work (from 1964 until 1968), Cox (1969) delineated 13 areas within E.L. 1/63 which required follow-up geological evaluation.

Follow-up work included geological mapping, soil, bedrock, stream sediment and water geochemistry with some ground and airborne magnetics, self potential and induced polarization surveys. This work has been summarized in McWatt (1971), Sale (1972), Ransom & Hunt (1972), Ransom (1972), Ransom & Simpson (1973), Ransom (1973), Sale (1974), Stuart-Smith (1974), Palmer (1975a & 1975b), Ransom (1976z & 1976b) and Gentle (1976). No outcropping orebodies were found outside the Mine area.

Statistical analysis of the geochemical data (Ransom 1977a & 1977b) showed the Mine/Falls Creek sequence was the most prospective rock unit for further exploration.

An escalation of Mine Exploration in 1978 resulted in no exploration being done within E.L. 1/63 from January, 1978 to December, 1978.

In late 1978 exploration recommenced with surface mapping south of the Mine, diamond drilling 500 metres north of the mine and a UTEM survey in selected areas north and south of the mine. The mapping (Eadie, 1979) showed Hall's Formation continued north and south of the immediate mine area. The UTEM survey failed to recognise the B-South mineralization but did delineate several weak electrical conductors in Hall's Formation.

During the year ending in August, 1980 several anomalous areas were further investigated (Ellis 1980a & 1980b). After check mapping in the Washington Hay area two diamond drill holes were drilled to test the anomalous geochemical zone. These intersected a brecciated fault zone with weak sub-economic mineralization. Mapping to the east and south of the mine showed a sequence of barren shales, volcanics and sandstone. A DIGHEM survey of the granite contact zones in the eastern areas of the licence showed one weakly anomalous zone.

During the summer season of 1980/81, a new grid was cut in the northern portion of the licence on the Magnet Range between the Corinna Highway and the northern boundary. Mapping of the preliminary lines indicated a largely uninterrupted succession of ultrabasics, sandstone, cherts and volcanics with only minor anomalous soil geochemistry. In addition, new aerial photography provided complete topographic coverage of the entire E.L. (Ellis, 1981).

B. EXPLORATION OBJECTIVES

Previous exploration in the last period has delineated several areas which required follow-up evaluation in varying degrees of detail. The areas and the work proposed were as follows:

a) MAGNET RANGE AREA

It was proposed that all the existing anomalous geochemical areas on the four preliminary lines be resampled at 12.5m intervals. In addition, 18 intermediate lines were proposed at 125m strike intervals which would be surveyed and traversed with magnetics, geological mapping and further geochemical soil sampling. The total analysis of all this data together with DIGHEM results would decide whether any further follow-up was required.

b) WHYTE HILL - W PROSPECT AREA

It was proposed that further strike mapping in conjunction with the completed ground magnetometer work would enable a less contentious interpretation of the area between Whyte Hill and Cleveland Mine. Depending on results, drilling may be warranted to test favourable stratigraphy at depth.

c) WASHINGTON HAY AREA

A series of costeans augmented by strike mapping and magnetometer traverses was proposed to allow correlation of stratigraphy and structure south of line RA12 in an area showing several weak geochemical anomalies.

d) HALL'S FORMATION STRATIGRAPHY

To provide stratigraphic data on Hall's Formation 500 metres south of the southernmost mine opening, a diamond drill hole was proposed to be collared in Eastern Sediments; to pass through Deep Creek Volcanics and Hall's Formation and terminate in Crescent Spur Sandstone.

e) GRANITE CONTACT ZONE

It was proposed that the weak DIGHEM anomaly in the Wombat Flats area of the Meredith Granite contact be initially investigated by geological mapping before further evaluation.

f) GENERAL WORK ON E.L. 1/63

A DIGHEM survey was proposed for the entire E.L.

Compilation of all data onto common 1:1,000 base sheets was proposed to continue; as was a comprehensive re-interpretaion of all data at 1:5,000 and 1:10,000.

3. EXPLORATION COMPLETED DURING THE PERIOD

The report detailed below represents one phase of a continuing exploration program and covers exploration activity for the period 14th January, 1981 to 11th August, 1981 ("this period") as well as outling further proposed exploration. The "last period" refers to the period 12th August, 1980 to 13th January, 1981.

A. MAGNET RANGE AREA

(i) COMPLETED EXPLORATION

The several areas showing weakly anomalous geochemistry on the four preliminary lines have been resampled at 12.5m intervals. Results to hand are listed in Appendix III.

Early in the period it was suspected that the relatively high background levels for tin were caused by contamination at the Cleveland Assay Laboratory and checks would be required from another laboratory.

Eighteen additional lines have been cut and surveyed in the area and are depicted on sheets

(ii) FUTURE WORK RECOMMENDED

Further assaying of the resampled intervals should be undertaken at an external laboratory. All additional lines should be geologically mapped, soil sampled and traversed by magnetometer. Any further work would be dependent on the outlining of geochemical anomalies.

B. WHYTE HILL - W PROSPECT AREA

(i) COMPLETED EXPLORATION

Apart from correction of the ground magnetometer traverse readings (Appendix IV), no further work was undertaken.

(ii) FUTURE WORK RECOMMENDED

Further strike mapping of continuously outcropping units should be performed with possible drilling of favourable stratigraphy at depth.

C. WASHINGTON HAY AREA

(i) COMPLETED EXPLORATION

No further work was undertaken during the period.

(ii) FUTURE WORK RECOMMENDED

Considering the problems of correlation of stratigraphy and structure south of RA12 and to the west of the holes drilled in 1980, strike mapping of continuously outcropping units is recommended. This can be assisted by magnetometer traverses on all existing lines with costeaning in areas of complexity.

D. HALL'S FORMATION STRATIGRAPHY

(i) COMPLETED EXPLORATION

As proposed, a diamond hole was drilled on Ax section 500 metres south of the present limit of information to test Hall's Formation Stratigraphy at depth. The hole was collared in Eastern Sediments just outside the Cleveland Mine Lease and following severe caving problems together with uncontrollable deviation, was abandoned at 397m; well short of the 650 metre proposed depth. 80m of collar pipe has been left in the hole to enable later safe entry with more sophistocated deviation control equipment. No mineralization was detected. Sheet Ax-1000-001 shows the location of the actual hole in comparison with the proposed path, designed on deviation experienced in holes further north. The unexpected deviation is thought to be the result of caving ground and the use of impregnated dust bits. A wedge placed at 337m produced little or no lift.

Geology within the hole was largely as expected from surface mapping. (see Appendix VI and sheet Ax-1000-001)

(ii) FUTURE WORK RECOMMENDED

When a suitable drill rig is available an attempt should be made to use arc-cutting equipment and complete the proposed hole.

E. GRANITE CONTACT ZONE

(i) COMPLETED EXPLORATION

Once the DIGHEM anomaly was located on the ground by magnetometer traversing on existing cut lines in the area, geological mapping augmented by later petrology (Appendix II) determined that the anomaly coincided with the Tertiary basalt contact and the electromagnetic anomaly is concluded to result from gravels (and associated groundwater) beneath the thin basalt cover.

(ii) FUTURE WORK RECOMMENDED

No further work is required.

F. GENERAL WORK ON E.L. 1/63

(i) DIGHEM SURVEY

In late February, 1981, a DIGHEM survey totalling 191 line km. was undertaken over the rest of E.L. 1/63, not previously covered in the 1980 survey (see Ellis 1980b). The full report (Appendix V) and plans are included.

At the time of writing Cleveland Tin is awaiting a further report from the Aberfoyle geophysicist on facets of this latest DIGHEM survey before detailing anomaly follow-up work.

DIGHEM Ltd. does not rate the few anomalies detected as high order.

(ii) COMPILATION

Due to the surface exploration cutback, little or no progress was made during the period with 1:1,000 compilation. However, a summary of the current geological interpretation of E.L. 1/63 at 1:10,000 was prepared and is included as sheet SG-IN-001.

(iii) FUTURE WORK PROPOSED

Once a final report from the Aberfoyle geophysicist is received, any recommended follow-up work on the DIGHEM survey should be undertaken.

Compilation of all data onto common base sheets should continue as an on-going priority task.

4. EXPENDITURE

Expenditure for the period January 14, to July 28, 1981 (to coincide with accounting periods) was as follows:

Geology and Administration	$8,431
Survey	9,732
Geochemistry	11,786
Geophysics	15,996
Sampling	1,617
Petrology	1,080
Drilling	35,228
Drafting	4,818
Total:	$88,688

5. CONCLUSIONS

A DIGHEM survey was undertaken over the entire E.L. and although final assessment of the consultant's report has not been completed, it has revealed little of interest, apart from a few low order anomalies probably requiring follow-up.

The work on Magnet Range has not progressed greatly apart from minor soil re-sampling and the cutting and survey of 18 additional lines.

The previously recorded weak DIGHEM anomaly in the Wombat Flats area has been satisfactorily explained as a probable gravel conductor beneath Tertiary basalt.

A stratigraphic drill hole collared south of the mine was abandoned after unexpected uncontrollable deviation put the Hall's Formation target out of reach.

A new interpretation of the E.L. geology at 1:10,000 has been completed.

Total expenditure for the period January 14, to July 28, 1981 was $88,688.

6. REFERENCES

Cox, R., 1967 Review of Activity on the Cleveland Exploration Licence 1/63. Unpublished report of Aberfoyle Tin Development Partnership.

Cox, R., 1969 Report of the Resident Geologist upon completion of initial exploration program (April, 1964 - December, 1968) in the Cleveland - Magnet Area, Luina District, Tasmania. Unpublished report of Aberfoyle Management Pty. Limited.

Eadie, A., 1979 Progress report on Exploration Licence 1/63 for period February, 1979 to August, 1979. Unpublished report of Cleveland Tin Limited.

Ellis, P.D., 1980a Progress report Exploration Licence 1/63 for six month period ending February 11, 1980. Unpublished report of Cleveland Tin Limited.

Ellis, P.D., 1980b Progress report Exploration Licence 1/63 for six month period ending August 11, 1980. Unpublished report of Cleveland Tin Limited.

Ellis, P.D., 1981 Progress report Exploration Licence 1/63 for the period August 12, 1980 to January 13, 1981. Unpublished report of Cleveland Tin Limited.

Gentle, L.V., 1976 Review of Exploration at Cleveland Tin N.L., C.E.P.L. unpublished report.

McWatt, R.M., 1971 Reconnaissance Exploration Geochemical, Magnetometer and Geological Data of E.L. 1/63 - area I. Cleveland Tin N.L. unpublished report.

Palmer, K.G., 1975a Progress report - Exploration Licence 1/63, Cleveland Tin Limited period ending February 11, 1975. C.E.P.L. unpublished report to Tas. Mines Dept.

Palmer, K.G., 1975b Progress report - Exploration Licence 1/63, Cleveland Tin Limited period ending August 11, 1975. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., 1972 Re-interpretation of the structure at Cleveland. Unpublished file note to C.E.P.L.

Ransom, D.M., 1973 Regional geology of the Luina-Waratah area and its relationship to the Precambrian/Early Cambrian stratigraphy of the West Coast, Tasmania. C.E.P.L. unpublished report.

Ransom, D.M., 1976a Progress report - Exploration Licence 1/63 for six months ending February 11, 1976. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., 1976b Progress report - Exploration Licence 1/63 for six months ending August 11, 1976. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., 1977a Progress report - Exploration Licence 1/63 for six months ending February 11, 1977. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., 1977b Progress report - Exploration Licence 1/63 for six months ending August 11, 1977. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., & Hunt, F., 1972 Cleveland Tin LImited year end report. C.E.P.L. unpublished report to Tas. Mines Dept.

Ransom, D.M., & Simpson, D.C., 1973 Progress report - Cleveland Tin Limited for six months ending June 30, 1973. C.E.P.L. unpublished report to Tas. Mines Dept.

Sale, R.V., 1972 Geochemistry progress report, Cleveland Tin N.L., E.L. 1/63. C.E.P.L. unpublished report to Tas. Mines Dept.

Sale, R.V., 1973 Progress report - Cleveland Tin N.L. - six months ending December 31, 1973. C.E.P.L. unpublished report to Tas. Mines Dept.

Stuart-Smith, P.G., 1974 Progress report - Cleveland Tin N.L. - six months ending June 30, 1974. C.E.P.L. unpublished report to Tas. Mines Dept.

APPENDIX I

MAGNET RANGE

ADDITIONAL THIN SECTION PETROLOGY

950015

DESCRIPTION OF ROCKS IN THE CLEVELAND MINE EXPLORATION AREA

Cleveland Tin Limited
Tasmania

GS3/43/6/0-3802/81 February 1981

The Australian
ral Development
Laboratories

in Street, Frewville,
outh Australia 5063
e Adelaide 79 1662
Telex AA 82520

Please address all
correspondence to
Box 114 Eastwood
SA 5063
In reply quote:

950016

amdel

19 February 1981

GS 3/43/6/0

Cleveland Tin Limited,
LUINA, TAS. 7321.

Attention: Senior Mine Geologist

REPORT GS 3802/81

YOUR REFERENCE:	Order No. 13312, and letter dated 23 January 1981
MATERIAL:	24 rock samples (3 of one number)
LOCALITY:	Cleveland Mine Exploration Licence Area
IDENTIFICATION:	Samples numbered between 249525 and 249699 (not consecutive)
DATE RECEIVED:	2 February 1981
WORK REQUIRED:	Routine petrographic description for all samples and (by telephone consultation) mineragraphic description of 3 samples.

Investigation and Report by: Sylvia Whitehead

Manager, Geological Services Division: Dr Keith J. Henley

Keith Henley

for Norton Jackson,
Managing Director.

ant: Osman Place
Thebarton S.A.
elephone 43 8053
Laboratory: Perth

SUMMARY OF SAMPLES

Sample and TS No.	
249525 TSC31652	Partly silicified and completely altered igneous rock which once had abundant pyroxene phenocrysts in a groundmass with an unusual texture resembling large-scale myrmekitic texture. The magma from what this crystallized probably had an unusual composition and it cannot be classified but may have been related to andesite or dacite.
249667 TSC31653	Chert breccia. There is evidence of at least two episodes of fracturing or brecciation.
249668 TSC31654 &C31676	Argillaceous chert possibly with some layers of cherty argillite.
249671 TSC31655 &C31677	Medium-grained and fine-grained dolerite. In the finer-grained rock most of the pyroxene has been replaced by amphibole.
249672 TSC31656	Fine-grained hornfels probably derived from a fine-grained sediment.
249673 TSC31657	Weakly metamorphosed arkosic sandstone originally composed of poorly sorted, immature detrital material mainly quartz, mica and feldspar.
249675 TSC31658	Weakly metamorphosed arkosic sandstone very similar to sample 249673 but finer-grained. It once had minor carbonate in the matrix.
249677 TSC31659	Arkosic-lithic sandstone. It is similar to 249675 but has less feldspar and mica and more lithic and chloritic grains, some of which were derived from volcanic rock. It could be classified as quartz greywacke.
249682 TSC31660	Argillaceous chert with a brecciated zone and small, stylolitic seams.
249684 TSC31661	Dolerite in which pryoxene occurs as aggregates of radiating crystals and textures suggest that some pyroxene and plagioclase crystallized simultaneously.

249685 TSC31662	Serpentinite derived from dunite.
249686 TSC31663	Indurated, fine-grained, tuffaceous sandstone or volcanic sandstone of basaltic or andesitic composition.
249688 TSC31664	Amphibolite derived from fine-grained dolerite.
249689 TSC31665	Amphibolite derived from medium-grained dolerite.
249690 TSC31666	Amphibolite derived from basalt (or from the fine-grained chilled margin of dolerite).
249691 TSC31667	Altered, very fine-grained volcanic rock, possibly vitreous which was either basalt or andesite. It has been fractured and invaded by quartz and minor sulphide.
249693 TSC31668	Partly altered and iron oxide-stained fine-grained dolerite (or coarse-grained basalt).
249696 TSC31669 C31670, &C31671	Partly altered dolerite which has been locally fractured and crushed. Fractured zones have veins of secondary minerals including plagioclase, epidote and prehnite.
249696 TSC31672	Amphibolite derived from dolerite. Fractured and crushed zones have veins of plagioclase, chlorite and prehnite.
249697 TSC31673 PSD6656	Dolerite in which the pyroxene has been extensively replaced by amphibole. There are minute traces of very fine-grained chalcopyrite and pyrite but no evidence of nickel-bearing sulphide. There is also no evidence to suggest that the rock contained olivine.
249698 TSC31674 PSD6657	Serpentinite derived from pyroxene dunite. There is a minute trace of sulphide probably all pyrite.
249699 TSC31675 PSD6658	Serpentine derived from dunite which had less interstitial pyroxene than sample 249698. Sulphide was not found.

2. PETROGRAPHY

Sample: 24925; TSC31652

Hand Specimen:

A very weathered rock which is predominantly pale greyish-orange but fresher zones visible in a freshly-cut surface a dull greyish-green. These show an indistinct mottling with a possible porphyritic texture. In some zones the rock has been extensively fractured or crushed and sheared, and in these zones there is a high proportion of clay lightly stained by iron oxide.

Thin Section:

A visual estimate of the minerals is as follows:

	%
Quartz (some secondary)	55-60
Chlorite (and clay)	40-45
Goethite	2-3
Opaque oxide crystals	Trace

The rock has been altered and at least partly silicified, but in many zones the original texture has been moderately well preserved.

The rock originally contained 30-40% of crystals 0.5-2 mm long, averaging about 1 mm long, which have been completely replaced by chlorite lightly stained by iron oxide, and many of these crystals have an external shape typical of that of pyroxene. There are a few which could have been olivine, but where the external shapes of cross-sections of the crystals are well preserved, they are generally typical of pyroxene. These have been replaced by chlorite and some of them also have veins now composed mainly of goethite.

These phenocrysts of pyroxene were originally scattered through a groundmass, which, relict textures suggest, had a very unusual texture. In this groundmass there are very numerous oval, almost spherical and elongate or rod-like bodies of clear quartz generally with a diameter of 0.05 to 0.1 mm, and the general pattern formed by these bodies of quartz is somewhat similar to that in myrmekitic intergrowths between quartz and plagioclase but, in this groundmass, it is on a larger scale than most myrmekitic intergrowths. The groundmass between the oval and elongate bodies of quartz is turbid and shows a very fine, fibrous texture, but it is now composed of chlorite, clay and secondary quartz which has grown out from the bodies of clear quartz. The texture is not that of a normal igneous rock and could possibly be an indication of lava or magma with an unusual composition in which there may have been some immiscible liquids. It is not absolutely certain that the oval and elongate bodies were originally quartz but, as there is no evidence to suggest the presence of another mineral, it is most likely that they were quartz, and the interstitial fibrous material may have contained feldspar.

The only accessory minerals found in the thin section are a few crystals of opaque oxide 0.1-0.4 mm in size.

In some zones the rock has been deformed and extensively fractured or sheared and there are also numerous veins now containing goethite.

In some of the veins there are relict textures suggesting that they once contained a high proportion of carbonate which has been leached and/or replaced by iron oxides. There is also an area in which the rock contains, or has been replaced by, a mass of fibrous, chalcedonic quartz, and this is cut by the porous goethite veins which once contained carbonate.

Conclusion:

This is an extensively altered and partly silicified igneous rock which once contained moderately abundant phenocrysts of pyroxene in a groundmass with a very unusual texture somewhat resembling large-scale myrmekitic texture. It probably crystallized from magma or lava of unusual composition, or may have contained residual fluid from crystallizing magma. Because of the unusual textures, partial silicification and degree of alteration, it is not possible to classify this rock as it does not strictly correspond to any of the conventional igneous rock names. It may have been related to andesitic or dacitic magma, but the concentration of pyroxene phenocrysts is unusual and may indicate more basic magma or the residual liquid from crystallization of more basic magma. These suggestions are tentative.

Sample: 249667; TSC31653

Hand Specimen:

A very fine-grained, pale grey rock weathering pale brown. It is very hard and resembles chert in general appearance. It is cut by numerous intersecting small joints or veins found in thin section to contain quartz.

Thin Section:

A visual estimate of the minerals is as follows:

	%
Microcrystalline to cryptocrystalline quartz	>90
Sericite and clay	2-3? (possibly more)
Chlorite	1-2
Allunite ?	Trace
Opaque material	Trace

The rock is composed predominantly of microcrystalline to cryptocrystalline quartz and it already had a fragmental structure before it was extensively fractured and cut by a network of quartz veins. The very fine-grained quartz contains a low concentration of scattered, tiny flakes of mica and chlorite and there are zones which are turbid, due mainly to the presence of minute voids which may be a result of partial leaching. There are also a few minute crystals or grains, probably of titanium oxide (rutile), and one minute tourmaline crystal was found. There may be a little argillaceous material obscured by the microcrystalline quartz but, in general, the rock is composed predominantly of very fine-grained silica.

In many areas variations in staining and turbidity define a fragmental structure in which there are very numerous, predominantly angular fragments of relatively clear microcrystalline to cryptocrystalline quartz with a more turbid matrix. There are other relatively large areas several millimetres in size of the clearer, microcrystalline quartz not showing a fragmental structure and, in general, the pattern of fragments as seen in the thin section is more consistent with that of a fractured or fragmented rock than a sedimentary breccia. In some of the more extensively fragmented zones there are small patches of fibrous, chalcedonic quartz.

The rock is now cut by a network of thin quartz veins, mainly between 0.1 and 0.5 mm, but varying up to 1 mm, and this quartz has filled later fractures in the rock as many of the thin quartz veins cut across the earlier fragmental structure. In the interior of some of the larger quartz veins there are small crystals and aggregates of an opaque mineral, probably now secondary iron oxide. This mineral has filled interstices between quartz crystals in the veins and there are no distinctive crystal shapes from which this opaque material can be identified.

Conclusion:

The rock is classified as a chert breccia, and it is composed predominantly of cryptocrystalline to microcrystalline quartz. There is evidence of at least two episodes of fracturing or brecciation and the latest fractures have been filled by quartz with trace amounts of an opaque mineral which has probably been oxidized.

Sample: 249668; TSC31654 & 31676

Hand Specimen:

Two samples of rock were submitted in this bag and both are very fine-grained and have a cherty appearance, but one is dark grey whereas the other is brownish-red with some evidence of layering and this tends to split along planes parallel to the bedding.

Thin Sections:

Two sections were prepared from the different samples and these were found to have a similar composition. A visual estimate of the minerals is as follows:

	%
Sericite and chlorite with some clay	35-40
Microcrystalline to cryptocrystalline quartz	60-65
Opaque grains	Trace
Leucoxene	Trace
Tourmaline	Very Minute Trace
Zircon	Very Minute Trace
Goethite staining	Varies

The rock has a background of cryptocrystalline to microcrystalline silica which is so fine-grained that it is barely visible in thin section with crossed nicols. This matrix of extremely fine-grained quartz contains numerous tiny flakes of mica and chlorite, most of them less than 0.05 mm long, but varying up to a maximum of about 0.08 mm, and most of these show a preferred orientation parallel to the direction of bedding, even in the grey rock in which little evidence of bedding could be seen in the hand specimen. There are also a few tiny opaque grains, traces of leucoxene, one or two tiny zircon grains and a few tiny (?)authigenic crystals of tourmaline about 0.02 mm long. In one of the sections there are also a few very small globules or globular bodies about 10-20 microns in diameter which are mainly defined by pale brown iron oxide staining, and in another area a few tiny globular bodies of very fine-grained silica were found.

In the reddish-brown sample in which there is clear evidence of bedding there are some layers which contain elongate fragments and streaks mainly less than 0.5 mm long of much finer-grained material and the general appearance suggests a small-scale intraformational conglomerate in which some layers contained reworked fragments of disrupted bottom sediment. In this thin section the tiny silica globules are slightly more abundant or, at least, are more conspicuous, possibly due to staining. In this reddish-brown sample much of the argillaceous material is lightly stained by reddish-brown iron oxide and in many places variations in the intensity of this staining emphasise the bedding.

The rock is cut by a very thin vein containing quartz and chlorite.

Conclusion:

Argillaceous chert which may contain some layers of cherty argillite.

Sample: 249671; TSC31655 & 31677

Hand Specimen:

Two samples of greyish-green rock were submitted, one of which is fine-grained and the other is medium-grained. Both appear to be massive.

Thin Sections:

A visual estimate of the minerals in the coarser-grained rock is as follows:

	%	
Extensively altered plagioclase	50-55	
Clinopyroxene	30-35	
Opaque oxide	7-12	
Chlorite	3-5	(varies)
Vein containing prehnite and feldspar	2-3	

In the finer-grained rock a large proportion of the pyroxene has been replaced by amphibole, but otherwise the composition is similar.

The coarser-grained rock contains a relatively high proportion of plagioclase crystals between 1 and 2 mm long and averaging about 0.5 mm thick, and these have been extensively replaced by turbid masses of very fine-grained zoisite and sericite with a few small patches of chlorite. A few of the crystals still show some evidence of twinning but in most of them alteration has been so extensive that all evidence of twinning has been obliterated. In less altered zones in the rock interstices between the plagioclase crystals contain aggregates of very pale coloured clinopyroxene which has a common grain size of between 0.3 and 0.6 mm, but there are a few larger crystals up to 1 mm long. There are also scattered crystals of opaque iron-titanium oxide mainly between 0.5 and 1 mm in size which occur mainly in interstices between plagioclase crystals, and a few of these partly enclose small plagioclase crystals or portions of small plagioclase crystals. Much of this opaque oxide has probably been replaced by leucoxene which is visible around the edges of many of the grains.

In some zones in this coarse-grained rock hydrothermal or deuteric alteration has resulted in replacement of most of the pyroxene by chlorite and, although it is clear that some crystals of pyroxene have been pseudomorphously replaced by chlorite, there are other interstices filled by chlorite which does not show any evidence of relict textures. The rock has also been fractured or sheared and along this zone there is now a vein up to 1 mm thick which contains prehnite and slightly turbid pale orange-stained feldspar showing twinning typical of that in albitic plagioclase. Positive identification of this would require separate tests with refractive index liquids or X-ray diffraction and these were thought to be unwarranted at present. The vein also contains a little chlorite and in one sheared zone there is a trace of epidote.

The finer-grained rock has a texture which is generally similar to that in the coarser-grained rock but intergrown plagioclase crystals are mainly between 0.3 and 0.6 mm long with a few up to about 0.8 mm, and, in general, they appear less altered than in the coarser-grained sample, although most of them have been at least partly replaced by sericite and

very fine-grained zoisite. Interstices between these plagioclase crystals once contained pyroxene with a common grain size of 0.1-0.3 mm but this pyroxene has been almost completely replaced by pale green amphibole and minor amounts of very fine-grained secondary iron oxide. In many of the crystals and aggregates of amphibole, however, there are small corroded remnants of clinopyroxene generally completely surrounded by amphibole. There are a few areas where pyroxene is less altered and in one of these there is some coarser-grained pyroxene which encloses or partly encloses a few small crystals of plagioclase, giving an area of ophitic texture typical of that in dolerite.

This finer-grained rock contains scattered crystals of opaque iron-titanium oxide 0.1-0.2 mm in size and there are also a few interstitial patches of chlorite which may have replaced pyroxene but which do not show any recognisable relict textures. In the area sectioned there is one large phenocryst of plagioclase over 2 mm long but this is insufficient to give a porphyritic texture to the rock.

Conclusion:

The coarser-grained rock is a dolerite in which some of the pyroxene has been replaced by chlorite. The finer-grained rock could be classified as a fine-grained dolerite (or coarse-grained basalt) in which the pyroxene has been extensively replaced by amphibole. It could also therefore be classified as amphibolite but, as it is probably related to the coarser-grained sample, it is best referred to as fine-grained dolerite in which the pyroxene has been replaced by amphibole.

Sample: 249672; TSC31656

Hand Specimen:

A pale greyish-orange to orange-grey, very fine-grained rock which does not show any special features, but on a wet, freshly cut surface there are slight variations in staining and grain size suggesting a possible bedded rock. There are also a few small patches of very fine-grained, almost black material which cannot be identified without examination of a polished section.

Staining with rhodizonate shows an abundance of plagioclase but staining with cobaltinitrite shows only a trace of potash feldspar. There are slight variations in the concentration of the plagioclase, also suggesting very indistinct layering.

Thin Section:

A visual estimate of the constituents is as follows:

	%
Plagioclase	50-55
Partly altered biotite and chlorite	25-30
Quartz	15-20
Opaque material	Trace-1 (more locally)
Leucoxene	Trace
Potash feldspar	Trace
Epidote or zoisite	Trace

This is a fine-grained rock which has recrystallized and now contains a relatively large proportion of turbid and lightly stained plagioclase with a common grain size of 0.05 to 0.15 mm intergrown with lesser quartz which is slightly finer-grained than the plagioclase. These felsic minerals are intergrown with very small flakes of biotite and chlorite which are mainly between 0.05 and 0.1 mm long and are stained orange to yellowish-brown by varying concentrations of iron oxide. The small micaceous flakes do not show any evidence of preferred orientation and the texture therefore resembles that of a hornfels rather than an incipient schist. There are a few small aggregates of very fine-grained zoisite or epidote also stained by iron oxide and a few very small grains or aggregates of leucoxene. In one area there are a few larger, poikilitic crystals and aggregates of a slightly coarser-grained member of the epidote group which varies in colour from pinkish-brown to brownish-green. These aggregates are up to 0.5 mm long.

There are some variations in grain size but these do not form patterns recognisable as bedding in the area sectioned.

The patches of dark material visible in the hand specimen contain porous masses of extremely fine-grained opaque material which cannot be identified in thin section but, surrounding these zones, the rock contains an abundance of tiny opaque grains some of which appear square in cross section and could have been tiny crystals of pyrite. Positive identification of this opaque material would require examination of a polished section.

In another part of the rock there is a crystal of oxidized pyrite 0.3 x 0.5 mm in size which has been replaced by translucent, reddish-brown goethite. In a zone adjacent to one of the masses of black

opaque material the rock has a few grains which have been replaced by chlorite and one or two of these have a square to slightly rectangular cross-section.

Conclusion:

This is a fine-grained hornfels which was probably derived from a fine-grained sediment. As no evidence of original textures has been preserved there is no means of determining whether or not the sediment was tuffaceous.

Sample: 249673; TSC31657

Hand Specimen:

A pale, dull orange, moderately fine-grained rock with a sandstone-like texture. Where it has split along planes parallel to the bedding a few small flakes of muscovite can be seen.

Staining with cobaltinitrite shows relatively minor potash feldspar in a few grains.

Thin Section:

A visual estimate of the minerals is as follows:

	%
Detrital quartz	30-35
Detrital mica	10-15 (possibly more)
Potash feldspar grains	5-10
Plagioclase	2-3?
Lithic grains	3-5
Grains replaced by chlorite	1-2
Leucoxene	Trace
Zircon	Minute Trace
Matrix of sericite and cryptocrystalline quartz	40-45

This is a weakly metamorphosed sediment which was originally composed of poorly-sorted grains varying in size from less than 0.05 mm to about 0.6 mm with a few larger lithic grains up to almost 1 mm in size and one microcline grain 1.5 mm long. Most of the quartz and feldspar grains are angular to subangular and the larger grains are scattered through a matrix of the smaller grains with no evidence to suggest sorting or layers containing grains of different size. Detrital mica flakes, including both biotite and muscovite, vary in size from less than 0.1 mm to about 1 mm long and many of the larger flakes are subparallel, possibly to the direction of bedding. The rock contains a few lithic grains, some of which are composed of microcrystalline quartz or chert, and a few are composed of very fine-grained quartz or mica ±feldspar, and these could have been derived from fine-grained metasediments. There are also a few grains or crystals 0.1-0.3 mm in size which have been replaced by chlorite and some of these show polygonal crystal shapes but, in general, they are not sufficiently distinctive for the former mineral to be identified. There are a few heavy mineral grains, mainly leucoxene, but also including a few tiny zircons, one of ?tourmaline and one of epidote.

The larger detrital grains are loosely packed and very few of the larger quartz and feldspar grains are touching. Most of them are separated by a fine-grained matrix consisting of deformed and partly recrystallized micaceous material and sericite with some small patches of microcrystalline quartz. Many of the detrital mica flakes have been deformed and altered and these merge with, and in many places are indistinguishable from, possible recrystallized argillaceous material in the matrix.

Conclusion:

This is a weakly metamorphosed arkosic sandstone originally composed of poorly-sorted, immature detrital material, mainly quartz, mica and feldspar.

Sample: 249675; TSC31658

Hand Specimen:
A pinkish-brown, fine-grained rock in which there are a few visible muscovite flakes less than 1 mm in size.

Staining with cobaltinitrite shows only a few grains containing potash feldspar.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Detrital quartz	30-35
Potash feldspar	5-10
Detrital mica	10-15?
Plagioclase	2-3
Lithic grains	1-2
Leucoxene	Trace
Tourmaline	Minute Trace
Matrix of sericite and fine-grained quartz	45-50
Goethite staining	Varies

This is a weakly metamorphosed sediment which is essentially very similar to sample 249673 and therefore a full description will not be repeated. It differs from sample 249673 in the following features.

The sedimentary material is slightly finer-grained and the grains vary in size from less than 0.05 mm to about 0.4 mm with only a few grains up to 0.5 mm. They are poorly sorted and predominantly angular. Detrital mica flakes are similar to those in sample 249673, include both biotite and muscovite, and show a preferred orientation probably parallel to the direction of bedding. In some zones or bands in the rock the proportion of detrital mica may be slightly higher than in the previous sample.

There are some slight variations in grain size in that there is a slightly coarser-grained zone at least 6 mm across, but this does not form any regular or recognisable bedding. It is possible that there was some soft-sediment deformation before the rock was consolidated.

The detrital grains are loosely packed, as in the previous sample, and most of the larger grains are separated by a very fine-grained matrix consisting of sericite, deformed and partly altered detrital mica and a little very fine-grained quartz. The matrix shows more iron oxide staining than in sample 249673 and there are a few places where small patches and aggregates of reddish-brown goethite have retained the shape of former rhombohedral crystals almost certainly of carbonate, which suggests that before weathering this sample contained a few percent of carbonate dispersed through the matrix.

Heavy mineral grains in this sediment are essentially similar to those in the previous sample but also include a few angular grains of garnet.

Conclusion:
Weakly metamorphosed arkosic sandstone which is very similar to sample 249673 but is finer-grained and once contained minor carbonate in the matrix.

Sample: 249677; TSC31659

Hand Specimen:
A brownish-grey, fine-grained rock in which a few small mica flakes are visible.

Staining with cobaltinitrite shows only a trace of potash feldspar.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Detrital quartz	25-30
Detrital mica	5-10?
Lithic grains	5-10
Grains now composed of chlorite	10-15
Feldspar	1-2
Leucoxene	Trace-1
Opaque grains	Trace
Tourmaline	Trace
Matrix of sericite, chlorite & fine-grained quartz	40-45
Goethite staining	

This is a sandstone composed of poorly-sorted detrital material in which the quartz and mica are similar to those in the two previous samples and the quartz varies in grain size up to about 0.4 mm. It therefore has a similar grain size to sample 249675, but it differs from that sample in that there is very little detrital feldspar and less detrital mica. It differs from the two previous samples in that there is a higher proportion of detrital grains now composed of chlorite and also more lithic grains, some of which show textures indicating derivation from very fine-grained, probably devitrified, volcanic rock. One grain, 0.2 mm in size, was derived from either basalt or andesite and there are others which are too fine-grained for their origin to be determined. There are also a number of grains now composed of chlorite stained in places by orange to brown iron oxide, and at least a few of these were probably also derived from volcanic material. In one of the chloritic grains containing leucoxene there are relict textures suggesting derivation from vesicular volcanic glass, but most of the chloritic grains do not show any recognisable relict textures or internal patterns. Heavy mineral grains are mainly dark, turbid grains of leucoxene but one moderately large tourmaline grain was found and also one grain of pale green amphibole about 0.5 mm long. There are one or two small grains of epidote and a minute trace (one grain) of apatite.

Mica flakes and elongate grains tend to be subparallel to the direction of bedding and the sediment also contains a few elongate fragments or streaks up to 0.5 mm thick of much finer-grained material which may represent fragments of shale derived from disrupted bottom sediment. The larger detrital grains are loosely packed and are cemented by a very fine-grained matrix which is generally too fine-grained to be resolved microscopically but which probably contains sericite, chlorite and possibly some very fine-grained quartz. There are a few tiny spheres of orange-brown goethite but these are probably of supergene origin.

Conclusion:

Arkosic-lithic sandstone. It is similar to sample 249675 but has less feldspar and mica and more lithic and chloritic grains, some of which were derived from volcanic rock. It could also be classified as a quartz greywacke and it was originally composed of poorly-sorted, immature detrital material.

Sample: 249682; TSC31660

Hand Specimen:
A slightly greenish-grey, very fine-grained rock weathering pale creamy colour to almost white. A freshly cut surface shows a fractured or brecciated zone and some areas which are stained by very fine-grained dark material.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Microcrystalline to cryptocrystalline quartz	>90
Mica/sericite	5-10
Chlorite	trace-1
Opaque grains/leucoxene	trace
Zircon	very minute trace
Oxidized pyrite	minute trace

Most of the rock is composed of cryptocrystalline or microcrystalline quartz but this siliceous material or siliceous matrix contains fine-grained impurities, most of which are tiny particles of mica or sericite and small flakes of chlorite but there are also a few dark grains mainly leucoxene, a few tiny zircon grains and a few grains which are too small to be identified. This argillaceous impurity is distributed uniformly throughout the cherty matrix and some of the tiny mica flakes show a preferred orientation which is probably the direction of bedding but no definite bedding planes or variations in composition could be found. There are a few tiny spheres 10 to 30 microns in diameter of clear silica similar to those in sample 249668.

In some zones in the rock there is a brecciated structure and the pattern suggests a tectonic rather than a sedimentary breccia. There are also a few abrupt changes in grain size generally separated by a thin stylolitic seam, along which there is a concentration of very fine-grained dark to opaque material. The chert is also cut by a few very thin fractures or veins which contain quartz and traces of goethite. There are one or two small grains of iron oxide which probably represent oxidized pyrite.

Conclusion:
Argillaceous chert with a brecciated zone and some small stylolitic seams.

Sample: 249684; TSC31661

Hand Specimen:

There are two rocks in this bag, one clearly labelled 249684 is a grey, medium-grained rock weathering to a paler greyish-brown and the other with very indistinct numbering is a more weathered, brownish rock with a sandstone-like tecture which is somewhat similar to sample 249673 and which is probably a feldspathic or arkosic sandstone. Only the fresher, grey rock was sectioned.

Thin Section:

A visual estimate of the minerals is as follows:

	%
Extensively altered plagioclase	50-55
Pyroxene (?pigeonite)	30-35
Chlorite	10-15
Opaque oxide	1-2
Calcite	trace

This is a medium-grained igneous rock originally composed predominantly of plagioclase and pyroxene but most of the plagioclase has been very extensively altered to very fine-grained zoisite or epidote associated with sericite and some secondary feldspar. Pyroxene has been partly replaced by chlorite and some of it by turbid, brownish material which may contain a little secondary amphibole.

The rock has a rather unusual texture in that pyroxene tends to occur as radiating aggregates suggesting that crystallization of pyroxene began at several points and there are some elongate crystals of pyroxene 2 to 3 mm long but these are not common. Some of these larger pyroxene crystals are curved and this has apparently developed during growth of the crystal. The pyroxene has a slightly lower extinction angle than diopside or augite and it has a low 2-V and these features suggest that it is probably pigeonite. In some areas pyroxene is closely intergrown with altered plagioclase and there are textures which are somewhat similar to graphic intergrowths between quartz and feldspar and these suggest that, in these areas, pyroxene and plagioclase may have crystallized more or less simultaneously. Some of the pyroxene has been replaced by chlorite. Crystals of opaque iron-titanium oxide generally between 0.2 and 0.3 mm in size are scattered sparsely through the rock and these have been extensively altered to leucoxene.

There is evidence at least mild hydrothermal alteration resulting in irregular and interstitial patches containing chlorite, secondary feldspar and calcite.

Conclusion:

This is a dolerite in which the pyroxene tends to occur as aggregates of radiating crystals and there is evidence to suggest that at least some of the pyroxene and plagioclase crystallized simultaneously.

Sample: 249685; TSC31662

Hand Specimen:
A massive, dark greenish-grey rock with a rather spotted appearance due to variations in colour.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Serpentine minerals	>90
Iron oxide	3-5

The rock has been almost completely replaced by serpentine minerals and minor secondary iron oxide but the original texture has been clearly preserved, mainly by variations in colour and staining. These relict textures show that the rock was originally composed mainly of olivine crystals, most of them between 0.5 mm and 1.5 mm in size with a few up to 2 mm and these olivine crystals were fairly closely packed with the smaller olivine crystals in interstices between the larger crystals. These olivine crystals have now been completely replaced by serpentine minerals and most of them also contain fine-grained to very fine-grained secondary iron oxide, probably magnetite.

Interstices between the former olivine crystals now contain rather turbid patches of very fine-grained material, much of which is obscured by dark staining or leucoxene, but it is probably mainly chlorite or serpentine possibly with some secondary clay. In general, this interstitial material shows very little evidence of relict textures but there are a few areas where patterns of staining suggest the former presence of crystals and fibrous aggregates of amphibole, which probably replaced original pyroxene.

Conclusion:
The rock is a serpentinite derived from dunite originally composed predominantly of olivine.

Sample: 249686; TSC31663

Hand Specimen:
A dark greenish-grey, fine-grained rock weathering pale pinkish-brown. Examination of a freshly cut surface shows that it has the texture of a fine sandstone or siltstone and there are slight variations in grain size but no regular bedding.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Grains composed mainly of zoisite or epidote including some volcanic-lithic grains	30-40
Plagioclase grains	10-15
Pyroxene grains	10-15
Chloritic grains	5-10
Opaque grains	trace
Oxidized pyrite	trace
Matrix of chlorite and zoisite or epidote	30-40

The sediment contains moderately well sorted, generally angular grains of plagioclase and very pale-coloured pyroxene commonly 0.05 to 1.5 mm in size, grains which are now composed entirely, or almost entirely, of chlorite and very numerous turbid grains which are now composed mainly of a very fine-grained member of the epidote group possibly zoisite associated with chlorite. In some of these turbid grains there are relatively clear textures showing that they were derived from fine-grained volcanic rock which was probably either basalt or andesite but in many of these turbid grains, there are no relict textures. In a few of the chloritic grains there is evidence of very small scale vesicular texture and probably most of these were volcanic glass, a few have shapes resembling volcanic shards and there are a few almost spherical grains of uncertain origin.

There are zones of irregular shape which are finer-grained and could possibly be classified as volcanic siltstone and there are also a few small streaks or pockets containing coarser-grained detrital material including one fragment of coarse-grained ?basalt about 0.4 mm long. The patterns formed by these variations in grain size suggest soft-sediment deformation possibly due either to slumping or dewatering.

The detrital grains are cemented by a very fine-grained matrix composed mainly of chlorite and zoisite or epidote and in many areas, this tends to merge with at least some of the altered lithic grains. There are only a few opaque and semi-opaque grains possibly of leucoxene and very few, tiny crystals of oxidized pyrite.

Conclusion:
Indurated, fine-grained tuffaceous sandstone or volcanic sandstone of basaltic or andesitic composition.

Sample: 249688; TSC31664

Hand Specimen:
Two rocks were submitted with this sample number. Both are greyish-green and one is coarser-grained than the other. The coarser-grained rock was sectioned.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Plagioclase	45-50
Amphibole	45-50
Chlorite	5-10
Opaque oxide/leucoxene	2-3
Goethite staining	

This is a medium-grained igneous rock containing elongate plagioclase crystals 0.5 to 1.5 mm long with a few up to 2 mm long and these were once intergrown with pyroxene crystals of similar size. Some interstices originally contained aggregates of finer-grained pyroxene and in a few there were finer-grained intergrowths of plagioclase and pyroxene.

The pyroxene has been completely replaced by bluish-green to yellowish-green amphibole which, in many zones shows patchy yellow, orange and brown staining by iron oxides. The plagioclase is turbid, possibly due to incipient development of very fine-grained zoisite but, in many of the crystals there also appear to be clouds of minute voids which may indicate some form of thermal alteration.

The rock contains scattered crystals of opaque iron-titanium oxide 0.1 to 0.3 mm in size which have been altered mainly to leucoxene and iron derived from these altered opaque grains has probably contributed to the orange to brown staining of adjacent amphibole. There are a few small patches of chlorite and also small patches and an irregular vein containing very fine-grained amphibole.

There are some bands or zones in the rock 1 to 3 mm thick along which there has been some shearing or crushing and in these zones of crushed material, there are fragments of plagioclase and amphibole in a turbid, fine-grained matrix.

Conclusion:
The rock is an amphibolite derived from a relatively fine-grained dolerite. There has been some local crushing but no general deformation of the texture.

Sample: 249689; TSC31665

Hand Specimen:
A massive, dark greenish-grey, medium-grained rock which appears weathered.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Extensively altered plagioclase	35-40
Amphibole	55-60
Altered unidentified mineral	5-10
Secondary iron oxides	variable

This was originally a medium-grained igneous rock of basic composition containing elongate plagioclase crystals mainly between 0.5 and 1.5 mm long and there are relict textures suggesting that these plagioclase crystals were intergrown with at least a few crystals of pyroxene averaging about 1 mm long. Interstices between the plagioclase crystals almost certainly were filled mainly by pyroxene. The plagioclase crystals have been very extensively altered and replaced by extremely fine-grained, orange to brown-stained phyllosilicate which is now heavily stained and partly replaced by secondary iron oxide or iron-manganese oxide. The pyroxene has been completely replaced by pale green, actinolitic amphibole, some of which is finely fibrous and some includes crystals up to 0.8 mm long.

There are scattered crystals of a completely altered mineral between 0.3 and 0.6 mm in size and these have been replaced by brownish turbid to translucent masses of very fine-grained secondary alteration products. Alteration has been too extensive for this mineral to be positively identified but it is possible that these were crystals of an iron-titanium oxide mineral replaced by leucoxene which has subsequently also been altered and stained.

There are some fractured zones in this rock which have been veined and replaced by masses of extremely fine-grained amphibole, possibly some chlorite and varying amounts of secondary iron oxides and ?manganese oxides.

Conclusion:
This a weathered amphibolite derived from a medium-grained dolerite.

Sample: 249690; TSC31666

Hand Specimen:
A dull green, fine-grained rock which is generally massive but in one zone shows a patchy variation in colour.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Amphibole	70-75
Plagioclase	25-30
Semi-opaque material	trace

This is a fine-grained igneous rock with a basaltic texture and throughout most of the area sectioned, it contains thin, elongate plagioclase crystals 0.2 to 0.6 mm long which are intergrown with random orientation. Interstices between these crystals are filled by pale green amphibole lightly stained in places by reddish-brown iron oxide and many of the plagioclase crystals are completely surrounded by this amphibole. Much of the amphibole is slightly fibrous and, although it does not show definite relict textures, it has almost certainly replaced original pyroxene. There are a few very small, very turbid patches which may be remnants of leucoxene but there is no other definite evidence to suggest that the rock originally contained any iron-titanium oxide.

There are a few small phenocrysts of plagioclase up to 0.5 mm long and there may have been a few small phenocrysts of pyroxene but these are not conspicuous. There are a few irregular, vein-like patches of rock which contain higher proportions of plagioclase, at least some of which is probably secondary and in one of these there is a trace of goethite which has replaced an unidentified mineral.

Conclusion:
Amphibolite derived from basalt (or from the fine-grained, chilled margin of dolerite).

Sample: 249691; TSC31667

Hand Specimen:

A dull greyish-green, very fine-grained rock locally stained by iron oxide. Examination of a wet , freshly cut surface suggests the presence of a small fracture zone and also of veinlets or zones of alteration and along some of these there are small aggregates of sulphide.

Thin Section:

The rock is now composed predominantly of very turbid, very fine-grained material and it is not possible to give an accurate quantitative estimate of the minerals present. It is probably now composed mainly of chlorite and ?amphibole and may also contain an extremely fine-grained member of the epidote group but individual grains cannot be identified microscopically and an accurate estimate of the present mineral composition of this rock could only be determined by X-ray diffraction. There is, however, some evidence of original texture.

The original rock was very fine-grained and may have been mainly volcanic glass with tiny crystals and crystallites of feldspar probably plagioclase. There are a few relict textures inherited from slightly larger plagioclase crystals about 0.1 mm long and in some places there are a few very small remnants of clinopyroxene. In a few places there were small phenocrysts of plagioclase generally less than 0.4 mm long and there are also a few small phenocrysts of clinopyroxene generally between 0.1 and 0.3 mm in size but with a few up to 0.6 mm long and these appear relatively unaltered but are not common.

This fine-grained volcanic rock has been extensively fractured in some zones and interstices in the fractured zones contain secondary or migratory quartz, some chlorite, possibly a little secondary feldspar and small aggregates of opaque sulphide with a grain size of 0.1 to 0.2 mm. There is also a trace of sulphide in an oval mass of secondary, fine-grained amphibole 0.5 mm long which may have been an amygdale.

Conclusion:

Altered very fine-grained volcanic rock which may have been a vitreous lava and which was either basalt or andesite. It has been fractured and invaded by quartz associated with minor sulphide.

Sample: 249693; TSC31668

Hand Specimen:
A reddish-brown, weathered and iron oxide-stained rock which is massive and appears to be medium-grained.

Thin Section:
A visual estimate of the minerals is as follows:

	%
Partly altered plagioclase	50-55
Partly altered pyroxene	25-30
Iron oxide-stained amphibole or chlorite	15-20
Grains replaced by leucoxene or sphene	2-3

The rock is weathered and extensively stained by reddish-brown iron oxide but much of its original texture has been preserved. It originally contained a relatively high proportion of plagioclase crystals 0.1 to 0.5 mm long but including a few larger crystals up to 1 mm long and also numerous aggregates of intergrown plagioclase crystals. The plagioclase is intergrown with small crystals of clinopyroxene, most of which are between 0.05 and 0.2 mm in size and there are a few larger pyroxene crystals. There are also numerous patches of translucent reddish-brown material which is either secondary mica or chlorite, possibly with some fibrous amphibole heavily stained by iron oxide and many of these patches of iron oxide-stained secondary mineral fill interstices between plagioclase crystals but in general, they do not show any evidence of relict texture. It is possible that this represents completely altered pyroxene but this could not be confirmed. The rock also contains a few scattered aggregates of turbid, very fine-grained material which is probably sphene and/or leucoxene and these aggregates probably represent altered crystals of iron-titanium oxide 0.2 to 0.5 mm in size.

There are a few small veins containing migratory and recrystallized plagioclase and minor amounts of fibrous amphibole.

Conclusion:
Partly altered and iron oxide-stained, fine-grained dolerite or very coarse-grained basalt.

...le: 249695; TSC31669, 31670 and 31671

... Specimen:
Three rocks were submitted with this number and it was requested that thin sections be prepared from all of them. They are all massive greyish-green rocks which vary in grain size. The coarser-grained rock which has been labelled A contains two zones or bands of relatively coarse-grained rock resembling dolerite separated by a fine-grained zone but the boundaries of the bands are not clearly defined and they are not regular or straight. The other two samples labelled B and C are very similar and are finer-grained than the sample labelled A.

Thin Sections:
These rocks have similar compositions and are almost certainly related and therefore one general description will be given.

A visual estimate of the minerals is given below but the proportions vary in different zones and in different samples. The rocks contain the following minerals:

	%	
Partly altered plagioclase	50-55	
Amphibole	25-30	
Pyroxene	10-15	
Opaque iron-titanium oxide	3-5	
Chlorite	trace	(varies)
Epidote	1-2	(varies)
Prehnite veins	1-2	(local concentrations)

These samples are of dolerite containing moderately abundant plagioclase crystals which vary in grain size in different zones but are mainly between 0.5 and 1.5 mm long with crystals up to 2 mm long in some places. There are some aggregates of finer-grained plagioclase and the relationship between these patches of finer-grained plagioclase and the coarser-grained plagioclase and the coarser-grained rock is not clear. The plagioclase was originally intergrown with clinopyroxene, much of which probably had a grain size of 0.5 to 1 mm and many interstices between plagioclase crystals were filled with pyroxene. Some zones still retain moderate amounts of unaltered pyroxene but in other zones it has been partly replaced by pale green amphibole. There are some zones in sample C in which all of the pyroxene has been replaced by amphibole. The dolerite also contains scattered crystals of opaque iron-titanium oxide, many of them between 0.5 and 1 mm in size and some of these include skeletal intergrowths possibly of titaniferous magnetite.

In some of these samples particularly in B and C and in the finer-grained zone of sample A, there is evidence of extensive fracturing or crushing and in a few places this has been so extensive that parts of the rock resemble mylonite. These fractured or crushed zones contain patches and veins of secondary minerals which include migratory and recrystallized plagioclase, epidote, chlorite and fibrous amphibole and in one zone in sample B, there is a relatively large vein of prehnite up to 2 mm thick.

Conclusion:
Partly altered dolerite which has been locally fractured and crushed. The crushed zones contain veins of secondary minerals.

Sample: 249696; TSC31672

Hand Specimen:
A dark greyish-green, medium-grained rock with some patches of paler-coloured minerals found in thin section to be mainly veins.

Thin Section:
A visual estimate of the minerals is as follows:

	%	
Plagioclase	40-45	
Amphibole	40-45	
Opaque iron-titanium oxide	10-15	
Prehnite	2-3	(local concentration)
Epidote	trace	
Sphene	trace	

This is a moderately coarse-grained igneous rock which, in undeformed zones contains plagioclase crystals 1 to 2 mm long including a few relatively large crystals which are sub-rectangular and not elongate as in most of the other samples. These were originally intergrown with pyroxene and pyroxene almost certainly filled interstices between the plagioclase crystals resulting in some zones which have a texture typical of that in dolerite. The pyroxene has been replaced by pale green actinolitic amphibole but there are a few crystals in which there are some corroded remnants of pyroxene and in a few places the amphibole has retained the external shape of the former pyroxene crystals. Many of the aggregates of amphibole also contain very fine-grained, secondary iron oxide or iron and titanium oxides probably released from the pyroxene when it was replaced by amphibole. The rock contains crystals and skeletal aggregates of opaque iron-titanium oxides, many of them about 1 mm in size and this opaque oxide is present in slightly higher concentration than in the previous samples of dolerite.

Parts of the rock have been deformed and crushed resulting in zones of small-scale breccia and finely crushed rock. These deformed and crushed zones contain irregular patches and veins, some of which have clear secondary plagioclase feldspar, some contain chlorite and there are also a few patches and veins of medium-grained prehnite in one of the crushed zones.

Conclusion:
Amphibolite derived from dolerite. Fractured and crushed zones have veins containing plagioclase, chlorite and prehnite.

Sample: 249697; TSC31673; PSD6656

Hand Specimen:
A greyish-green, medium-grained rock which has a uniform composition and texture resembling dolerite.

Thin and Polished Sections:
A visual estimate of the minerals is as follows:

	%
Partly altered plagioclase	55-60
Amphibole	40-45
Titaniferous magnetite partly altered	5-10
Pyroxene remnants	1-2
Chlorite	1-2
Prehnite	trace
Chalcopyrite	minute trace
Pyrite	minute trace

This is a moderately coarse-grained dolerite containing elongate plagioclase crystals 1 to 2 mm long which have been partly replaced by generally relatively minor amounts of very fine-grained chlorite and epidote or zoisite with a little sericitic material. One or two of the larger plagioclase crystals have been slightly bent but this probably occurred during solidification of the rock as there is no evidence of deformation due to tectonic stress. Interstices between the plagioclase crystals once contained pyroxene but this has been almost completely replaced by pale green actinolitic amphibole which, in many crystals or aggregates, is slightly fibrous. There are a few remnants of unaltered pyroxene generally closely associated with, or surrounded by, the secondary amphibole and this pyroxene is very pale in colour to almost colourless. In the secondary amphibole replacing pyroxene, there are small amounts of very fine-grained titaniferous material or leucoxene, probably released from the pyroxene and in a few areas of secondary amphibole, there are traces of extremely fine-grained sulphide. In the polished section, a few tiny grains of chalcopyrite varying in size from a few microns up to 20 microns were found in the secondary amphibole and in other places there are also a few tiny cubic crystals of pyrite varying in size from 10 microns to almost 50 microns.

Opaque oxide crystals 0.5 to 1.5 mm in size are scattered through the rock and in the polished section these were found to be titaniferous magnetite containing numerous exsolved lamellae of ilmenite which has been partly altered to leucoxene or very fine-grained rutile or sphene. In one of the skeletal crystals of titaniferous magnetite which has been partly altered, there is a trace of carbonate possibly siderite.

There is a slightly sheared zone containing deformed and iron oxide-stained amphibole associated with concentrations of fine-grained, secondary iron oxide but this is not extensive.

Conclusion
This is an amphibolite derived from a moderately coarse-grained dolerite or, it could also be classified as a dolerite in which the pyroxene has been extensively replaced by amphibole.

It contains a trace of sulphide including both chalcopyrite and pyrite but no evidence could be found to suggest the presence of nickel-bearing sulphide. There is also no evidence to suggest that the rock originally contained olivine which is commonly a source of anomalous nickel found in igneous rocks.

Along one side of the sample, some of the secondary silicates are more or less heavily stained by reddish-brown iron oxide including goethite but this would seem to be insufficient to explain an anomalous amount of nickel if it were present in goethite.

Sample: 249698; TSC31674; PSD6657

Hand Specimen:

A dark greenish grey rock with a slightly slippery feel on a freshly cut surface. It has a mottled appearance due to variations in colour.

Thin and Polished Sections:

A visual estimate of the minerals is as follows:

	%
Serpentine minerals	70-75
Tremolite	10-15
Pyroxene remnants	5-10
Chlorite or clay	5-10
Olivine remnants	trace
Magnetite	1-2
Sulphide including pyrite	very minute trace

This is a medium-grained igneous rock of ultrabasic composition in which the original minerals have been almost completely replaced by secondary minerals but much of the original texture has been preserved. It originally contained about 75% of olivine crystals varying in size from 0.1 to 2 mm and these were loosely packed with the smaller olivine crystals in interstices between the larger crystals. Interstices between the olivine crystals originally contained pyroxene, some of which was poikilitic with optically continuous crystals up to 2 mm long and these enclosed many of the smaller olivine crystals. The olivine has been completely replaced by serpentine minerals except for two small remnants of unaltered olivine within larger crystals but the external shape of the former olivine crystals has been clearly preserved.

Some of the interstitial pyroxene has remained unaltered and this shows a lamellar texture suggesting possible diallage but in some zones in the rock the pyroxene has been replaced by tremolite and locally by serpentine minerals. There are also patches of very turbid, very fine-grained interstitial material which has an extremely low birefringence and this could be a secondary clay mineral but it is too fine-grained to be positively identified. There are also traces of chlorite associated with some of the tremolite.

Small crystals of magnetite 0.02 to 0.05 mm in size are scattered throughout the rock and these are present in altered olivine crystals and also in some of the interstitial pyroxene or altered pyroxene. Some of these magnetite crystals are almost globular and they almost certainly formed during crystallization of the magma but there is also a little secondary, very fine-grained magnetite in some of the serpentinized olivine crystals.

In the polished section, a few tiny grains and aggregates of sulphide were found and these vary in grain size from less than 0.01 mm to a maximum of 0.03 mm. The larger sulphide grains can be identified as pyrite but some of the very tiny sulphide grains are too small to be identified microscopically and, although they are probably also pyrite, this could not be confirmed. The amount of sulphide present in the rock is quantitatively insignificant and even if it did include pentlandite would be insufficient to account for the reported 0.24 nickel.

Conclusion:

The rock is a serpentinite derived from a pyroxene dunite. It is similar to sample 249685 but originally contained a little pyroxene in interstices between the olivine crystals.

Sample: 249699; TSC31675; PSD6658

Hand Specimen:
A dark greenish-grey rock very similar in general appearance to sample 249698.

Thin and Polished Sections:
A visual estimate of the minerals is as follows:

	%
Serpentine after olivine	85-90
Altered pyroxene	10-15
Magnetite	2-3
Chlorite	trace

This is a serpentinite which has a generally similar texture to that of sample 249698 but it differs in that it was originally composed mainly of olivine with less pyroxene than was present in sample 249698. The original olivine crystals varied in size from about 0.2 mm to a maximum of 2 mm but most of them were less than 1 mm and they were moderately closely packed with smaller olivine crystals in interstices between the larger ones. The olivine has been completely replaced by serpentine but the external shape of most of the crystals has been clearly preserved. Most of them also contain a little very fine-grained secondary magnetite dispersed through parts of the former olivine crystal or concentrated along a few former fractures in the olivine.

The remaining interstices between olivine crystals originally contained pyroxene but this has been completely altered and replaced by turbid, very fine-grained material with relatively low refractive index and very low birefringence and this could be a clay mineral stained by leucoxene but positive identification would require the use of X-ray diffraction. Relict textures suggest the presence of cleavage in the interstitial pyroxene and it probably occurred as very poikilitic crystals over areas of up to 1 mm in size and these enclosed some of the small olivine crystals.

The rock contains scattered small crystals of magnetite 0.02 to 0.5 mm with a few up to 0.1 mm and these are very similar to the crystals of magnetite noted in sample 249698. As in that sample, a few of them are almost globular.

No sulphide grains were found in the polished section of this sample.

Conclusion:
Serpentinite derived from dunite which contained less pyroxene than sample 249698.

Sulphide was not found and any nickel which is present is almost certainly in silicate derived from olivine.

APPENDIX II

GRANITE CONTACT DIGHEM ANOMALY

THIN SECTION PETROLOGY

950048

EXAMINATION OF SAMPLES FROM CLEVELAND MINE AREA

Cleveland Tin Ltd
Tasmania

3/43/6/0-GS5081/81 May 1981

The Australian
ieral Development
Laboratories

ıtton Street, Frewville,
South Australia 5063
one Adelaide 79 1662
Telex AA 82520

Please address all
correspondence to
) Box 114 Eastwood
SA 5063
In reply quote:

950049

amdel

15 May 1981

GS 3/43/6/0

Cleveland Tin Limited,
LUINA, Tas. 7321.

Attention: Mr G.J. McArthur

REPORT GS 5081/81

YOUR REFERENCE: Order 14806 dated 9 April 1981

MATERIAL: 26 rocks

LOCALITY: Western Tasmania

IDENTIFICATION: 249700-735

DATE RECEIVED: 16 April 1981

WORK REQUIRED: Petrography

Investigation and Report by: Dr Brian Steveson

Manager, Geological Services Division: Dr Keith J. Henley

Keith Henley

for Norton Jackson
Managing Director

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Melbourne Vic.
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EXAMINATION OF SAMPLES FROM CLEVELAND MINE AREA

Sample: 249700; TSC32773

Location:
Wombat

Rock Name:
Basaltic microbreccia

Hand Specimen:
A weathered grey rock which is massive and essentially compact. The cut surface of the fresher material shows a fine-grained grey rock with lighter and darker specks rather poorly developed.

Thin Section:
This is a curious rock which consists of small equant but irregular fragments of basalt and altered equivalents in a relatively sparse"groundmass" of turbid fine-grained material, much of which is probably titaniferous oxide/hydroxide.

The basaltic fragments are commonly 0.15 to 0.3 mm in size. Most are equant in shape but there is some irregularity and even some evidence of the fragments fitting together closely. The fragments are clear in plane polarized light and most appear to consist of fine-grained more or less altered plagioclase feldspar. There are sericitized remnants of plagioclase microphenocrysts as much as about 0.3 mm in size. The other feature of the basaltic fragments is the presence of clinopyroxene and secondary colourless amphibole derived from it. Together these two minerals comprise probably about 15% of the volume of the rock and the clinopyroxene is more abundant than the secondary ?tremolite. In some places there are well formed clinopyroxene crystals as much as about 0.1 mm in size but much of the material is finer-grained and there is evidence that the clinopyroxene was probably irregularly distributed within the original basalt.

Between the fragments of basalt is material which is very dark both in plane polarized light and between crossed nicols. The material appears to have a dusty appearance and it is likely to be some kind of fine-grained secondary titaniferous material. There are rare patches of this up to about 0.5 mm in size but for the most part it forms a fairly well defined network around and between the fragments of basalt. The rock also contains both fine-grained and coarse-grained opaques, some generally occurring within the basalt fragments but elsewhere there are one or two relatively large opaque fragments apparently of secondary origin in some way.

It is not clear from the petrography whether the unusual microbreccia texture of the rock is of primary or secondary origin. If primary, it probably results from some kind of autobrecciation (possibly by gases) of the original basalt. If the texture is of secondary origin, it is probably some very late brecciation possibly not even associated with the volcanic period during which the basalt was crystallized.

950051

Sample: 249701; TSC32774

Location:
Wombat

Rock Name:
Secondary biotitic rock (?altered basalt)

Hand Specimen:
This is a massive and compact aphanitic grey rock with a brown weathered crust.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Biotite	75
Quartz	10
Opaques	10
Plagioclase	≤5

This sample consists of a fine-grained mosaic of biotite and opaques within which are quartz and plagioclase crystals commonly ranging in size from 0.1 to 0.2 mm. It is not clear whether the sample is a basaltic rock which has been completely altered and in which biotite and plagioclase represent, in some way, remnant microphenocrysts or whether the sample was possibly some kind of intermediate tuffaceous rock and the groundmass has now been altered completely to biotite and the quartz and feldspar represent fragments included in the tuff. The quartz and feldspar fragments, themselves, are equant anhedra ranging in some instances to subhedral shapes of plagioclase. Plagioclase laths are generally fairly fresh and show fairly broad polysynthetic twinning. The quartz crystals tend to be somewhat embayed and serrated in details of their outlines. The quartz and feldspar are not, of course, sufficiently abundant to form any kind of framework.

The groundmass is completely homogeneous over the area of the thin section and consists of a mosaic of extremely fine-grained biotite with opaques. The average crystal size of the biotite could not be determined even under high magnification but it is probably significantly less than 0.02 mm. The biotite is a pale brown pleochroic variety and appears to be of secondary origin entirely. In one or two places, there are slightly coarser-grained patches of biotite and these, in effect, speckle the rock. These coarser patches are not more than 0.1 mm in size and they may represent completely altered mafic phenocrysts or crystals of some kind. The opaques are small specks, some of which are elongate but most are fine-grained and dusty.

The preferred interpretation of this rock is that it is some kind of basic or intermediate volcanic rock probably with a crystal tuff component. Original mafic or intermediate constituents have now been completely altered to secondary fine-grained biotite.

Sample: 249702; TSC32775

Location:
Wombat

Rock Name:
Altered biotite-rich ?tuff

Hand Specimen:
The sample is similar to 249701 in that it it is a massive and compact grey aphanitic rock.

Thin Section:
In overall mineralogical terms this sample is similar to 249701 but amongst the fine-grained biotite, there is more evidence in this sample of the presence of fine-grained felsic minerals and colourless phyllosilicate. The whole texture of this part of the rock is apparently fragmentary on a small scale and also there is some evidence of parallel orientation of the long axes of the textural features so the sample has much more the appearance of a tuffaceo or extrusive rock (very likely the former) than an intrusive altered basalt, for example.

There are monomineralic patches of biotite up to about 0.3 mm in size. Thes tend to be relatively coarse-grained and may represent pseudomorphs after original mafic components. Most of the biotite in the rock, however, occurs in a rather heterogeneous groundmass consisting of biotite, opaques and indefinite fine-grained colourless minerals. The overall crystal size of this part of the rock is less than 0.04 mm but mineralogical differences serve to define a fragmentary texture on a scale of approximately 0.1 mm. Fragments with slightly different proportions of the minerals and different textures are ill-defined but most appear to be equant to a little elongate. The colourless components are probably mainly sericite/muscovite with small proportions of secondary quartz and feldspar. Opaques are fairly common and probably comprise fully 10% of the volume of the rock. Most of the opaques are extremely fine-grained and dusty and there are some patches in wh such fine-grained material is concentrated. Elsewhere opaques form monomineralic but fine-grained patches up to about 0.1 mm in size. Also present in the rock are a few well-defined crystals or aggregates of quartz and feldspar but these comprise less than 7% of the volume of the rock and most are not more than about 0.2 mm in size. Rare instances are poly-crystalline feldspar fragments up to 0.4 mm. All of these larger features are thought to be crystal fragments incorporated in what is, in the main, a intermediate fine-grained tuff of some kind.

Sample: 249703; TSC32776

Rock Name:
Altered basalt

Hand Specimen:
A massive and compact aphanitic grey rock which shows a considerable amount of weathering particularly to porous brown material.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Plagioclase	50
Semi-opaques and clinopyroxene	30
Olivine	10
Carbonate	10

This sample is clearly an olivine basalt which has been subjected to considerable alteration of the clinopyroxene.

Olivine is present as microphenocrysts ranging in size commonly up to about 1 mm. As far as can be determined, the olivine is essentially fresh but many of the crystals are somewhat cracked and few show even subhedral outlines. Original finely granular clinopyroxene apparently formed in the irregular spaces between interlocked crystals of plagioclase. Much of this intergranular space is now semi-opaque in plane polarized light but under high magnification and intense illumination, it appears likely that much of the clinopyroxene has in fact been preserved or only partly altered and is simply masked by the fine-grained nature of some of the secondary iron oxide and titanium oxide material. At any rate, this semi-opaque material now occupies a considerable proportion of the rock and forms a virtually contiguous mosaic around the fresher olivine and plagioclase.

Laths of the latter mineral have a decussate interlocked arrangement such as characterises basalts and dolerites. Most laths are not more than 0.3 mm in length and all are fresh and show some evidence of polysynthetic twinning on the Albite Law.

Finally, the sample shows considerable alteration to carbonate. This mineral forms small granular aggregates consisting of unstained material (therefore probably dolomite) and individual crystals are up to 0.2 mm in size. In one place in the thin section there is a large spray of radially-arranged carbonate crystals possibly related to some kind of vesicle.

This sample is a typical basalt showing extensive alteration of clinopyroxene partly obscured by diffuse opaque and semi-opaques. The latest stage of alteration has resulted in the introduction of granular ?dolomite.

Sample: 249704; TSC32777

Location:
Kombat

Rock Name:
Altered basalt

Hand Specimen:
A massive and compact grey aphanitic rock which shows a considerable amount of weathering both on the surface and in some patches in the body of the rock.

Thin Section:
The sample is very similar to 249703 and hence a detailed description will not be given. The rock is clearly an olivine basalt showing a typical subophitic texture. Olivine is present as microphenocrysts which comprise about 10 to 15% of the volume of the rock. These crystals are less than 1 mm in size. Plagioclase is fresh and forms subhedral to euhedral laths in a typical decussate arrangement. Alteration has affected the clinopyr predominantly. This is now present in opaque to semi-opaque fine-grained aggregates between the laths of feldspar. Under high magnification and intense illumination, fine-grained granular ?clinopyroxene can still be seen in these aggregates even despite the large amount of fine-grained opaque material. A late-stage of alteration in the rock has resulted in the deposition of carbonate. For the most part, this forms clear crystals generally about 0.1 to 0.2 mm in size and these appear likely to be dolomite There are some partly radiating arrays of this mineral and some patches of brownish carbonate which may be siderite. Carbonate overall comprises not more than about 5% of the volume of the sample.

With respect to this group of rocks (249700-249704) the last two, 703-704, are straightforward olivine basalts, 701 and 702 are tentatively interpreted as basic or intermediate igneous rocks possibly tuffs of some kind and final 249700 is a basaltic rock which shows some evidence of what is interpreted a autobrecciation.

Sample: 249705; TSC32778

Location:
Main Road

Rock Name:
Biotite hornfels (maculose in places)

Hand Specimen:
This is an extremely fine-grained black rock with a subconchoidal fracture. The hand specimen shows some evidence of a foliation but this is not as well developed as in the thin section.

Thin Section:
This is a fine-grained rock consisting of biotite and felsic components with smaller amounts of opaque and tourmaline. In places there are well defined lenses and bands which have a similar mineralogy but are characterised by the presence of numerous spots. The rock is clearly of metamorphic origin but it is not possible to distinguish whether it is of igneous or sedimentary origin.

The bulk of the rock has an average crystal size of approximately 0.05 mm and consists of a mosaic of biotite and opaques with fairly abundant, partly sericitized feldspar and small crystals of quartz. Apart from the biotite and opaques, the other components tend to be somewhat obscured by sericitic material and it is difficult to determine the nature of the feldspar. There is some evidence that original feldspar crystals may have been of the order of 0.1 to 0.2 mm in size and have now been obscured by the presence of biotite and, more importantly, sericitic material. Quartz forms fairly clear crystals as much as 0.1 mm in size. The remainder of the material is dusty opaques and fine-grained deep brown biotite rather typical of metamorphic rocks.

There are well defined, somewhat irregular lenses which consist of a fine-grained mosaic of biotite and opaques with minor felsic components but characterised by the presence of distinct dark spots. These spots are dark between crossed nicols as a result of the concentration within them of fine-grained opaques. Under crossed nicols, however, many show bulk extinction and it is at least a possibility that they are single crystals of a mineral such as andalusite or plagioclase very largely obscured by the opaques. These circular to oval spots are generally about 0.1 mm in size and comprise 30 to 40% of the volume of the bands in which they occur. The matrix of these spots has a similar mineralogy to the bulk of the rock but is much finer-grained.

Overall, the sample has the appearance of a biotite hornfels showing a tendency towards the development of porphyroblasts of a mineral such as plagioclase or andalusite. Unfortunately, many details of the rock are obscured by opaques and sericitic material and, although the chemistry of the rock is rather indicative of the sedimentary origin, an igneous precursor cannot be entirely ruled out.

Sample: 249706; TSC32779

Location:
Main Road

Rock Name:
Olivine basalt

Hand Specimen:
An aphanitic black rock which is massive and compact. The sample contains spherical features which contain somewhat coarser-grained green material.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Plagioclase	50
Clinopyroxene	20
Olivine	15
Opaques	10
Secondary minerals	5

The sample is a typical microporphyritic olivine basalt. The rock shows minor alteration resulting in the formation of a brown secondary product after olivine and dispersed green phases probably akin to serpentine.

Olivine microphenocrysts are present in a glomeroporphyritic texture and individual crystals are up to about 0.6 mm in size. Some olivine crystals are subhedral but most are distinctly anhedral. Cleavage traces and other parts of the crystals show some alteration resulting in the presence of a brown secondary product and some greenish-brown material, all of which are probably serpentine-like phases.

The remainder of the rock is fine-grained and consists of a mosaic of plagioclase laths and finely granular clinopyroxene. The latter mineral is notably fresh and consists of subhedral to anhedral crystals commonly less than 0.05 mm in size. Clinopyroxene virtually fills much of the intergranular space between the microphenocrysts and the laths of plagioclase. The latter is also completely fresh and the laths are generally of the order of 0.1 to 0.2 mm in length; they form a mesh of interlocked randomly arranged laths within which the pyroxene occurs in typical subophitic textures. Also present is a scattering of fine-grained granular opaques and diffuse patches of secondary green material.

The sample is a typical basalt showing patchy alteration of mafic phases to brown and green phyllosilicates.

Sample: 249710; TSC32780

Location:
Main Road

Rock Name:
Biotite-epidote schist (?hornfels)

Hand Specimen:
This is a fine-grained essentially black rock with a brown weathered crust. The cut surface of the hand specimen shows indefinite spotting on a scale of about 5 to 8 mm.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz/plagioclase	45
Biotite	30
Epidote	20
Opaques	3-5

This sample has a heterogeneous mineralogy and texture and the spotting seen in the hand specimen is reflected by mineralogical variation in the thin section. The sample is clearly essentially of metamorphic rock and there is no evidence of the specific nature of the precursor. The sample may be better described as some kind of hornfels particularly in that the sample has developed some spotting as in the case of 249705.

Most of the sample consists of a fine-grained homogeneous mosaic of biotite, opaques and felsic minerals. The average crystal size of the randomly oriented brown biotite flakes is about 0.05 mm. Between these flakes is a matrix of fairly fine-grained felsic material. Under crossed nicols this shows a spotted texture on a scale of about 0.2 mm and it is thought that the indefinite spots are probably relics of plagioclase feldspar whereas in the remainder of the rock the biotite probably occurs with fine-grained quartz. This is difficult to evaluate positively because of the presence of fine-grained ?sericite and dusty opaques. The texture may be some indication that the original rock contained small plagioclase crystals but, equally well, the plagioclase crystals may be porphyroblasts developed during metamorphism.

In the remainder of the rock quartz and epidote are the predominant minerals. There are many fields of view containing more than 50% of epidote. Both the epidote, quartz and the small amount of opaques are finely granular components and have an average crystal size of about 0.04 mm. In some cases epidote crystals show some somewhat tabular outlines and an indication of preferred orientation of the crystals. There is also some suggestion in the thin section of the epidote having a radial habit and it seems possible that the epidote-quartz-opaques assemblage has developed at the expense of the biotite-quartz-plagioclase assemblage. The texture is therefore thought to be overall a result of metamorphism rather than a reflection of the nature of the original sample.

The sample is a metamorphic rock characterised by the predominance in different places (they do not occur together) of biotite and epidote. The sample shows some spotting textures on a range of scales as a result of the growth of the crystals during metamophorism. The sample is some kind of hornfels but it is not possible to indicate the nature of the precursor.

Samples 249705-249707 are a single group from Main Road and samples 249705 and 249707 can be compared with each other in that both are metamorphic rocks rich in biotite. Sample 249706 is, however, an olivine basalt similar to other olivine basalts described above and quite dissimilar from samples 249705 and 249707.

Sample: 249711; TSC32781

Location:
Main Road - Badger to Betts

Rock Name:
Altered intermediate igneous rock

Hand Specimen:
This is a massive and compact grey aphanitic rock with a prominent pale brown weathered crust.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Felsic minerals in the groundmass	50
Amphibole	30
Quartz	15
Opaques	5
Chlorite	<5

The bulk of this rock is a fine-grained granular mosaic of quartz and feldspar with a rather varied mesh of interlocked needles of colourless amphibole. Within this are coarser-grained patches of quartz, amphibole and opaques. The rock is interpreted as being some kind of altered ?intermediate porphyritic igneous rock.

Quartz crystals in the list above refers to equant anhedral crystals generally 0.1 to 0.3 mm in size. These are widely and randomly distributed throughout the sample. One or two have marginal zones of ?feldspar and in some cases the quartz shows evidence of having been micrographically intergrown with potassium feldspar so that the quartz is interpreted as being of igneous origin rather than sedimentary. The quartz occurs in a groundmass in which the average crystal size of felsic minerals is less than 0.01 mm. As far as can be determined quartz and ?plagioclase are both significant components of the groundmass and it is possible that much of this material is essentially unmodified primary igneous groundmass. There is a fine mesh of acicular needles of tremolite throughout the groundmass but the proportion of this material varies significantly from place to place in the thin section. In some places, there are coarser-grained aggregates of monomineralic amphibole but these tend to have rather diffuse outlines and irregular shapes so that it is not possible to relate them to, say, mafic phenocrysts. The rock shows some banding due to variations in the proportions of the minerals and this is thought to reflect variations in the nature of the original rock. In one place there is an indefinite band of relatively coarse-grained amphibole and secondary opaques and quartz.

The sample is sieved with fine-grained opaques and these, to a certain extent, obscure the fine-grained felsic groundmass. In plane polarized light it can be seen that there are considerable variations in the nature of the material from place to place in the thin section even on a scale as small as about 0.2 mm.

This is a secondary rock of rather intermediate composition and characterised by the abundance of secondary amphibole. The sample is thought to be an altered igneous rock probably a porphyritic intrusive. It is just possible that the sample may have some kind of tuff and that the quartz crystals now represent material deposited in a tuffaceous matrix but the sample is so altered that it is not possible to give a specific origin for the rock.

Sample: 249712; TSC32782

Location:
Main Road - Badger to Betts

Rock Name:
Weathered biotite schist

Hand Specimen:
This is an aphanitic grey rock which shows considerable weathering. The hand specimen is tabular and has an ill-defined schistose appearance overall. There are cross-cutting veinlets and patches of the weathered material and one vein is as much as 1 mm in width.

Thin Section:
This is an extremely fine-grained rock consisting principally of biotite and its alteration products together with opaques and felsic phases. The average crystal size of the biotite and opaques is generally less than 0.01 mm and it is not possible to give details, particularly of the felsic phases. It is possible that this material comprises less than 10% of the volume of this part of the rock and the bulk of the remainder is phyllosilicate minerals comprising either fairly pale brown biotite and colourless minerals which are probably largely chloritic. The sample shows hardly any bulk extinction and it is likely that on a small scale the texture is essentially random and granular. The rock contains about 15 to 20% of fine-grained opaques randomly scattered throughout the mosaic of silicates.

On the relatively large scale the rock is fairly well banded and there are variations in the colour of the material in plane polarized light on a scale of the order of 1 to 2 mm. To some extent this is clearly the result of weathering and the deposition of secondary ferruginous material but it probably also reflects variations in the composition of the original material now shown by changes in the ratio of phyllosilicate to felsic components. The sample contains veinlets of limonitic material and there are patches of semi-opaque dark red material which are probably also limonite, possibly after original pyrite.

The sample can probably best be described as a fine-grained metamorphic rock of acid to intermediate composition and showing some evidence of pre-metamorphic banding. The composition of the rock is rather more akin to a metamorphosed sediment than an igneous rock although it is scarcely possible to be certain of this in view of the fine-grained nature of the minerals and the difficulty in making mineral identification.

[illegible] 0713; TSC32783

[illegible]
Main Road - Badger to Betts

[illegible]
[illegible]

Hand Specimen:
This is a very weathered rock which has an overall buff colour. There is some evidence of foliation of the rock but this is shown as much by the overall shape of the hand specimen as by any textures on the cut surface. The sample is soft and clayey and there are friable irregular veinlets of pale weathered material.

Thin Section:
This sample is so weathered and obscured by secondary limonitic material that it is scarcely possible to indicate the minerals present and their proportions. All that can be seen in thin section is quartz crystals commonly not more than 0.2 mm in size which comprise about 10% of the volume of the rock. These occur in a matrix of turbid more or less dark material which probably consists of clays, limonite and possibly remnants of fine-grained feldspar. A characteristic feature of the bulk of the rock, however, is a variation on a scale of about 0.2 mm. This results from what appears to be an indefinite network of iron-rich material surrounding equant to oval patches of what is probably clay-rich material. It is at least a possibility that the argillacous patches represent fragments of some kind deposited in tuff and it seems most likely that the sample is some kind of acid or intermediate tuffaceous rock which possibly originally contained numerous pumice fragments as well as crystals of quartz. This is a tentative interpretation based on the overall appearance of the texture of the rock.

The sample also contains numerous cross cutting veinlets, in many respects similar to the bulk of the rock. Most are altered ferruginous patches but in one or two of the larger veinlets there is a texture roughly at right angles to the length of the vein indicated by stacks of phyllosilicate (?kaolinite). All of the veinlets are more or less obscured by limonite or a similar phase.

Sample: 249714; TSC3778.

Location:
Main Road - Badger to Petit

Rock Name:
Altered basic or intermediate igneous rock

Hand Specimen:
This is a weathered grey to somewhat brown coloured rock which is fairly compact but shows some jointing and veining in several directions.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Matrix	25
Quartz	30
Epidote	20(+)
Tremolite	15
Chlorite	5
Opaques	5
Plagioclase	<5

This is a rather heterogeneous rock which consists mainly of secondary minerals probably derived from a basic or intermediate precursor. Some of the secondary minerals (particularly tremolite and quartz) are associated with cross cutting veinlets and epidote generally occurs throughout the rock in fine-grained granular mosaics. The mineralogical composition given above should be regarded as approximations, only, since the sample is fine-grained and turbid in many places and it is possible, for example, that there may be considerably more epidote than listed above. The fine-grained material referred to as matrix is fairly turbid and dark in plane polarized light and generally more or less dark between crossed nicols. In some places much of the material is clearly a plyllosilicate related to sericite and it is possible that there are pseudomorphs of small tabular plagioclase crystals. Elsewhere similar phyllosilicate material is intergrown with opaques and epidote in granular mosaics which vary considerably on a scale of about 0.2 to 0.5 mm.

Amongst this fine-grained material, quartz occurs both as discrete crystals and in irregular monomineralic polycrystalline aggregates. Discrete crystals are generally 0.1 to 0.5 mm in size but there is virtually a gradation towards rather indefinite veinlets containing coarse-grained quartz and mafic minerals. These veinlets are generally of the order of 0.5 mm in width and have a granular texture in which quartz occurs with tremolite and chloritic material. Some aggregates of tremolite are as much as 0.5 mm in size overall. Epidote and opaques are also minor constituents of these veinlets.

Epidote and chlorite mainly occur throughout the bulk of the rock where they are intergrown with opaques and indeterminate fine-grained felsic phases. Epidote includes both picotite and clinozoisite and chlorite is generally a more or less colourless variety showing blue anomalous interference colours. Both minerals are commonly essentially fine-grained and granular and there are some fields of view where both together comprise as much as 70 or 80% of the volume of the sample.

It is the secondary mineral assemblage of epidote, chlorite, tremolite and

quartz which suggests that the sample was derived from a basic or intermediate igneous precursor. There are some textural features of the fine-grained part of the rock rather akin to tuff but this is not as well defined as in other rocks in this collection and may be a function of mode of alteration. In one place there is an aggregate of tabular plagioclase crystals quite different from the remainder of the rock and the heterogeneity represented by this and other features of the sample, suggests the possibility of a tuffaceous origin although this hardly accords with the apparently basic composition of the rock overall.

950064

Sample: 249716; TSC32785

Location:
Main Road - Badger to Betts

Rock Name:
Fine-grained secondary rock

Hand Specimen:
This is a buff-coloured rock which is somewhat heterogeneous and shows some evidence of banding. The cut surface shows several aphanitic lithologies ranging in colour from almost pink to a homogeneous buff colour. Also present are concordant weathered-out veinlets of apparently ferruginous material.

Thin Section:
The rock appears to be somewhat more homogeneous in thin section than in hand specimen and the bulk of it consists of an extremely fine-grained aggregate of randomly oriented phyllosilicates and opaques, possibly with some quartz and/or feldspar also. Much of the rock appears, however, to be phyllosilicates showing moderate birefringence and hence probably referable to either sericite or illite. This material has a random orientation and in some places individual flakes up to about 0.01 mm in size can be seen. The rock also contains dispersed opaque and semi-opaque ferruginous or titaniferous material and this comprises of the order of 10% of most of fields of view. The extent to which very fine-grained quartz or feldspar is present with the phyllosilicate and opaques is difficult to determine by optical means alone; if such minerals are present, then they are extremely fine-grained and probably do not comprise more than about 20% of the volume of the bulk of the sample. The rock appears to be a completely homogeneous mosaic very largely of clay and it is thought that this is derived from the complete alteration and replacement of original constituents. Any original textures have been completely obliterated from the bulk of the sample.

Heterogeneities in the rock are represented by some places where there is a more spotted appearance largely due to variations in the amount of ferruginous material. Darker parts of the rock form a fairly abundant network within which are clearer patches generally ranging in size from 0.1 to 0.3 mm. Elsewhere opaques and are relatively coarse-grained and patches of limonitic material are up to 0.1 mm in size.

The rock contains cross cutting veinlets of secondary granular quartz associated with a little opaque material.

It is not possible to give an origin for this rock since original minerals appear to have been completely replaced and none of the original textures have been preserved apart, possibly, for some spotting which may be a little evidence to suggest that the rock is more likely to have been of sedimentary or tuffaceous origin rather than an intrusive igneous rock.

[illegible] 249717; TSC32786

[illegible]:
Main Road - Badger to Betts

[illegible] Name:
Altered tuff

[illegible] Specimen:
A grey aphanitic rock which has a somewhat tabular appearance overall. There are a few irregular paler veinlets.

[illegible] Section:
This is a generally fine-grained rock with a homogeneous mineralogy and texture overall but showing variations on a small scale. The sample is thought to be some kind of altered tuffaceous rock and this interpretation is based largely on textural features. Approximately 30% of the rock consists of clear crystals of quartz and somewhat more altered and turbid crystals of feldspar. These rest in a finer-grained matrix consisting of clays, biotite and possibly fine-grained quartz and feldspar also. There is a considerable amount of dispersed dark material.

The larger quartz and feldspar crystals range in size from about 0.05 mm to 0.2 mm and most are equant anhedral crystals. Quartz is far more abundant than feldspar and, in fact, only a few feldspar crystals could be positively identified.

These crystals rest in a matrix of much finer-grained material which contains fairly abundant phyllosilicate minerals. Some of the latter are clearly secondary biotite which forms fine-grained aggregates and elsewhere there is more or less turbid material of colourless clays (possibly including chlorite) and fine-grained quartz and feldspar. The whole is obscured by dusty opaque and semi-opaque material as well as dispersed clay and sericite. This fine-grained part of the rock shows a somewhat variable texture on a scale of the order of 0.1 to 0.2 mm and it is this which suggests that the rock is a tuff. That the sample is not an intermediate or basic igneous rock is suggested by the presence of rare crystals of tourmaline since this is not a common accessory in such rocks. The sample is therefore thought most likely to be a tuff which has a sedimentary component and also includes, in this case, crystal fragments and possibly now altered pumice fragments and small lapilli.

[illegible] 9718; TSC32787

[illegible]
[illegible]at

[illegible]:
[illegible]ied intermediate or acid igneous rock (?tuff)

[illegible] Specimen:
A[illegible]ssive and compact grey aphanitic rock.

[illegible]ion:
An optical estimate of the constituents gives the following:

	%
Amphibole	50
Quartz	25
Opaques	15
Feldspar	10

This is generally a fine-grained but fairly well crystallised rock which is notably homogeneous. The sample contains relatively large crystals of quartz and feldspar in a finer-grained mosaic in which amphibole and opaques are the predominant phases. It is difficult to estimate the proportions of quartz and feldspar in the fine-grained material but it is probably a relatively small proportion of the matrix. The larger quartz and feldspar crystals could be interpreted either as remnants of phenocrysts or of crystals incorporated in some kind of vitric tuff. The overall appearance of the sample and analogy with other samples in this group, inclines the writer to the view that the sample is more likely to be of tuffaceous origin.

Quartz and feldspar crystals range in size up to 0.4 mm. The feldspar shows complex twinning and much of it is clearly plagioclase and it is at least a possibility that all of it is, in fact, plagioclase possibly modified during metamorphism and partial recrystallisation of the whole of the rock. The crystals of quartz and feldspar are equant anhedra and they appear to be randomly distributed throughout the rock. Many of the crystals are embayed by needles of amphibole.

The bulk of the rock is a fine-grained mosaic in which amphibole and opaques are more abundant than colourless minerals. The amphibole forms blades and needles generally not more than 0.1 mm in length. The mineral shows pleochroism in pale shades of brown and while it is recognised that this is unusual, the mineral certainly does not appear to be biotite. The needles of amphibole have a random orientation and form a mesh throughout virtually the whole of the rock. In a few places, there are monomineralic aggregates of the amphibole but these are small and do not have any characteristic shapes to indicate that they are, for example, pseudomorphs after original phenocrysts. Opaques are widely distributed throughout the rock as fine dusty material and quartz and feldspar occur in the interstices between the amphibole needles as crystals ranging in size effectively from about 0.1 mm downwards.

This is probably largely a secondary rock with the mineral assemblage of amphibole-opaques-quartz-plagioclase. Quartz and plagioclase may be remnants of an original igneous or tuffaceous rock but the amphibole is completely recrystallised. The amphibole is an unusual brown pleochroic variety occurring as distinctly needle-like crystals.

Sample: 249720; TSC32788

Location:
Wombat

Rock Name:
Metamorphic amphibole-rich rock

Hand Specimen:
This is a grey fairly massive rock which has an aphanitic texture. The hand specimen has a somewhat platy appearance and the rock may have a weakly developed schistosity. There is a prominent brown weathered surface.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz and plagioclase	45
Amphibole	40
Opaques	10
Biotite	5

This rock is a homogeneous fine-grained mosaic of the minerals listed above. There are only minor variations in the mineralogy of different fields of view and the texture and mineralogy both appear to be derived from the secondary processes that have operated on the rock rather than being the result of, for example, magmatic crystallisation. Much of the rock consists of crystals which are less than 0.05 mm in size. For the most part there is an interlocked mosaic of acicular colourless amphibole crystals within which is granular colourless material. The latter is better-crystallised than in many rocks in this collection and quartz and plagioclase can commonly be specifically identified. Larger crystals of these minerals are up to 0.1 mm in size but most are significantly smaller. In addition, the felsic minerals are partly obsured by very fine-grained opaques. The clear nature of the quartz and, particularly, the feldspar suggests that these minerals are of metamorphic origin rather than being altered remnants of original primary igneous minerals. Rare quartz and feldspar crystals are as much as 0.2 mm in size but these are equant anhedra and again are probably of metamorphic origin rather than being unrecrystallised relics of micro-phenocrysts.

Biotite is fairly widely distributed throughout the sample but has a tendency to occur in specific aggregates rather than as discrete flakes. These aggregates are by no means monomineralic and few are well defined, rather they show gradational contacts with the adjacent amphibole and felsic material.

In brief, therefore, the sample has a metamorphic mineral assemblage of tremolite-plagioclase-quartz-biotite. The rock has a massive interlocked texture and is probably best regarded as a hornfels which, on petrographic evidence alone, may be of either sedimentary or igneous origin. The rock appears to have an intermediate composition so that if it were derived from an igneous precursor this would have probably been a plagioclase-rich andesitic or dacitic rock.

Sample: 249722; TSC32789

Location:
Kambalda

Rock Name:
Fine-grained amphibolitic ?hornfels

Hand Specimen:
A massive and compact aphanitic grey rock with a prominent brown weathered crust.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Amphibole	∿50
Quartz and plagioclase	40
Opaques	10
Biotite	≤10

The sample shows irregular variations in the proportions of the minerals from place to place in the thin section but the overall metamorphic assemblage is as indicated in the list of minerals above. In general the sample is fine-grained and there is little or no foliation particularly on the broad scale of the thin section. On this basis the sample is probably best regarded as a hornfels and it is not possible to determine whether it was derived from a sediment or a igneous rock.

The bulk of the sample consists of a mosaic of finely granular quartz and plagioclase associated with a colourless amphibole which forms a virtually contiguous aggregate throughout the rock. Although the average crystal size of the quartz and feldspar (and biotite and opaques) is generally less than 0.05 mm, the amphibole shows common extinction positions over considerable areas of the thin section. This is probably due to the excellent parallel orientation of the long axes of the amphibole crystals although it is also possible that the amphibole is present as large crystals densely sieved by the other components in the rock. The texture is rather obscured in places as a result of the fine-grained nature of the rock and the presence of some intergranular turbidity in most areas of the section. In some fine-grained amphibole-rich parts of the rock it is possible that there is a little epidote as well as the other minerals listed.

Biotite does not show the same parallel orientation as does the amphibole and the flakes apparently have a decussate arrangement. The biotite is a typical metamorphic variety showing marked pleochroism from brownish-red to pale yellow. The flakes tend to be a little larger than the crystals of quartz and plagioclase and they are commonly about 0.1 mm in size overall. The quartz and plagioclase themselves form a granular to, in many places, granoblastic mosaic characterised by the presence of simple crystal margins and triple point junctions. The whole is sieved with very fine-grained dusty opaques. It is thought that quartz is considerably more abundant than plagioclase but some of the latter can be specifically identified in some places in the thin section.

Quartz and amphibole are present in the rock in rather irregular veinlets and there are also some veins of a limonitic material. In one or two places there is some rather turbid greenish material which may well be a little

...lorite.

...is is a massive fine-grained metamorphic rock characterised by the ...ndance of colourless amphibole, quartz and plagioclase with minor ...tite. The sample has been derived from the complete recrystallisation ...der metamorphic conditions of some kind of intermediate rock.

...21; TSC32790

...altered medium-grained granitic rock(?)

...ea:
...medium-grained speckled grey rock which appears to be massive
...quet.

...:
...optical estimate of the constituents gives the following:

	%
Quartz	50
Sericite/muscovite	30
Chlorite	15
Opaques/semi-opaques	3

...essence, the sample consists of quartz crystals ranging in size from ...to about 0.8 mm in a matrix of finely granular sericitic material. ...one or two places there is some evidence that the sericite may have ...derived from the complete alteration of tabular feldspar crystals. ...sample may well, therefore, have originally been some kind of medium-...ained acid igneous rock in which the feldspar has been completely ...ericitised. The sample contains a large amount of quartz even by the ...ndards of acid magmatic rocks and it is thought likely that if this ...erpretation is correct the sample has been subjected to some kind of late ...ification possibly akin to a greisenisation process.

...artz crystals are equant anhedra and they comprise about 50% of the volume ...the rock. Most of the crystals are distinctly irregular in shape and ...here they occur together there is considerable evidence of interlocking. ...between these crystals fine-grained colourless mica forms a random mosaic ...posed of flakes generally not more than about 0.05 mm in size. In one ...or two places there is evidence of parallel orientation of the flakes and ...they occur in a relatively dense aggregate; in these places the sericite ...may be a pseudomorph after tabular crystals of plagioclase possibly more ...than 1 mm in length.

...inor components of the rock are patches of chlorite with intergrown opaque ...and semi-opaque titaniferous material. Some of the aggregates of chlorite ...are as much as 1 mm in length and they appear to be single crystals possibly ...derived from the complete replacement of original primary igneous biotite. ...certainly the way the chlorite occurs in small patches throughout the rock ...is similar to the occurrence of biotite in granitic samples. In other places ...the chlorite is finer-grained and closely intergrown with the sericite but ...this is less common than fairly well formed crystals or aggregates of chlorite ...with parallel-aligned wisps of semi-opaque titaniferous material.

...mples 249718-249723 are from the same general area but the rocks are difficult to relate to each other from petrographic evidence alone. Samples 249718, ...720 and 722 are fine-grained metamorphic rocks characterised by the presence of ...amphibole and/or biotite. The origin of the rocks is rather difficult to determine but it is thought likely that these are horfels and they are certainly of metamorphic origin. Sample 249723, on the other hand, is a much coarser-grained rock and is thought likely to be some kind of intensely altered and possibly silicified medium-grained acid igneous rock.

[illegible]; TSC32791

[illegible] Tailings

[illegible]:
[illegible] Tuff

[illegible]:
[illegible]ample is an extremely weathered friable rock which has a brown or [illegible] colour. The cut surface shows mainly aphanitic material but this [illegible] a matrix within which are paler clayey fragments up to about 1 cm [illegible] size. These fragments are notably randomly distributed throughout [illegible] rock and large and small fragments occur together.

[illegible]ction:
[illegible] thin section consists mainly of secondary phyllosilicate minerals [illegible] clays together with small amounts of secondary quartz and limonitic [illegible]terial. It is impossible to give details of the mineralogy by optical [illegible]amination alone.

[illegible] matrix of the rock shows some colours in crossed nicols and these [illegible]obably derive from extremely fine-grained sericitic or illitic material. [illegible] remainder of the matrix is dark between crossed nicols and fairly turbid [illegible] plane polarized light and it probably consists of a mixture of iron and [illegible]itanium oxide/hydroxides and clays. The material appears to be massive [illegible] there is little evidence of an overall bulk extinction. There are [illegible]riations in the mineralogy of the groundmass on a scale of the order of [illegible]bout 0.1 to 0.2 mm and in many places this results in the groundmass having [illegible]somewhat foliated appearance but this is by no means well defined.

[illegible] fragments which can be seen in the hand specimen appear in thin section [illegible] homogeneous fine-grained aggregates of somewhat rounded to blocky fragments. [illegible] range in size in the thin section from about 0.5 mm up to several [illegible]illimetres. These fragments can be distinguished from the bulk of the [illegible]k largely by the smaller proportion of sericitic material and probably [illegible]rrespondingly greater amount of clay. Most of the fragments have a thin [illegible]rginal zone of secondary ferruginous material.

[illegible] sample is probably some kind of tuff containing a wide range of lapilli [illegible] possibly pumice fragments in a completely altered matrix now consisting [illegible]rgely of clays and phyllosilicates. This interpretation is tentative [illegible]ly and based on the overall appearance of the material in thin section. [illegible] sample has been effectively completely weathered or altered in some other [illegible].

249726; TSC32792

No. 3 Tailings

Secondary argillaceous rock with quartz veins

A very aphanitic rock characterised by the abundance of irregular intersecting veinlets. Most of the latter are pale in colour but some consist of secondary ferruginous and limonitic material.

The rock consists essentially of three types of material. The most abundant is dark fine-grained argillaceous material of secondary origin; there are also patches of finely granular quartz or chalcedonic material and finally these two phases have been veined by fairly coarse-grained quartz with minor plagioclase and biotite.

The bulk of the rock is rather similar to the fragments in sample 249725 in that it is a fine-grained completely homogeneous mosaic which is essentially dark between crossed nicols. The material is thought to be very largely clay with probably finely disseminated iron and titanium oxide/hydroxide material. The sample is intersected by very thin quartz veinlets but apart from these is completely structureless.

In some places in the thin section clay material such as that described above occurs as a network around fragments of finely granular quartz or chalcedonic material. This part of the rock seems like some kind of microbreccia. The quartz-rich fragments are commonly several millimetres in size but range down to a few as little as 0.2 mm in overall size. In detail the material has a finely granular texture and an average crystal of about 0.02 mm. Quartz appears to be the predominant component but there is pale brown material which is probably some secondary component possibly derived from original biotite.

Finally both these components have been intersected by prominent and fairly coarse-grained quartz veins. These have a markedly granular texture in the bulk of the vein but contain finer-grained material at the edge. Here, also, there is relatively fine-grained plagioclase and a selvedge of rather altered biotite. In the bulk of the vein the quartz forms crystals commonly 0.5 to 0.8 mm in size whereas plagioclase crystals are generally not more than about 0.3 mm in diameter and the biotite flakes not more than about 0.1 mm in length. The biotite appears to have been somewhat altered and is now a rather pale brown colour although most flakes generally show some pleochroism.

The sample appears to be some kind of fine-grained, possibly igneous or tuffaceous rock which has been completely altered and possibly brecciated. The rock may well have contained ill-sorted acidic fragments. Subsequently this rock has been veined by coarse-grained quartz.

Sample: 249727; TSC32793

Location:
No. 3 Tailings

Rock Name:
Altered rock (?basalt)

Hand Specimen:
This is a pale brown or buff coloured rock which is somewhat friable. The cut surface is fairly porous and the rock appears to have undergone some leaching and cavity infilling by ferruginous material.

Thin Section:
The rock has a somewhat coarser-grained aspect than the two samples described above and there appear to be remnants of small laths of plagioclase, These remnants are obscured by secondary material and there are fairly large patches of secondary phyllosilicates and brown phases of various kinds. The overall texture of the sample and the mineralogy both suggest that the sample may well have been either a basalt or a dolerite in which mafic minerals have been entirely replaced and plagioclase is present only as rather indefinite remnants. There are irregular cavity infillings probably aligned with rather characteristically developed clays.

In some places in the thin section there are remnants of plagioclase laths which were clearly up to about 0.3 mm in length. These remnants certainly contain felsic minerals but they are obscured by patches of brown or brownish-green secondary components and it is possible that the secondary mineral may well be secondary quartz. Certainly there is barely any evidence of polysynthetic twinning in the material. Where the remnants of plagioclase are common the texture suggests that they form an interlocked mosaic of crystals rather similar to the typical texture of basaltic and doleritic rocks. Approximately 50% of most parts of the rock now consist of various brown or green secondary phases. These are commonly fairly homogeneous in plane polarized light but under crossed nicols they can be seen to be aggregates of small flakes commonly arranged systematically with respect to the boundaries of the particular aggregates in which they occur. In the bulk of the rock typical greenish serpentine or montmorillonite-type minerals occur in patches up to about 0.1 mm in size with the shape of the patch controlled by adjacent plagioclase pseudomorphs. Elsewhere this pale green mineral forms elongate irregular strands around what appear to have been cavities and now partly infilled with limonitic material.

In addition the rock contains fairly abundant brown secondary material which is rather indefinite and probably consists of an admixture of limonitic material and clay. Also present are a few aggregates of secondary quartz or chalcedonic material generally forming in discontinuous irregular veinlets.

The sample can be interpreted fairly safely as being probably a relatively fine-grained homogeneous doleritic rock. It now shows extensive alteration particularly to brownish-green birefringent phyllosilicate phases which can probably be related to montmorillonite or similar minerals. As is common in secondary rocks of this kind, there is widely dispersed rather indefinite secondary material which tends to obscure a considerable amount of the texture of the sample.

Sample: 249728; TSC32794

Location:
No. 3 Tailings

Rock Name:
Tuff

Hand Specimen:
This sample is a distinctly buff to orange coloured rock which is massive and fairly compact. The cut surface shows that the material is essentially entirely aphanitic but there are colour variations which suggest that the sample may well be tuffaceous. These variations define fragments which range in size up to about 1 cm. Large and small fragments occur together in a random way and some of the smaller pale patches have an elongate smeared-out appearance.

Thin Section:
Part of the thin section is occupied by one of the large fragments in the sample and the remainder consists of matrix material.

The fragments is a microgranular mosaic of quartz and clays in which quartz crystals are less than 0.02 mm in size. The texture appear to be random and homogeneous and there is no evidence whatsoever of any structures within the fragment.

The remainder of the rock contains more birefringent clay material commonly showing bulk extinction which defines some kind of foliation. In plane polarized light the material is more or less brown or red in colour as a result of the finely disseminated and abundant limonitic material. Variations in colour indicate the presence of fragments, some of which are as little as 0.1 mm in size but most are of the order of 0.2 to 0.6 mm. The fragments are generally rather shadowy and some have distinctly irregular outlines. Large and small fragments occur together and it seems likely that the texture is one of a tuffaceous type of rock rather than a true waterlain or wind-deposited sediment. On this basis the sample has been regarded as being tuff of some kind containing fragments sufficiently large to be regarded as lapilli.

There are cross cutting veinlets and rather irregular patches of chlorite and ferruginous material and one or two veinlets of relatively late coarsely granular quartz.

Sample: 24929; TSC32795

Location:
No. 3 Tailings

Rock Name:
Immature lithic sandstone

Hand Specimen:
This is a characteristically tan-coloured rock which has a fine- to medium-grained granular texture. The sample is essentially massive and compact. The cut surface shows some white soft grains and other darker grains up to about 1 mm in size. They are thin cross cutting veinlets.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	35-40
Lithic fragments and matrix	35-40
Biotite	15
Opaques and semi-opaques	5
Muscovite	2
Chert	1
Feldspar	1
Heavy minerals	trace

This sample is a sandstone characterised by the abundance of labile material. Well defined detrital fragments commonly consist grains of quartz and biotite but elsewhere there appears to be a gradation from fine-grained clasts to what is in effect a matrix. In effect, therefore, the matrix of the rock consists of fine-grained detritus probably deposited at the same time or a little after the bulk of the sand grade material. There are trace amounts of detrital chert and feldspar and one or two fairly well defined lithic clasts.

Quartz and feldspar grains (very largely quartz) range in size up to about 0.4 mm and have an average size of about 0.2 mm. There is a distinct tail in the grain size distribution towards the finer sizes and this applies both to the quartz and to the detrital biotite. The quartz grains are generally equant in shape but most are subangular and these appear to be fairly typical, or plutonic quartz. Feldspar grains are only rare and generally consist of either plagioclase or an ill-defined type of feldspar which may well be potassium feldspar. There are fairly large lithic fragments, some of which are clearly of fine-grained volcanic origin but others are rather more indeterminate although generally fine-grained and consisting largely of felsic minerals.

The other major sand-grade type of detrtial material is mica. Most of this is unusually fresh and abundant biotite which forms flakes commonly as much as 0.3 mm in length. There is a weak preferred orientation of the long axes of the biotite flakes. The mineral itself if brown and pleochroic and some of the flakes show distorted shapes as a result of compaction around the more rigid quartz grains. Muscovite is generally similar in shape and habit to the biotite but is much less abundant.

These fairly well defined detrital fragments rest in a matrix which consists of indeterminate material containing biotite, quartz and ?feldspar and ?clay. The matrix is thought to have been derived from either fine-grained

equivalents of the sand-grade grains or from labile lithic fragments which have been distorted and possibly partly recrystallised during lithification of the rock. In one or two places there are some vague outlines of what may have been lithic clasts in fine-grained material essentially difficult to distinguish from the bulk of the matrix in the rock.

The sample contains traces of dark heavy minerals which are probably altered mafic phases or possibly slightly metamict zircon in some cases.

This is a fairly homogeneous and massive sandstone containing ill-sorted fragments with a markedly skewed grain size distribution. Biotite is an unusually abundant detrital phase.

Sample: 249730; TSC32796

Location:
No. 3 Tailings

Rock Name:
Secondary argillaceous rock

Hand Specimen:
This is a buff coloured rock which contains a few narrow cross cutting veinlets. The cut surface of the sample is completely aphanitic.

Thin Section:
This is a notably homogeneous rock consisting of a very fine-grained mosaic of secondary minerals of which the principal one is probably clay. There are veinlets of coarser material in which quartz and ?biotite can be seen and in other veins there is simply limonitic material.

The bulk of the rock is a completely homogeneous and random mosaic of material which is turbid in plane polarized light and very dark between crossed nicols. Possibly as much as 15% of this material can be specifically identified as colourless sericitic or illitic material and there are places where very small crystals of felsic minerals (quartz or feldspar) can be seen; elsewhere the material is too fine-grained for optical identification but it seems likely that a considerable amount of this finer material is clay and probably there is a significant amount of semi-opaque limonitic or titaniferous oxide material. In view of the mineralogy and texture it is not possible to indicate the nature of the rock before alteration.

Veinlets are up to about 0.5 mm in width and have a rather variable mineralogy although most contain some granular quartz and a greenish-brown phyllosilicate which may well be altered biotite. Some of the veins have an elongation and it is possible that there may have been some shearing of the rock preferentially along these veins. This would certainly be possible in places where the veins are particularly straight.

Sample: 249734; TSC32797

Location:
No. 3 Tailings

Rock Name:
Altered micaceous schist

Hand Specimen:
This is a tabular weathered rock which has a tan colour. The sample is notably aphanitic but apparently homogeneous.

Thin Section:
Approximately 30% of the thin section consists of mica and of the order of 40% of semi-opaque brown ferruginous material. Part of the remainder consists of identifiable quartz crystals ranging in size down to about 0.02 mm. The remainder of the rock is too fine-grained for specific optical identification but is thought to consist of an aggregate of phyllosilicates and felsic minerals. The largest components in the rock are the flakes of mica and since these have a well defined parallel orientation the rock has a distinctly schistose lepidoblastic texture.

Flakes of muscovite and biotite are as much as 0.2 mm in length and most of the flakes are notably thin and straight. Muscovite predominates and biotite is represented by weakly pleochroic possibly slightly altered brown flakes. These flakes are completely randomly distributed throughout the area of the thin section.

When the section is viewed with intense illumination it can be seen that a considerable proportion of the rock is composed of finely disseminated semi-opaque ferruginous material. In some fields of view this material is particularly abundant but this probably represents patches of more intense weathering and alteration. The dark material probably consists either completely of limonite or of ?clays densely stained with limonite.

The remainder of the rock consists either of silt-grade quartz grains which are angular and randomly distributed throughout the rock or of a fine-grained matrix of clay and felsic minerals in a randomly oriented mosaic. This part of the rock is essentially unresolvable but it is probably of acidic and possibly aluminous composition.

The sample is a fine-grained micaceous schist and, superficially, it appears more likely to have been derived from a sediment than a igneous rock (which would be less aluminous).

Sample: 249735; TSC32798

Location:
No. 3 Tailings

Rock Name:
Immature lithic sandstone

Hand Specimen:
This is a pale brown medium-to fine-grained rock which is massive and compact. The cut surfaces of the sample have a speckled appearance and the sample has very much the appearance of a clayey sandstone.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Matrix	40
Quartz	35
Biotite	15
Lithic fragments	5-10
Muscovite	2
Feldspar	2
Heavy minerals	trace

In this sample there appears to be a clearer distinction between lithic fragments and the fine-grained material which comprises the matrix of the rock. Apart from this colour the sample is very similar to the sandstone described above and both are characterised by the unusual abundance of detrital biotite.

Detrital quartz, feldspar and lithic fragments are generally 0.05 to about 0.3 mm in size and the rock has a distinctly ill-sorted appearance. The quartz grains are equant but commonly angular in shape and the rock is characterised by the way in which both large and small fragments occur together. Feldspar shows similar size and shape characteristics but most of the grains are notably fresh and both ptoassium feldspar and sodic plagioclase were identified in the rock. Lithic fragments are fine-grained rocks which are dark between crossed nicols. Most are probably secondary rocks of some kind, grading in some instances to fine-grained quartzitic samples.

The rock contains an unusually large amount of detrital mica, most of which is fresh biotite. Flakes of this biotite and muscovite are as much as 0.2 mm in length and in some instances as much as 0.6 mm. The biotite is fresh and shows pleochroism in shades of brown and many of the flakes show a little distortion as a result of compaction.

These detrital fragments rest in a fine-grained matrix which is more or less pale brown in plane polarized light. Under high magnfication it can be seen that the matrix consists of fine-grained clays, biotite and felsic minerals and it is possible that the mineralogy of the matrix is not too dissimilar from that of the detrital fragments. The matrix certainly appears to be the detritus which has been deposited between the larger fragments probably very soon after the bulk of the deposition of the framework. A sample such as this is probably of non-marine origin and was deposited close to the source.

APPENDIX III

MAGNET RANGE

12.5M SOIL RE-SAMPLING

ASSAY RESULTS

(1)

LINE	SAMPLE DISTANCE	PPM Sn	PPM Ag	PPM Rb	PPM As	PPM WO_3	PPM Cu	PPM Pb	PPM Zn	PPM Ni	PPM Bi	SAMPLE No.
		1				5	2	1	3	6		
NL22W	100W	15	<10	160	<10	60	30	30	80	15	40	2684432
	975W	<10	<10	<10	<10	<20	100	20	120	700	20	2684465
	1125W	30	<10	20	<10	<20	60	10	120	550	20	2684471
NL10E	75E	45	<10	110	<10	40	80	30	100	15	20	2685001
	87.5E	25	<10	140	10	40	80	30	100	20	15	2685002
	100E	20	<10	90	<10	<20	70	20	140	20	10	2685003
	112.5E	15	<10	80	<10	<20	100	40	120	70	5	2685004
	125E	45	<10	70	<10	<20	100	40	120	70	10	2685005
NL10E	325E	15	<10	<10	15	40	25	20	140	200	15	2685006
	337.5E	10	<10	10	<10	60	35	20	160	200	10	2685007
	350E	<10	<10	15	<10	20	35	20	180	400	10	2685008
	362.5E	20	<10	70	<10	20	40	30	140	40	10	2685009
	375E	25	<10	20	15	60	70	100	180	15	10	2685010
	387.5E	20	<10	25	<10	<20	70	40	140	40	10	2685011
	400E	45	<10	15	<10	80	80	30	100	20	15	2685012
	412.5E	20	<10	35	<10	60	70	30	120	30	15	2685013
	425E	60	<10	60	<10	<20	90	30	140	35	5	2685014

9500081

(2)

LINE	SAMPLE DISTANCE	1 PPM Sn	PPM Ag	PPM Rb	PPM As	5 PPM WO_3	2 PPM Cu	4 PPM Pb	3 PPM Zn	6 PPM Ni	PPM Bi	SAMPLE No.
NL 10E	600E	35	<10	35	<10	<20	120	20	140	60	5	268515
	612.5E	20	<10	20	<10	60	50	20	80	15	5	268516
	625E	35	<10	90	<10	<20	60	10	80	20	10	268517
	637.5E	30	<10	25	<10	40	60	10	90	20	5	268518
	650E	20	<10	70	<10	<20	70	10	140	50	5	268519
	662.5E	20	<10	45	<10	40	100	30	160	60	5	268520
	675E	20	<10	25	<10	<20	60	20	100	25	5	268521
	687.5E	10	<10	25	<10	40	70	20	100	25	10	268522
	700E	35	<10	35	<10	<20	90	20	120	60	5	268523
NL 10E	750E	30	<10	45	<10	80	60	20	120	40	5	268524
	762.5E	<10	<10	40	15	100	60	20	80	30	<5	268525
	775E	45	<10	80	<10	60	40	20	70	20	10	268526
	787.5E	30	<10	60	10	<20	120	40	200	100	5	268527
	800E	15	<10	70	25	<20	70	30	120	35	5	268528
NL 14E	300E	20	<10	30	<10	<20	70	20	200	40	10	268529
	312.5E	60	<10	10	<10	80	240	120	180	20	5	268530
	325E	30	<10	10	15	<20	70	30	180	25	<5	268531
	337.5E	25	<10	20	10	<20	160	100	240	40	<5	268532

950082

(3)

LINE	SAMPLE DISTANCE	1 PPM Sn	PPM Ag	PPM Rb	PPM As	5 PPM WO_3	2 PPM Cu	4 PPM Pb	3 PPM Zn	6 PPM Ni	PPM Bi	SAMPLE No.
NL14E	350E	30	<10	45	<10	<20	100	40	240	45	<5	268533
	362.5E	25	<10	60	<10	<20	60	30	180	30	10	268534
	375E	45	<10	70	<10	<20	70	30	180	30	10	268535
	387.5E	30	<10	20	<10	<20	80	30	200	25	20	268536
	400E	20	<10	20	<10	<20	45	20	180	20	15	268537
	412.5E	15	<10	30	10	<20	60	30	180	30	<5	268538
	425E	20	<10	35	<10	<20	120	40	200	50	15	268539
	437.5E	15	<10	20	<10	<20	90	30	140	20	10	268540
	450E	20	<10	10	<10	<20	200	60	220	35	20	268541
NL14E	625E	90	<10	<10	<10	<20	120	40	200	60	20	268542
	637.5E	15	<10	<10	<10	<20	120	40	380	70	15	268543
	650E	25	<10	<10	<10	<20	200	250	500	60	15	268544
	662.5E	30	<10	120	<10	<20	45	20	100	45	15	268545
	675E	10	<10	80	<10	<20	120	40	150	120	10	268546
	687.5E	20	<10	15	<10	500	60	30	80	10	20	268547
	700E	35	<10	60	<10	<20	80	20	120	40	15	268548
	712.5E	25	<10	80	10	<20	70	10	120	50	15	268549
	725E	20	<10	50	<10	<20	200	50	120	160	<5	268550
	737.5E	160	<10	<10	<10	350	200	70	120	35	10	268551

950083

LINE	SAMPLE DISTANCE	1 PPM Sn	PPM Ag	PPM Rb	PPM As	5 PPM WO_3	2 PPM Cu	4 PPM Pb	3 PPM Zn	6 PPM Ni	(4) PPM Bi	SAMPLE No.
NL 14E	750E	45	<10	60	<10	<20	120	40	180	280	<5	268552
	762.5E	15	<10	45	<10	<20	40	10	100	60	<5	268553
	775E	25	<10	70	10	<20	60	20	120	50	15	268554
NL 14E	850E	25	<10	50	<10	<20	60	20	100	20	15	268555
	862.5E	<10	<10	30	<10	<20	50	10	140	30	15	268556
	875E	40	<10	15	<10	<20	60	10	200	70	15	268557
	887.5E	25	<10	100	<10	<20	50	20	120	35	15	268558
	900E	10	<10	90	<10	40	30	10	80	20	15	268559

950084

950085

APPENDIX IV

WHYTE HILL - W PROSPECT

MAGNETOMETER TRAVERSE RESULTS

CONTROL READINGS

950086

BASE (Eastern Sediments)		61970
NL 10/BASE LINE		62410
NL14 - 0		
NL18 - 0		
NL22 - 0		
WOMBAT - 2400N		61901
- 1800N		61931
- 1200N		61986
W-PROSPECT -	G1	62447
	G1A	62139
	G1B	62035
	.G2/G2A	61889
	G2E	61960
	.G3	62009
	.G3A	61975
	G4-0	62886
	.G4-tram	62030
	.G5	62175
	.G5A	63179
	.G6	62194
	.G7	62204
	.G9	62057
	.G11	62015
	.G12	62013
	.G13	61875
	.G15	62010
	.G16	62048
	.G17	61959
	DC6	62017

950087

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.1 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	1.25	61971	61971	61970
0	1.45	62457	62456	62455
25	1.50	61991	61990	61989
50	1.55	61979	61978	61977
75	1.58	61907	61906	61905
100	2.03	61786	61784	61783
125	2.15	61520	61518	61517
150	2.24	61599	61596	61595
175	2.29	61595	61592	61591
200	2.40	63044	63040	63039
225	2.43	65866	65862	65861
250	2.45	64454	64450	64449
275	2.53	62761	62757	62756
300	2.57	63374	63369	63368
325	3.00	63002	62997	62996
350	3.03	62543	62538	62537
375	3.27	63613	63607	63606
Base	4.41	61982	61971	61970

950088

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No: G.1 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	9.02	61982	61982	61970
0	9.38	62458	62459	62447
25	9.44	61926	61927	61915
50	9.45	62047	62048	62036
75	9.48	62070	62071	62059
100	9.50	62054	62055	62043
125	9.57	62056	62057	62045
150	10.08	62043	62045	62033
175	POWER LINES			
200	POWER LINES			
225	10.45	62020	62023	62011
250	10.48	62038	62041	62029
275	10.50	62019	62022	62010
300	10.55	62001	62005	61993
325	11.02	61974	61978	61966
350	11.10	61973	61977	61965
375	11.12	61984	61988	61976
400	11.18	62004	62008	61996
425	11.20	61993	61998	61986
450	11.22	61972	61977	61965
475	11.23	61989	61994	61982
500	11.25	61984	61989	61977
525	11.28	61981	61986	61974
550	11.30	61995	62000	61988
Base	11.50	61976	61982	61970

950089

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MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°G1A. E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	1.20	61978	61978	61970
0	1.55	62125	62124	62116
25	1.57	62109	62108	62100
50	1.59	61970	61969	61961
75	2.04	61888	61887	61879
100	2.11	62700	62699	62691
125	2.21	61579	61577	61569
150	2.25	61604	61602	61594
175	2.28	61653	61651	61643
200	NOT STABLE			
225	2.38	65284	65282	65274
250	2.41	63520	63518	63510
275	NOT STABLE			
300	NOT STABLE			
325	2.55	62920	62917	62909
350	3.00	62667	62664	62656
375	3.03	62809	62806	62798
400	3.17	62931	62927	62919
425	3.20	61376	61372	61364
450	3.22	61854	61850	61842
475	3.24	62025	62021	62013
500	3.29	62268	62264	62256
Base	4.38	61985	61978	61970

950090

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G1A W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	8.25	61969	61969	61970
0	8.54	62140	62138	62139
25	8.56	62327	62325	62326
50	8.58	62055	62053	62054
75	8.59	62049	62047	62048
100	9.00	62047	62045	62046
125	9.03	62040	62037	62038
150	POWER LINES			
175	POWER LINES			
200	POWER LINES			
225	10.30	62018	62009	62010
250	10.35	62004	61994	61995
275	10.38	62029	62019	62020
300	10.40	61984	61974	61975
325	10.42	61981	61971	61972
350	10.45	62004	61993	61994
375	10.58	61982	61970	61971
400	11.00	61977	61965	61966
425	11.03	61949	61937	61938
450	11.05	61992	61980	61981
475	11.07	62046	62034	62035
500	11.09	62003	61990	61991
525	11.11	61974	61961	61962
550	11.13	62044	62031	62032
Base	11.47	61985	61969	61970

950091

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G1B E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	1.13	61974	61974	61970
0	1.58	62053	62049	62045
25	2.00	62013	62009	62005
50	2.05	61935	61930	61926
75	2.10	61882	61877	61873
100	2.15	61786	61780	61776
125				
150				
175	2.20	61755	61749	61745
180	2.30	61582	61575	61571
Base	4.15	61992	61974	61970

950092

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No. G1B W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	8.12	62004	62004	61970
0	8.35	62065	62069	62035
25	8.38	62065	62070	62036
50	8.41	62047	62053	62019
75	8.42	62043	62049	62015
100	POWER LINES			
125	POWER LINES			
150	9.58	62031	62040	62006
175	10.00	62029	62051	62017
200	10.04	62030	62053	62019
225	10.20	62015	62041	62007
250	10.25	61983	62010	61976
275	10.28	62013	62041	62007
300	10.30	62010	62038	62004
325	10.33	62021	62050	62016
350	10.35	62006	62035	62001
375	10.43	61965	61996	61962
400	10.47	62004	62036	62002
425	10.50	62002	62034	62000
450	10.55	61962	61995	61961
475	10.58	61973	62007	61973
500	11.00	62001	62035	62001
525	11.03	62002	62037	62003
Base	11.30	61963	62004	61970

950093

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G2/G2A E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	1.15	61970	61970	61970
0	1.44			
25	1.48	62015	62012	62012
50	1.50	61982	61979	61979
75	1.53	61963	61960	61960
100	1.55	61972	61968	61968
125	2.15	61998	61992	61992
150	2.19	61975	61969	61969
175	2.22	62069	62063	62063
200	2.27	62155	62148	62148
225	2.30			
250	2.31	62443	62035	62035
275	2.33	61958	61951	61951
300	2.35	65000	64992	64992
325	2.39	64616	64608	64608
350	2.45	62364	62355	62355
375	2.49	63108	63099	63099
400	2.50	61811	61802	61802
425	2.55	62571	62561	62561
450	3.19	61014	61002	61002
475	3.23	62068	62056	62056
500	3.24	62105	62092	62092
525	3.27	61478	61465	61465
550	3.34	61613	61599	61599
575	3.37	61802	61788	61788
600	3.41	62768	62754	62754
625	3.44	62000	61085	61085
650	3.46	62088	62073	62073
675	3.54	62542	62526	62526
700	3.55	62846	62830	62830
Base	5.54	61998	61970	61970

950094

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: PD & JF DATE:

LINE N°: G2/G2A W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	8.15	61964	61964	61970
0	9.04	61878	61883	61889
25	9.06	61998	62003	62009
50	9.12	61986	61992	61998
75	9.15	61997	62003	62009
100	9.26	61997	62004	62010
125	9.30	62007	62015	62021
150	9.32	62022	62030	62036
175	9.35	62028	62036	62042
200	9.47	62015	62025	62031
225	9.55	62000	62010	62016
250	9.56	62006	62017	62023
275	10.04	61993	62005	62011
300	10.07	62072	62084	62090
325	10.25	62062	62076	62082
350	10.28	62097	62111	62117
375	10.37	62128	62143	62149
400	10.38	62036	62051	62057
425	10.39	62028	62044	62050
450	10.47	61993	62009	62015
475				
500	10.53	61979	61996	62002
Base	11.32	61943	61964	61970

950095

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No: G 3 E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.45	61857	61857	62009
25	8.48	62017	62015	62167
50	8.50	61920	61917	62069
75	8.53	61821	61817	61969
100	8.55	61982	61977	62129
125	9.00	62168	62160	62312
150	9.03	63463	63454	63606
175	9.07	62941	62930	63082
200	9.15	63190	63175	63327
225	9.18	63786	63769	63921
250	9.21	62846	62828	62980
275	9.23	62556	62537	62689
300	9.28	63363	63341	63493
325	9.33	63488	63464	63616
350	9.36	62223	62197	62349
375	9.38	61847	61820	61972
400	9.45	62475	62445	62597
425	9.48	62158	62126	62278
450	9.51	61412	61379	61531
0	11.48	61947	61856	62009

950096

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No: G3 W

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	1.30	61952	61952	61970
0	2.14	61992	61991	62009
25	2.15	62011	62010	62028
50	2.17	61943	61942	61960
75	2.19	61956	61955	61973
100	2.25	62090	62088	62106
125	2.29	62033	62031	62049
150	2.31	62021	62019	62037
175	2.34	61988	61986	62004
200	2.37	62001	61999	62017
225	2.38	62029	62027	62045
250	2.41	62001	61999	62017
275	2.45	61999	61997	62015
300	2.50	61988	61985	62993
325	3.13	61992	61989	62007
350	3.18	61992	61988	62006
375	3.22	62014	62010	62028
400	3.26	62096	62092	62110
425	3.33	62265	62061	62079
450	3.40	62096	62092	62110
475	3.47	62083	62078	62096
500	3.50	62098	62093	62111
525	3.54	62020	62015	62033
550	3.58	62025	62020	62038
575	4.00	62017	62012	62030
Base	4.32	61959	61952	61970

950097

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G3 A E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	11.48	61947	61947	61975
25	11.45	62005	62006	62034
50	11.40	62116	62120	62148
75	11.35	61767	61773	61801
100	11.32	61870	61878	61906
125	11.30	61862	61871	61899
150	11.25	62194	62205	62233
175	11.22	62205	62218	62246
200	11.19	62586	62601	62629
225	11.17	63282	63298	63326
250	11.09	63977	63997	64025
275	11.08	63074	63094	63122
300	11.06	63030	63051	63079
325	11.04	64265	64287	64315
350	11.02	63435	63458	63486
375	11.00	62133	62157	62185
400	10.58	61805	61830	61858
425	10.44	62065	62097	62125
450	10.41	62143	62177	62205
475	10.36	61429	61465	61493
River	10.33	61451	61489	61517
0	8.45	61857	61947	61975

950098

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G3 A W

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	8.15	61976	61976	61970
G3A - 0	8.47			
25	8.49	62084	62076	62070
50	8.50	62049	62041	62035
75	8.53	62029	62020	62014
100	8.54	62022	62013	62007
125	8.58	62008	61998	61992
150	9.03	62008	61996	61990
175	9.05	62013	62001	61995
200	9.06	62014	62002	61996
225	9.08	62038	62025	62019
250	9.10	62001	61988	61982
275	9.13	62016	62002	61996
300	9.16	62015	62000	61994
325	9.20	62027	62011	62005
350	9.28	62057	62039	62033
375	9.37	61999	61979	61973
400				
425	9.55	62041	62016	62010
450				
475	10.00	62058	62032	62026
490	10.03	62056	62029	62023
Base	11.00	62011	61976	61970

950099

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G4 E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
G5 - 0	8.50	62200	62200	62175
G4 - 0	12.08	62889	62911	62886
25	POWER LINE			
50	12.03	62388	62409	62384
75	12.03	63511	63532	63507
100	12.00	62892	62913	62888
125	11.58	62414	62434	62409
150	11.57	62276	62296	62271
175	11.56	63785	63805	63780
200	11.55	65055	65075	65050
225	11.54	62860	62880	62855
250	11.52	63034	63054	63029
275	11.50	64817	64836	64811
300	11.46	63100	63119	63094
325	11.44	62298	62317	62292
350	11.40	61898	61916	61891
375	11.37	61690	61708	61683
400	11.29	61624	61641	61616
425	11.20	61394	61410	61385
CHANGE IN PEG NUMBERS - BUT CONTINUOUS PEGS				
1050	11.14	61788	61803	61778
1025	11.11	61814	61829	61804
950	11.07	62145	62160	62135
925	11.04	62513	62527	62502
900	11.03	62683	62697	62672
875	11.00	63591	63605	63580
850	10.43	63135	63147	63122
G5 - 0	12.18	62177	62200	62175

950100

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G4 W

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
Base	8.17	61977	61977	61970
G4 Tram	8.45	62082	62083	62076
100	8.50	62089	62090	62083
125	8.52	62103	62104	62097
150	8.53	62080	62082	62075
175	8.55	62057	62059	62052
200	8.57	62064	62066	62059
225	9.01	62041	62043	62036
250	9.02	62020	62022	62015
275	9.04	62010	62012	62005
300	9.06	62024	62026	62019
325	9.10	61998	62000	61993
350	9.12	62016	62019	62012
375	9.14	62024	62027	62020
400	9.17	61993	61996	61989
425	9.25	62001	62004	61997
450	9.29	61957	61961	61954
475	9.32	62000	62004	61997
500	9.36	61986	61990	61983
525	9.39	61981	61985	61978
550	9.42	61977	61981	61974
575	9.45	62000	62004	61997
600	9.47	61977	61981	61974
625	9.50	61978	61983	61976
650	9.53	61985	61990	61983
675	9.56	61984	61989	61982
700	9.58	62039	62044	62037
725	10.00	62034	62039	62032
750	10.05	61989	61994	61987
775	10.10	61999	62005	61998
Base	10.58	61968	61976	61970

950101

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G4 W (EAST OF TRAM)

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
G5 - 0	8.50	62200	62200	62175
G4 - 0	12.08	62889	62911	62886
25				
50	12.12	62145	62167	62142
75	12.14	62044	62066	62041
G4 Tram	12.15	62033	62055	62030
G5 - 0	12.18	62177	62200	62175

950102

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No. G.5 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.50	62200	62200	62175
25	8.51	62402	62402	62377
50	8.53	62372	62372	62347
75	8.55	62820	62820	62795
100	9.00	63665	63666	63641
125	9.02	63758	63759	63734
150	9.06	64566	64567	64542
175	POWER LINES			
200	9.09	63002	63004	62979
225	9.12	63212	63214	63189
250	9.14	63153	63155	63130
275	9.15	62511	62513	62488
300	9.16	62099	62101	62076
325	9.21	61675	61678	61653
350	9.23	62553	62558	62533
375	9.25	63186	63189	63164
400	9.27	63999	64003	63978
425	9.29	62299	62303	62278
450	9.30	62204	62208	62183
475	9.32	61387	61391	61366
500	9.35	61415	61420	61395
525	9.42	61545	61550	61525
550	9.45	61569	61575	61550
575	9.53	61718	61725	61700
600	9.56	61771	61778	61753
625	9.58	62056	62063	62038
650	10.03	62417	62425	62400
675	10.05	63186	63194	63169
700	10.21	63365	63375	63350
725	10.23	64202	64212	64187
0	12.18	62177	62200	62175

950103

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No. G.5. W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	9.27	62216	62216	62175
25	9.28	62114	62114	62073
50	9.29	62480	62480	62439
75	9.31	62300	62300	62259
100	9.32	62231	62231	62190
125	9.33	62181	62181	62140
150	9.33	62132	62132	62091
175	9.34	62091	62091	62050
200	9.35	62057	62057	62016
225	9.37	62049	62048	62007
250	9.38	62020	62019	61978
275	9.40	62016	62015	61974
300	9.42	62002	62001	61960
325	9.43	61999	61998	61957
350	9.45	61984	61982	61941
375	9.51	61999	61997	61956
400	9.54	61987	61984	61943
425	10.05	62006	62002	61961
450	10.14	61951	61946	61905
475	10.18	61986	61981	61940
500	10.19	61959	61953	61912
525	10.22	61965	61959	61918
550	10.23	61969	61963	61922
575	10.24	61987	61981	61940
600	10.28	61970	61963	61922
625	10.40	61990	61982	61941
0	12.12	62235	62215	62175

950104

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.5A. E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	11.00	63172	63172	63179
25	11.07	63851	63840	63847
50	11.10	62084	62068	62075
75	11.12	62987	62968	62975
100	11.13	63548	63527	63534
0	11.20	63204	63172	63179

950105

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.5A. W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	10.40	63125	63125	63179
25	10.41	62974	62972	63026
50	10.42	62799	62794	62848
75	10.43	62299	62292	62346
100	10.45	62158	62146	62200
125	10.46	62245	62231	62285
150	10.47	62176	62160	62214
0	11.00	63172	63125	63179

950106

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.6. E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	1.49	62250	62250	62194
25	1.50	62887	62887	62931
50	1.52	63104	63104	63148
75	1.53	62649	62649	62693
100	1.54	61858	61858	61902
125	1.55	62237	62237	62281
150	1.56	63179	63179	63223
175	1.57	62342	62342	62386
200	1.58	63610	63610	63654
225	POWER LINES			
250	POWER LINES			
275	2.05	64535	64535	64579
300	2.07	62337	62337	62381
325	2.09	61393	61393	61437
350	2.11	61336	61336	61380
375	2.12	62776	62776	62820
400	2.14	64187	64186	64230
425	2.15	62594	62593	62637
450	2.16	61466	61465	61509
475	2.18	61588	61587	61631
500	2.33	61680	61679	61723
525	2.35	61752	61751	61795
550	2.40	61940	61938	61982
575	2.55	61836	61834	61878
600	2.56	62515	62513	62557
0	4.20	62256	62250	62194

950107

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.6. W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
G5-0	12.12	62234	62216	62176
G6-0	12.08	62254	62235	62194
25	12.07	62464	62445	62404
50	12.06	62882	62863	62822
75	10.04	62514	62495	62454
100	12.02	62230	62214	62173
125	12.00	62208	62182	62141
150	11.58	62149	62133	62092
175	11.56	62163	62147	62106
200	11.54	62094	62078	62037
225	11.52	62105	62090	62049
250	11.50	62076	62061	62020
275	11.48	62093	62078	62037
300	11.45	62068	62013	61972
325	11.42	62057	62043	62002
350	11.31	62104	62091	62050
375	11.30	62054	62041	62000
400	11.28	62073	62060	62019
425	11.27	62053	62040	61999
450	11.25	62044	62032	61991
475	11.23	62035	62023	61982
500	11.20	62081	62069	62028
525	11.19	62033	62021	61980
550	11.17	62023	62011	61970
575	11.15	62208	62197	62156
600	11.14	62029	62018	61977
625	11.12	62021	62010	61969
650	11.10	62025	62014	61973
675	11.09	62048	62037	61996
700	11.08	62048	62037	61996
725	11.05	61992	61982	61941
G5-0	9.27	62216	62216	62175

950108

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.7 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.39	62162	62162	62204
25	8.41	62195	62195	62237
50	8.43	62263	62263	62305
75	8.45	62374	62374	62416
100	8.46	62704	62704	62746
125	8.47	62843	62842	62884
150	8.48	61346	61345	61387
175	8.51	61669	61668	61710
200	8.56	61673	61671	61713
225	9.00	61704	61702	61744
250	9.01	61786	61784	61826
275	9.02	61872	61869	61911
300				
325	9.09	64276	64272	64314
350	POWER LINES			
375	9.13	62877	62873	62915
400	9.15	61861	61857	61899
425	9.17	61810	61805	61847
450	9.19	61718	61713	61755
0	10.10	62174	62162	62204

950109

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.7 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
G9W-0	11.50	62018	62018	62057
G7W-0	11.45	62168	62165	62204
25	11.44	62154	62150	62189
50	11.43	62132	62128	62167
75	11.42	62130	62125	62164
100	11.41	62110	62105	62144
125	11.40	62119	62114	62153
150	11.37	62094	62087	62126
175	11.36	62103	62096	62135
200	11.35	62103	62095	62134
225	11.33	62056	62048	62087
250	11.31	62062	62053	62092
275	11.30	62049	62039	62078
300	11.25	62035	62023	62101
325	11.22	62027	62014	62053
350	11.21	62035	62021	62060
375	11.20	62057	62043	62082
400	11.08	62034	62014	62053
425	11.05	62065	62044	62083
450	11.03	62033	62011	62050
475	11.01	62022	61999	62038
500	11.00	62005	61982	62021
525	10.58	62021	61997	62036
550	10.57	62014	61990	62029
575	10.50	61936	61909	61948
600	10.48	61999	61971	62010
625	10.46	61984	61955	61994
650	10.45	61992	61962	62001
675	10.43	62017	61986	62025
700	10.41	61996	61965	62004
725	10.40	61979	61947	61986

950110

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.7 W (cont'd)

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
750	10.39	61978	61946	61985
775	10.38	62006	61973	62012
800	10.37	62003	61970	62009
825	10.35	62015	61981	62020
G9W-0	9.09	62089	62018	62057

950111

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.9 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	2.04	62030	62030	62057
25	2.05	62012	62012	62039
50	2.07	62009	62009	62036
75	2.08	62000	62000	62027
100	2.09	62003	62002	62029
125	2.10	62000	61999	62026
150	2.12	61999	61998	62025
175	2.14	62006	62004	62031
200	2.15	62024	62022	62049
225	2.16	62035	62033	62060
250	2.17	61965	61962	61989
275	2.19	61873	61870	61897
300	2.22	61886	61882	61909
325	2.23	61884	61880	61907
350	2.24	61926	61922	61949
375	2.27	62059	62054	62081
400	2.29	61948	61942	61969
425	2.31	61828	61822	61849
450	2.34	61782	61775	61802
475	2.38	61829	61821	61849
500	2.40	62043	62034	62061
0	3.15	62047	62030	62057

950112

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No. G.9 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	3.50	62019	62019	62057
25	3.52	62041	62049	62087
50	3.53	62007	62019	61982
75	3.54	62013	62028	62066
100	3.55	62023	62052	62090
125	3.56	62016	62039	62077
150	3.57	62054	62081	62119
175	3.59	62009	62044	62085
200	4.00	62072	62112	62149
225	4.01	62043	62085	62123
250	4.03	61945	61995	62033
275	4.05	61910	61968	62006
300	4.07	61921	61986	62024
325	4.08	61922	61991	62032
350	4.09	61945	62018	62056
375	4.10	62049	62126	62164
400	4.12	61964	62049	62087
425	4.13	61848	61937	61975
450	4.14	61767	61859	61897
475	4.15	61744	61840	61878
490	4.17	62079	62175	62213
0	4.38	61834	62019	62057

MAGNETIC STORM

950113

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.9 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	9.09	62089	62089	62057
25	9.11	62093	62094	62062
50	9.12	62020	62021	61989
75	9.13	62032	62034	62002
100	9.15	62017	62020	61988
125	9.18	62005	62009	61977
150	9.19	62018	62022	61990
175	9.21	62064	62069	62037
200	9.23	62036	62042	62010
225	9.26	62059	62066	62034
250	9.28	62013	62021	61989
275	9.30	61997	62006	61974
300	9.32	62041	62051	62019
325	9.34	61984	61995	61963
350	9.36	62025	62037	62005
375	9.38	62042	62055	62023
400	9.41	62036	62050	62018
425	9.43	61996	62011	61979
450	9.45	62024	62040	62008
475	9.48	62012	62029	61997
500	9.50	62019	62047	62015
525	9.52	61991	62010	61978
550	9.53	62048	62067	62035
575	9.54	62015	62035	62003
600	9.56	61996	62017	61985
625	9.57	62074	62095	62063
650	9.58	61999	62021	61989
675	10.00	61976	61998	61966
700	10.01	61987	62010	61978
725	10.02	61942	61925	61893
750	10.03	62015	62039	62007

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.9 W. (cont'd)

STATION IDENTITY	TIME.	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
775	10.04	61911	61935	61903
800	10.05	62051	62076	62044
0	11.50	62018	62089	62057

950115

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.11 E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	10.18	61985	62001	62015
25	10.21	62020	62035	62049
50	10.22	62017	62032	62046
75	10.23	62028	62043	62057
100	10.24	62019	62034	62048
125	10.26	62000	62015	62029
150	10.27	62015	62029	62043
175	10.29	62007	62021	62035
200	10.30	62025	62039	62053
225	10.32	62026	62040	62054
250	10.33	62042	62056	62070
275	10.34	62125	62138	62152
300	10.36	62142	62155	62169
325	10.37	62013	62026	62040
350	10.38	62036	62049	62063
375	10.40	62081	62093	62107
400	10.42	62076	62088	62102
425	10.44	62255	62267	62281
450	10.45	61424	61436	61450
475	10.46	61984	61996	62010
500	10.48	61931	61942	61956
525	10.58	61977	61987	62001
550	11.00	61919	61928	61942
575	11.02	62012	62021	62035
600	11.04	62025	62034	62048
625	11.05	62070	62079	62093
650	11.07	62069	62067	62081
675	11.08	62089	62097	62111
700	11.10	61912	61920	61934
725	11.11	61987	61995	62009
750	11.13	61913	61920	61934
775	11.19	61958	61964	61978
0	12 04	62001	62001	62015

950116

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No: G.11 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	1.37	62068	62068	62015
25	1.45	62035	62035	61982
50	1.50	62072	62072	62019
75	1.52	62032	62033	61980
100	1.54	62011	62012	61959
125	1.55	61977	61978	61925
150	1.57	62023	62024	61971
175	2.00	62001	62002	61949
200	2.02	62017	62018	61965
225	2.03	61963	61964	61911
250	2.08	61862	61864	61811
275	2.12	61948	61950	61897
300	2.14	61889	61891	61838
325	2.16	61806	61808	61755
350	2.18	62119	62121	62068
375	2.20	61856	61859	61806
400	2.23	61736	61739	61686
425	3.45	61513	61522	61469
450	3.48	62025	62034	61981
475	3.50	61685	61694	61641
500	3.53	61832	61841	61788
525	3.56	61889	61898	61845
550	3.57	61888	61898	61845
575	4.00	62023	62033	61980
600	4.03	61971	61981	61928
625	4.05	61984	61994	61941
650	4.08	62038	62048	61995
0	4.29	62056	62068	62015

950117

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.12 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	10.36	62008	62000	62013
25	10.38	61996	61989	62002
50	10.39	62002	61996	62009
75	10.40	61993	61988	62001
100	10.41	61995	61991	62004
125	10.43	62007	62003	62016
135	10.44	61992	62008	62008
0	10.48	62000	62000	62013

950118

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.13 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	10.50	61910	61910	61875
25	10.51	62041	62041	62006
50	10.53	61988	61988	61953
75	10.54	62003	62003	61968
100	10.56	62028	62028	61993
125	10.57	62062	62062	62027
150	10.58	62092	62092	62057
175	10.59	62006	62006	61971
200	11.00	62005	62005	61970
225	11.01	62009	62009	61974
250	11.03	62003	62003	61968
275	11.04	61940	61940	61905
300	11.05	61941	61941	61906
325	11.06	61955	61955	61920
350	11.07	61931	61932	61897
375	11.12	61940	61941	61900
400	11.13	61941	61942	61907
425	11.14	61955	61956	61921
450	11.15	62010	62011	61976
475	11.16	61992	61993	61958
500	11.24	62271	62273	62238
0	11.41	61907	61910	61875

950119

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.13 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.52	61884	61884	61875
25	8.54	62225	62225	62216
50	8.57	62117	62116	62108
75	8.59	62103	62102	62093
100	9.00	62106	62104	62095
125	9.01	62050	62048	62039
150	9.03	62063	62061	62052
175	9.04	62046	62043	62034
200	9.05	62058	62055	62046
225	9.08	62052	62048	62039
250	9.09	62049	62045	62036
275	9.11	62033	62029	62020
300	9.12	62033	62028	62019
325	9.13	62072	62067	62058
350	9.14	62045	62040	62031
375	9.15	62049	62044	62035
400	9.19	62042	62036	62027
425	9.20	62033	62026	62017
450	9.22	62018	62011	62002
475	9.25	62030	62022	62013
500	9.27	62002	61996	61977
525	9.40	61999	61987	61978
550	9.42	61990	61978	61969
575	9.44	61975	61962	61953
600	9.47	61991	61978	61969
625	9.49	62008	61994	62085
650	9.52	62057	62042	62033
675	9.53	62035	62020	62311
700	9.56	62391	62375	62566
725	9.58	62586	62570	62561
750	10.00	62393	62376	62367

950120

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.13 W. (cont'd)

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
775	10.02	62198	62181	62172
800	10.04	61929	61911	61901
825	10.22	61752	61730	61721
850	10.26	61880	61857	61848
875	10.28	62243	62219	62210
900	10.31	62169	62145	62136
0	11.32	61925	61885	61876

950121

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 15 E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	2.53	62055	-	62010
25	2.55	62043	-	61998
50	2.57	62166	=	62121
75	3.00	Not stable	-	-
100	3.05	62050	-	62005
125	3.08	62082	-	62037
150	3.10	62011	-	61966
175	3.12	62025	-	61980
200	3.14	62004	-	61959
225	3.20	62056	-	62011
250	2.23	62067	-	62022
275	3.27	62066	-	62021
300	3.28	62108	-	62063
325	3.29	62122	-	62077
350	3.30	62080	-	62035
375	3.32	62087	-	62042
400	3.36	62041	-	61996
425	3.50	62063	-	62018
450	3.54	62042	-	61997
475	3.56	62152	-	62107
500	4.00	62100	-	62055

950122

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 15 W.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	9.00	62053	62053	62010
25	9.01	62017	62017	61974
50	9.05	61987	61989	61946
75	9.07	62014	62017	61974
100	9.09	62088	62092	62049
125	9.10	62210	62215	62172
150	9.12	62040	62046	62003
175	9.14	62032	62039	61996
200	9.16	62003	62011	61968
225	9.17	62007	62015	61972
250	9.18	62016	62025	61982
275	9.24	62025	62037	61994
300	9.26	62097	62110	62067
325	9.28	62767	62781	62738
350	9.30	62631	62646	62603
375	9.33	62777	62793	62750
400	9.35	61999	62016	61973
425	9.37	61880	61898	61855
450	9.41	61846	61866	61823
475	9.44	61845	61867	61824
500	9.48	61870	61894	61851
525	10.01	61854	61884	61841
550	10.03	61913	61944	61901
575	10.06	61927	61960	61917
600	10.19	61911	61950	61907
625	10.21	62096	62136	62093
650	10.23	62778	62819	62776
0	10.40	62003	62053	62010

950123

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G.16 E.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.52	62115	62115	62048
25	9.02	61931	61933	61866
50	9.05	62004	62007	61940
75	9.08	61993	61997	61930
100	9.11	62003	62007	61940
125	9.17	62042	62048	61981
150	9.20	62055	62062	61995
175	9.23	62066	62073	62006
200	9.25	62037	62045	61978
225	9.28	62046	62055	61988
250	9.31	62043	62052	61985
275	9.35	62155	62165	62098
300	9.40	62025	62037	61970
325	9.43	62028	62040	61973
350	9.46	62074	62087	62020
375	9.50	62030	62044	61977
400	10.04	62036	62054	61987
425	10.07	62030	62048	61981
450	10.10	62044	62063	61998
475	10.12	62027	62047	61980
500	10.14	62015	62035	61968
525	10.17	62059	62080	62013
550	10.21	62060	62082	62015
575	10.25	62036	62059	61992
600	10.27	62073	62096	62029
625	10.31	62090	62114	62047
650	10.33	62083	62108	62041
675	10.35	62091	62116	62049
700	10.38	61990	62016	61949
725	10.42	62111	62138	62071
0	11.30	62074	62115	62048

950124

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 16 W

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	1.35	62079	62079	62048
25	1.37	61985	61985	61954
50	1.42	61994	61995	61964
75	1.44	62000	62002	61971
100	1.46	62099	62101	62070
125	1.49	61929	61932	61901
150	1.51	61908	61911	61880
175	1.53	61895	61899	61868
200	1.56	61986	61990	61959
0	2.43	62066	62079	62048

950125

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 17 E

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	8.42	62000	-	61959
25	8.45	61955	-	61914
50	8.46	61980	-	61939
75	8.47	61978	-	61937
100	8.49	62014	-	61973
125	8.51	62002	-	61961
150	8.52	62052	-	62011
175	8.53	62031	-	61990
200	8.55	62045	-	62004
225	8.56	60287	-	62046
250	8.57	62099	-	62058
275	8.58	62133	-	62092
300	9.00	62000	-	61959
325	9.01	62007	-	61966
350	9.13	62000	-	61959
375	9.15	61999	-	61958
400	9.17	62018	-	61977
425	9.18	62002	-	61961
450	9.22	62015	-	61974
475	9.24	62023	-	61982
500	9.25	62055	-	62014
525	9.27	62024	-	61983
550	9.28	62043	-	62002
575	9.37	62047	-	62006
600	9.41	62049	-	62007
625	9.43	62065	-	62024
650	9.44	62074	-	62033
675	9.47	62094	-	62053
700	9.51	62068	-	62027
725	9.54	62082	-	62041
750	9.56	62051	-	62010

950126

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 17 E (cont'd)

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
775	9.58	62056	-	62015
800	10.02	62036	-	61995
825	10.04	62071	-	62030
850	10.10	62102	-	62061
875	10.12	62174	-	62133
900	10.13	62169	-	62128
925	10.30	62186	-	62145
930	10.33	62258	-	62217

950127

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 17 W

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	1.30	62013	-	61959
25	1.34	61979	-	61925
50	1.36	61987	-	61933
75	1.38	61956	-	61902
100	1.41	62021	-	61967
125	1.42	62110	-	62056
150	1.48	61995	-	61941
175	1.55	61974	-	61920
200	1.58	62020	-	61966
225	2.03	61934	-	61880
250	2.05	61935	-	61881
275	2.07	61923	-	61869
300	2.08	62030	-	61976
325	2.10	62107	-	62053
350	2.13	61957	-	61903
375	2.20	61867	-	61813
400	2.36	61848	-	61794
425	2.42	61832	-	61778
450	2.45	61808	-	61754
475	2.47	61769	-	61715
500	2.50	61967	-	61913
525	2.53	61864	-	61810
550	2.57	61865	-	61811
575	3.00	61875	-	61821
600	3.12	61890	-	61836
625	3.15	62018	-	61964
650	3.17	62020	-	61966
675	3.19	62014	-	61960
700	3.21	62091	-	62037
725	3.23	61981	-	61927
750	3.28	62088	-	62034

950128

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: G 17 W (cont'd)

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
775	3.31	62027	-	61973
800	3.34	62018	-	61964
825	3.36	62011	-	61957
850	3.37	61959	-	61905
875	3.40	61963	-	61909
900	3.40	62008	-	61954
925	3.49	61977	-	61923
950	3.59	61975	-	61921
975	4.02	61938	-	61884
1000	4.07	61958	-	61904
1025	4.13	62025	-	61971
1050	4.16	61950	-	61896
1075	4.19	62002	-	61948
1100	4.22	62029	-	61975
1125	4.27	62049	-	61995
1150	4.29	62048	-	61994
1175	4.31	62021	-	61967
1200	4.34	62025	-	61971
1225	4.36	62020	-	61966
1250	4.38	61972	-	61918
1275	4.42	61937	-	61883
1300	4.49	61914	-	61860
1325	4.52	61847	-	61793
1350	4.58	61893	-	61839
1375	5.01	61912	-	61858
1400	5.04	61822	-	61768
1425	5.08	61925	-	61871
1450	5.10	61891	-	61837
1475	5.15	61700	-	61646
1500	5.18	61636	-	61582

950129

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: DC - 6.

STATION IDENTITY	TIME	AVERAGE READING	TIME CORRECTED	ADJUSTED READING
0	1.50	62046	62046	62017
25	1.52	62042	62042	62013
50	1.54	62029	62029	62000
75	1.55	62048	62048	62019
100	1.59	61975	61975	61946
125	2.10	61949	61951	61922
150	2.14	62046	62048	62019
175	2.15	62038	62040	62011
200	2.16	61955	61957	61928
225	2.17	62025	62027	61998
250	2.20	61954	61957	61928
275	2.28	62004	62007	61978
300	2.34	61884	61893	61864
325	2.38	61953	61957	61928
350	2.40	62008	62013	61984
375	2.48	61996	62001	61972
0	3.30	62036	62046	62017

950130

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE No. 1200 N. WOMBAT

DISTANCE	TIME	AVERAGE	ADJUSTED TO O	ADJUSTED TO NLBL BASE.
0 (4300)				
4325	9.45	61958	61958	61986
4350	9.46	61942	61942	61970
4375	9.47	61946	61946	61974
4400	9.49	61937	61937	61965
4425	9.50	61988	61988	62016
4450	9.52	61868	61868	61896
4475	9.54	61936	61937	61965
4500	9.58	61931	61932	61960
4525	10.00	61897	61898	61926
4550	10.08	61891	61894	61922
4575	10.10	61882	61885	61913
4600	10.12	61885	61888	62916
4625	10.14	61911	61914	61942
4650	10.15	61943	61946	61974
4675	10.16	61973	61977	62005
4700	10.17	62031	62035	62063
4725	10.18	62054	62058	62086
4750	10.20	62022	62026	62054
4775	10.22	62044	62048	62076
4800	10.23	62024	62029	62057
4825	10.25	62045	62050	62078
4850	10.27	62055	62060	62088
4875	10.30	62016	62021	62049
4900	10.50	62033	62041	62069
4325	11.16	61946	61958	61986

950131

CLEVELAND TIN LTD.

MAGNETOMETER TRAVERSE

INSTRUMENT: MP-2 OPERATORS: P.D. & J.F. DATE:

LINE N°: 1200 N. WOMBAT (cont'd)

DISTANCE	TIME	AVERAGE	ADJUSTED TO 0	ADJUSTED TO NLBL BASE.
4325	1.57	61921	61921	61986
4900	2.18	61996	61993	62058
4925	-	-	-	-
4950	2.21	62223	62220	62285
4975	2.23	62004	62000	62065
5000	2.24	62157	62153	62218
5025	2.26	62116	62112	62177
5050	2.27	62164	62160	62215
5075	2.29	62174	62169	62224
5100	2.30	61899	61894	61959
5125	2.31	62164	62159	62224
5150	2.32	62181	62176	62241
5175	2.33	62303	62298	62363
5200	2.35	62291	62285	62350
5225	2.36	62352	62346	62411
5250	2.37	62348	62342	62407
5275	2.38	62443	62437	62502
5300	2.40	62535	62528	62593
5325	2.41	62659	62652	62717
5350	2.42	62686	62679	62744
5375	2.43	62865	62858	62923
	2.44	62804	62797	62862
5425	2.45	62768	62761	62826
5450	2.46	62772	62764	62829
5475	2.47	62933	62925	62990
5500	2.48	62660	62652	62717
5525	2.50	62896	62888	62953
5550	2.51	63126	63118	63183
5575	2.53	63137	63128	63193
5600	2.54	63264	63255	63320
4325	3.44	61939	61921	61986

APPENDIX V

DIGHEM SURVEY E.L. 1/63

REPORT BY CONSULTANTS

950133

REPORT NO. 328

DIGHEM^{II} SURVEY

OF

CLEVELAND AREA, TASMANIA

FOR

ABERFOYLE EXPLORATION PTY. LTD.

BY

DIGHEM LIMITED

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April 30, 1981

950134

SUMMARY

A DIGHEM^{II} airborne electromagnetic/resistivity/magnetic survey totalling 218 line-km was flown in the Cleveland area, Tasmania, for Aberfoyle Exploration Pty. Ltd. in February 1981.

The geologic environment in the survey area was generally resistive and magnetically active. Several EM anomalies were detected which occurred due to locally conductive bedrock and overburden features, as well as due to culture. The resistivity technique delineated several low resistivity zones which occur in the bedrock and appear to warrant ground follow-up work.

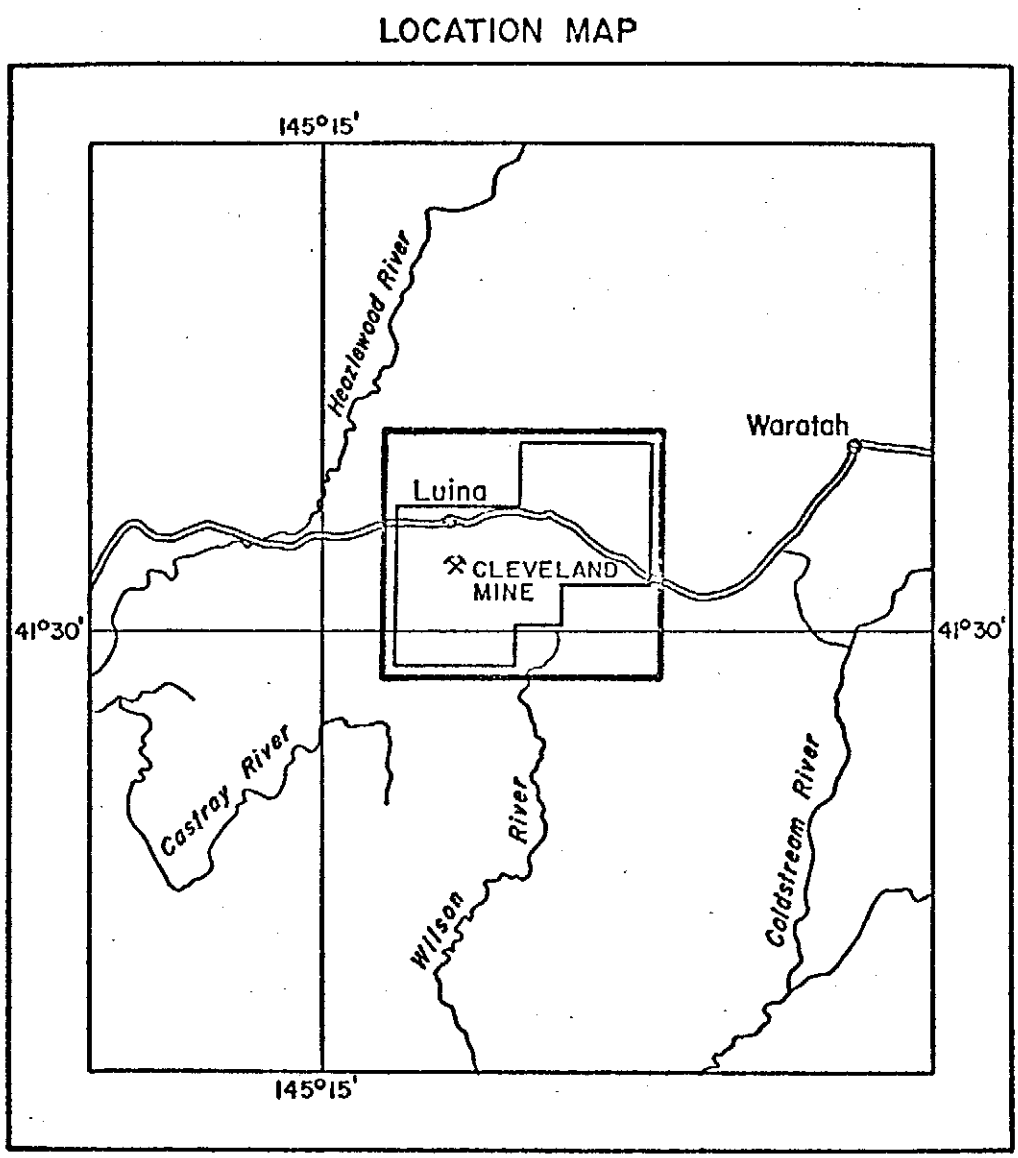

FIGURE 1. THE SURVEY AREA

5 cm

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APPENDIX A: The Flight Record and Path Recovery

APPENDIX B: EM Anomaly List

INTRODUCTION

A DIGHEM^{II} survey of 218 line-kilometres was flown with a 200 m line-spacing for the Aberfoyle Exploration Pty. Ltd. on February 21 and February 22, 1981 in the Cleveland area, Tasmania (Figure 1).

The Lama VH-PDU jet helicopter flew with an average airspeed of 110 km/h and EM bird height of 36 m. Ancillary equipment consisted of a Geometrics 803 magnetometer with its bird at an average height of 51 m, a Sperry radio altimeter, Geocam sequence camera, Barringer 8-channel hot pen analog recorder, and a Geometrics G-714 digital data acquisition system with a Kennedy 9700 9-track 800-bpi magnetic tape recorder. The analog equipment recorded four channels of EM data at approximately 900 Hz, two ambient EM noise channels (for the coaxial and coplanar receivers), and one channel each of magnetics and radio altitude. The digital equipment recorded the EM data with a sensitivity of 0.25 ppm/bit and the magnetic field to one gamma/bit.

The Appendix provides details on the data channels, their respective noise levels, and the data reduction procedure. The quoted noise levels are generally valid for wind speeds up to 35 km/h. Higher winds may cause the system to be grounded because excessive bird swinging

produces difficulties in flying the helicopter. The swinging results from the 5 m^2 of area which is presented by the bird to broadside gusts. The DIGHEM system nevertheless can be flown under wind conditions that seriously degrade other AEM systems.

ELECTROMAGNETICS

DIGHEM electromagnetic responses fall into two general classes, discrete and broad. The discrete class consists of sharp, well defined anomalies from discrete conductors such as sulfide lenses and steeply dipping sheets of graphite and sulfides. The broad class consists of wide anomalies from conductors having a large horizontal surface such as flatly dipping graphite or sulfide sheets, saline water-saturated sedimentary formations, conductive overburden and rock, and geothermal zones. A vertical conductive slab with a width of 100 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. All anomalies plotted on the electromagnetic map are interpreted according to this model. The following section entitled Discrete conductor analysis describes this model in detail,

including the effect of using it on anomalies caused by broad conductors such as conductive overburden.

The conductive earth (half space) model is suitable for broad conductors. Resistivity contour maps result from the use of this model. A later section entitled Resistivity mapping describes the method further, including the effect of using it on anomalies caused by discrete conductors such as sulfide bodies.

Discrete conductor analysis

The EM anomalies appearing on the electromagnetic map are interpreted by computer to give the conductance (i.e., conductivity-thickness product) in mhos of a vertical sheet model. DIGHEM anomalies are divided into six grades of conductance, as shown in Table I. The conductance in mhos is the reciprocal of resistance in ohms.

Table I. EM Anomaly Grades

Anomaly Grade	Mho Range
6	greater than 99
5	50 - 99
4	20 - 49
3	10 - 19
2	5 - 9
1	less than 5

The mho value is a geological parameter because it is a characteristic of the conductor alone; it generally is independent of frequency, and of flying height or depth of burial apart from the averaging over a greater portion of the conductor as height increases.[1] Small anomalies from deeply buried strong conductors are not confused with small anomalies from shallow weak conductors because the former will have larger mho values.

Conductive overburden generally produces broad EM responses which are not plotted on the EM maps. However, patchy conductive overburden in otherwise resistive areas can yield discrete-like anomalies with a conductance grade (cf. Table I) of 1, or even of 2 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities can be as low as 1 ohm-m, anomalies caused by weathering variations and similar causes can have conductance grades as high as 4. The anomaly shapes from the multiple coils often allow such surface conductors to be recognized, and these are indicated by the letter S on the map. The remaining anomalies in such areas could be

[1]This statement is an approximation. DIGHEM, with its short coil separation, tends to yield larger and more accurate mho values than airborne systems having a larger coil separation.

bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: DIGHEM's New Insco copper discovery (Noranda, Quebec, Canada) yielded a grade 4 anomaly, as did the neighbouring copper-zinc Magusi River ore body; Mattabi (copper-zinc, Sturgeon Lake, Ontario, Canada) and Whistle (nickel, Sudbury, Ontario, Canada) gave grade 5; and DIGHEM's Montcalm nickel-copper discovery (Timmins, Ontario, Canada) yielded a grade 6 anomaly. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

Strong conductors (i.e., grades 5 and 6) are characteristic of massive sulfides or graphite. Moderate conductors (grades 3 and 4) typically reflect sulfides of a less massive character or graphite, while weak bedrock conductors (grades 1 and 2) can signify poorly connected graphite or heavily disseminated sulfides. Grade 1 conductors may not respond to ground EM equipment using frequencies less than 2000 Hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, New Brunswick,

Canada, yielded a well defined grade 1 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction.

Faults, fractures and shear zones may produce anomalies which typically have low conductances (e.g., grade 1 and 2). Conductive rock formations can yield anomalies of any conductance grade. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

On the electromagnetic map, the actual mho value and a letter are plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots, beside each anomaly symbol, indicate the anomaly amplitude on the flight record. The vertical column of dots gives the estimated depth. In areas where anomalies are crowded, the identifiers, dots and mho values may be obliterated. The EM grade symbols, however, will always be discernible, and the obliterated information can be obtained from the anomaly listing appended to this report.

The purpose of indicating the anomaly amplitude by dots is to provide an estimate of the reliability of the conductance calculation. Thus, a conductance value obtained from a large ppm anomaly (3 or 4 dots) will be accurate whereas one obtained from a small ppm anomaly (no dots) could be inaccurate. The absence of amplitude dots indicates that the anomaly from the coaxial coil-pair is 5 ppm or less on both the inphase and quadrature channels. Such small anomalies could reflect a weak conductor at the surface or a stronger conductor at depth. The mho value and depth estimate will illustrate which of these possibilities fits the recorded data best.

Flight line deviations occasionally yield cases where two anomalies, having similar mho values but dramatically different depth estimates, occur close together on the same conductor. Such examples illustrate the reliability of the conductance measurement while showing that the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be

deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock on the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.

Dip symbols are used to indicate the direction of dip of conductors. These symbols are used only when the anomaly shapes are unambiguous, which usually requires a fairly resistive environment.

A further interpretation is presented on the EM map by means of the line-to-line correlation of anomalies, which is based on a comparison of anomaly shapes on adjacent lines. This provides conductor axes which may define the geological structure over portions of the survey area. The absence of conductor axes in an area implies that anomalies could not be correlated from line to line with reasonable confidence.

DIGHEM electromagnetic maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with

geology when planning a follow-up program. The actual mho values are plotted for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of conductors in terms of length, strike direction, conductance, depth, thickness (see below), and dip. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.

An EM anomaly list attached to each survey report provides a tabulation of anomalies in ppm, and in mhos and estimated depth for the vertical sheet model. The EM anomaly list also shows the conductance in mhos and the depth for a thin horizontal sheet (whole plane) model, but only the vertical sheet parameters appear on the EM map. The horizontal sheet model is suitable for a flatly dipping thin bedrock conductor such as a sulfide sheet having a thickness less than 15 m. The list also shows the resistivity and depth for a conductive earth (half space) model, which is suitable for thicker slabs such as thick conductive overburden. In the EM anomaly list, a depth value of zero for the conductive earth model, in an area of thick cover, warns that the anomaly may be caused by conductive overburden.

Since discrete bodies normally are the targets of EM surveys, local base (or zero) levels are used to compute local anomaly amplitudes. This contrasts with the use of true zero levels which are used to compute true EM amplitudes. Local anomaly amplitudes are shown in the EM anomaly list and these are used to compute the vertical sheet parameters of conductance and depth. Not shown in the EM anomaly list are the true amplitudes which are used to compute the horizontal sheet and conductive earth parameters.

X-type electromagnetic responses

DIGHEM^{II} maps contain x-type EM responses in addition to EM anomalies. An x-type response is below the noise threshold of 2 ppm, and reflects one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of a flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are mentioned in the report. The others should not be followed up unless their locations are of considerable geological interest.

The thickness parameter

DIGHEM^{II} can provide an indication of the thickness of a steeply dipping conductor. The ratio of the anomaly amplitude of channel 24/channel 22 generally increases as the apparent thickness increases, i.e., the thickness in the horizontal plane. This thickness is equal to the conductor width if the conductor dips at 90 degrees and strikes at right angles to the flight line. This report refers to a conductor as thin when the thickness is likely to be less than 3m, and thick when in excess of 10 m. In base metal exploration applications, thick conductors can be high priority targets because most massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are usually thin. An estimate of thickness cannot be obtained when the strike of the conductor is subparallel to the flight line,when the conductor has a shallow dip, when the anomaly amplitudes are small, or when the resistivity of the environment is below 100 ohm-m.

Resistivity mapping

Areas of widespread conductivity are commonly encountered during surveys. In such areas, anomalies can be generated by decreases of only 5 m in survey altitude as

well as by increases in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active; local peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity profiles and contour maps are necessary for the interpretation of the airborne data. The advantage of the resistivity parameter is that anomalies caused by altitude changes are virtually eliminated, so the resistivity data reflect only those anomalies caused by conductivity changes. This helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. Discrete conductors will generally appear as narrow lows on the contour map and broad conductors will appear as wide lows.

Channel 40 (see Appendix) and the resistivity contour map present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined in Fraser (1978)[2]. This model consists of a resistive layer overlying a conductive half space. Channel 41 gives the apparent depth below surface of the conductive material.

[2]Resistivity mapping with an airborne multicoil electromagnetic system: Geophysics, v 43, p. 144-172.

The apparent depth therefore is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover). The inputs to the resistivity algorithm are the inphase and quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

The apparent depth parameter is a useful indicator of simple layering in areas lacking a heavy tree cover. The DIGHEM^{II} system has been flown for the purpose of permafrost mapping, where positive apparent depths were used as a measure of permafrost thickness. However, little quantitative use has been made of negative apparent depths because the absolute value of the negative depth is not a measure of the thickness of the conductive upper layer and, therefore, is not meaningful physically. Qualitatively, a negative apparent depth estimate usually shows that the EM anomaly is caused by conductive overburden. Consequently, the apparent depth channel 41 can be of significant help in distinguishing between overburden and bedrock conductors.

Interpretation in conductive environments

Environments having background resistivities below 30 ohm-m cause all airborne EM systems to yield very large responses from the conductive ground. This usually prohibits the recognition of bedrock conductors. The processing of DIGHEM^{II} data, however, produces four channels which contribute significantly to the recognition of bedrock conductors. These are the inphase and quadrature difference channels (number 33 and 34), and the resistivity and depth channels (40 and 41). The EM difference channels

eliminate up to 99% of the response of conductive ground, leaving responses from bedrock conductors, cultural features (e.g., telephone lines, fences, etc.) and edge effects. An edge effect arises when the conductivity of the ground suddenly changes, and this is a source of geologic noise. While edge effects yield anomalies on the EM difference channels, they do not produce resistivity anomalies. Consequently, the resistivity channel aids in eliminating anomalies due to edge effects. On the other hand, resistivity anomalies will coincide with the most highly conductive sections of conductive ground, and this is another source of geologic noise. The recognition of a bedrock conductor in a highly conductive environment therefore is based on the anomalous responses of the two difference channels (33 and 34) and the resistivity channel (40). The most favourable situation is where anomalies coincide on all three channels.

Channel 41, which is the apparent depth to the conductive material, also helps determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When this channel rides above the zero level on the orange profile paper (i.e., it is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, i.e., conductive

overburden. If channel 41 is below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor.

Channels 35 and 36 are the anomaly recognition functions. They are used to trigger the conductance channel 37 which identifies discrete conductors. In highly conducting environments, channel 36 may not be generated because it is subject to some corruption by highly conductive earth signals. Some of the automatically selected anomalies (channel 37) are discarded by the human interpreter. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter then classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those rising from geologic or aerodynamic noise.

The resistivity map often yields more useful information on conductivity distributions than the EM map. In comparing the EM and resistivity maps, keep in mind the following:

(a) The resistivity map portrays the absolute value of the earth's resistivity.

(b) The EM map portrays anomalies in the earth's resistivity. An anomaly by definition is a change from the norm and so the EM map displays anomalies, (i) over narrow, conductive bodies and (ii) over the boundary zone between two wide formations of differing conductivity.

The resistivity map might be likened to a total field map and the EM map to a horizontal gradient in the direction of flight[3]. Because gradient maps are usually more sensitive than total field maps, the EM map therefore is to be preferred in resistive areas. However, in conductive areas, the absolute character of the resistivity map usually causes it to be more useful than the EM map.

Reduction of geologic noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden

[3]The gradient analogy is only valid with regard to the identification of anomalous locations. The calculation of conductance is based on EM amplitudes relative to a local base level, rather than to an absolute zero level as for the resistivity calculation.

and magnetic polarization. It was mentioned above that the EM difference channels (i.e., channel 33 for inphase and 34 for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM^{II} is the only EM system which yields channels having an exceptionally high degree of immunity to conductive overburden.

Magnetite produces a form of geological noise on the inphase channels of all EM systems. Rocks containing less than 1% magnetite can yield negative inphase anomalies caused by magnetic polarization. When magnetite is widely distributed throughout a survey area, the inphase EM channels may continuously rise and fall reflecting variations in the magnetite percentage, flying height, and overburden thickness. This can lead to difficulties in recognizing deeply buried bedrock conductors, particularly if conductive overburden also exists. However, the response of broadly distributed magnetite generally vanishes on the inphase difference channel 33. This feature can be a significant aid in the recognition of conductors which occur in rocks containing accessory magnetite.

MAGNETICS

The existence of a magnetic correlation with an EM anomaly is indicated directly on the EM map. An EM anomaly with magnetic correlation has a greater likelihood of being produced by sulfides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Ontario, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Ontario).

The magnetometer data are digitally recorded in the aircraft to an accuracy of one gamma. The digital tape is processed by computer to yield a standard total field magnetic map which is usually contoured at 25 gamma intervals. The magnetic data also are treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic map is produced with a 100 gamma contour interval. The response of the enhancement operator in the frequency domain is shown in Figure 2. The 100 gamma contour interval is equivalent to a 5 gamma interval for the passband components of the airborne data. This is because these components are amplified 20 times by the operator of Figure 2.

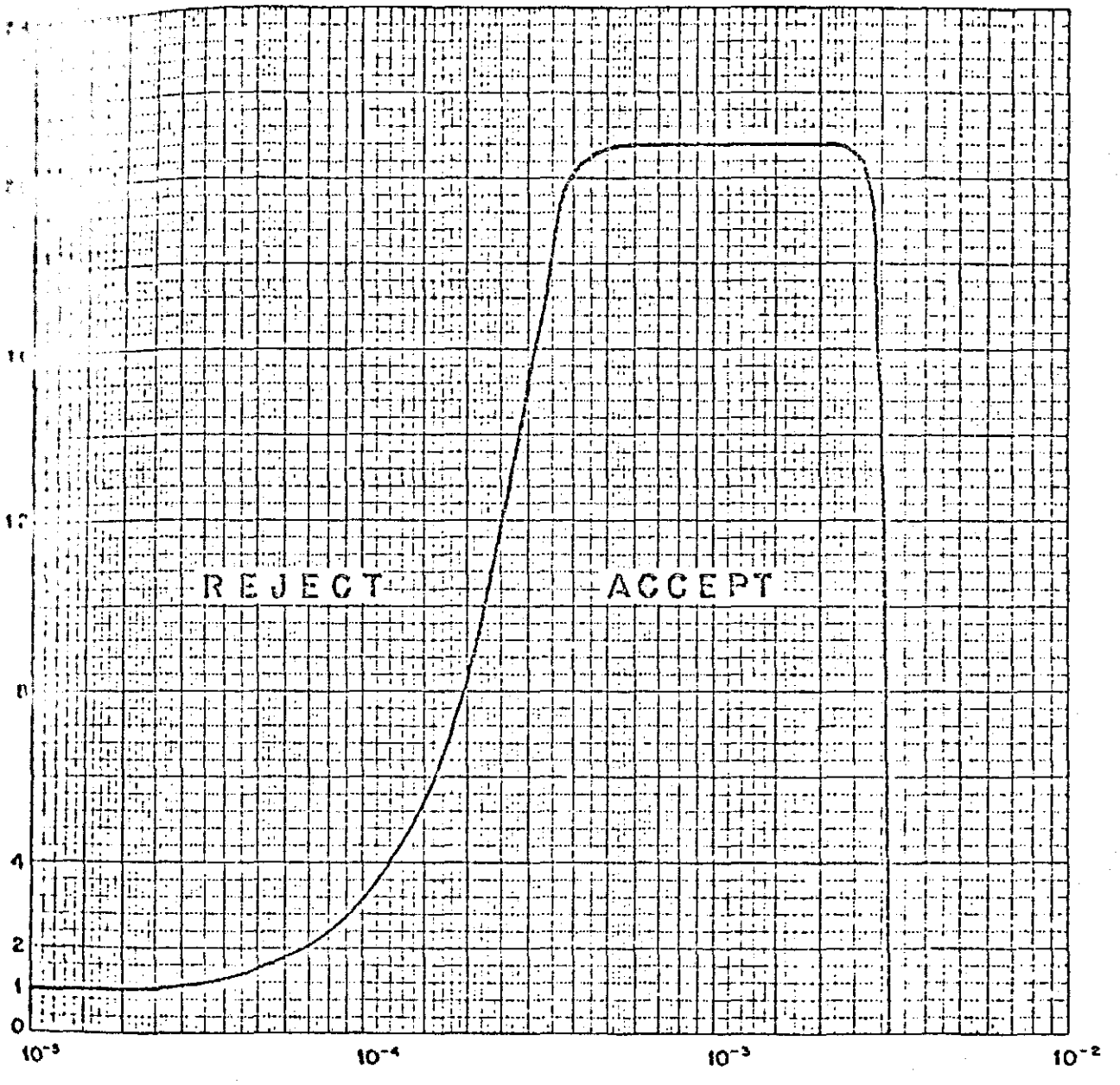

Figure 2 Frequency response of magnetic operator

The enhanced map, which bears a resemblance to a downward continuation map, is produced by digital bandpass filtering the total field data. The enhancement is equivalent to continuing the field downward to a level (above the source) which is 1/20th of the actual sensor-source distance.

Because the enhanced magnetic map bears a resemblance to a ground magnetic map, it simplifies the recognition of trends in the rock strata and the interpretation of geological structure. The contour interval of 100 gammas is suitable for defining the near-surface local geology while de-emphasizing deep-seated regional features.

CONDUCTORS IN THE SURVEY AREA

The electromagnetic map shows the location of conductors and their interpreted conductance (i.e., conductivity-thickness product) and depth. Their strike direction and length are also shown when anomalies can be correlated from line-to-line. When studying the maps for follow-up planning, consult the anomaly listings appended to this report to ensure that none of the conductors are overlooked.

Numerous cultural sources, such as power lines, metal fences and the like, exist in the central part of the survey area. In some instances, they have produced resistivity lows which, in turn, have caused distortions of the resistivity contour patterns.

The resistivities within the survey area range from about 50 ohm-m to in excess of 1,000 ohm-m. Well defined low resistivity zones of a north-to-northeasterly trend occur along the western and eastern boundaries of the survey block. The apparent depth channel (41 on the grey computer generated profiles) indicates that some of these zones reflect conductive material which definitely occurs in the bedrock (e.g., the low resistivity zone at the west end of lines 1 to 4, along the east central portion of lines 24 to 27, and along the western end of lines 30 to 35). They should be correlated with information available from other exploration sources and, if warranted, standard ground follow-up work should be undertaken.

The EM map indicates which anomalies are believed to be caused by culture or surficial sources. Generally, such anomalies are not commented on below as the discussions are directed to identifying bedrock features.

Anomaly 1A — This single-line grade 1 non-magnetic anomaly is somewhat suspect, although probably real.

Anomaly 14B — This single-line grade 1 anomaly appears to reflect a bedrock conductor. Because the anomaly correlates with a tailings pond dam, its source could be cultural. Note the distinct magnetic anomaly of a dipolar character associated with this conductor.

Anomaly 14xA-17xD — These grade 1 and 2 anomalies and associated x-type responses appear to reflect a bedrock conductor. An analysis of the EM responses indicates that the conductor is depth limited.

Anomaly 16A-17A — These grade 1 anomalies displav characteristics similar to tors 14B and 14xA-17xD conductor correlat·

appears to be depth limited and, 17A is associated with a magnetic dipolar anomaly.

Anomaly 18G — This single-line grade 2 anomaly appears to reflect a non-magnetic bedrock conductor.

Anomaly 23B — This grade 1 anomaly reflects a non-magnetic bedrock conductor which is associated with a relatively poorly defined low resistivity zone of a northeasterly trend.

Anomalies 23P, 25xD-27G — These grade 1 and 2 anomalies reflect non-magnetic bedrock conductors. The resistivity map suggests that they may be related to a common source.

Anomalies 27A-28A, 32xA-35A — These grade 1 anomalies reflect non-magnetic bedrock conductors. Conductor 32xA-35A may extend to

31A and further north beyond the survey boundary.

Respectfully submitted,
DIGHEM LIMITED

Z. Dvorak
Geophysicist

S. Vergos
Geophysicist

Four map sheets accompany this report.

Electromagnetics	1 map sheet	×2
Resistivity	1 map sheet	
Magnetics	1 map sheet	
Enhanced magnetics	1 map sheet	

Job No. 328
D SV-9

A P P E N D I X A

THE FLIGHT RECORD AND PATH RECOVERY

Both analog and digital flight records are produced. The analog profiles are recorded on green chart paper in the aircraft during the survey. The digital profiles are generated later by computer and plotted on orange chart paper at a scale identical to the geophysical maps. The digital profiles, which may be displayed, are as follows:

Channel Number/ Label	Parameter	Scale units/mm	Noise
20 MAG	magnetometer	10 gamma	2 gamma
21 ALT	bird height	10 feet	5 feet
22 CXI	coaxial coil-pair inphase	1 ppm	1-2 ppm
23 CXQ	coaxial coil-pair quadrature	1 ppm	1-2 ppm
24 CPI	coplanar coil-pair inphase	1 ppm	1-2 ppm
25 CPQ	coplanar coil-pair quadrature	1 ppm	1-2 ppm
26 VLFT	VLF-EM total field	1 %	1-2 %
27 VLFQ	VLF-EM vertical quadrature	1 %	1-2 %
28 CXS	ambient noise monitor (coaxial coil)	1 ppm	1 ppm
29 CPS	ambient noise monitor (coplanar coil)	1 ppm	1 ppm
33 DIFI	difference function inphase	1 ppm	1-2 ppm
34 DIFQ	difference function quadrature	1 ppm	1-2 ppm
35 REC1	first anomaly recognition function	1 ppm	1-2 ppm
36 REC2	second anomaly recognition function	1 ppm	1-2 ppm
37 SIGT	conductance	1 mho	
40 RES	log resistivity at main frequency	.03 decade	
41 DP	apparent depth at main frequency	3 m	
45 RES2	log resistivity at secondary frequency	.03 decade	
46 DP2	apparent depth at secondary frequency	3 m	

Note: Channels 42 to 44 are experimental.

The log resistivity scale of 0.03 decade/mm means that the resistivity changes by an order of magnitude in 33 mm. The resistivities at 0, 33, 67 and 100 mm up from the bottom of the chart are respectively 1, 10, 100 and 1000 ohm-m.

The fiducial marks on the flight records represent points on the ground which were recognized by the aircraft navigator. Continuous photographic coverage allowed accurate photo-path recovery locations for the fiducials, which were then plotted on the geophysical maps to provide the track of the aircraft.

The fiducial locations on both the flight records and flight path maps were examined by a computer for unusual helicopter speed changes. Such changes may denote an error in flight path recovery. The resulting flight path locations therefore reflect a more stringent checking than is provided by standard flight path recovery techniques.

The following brief description of DIGHEM^{II} illustrates the information content of the various profiles*.

*For a detailed description, see D.C. Fraser, Geophysics, v.44, p.1367-1394.

Multi-frequency surveying

The DIGHEM^{II} system has two transmitter coils which are mounted at right angles to each other. Both coils transmit at approximately the same frequency. (This frequency is given in the Introduction.) Thus, the system provides two completely independent surveys at one pass. In addition, the digital flight chart profiles (generated by computer) include an inphase channel and a quadrature channel which essentially are free of the response of conductive overburden. Also, the EM channels may indicate whether the conductor is thin (e.g., less than 3 m), or has a substantial width (e.g., greater than 10 m). Further, the EM channels include channels of resistivity, apparent depth and conductance. A minimum of 11 EM channels are provided. The DIGHEM^{II} system therefore gives information in one pass which cannot be obtained by any other airborne or ground EM technique.

Figure A1 shows a DIGHEM^{II} flight profile over the massive pyrrhotite ore body in Montcalm Township, Ontario. It will serve to identify the majority of the available channels.

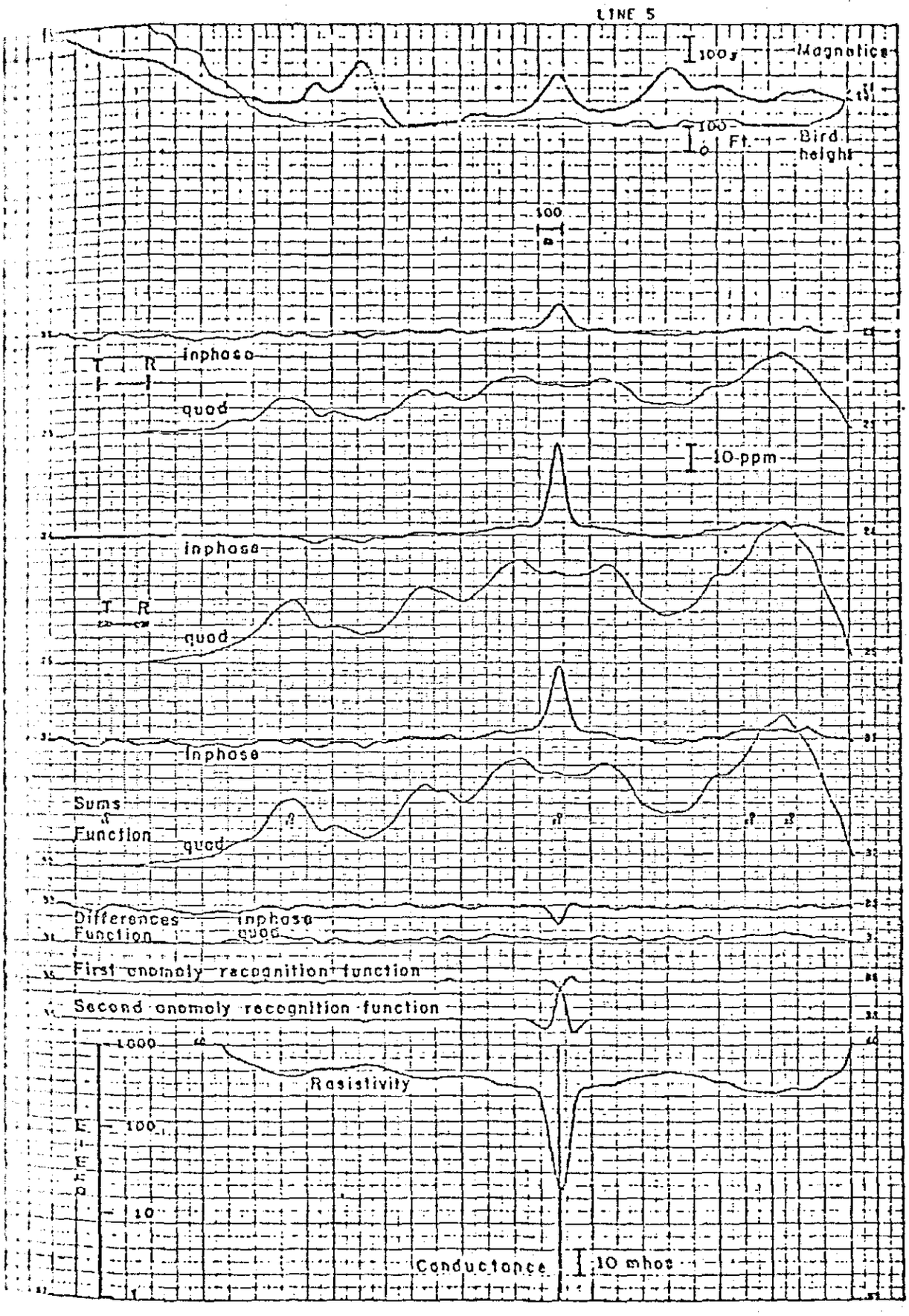

Fig. A1. Flight over Montcalm deposit, with line parallel to strike

The two upper channels (numbered 20 and 21) are respectively the magnetics and the radio altitude. Channels 22 and 23 are respectively the inphase and quadrature of the coaxial coil-pair, which is termed the standard coil-pair. This coil-pair is equivalent to the standard coil-pair of all inphase-quadrature airborne EM systems. Channels 24 and 25 are the inphase and quadrature of the additional coplanar coil-pair which is termed the whaletail coil-pair.

Channels 31 and 32 are inphase and quadrature sum functions of the standard and whaletail channels; they provide a condensed view of the four basic channels 22 to 25. The sum channels normally are not plotted.

Channels 33 and 34 are inphase and quadrature difference functions of the standard and whaletail channels. The difference channels are almost free from the response of conductive overburden. Channel 37 is the conductance. The conductance channel essentially is an automatic anomaly picker calibrated in conductance units of mhos; it is triggered by the anomaly recognition functions shown as channels 35 and 36.

Channel 40 is the resistivity, which is derived from the whaletail channels 24 and 25. The resistivity channel 40 yields data which can be contoured, and so the DIGHEM^{II} system yields a resistivity contour map in addition to an electromagnetic map, a magnetic contour map, and an enhanced magnetic contour map. The enhanced magnetic contour map is similar to the filtered magnetic map discussed by Fraser.*

Figure A2 presents the DIGHEM^{II} results for a line flown perpendicularly to the Montcalm ore body. Channel 20 shows the 175 gamma magnetic anomaly caused by the massive pyrrhotite deposit. For the EM channels, the following points are of interest:

1. On channels 22-25 and 31-34, the ore body essentially yields only an inphase response. The quadrature response is almost completely caused by conductive overburden (which also gives a small inphase response). The hachures show the EM response from the overburden. The overburden response vanishes on the

*Cdn. Inst. Mng., Bull., April 1974.

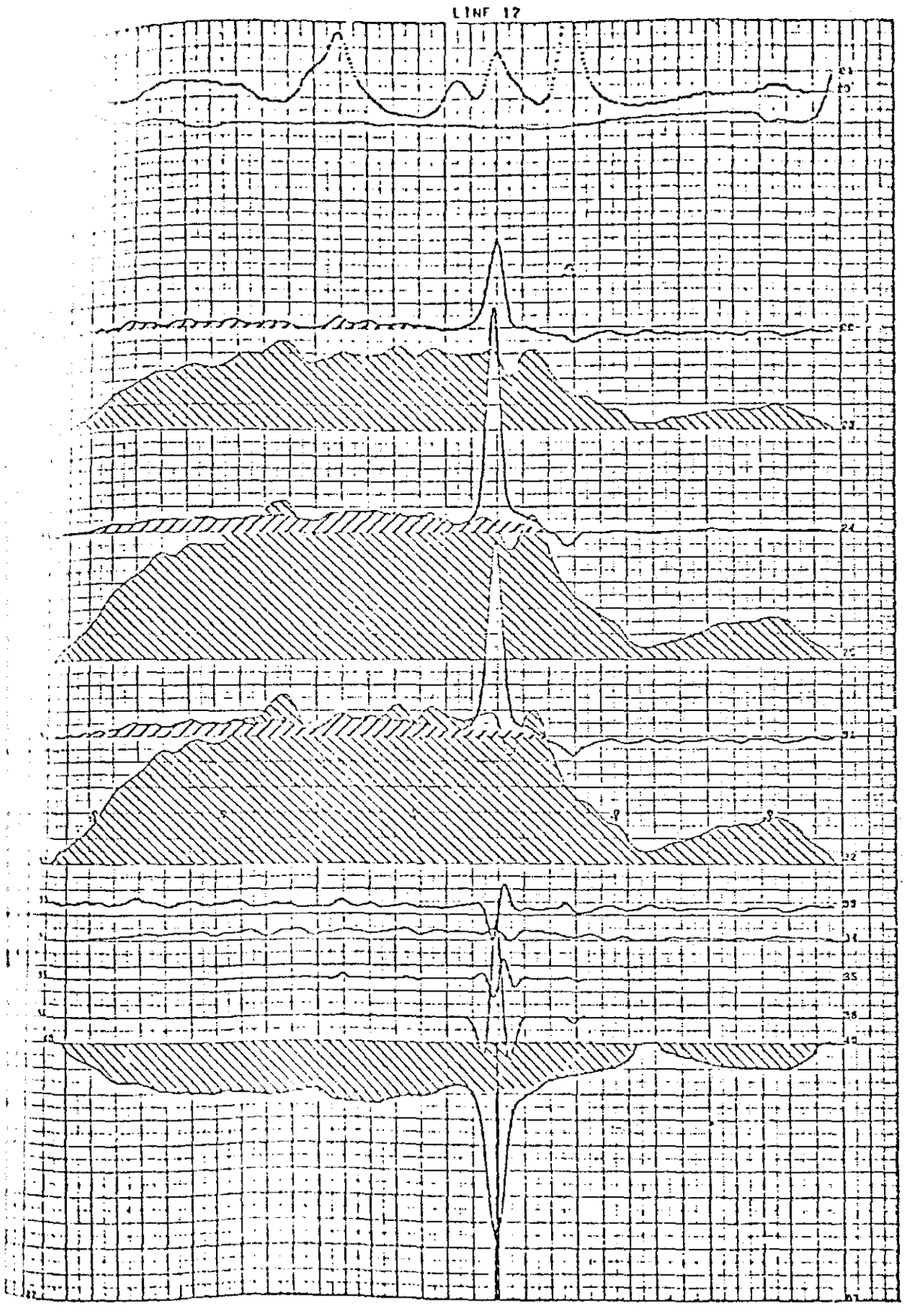

Fig. A2. Flight over Montcalm deposit, with line perpendicular to strike.

difference EM channels, as can be seen by comparing the quadrature channels 25 and 34. This is an important point to note because DIGHEM^{II} is the only EM system which provides an inphase channel and a quadrature channel which are essentially free of conductive overburden response.

2. The whaletail anomaly of channel 24 has a single peak. This shows that the conductor has a substantial width. If the width had been under 3 m, the conductor would have produced a weak m-shaped anomaly on channel 24.

3. The ore body yields a resistivity of 5 ohm-m in a background of about 200 ohm-m (cf. channel 40). A dipole-dipole ground resistivity survey with an a-spacing of 50 m showed a similar background, but the ore body gave a low of only 53 ohm-m because of the averaging effect inherent in the ground technique.

4. The ore body has a conductance of 330 mhos according to its EM response on this particular flight line. The conductance channel 37 saturates at 100 mhos, and so the deposit is indicated by a 100-mho spike.

Figure A1 illustrates the DIGHEM^{II} results for a line flown subparallel to the ore body. The ore body anomaly is small on the standard coil-pair (channel 22) but shows up strongly on the whaletail coil-pair (channel 24).

Dual-frequency interpretation

For surveys flown primarily for resistivity mapping, as opposed to EM surveying, the two transmitter coils may be energized at two well-separated frequencies (e.g., 900 and 3600 Hz). Apparent resistivity and apparent depth maps can be made independently for each frequency. The interpretation procedure involves comparing the apparent resistivities and apparent depths at the two frequencies.

The use of two different coil-pair orientations (i.e., standard and whaletail) for dual-frequency resistivity mapping is an unorthodox procedure. However, as long as the current flow patterns are primarily horizontal, the different coil orientations do not influence the results, according to superposed dipole theory. Wire fences and other cultural features will produce local deviations,

cause they usually respond preferentially to one or the of the coil-pairs.

The difference channels 33 and 34 are not produced cause the divergent frequencies of the two coil-pairs ders them meaningless. In addition, channels 35 to 37 also are not produced.

APPENDIX B

EM ANOMALY LIST

[The computer has selected those anomalies indicated by the symbol " + " on the following list as the most likely ones to be caused by bedrock conductors. In areas where the resistivity of the environment is less than 100 ohm-m and where EM anomalies are numerous, attention should be primarily directed to those anomalies indicated by this symbol. In areas of higher resistivity, most anomalies (regardless of the lack of the symbol " + ") will indicate bedrock conductors with the exception of those which are flagged on the EM map by the letters L, L?, S, S?; see EM map legend.]

950173

ABERFOYLE CLEVELAND MARCH/31 A

LINE & ANOMALY	COAXIAL COIL REAL PPM	COAXIAL COIL QUAD PPM	COPLANAR COIL REAL PPM	COPLANAR COIL QUAD PPM	VERTICAL DIKE COND MHOS	VERTICAL DIKE DEPTH* FEET	HORIZONTAL SHEET COND MHOS	HORIZONTAL SHEET DEPTH FEET	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH FEET
1A	2	2	1	3	4	159	1	411	813	54
14B	16	54	46	123	4	0	2	34	43	0
14C	1	5	1	1	2	0	1	243	1035	0
15A	3	3	0	1	5	0	1	230	130	50
16A	3	9	1	6	2	0	1	87	279	0
16B	3	5	1	4	2	0	1	114	364	0
16D	0	2	5	5	2	105	2	521	66	376
16E	1	4	0	4	4	59	1	649	1035	0
17A	21	67	32	115	4	0	1	31	65	0
17B	3	0	0	0	10	176	1	132	118	0
17C	1	3	0	2	6	139	1	688	1035	0
17D	9	8	0	7	6	46	1	480	1035	0
18A	5	0	3	0	52	185	1	228	894	0
18B	5	4	3	11	5	74	1	158	231	14
18C	4	2	3	0	29	35	1	263	76	110
18G +	4	4	3	8	5	76	1	133	352	0
18H	0	8	0	4	8	67	1	359	1035	0
18I	6	0	0	1	195	223	1	713	1035	0
19A	3	1	0	0	8	0	1	449	1035	0
19B	9	0	1	5	9	0	1	369	1035	0
19C	0	6	19	41	3	0	1	95	72	0
19E	1	2	2	0	5	218	1	382	953	44
19G	1	1	11	3	18	134	3	325	24	224
19H	10	1	3	5	34	76	1	219	126	64
19J	6	12	4	8	4	0	1	132	94	3
19N	11	6	0	2	8	38	1	121	935	0
19O	10	9	2	3	8	73	1	244	246	79
19P	2	5	0	0	3	0	1	595	1035	0

+ PROBABLE BEDROCK CONDUCTOR (SEE TITLE PAGE OF APPENDIX B)

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

950174

28 ABERFOYLE CLEVELAND MARCH/81 B

LINE & ANOMALY	COAXIAL COIL REAL PPM	COAXIAL COIL QUAD PPM	COPLANAR COIL REAL PPM	COPLANAR COIL QUAD PPM	VERTICAL DIKE COND MHOS	VERTICAL DIKE DEPTH* FEET	HORIZONTAL SHEET COND MHOS	HORIZONTAL SHEET DEPTH FEET	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH FEET
20A	8	5	2	3	11	32	1	249	390	43
20B	0	11	1	0	1	0	1	447	806	2
20C	10	10	2	1	9	0	1	476	1035	0
20D	6	4	0	0	11	0	1	498	1035	0
20E	4	2	0	5	7	0	1	291	1035	0
20F	0	2	3	6	1	0	1	375	152	167
20H	2	2	6	8	7	6	1	612	1035	0
20J	1	3	8	2	7	0	3	318	26	202
20N	4	7	2	6	3	0	1	89	146	0
20P	10	4	0	0	8	23	1	93	585	0
21F	0	5	3	3	2	80	1	442	210	233
21G	11	0	2	0	2840	0	2	163	44	47
21H	3	3	4	13	9	41	1	165	82	38
21I	3	7	0	10	1	0	1	186	145	51
21M	15	16	6	24	6	0	1	119	82	9
21N	0	11	0	0	3	19	1	211	123	73
21O	6	6	2	3	6	85	1	160	166	26
22C	1	6	9	5	4	23	2	259	35	155
22D	4	1	3	0	61	165	1	220	142	63
22E	5	8	5	6	4	0	1	159	103	24
22F	3	8	0	0	7	46	1	205	126	56
22J	5	3	2	9	5	60	1	163	126	27
23B	6	14	6	19	3	16	1	151	70	46
23E	12	11	2	8	8	45	1	137	159	9
23F	3	0	2	0	32	178	1	650	1035	0
23H	0	6	1	0	1	0	1	675	1035	0
23I	5	12	0	2	2	22	1	451	1035	0
23J	7	3	4	7	10	105	1	395	132	215
23N	8	7	3	0	7	0	1	323	190	123
23O	9	21	0	1	4	0	1	205	344	20
23P	5	8	5	13	3	31	1	186	92	60
23Q	1	9	1	15	1	0	1	132	187	7

* PROBABLE BEDROCK CONDUCTOR (SEE TITLE PAGE OF APPENDIX B)

** ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

28 ABERFOYLE CLEVELAND MARCH/31 C

LINE & ANOMALY	COAXIAL COIL REAL PPM	COAXIAL COIL QUAD PPM	COPLANAR COIL REAL PPM	COPLANAR COIL QUAD PPM	VERTICAL DIKE COND MHOS	VERTICAL DIKE DEPTH* FEET	HORIZONTAL SHEET COND MHOS	HORIZONTAL SHEET DEPTH FEET	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH FEET
24C	1	6	0	0	2	18	1	297	170	112
24D	10	1	1	0	102	0	1	436	112	249
24E	2	0	2	1	12	187	1	593	130	393
25A	2	4	2	4	3	3	1	199	255	20
25D	3	1	0	1	12	237	1	692	1035	0
26B	3	11	9	20	3	6	1	155	84	43
26D	6	6	7	13	5	51	1	174	103	49
27A	3	10	7	16	3	23	1	160	127	41
27C	2	4	0	2	3	86	1	299	1035	0
27G	5	9	11	21	4	15	1	153	79	39
27H	3	10	5	14	2	3	1	168	167	34
28A +	4	8	7	18	3	10	1	176	137	44
30A	3	4	3	9	3	34	1	138	118	10
31A	2	2	6	3	10	136	1	160	64	43
31B	3	13	2	21	1	0	1	114	132	0
32A	1	0	4	0	36	272	3	676	22	556
35A	4	8	6	14	3	0	2	156	55	43

+ PROBABLE BEDROCK CONDUCTOR (SEE TITLE PAGE OF APPENDIX B)

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

APPENDIX VI

GEOLOGICAL LOG

DDH C1610

STRATIGRAPHIC TESTING

CLEVELAND TIN — GEOLOGY DEPT.

HOLE No - C1/10

DRILL HOLE RECORD SHEET

Location: Eastern Sediments

Sect: AX

Objective: Stratographic

Category: Surface S/E

Proposed Azimuth: 290°

Proposed Dip: -52°

Survey P/U Azimuth: 277° 10' 34"

Survey P/U Dip: -52° 07' 22"

Calced by N.J. Hall (30/3/81)

Instrument Azimuth Correction Factor:

Collar Co-ords: 14523.394 N. 10933.229 E.

Collar R.L.: 1470.500

Final Depth: 397 m

Drilled By: Longyear - N. Harvey, A. Bloore

Rig Type: EHS 38

Core Size: HQ, NQ + BQ

Drilling Commenced: 27/2/81

Drilling Completed: 23/3/81

Survey Data				Interpolated Data		
Survey Inst.	Depth	Az.	Dip	Depth	Az.	Dip
Surv. P/U	0	277	-52	0	277	-52
Cam: NH	70	281	-52	12.5	278	-52
NH	130	280	-54.2	37.5	279.5	-52
NHy	160	280	-54.5	62.5	280.5	-52
AB	184.5	279	-55.2	87.5	281	-54.5
NH	222	278	-56	112.5	280.5	-54
NH	251	278	-56	137.5	280	-56
AB	283	279	-56	162.5	280	-54.5
"	314	276	-57.2	187.5	279	-55.5
NHy	334	273	-57.6	212.5	278	-56
AB	340	272	-57	237.5	278	-56
"	353	270	-58	262.5	278	-56
AB	379.5	269	-58	287.5	279	-56
NHy	397	269	-59.5	312.5	276.5	-57
				337.5	272	-57
				362.5	269.5	-58
Wedge	356.1			387.5	269	-59
				397	269	-59.5

SMITH PRINT

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950178 A



CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº C1610

BY P.D.E.

DATE 9/3/81

PAGE 1 OF 20

INTERVAL	CORE RECOVERY	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL
DEPTH M	LIFTS / LOSS	VB VT LST SS SH CH L	BLACK WHITE GREY BROWN KHAKI GREEN PURPLE LIGHT DARK	FINE MEDIUM COARSE	BANDED CHAOTIC	BRECCIATED SHEARED SLICKENSIDE JOINTED BROKEN	LOCATION & THICKNESS	SiO2 Chl Tm Co3 Bleach	LOC & THICK. QTZ CHL CO3 TM FL PO CPY PY SP AS CASS MICA	QTZ CHL CO3 TM FL AM PO CPY PY SP CASS			DEPTH M
0	Tri cone 1.5	1.5										Surface to 3.0 meters is bleached to a white cream orange - originally brown shale - cherty in parts	0
2	3.0	0.4											2
4	4.2	0.7										From 3.0 to 13.5 meters is weathered to an orange brown	4
	5.1	0.4							25 / 15	1 / 1			
6	6.0	0.7											6
	7.2	1.20											
8	9.0	1.8									weak Shb		8
10													10
12	BAD GROUND - TRICONED												12
												13.5	
14		11.5											14
16											Shb		16
18													18
20													20
DEPTH M	LIFTS / LOSS	VB VT LST SS SH CH L	BLACK WHITE GREY BROWN KHAKI GREEN PURPLE LIGHT DARK	FINE MEDIUM COARSE	BANDED CHAOTIC	BRECCIATED SHEARED SLICKENSIDE JOINTED BROKEN	LOCATION & THICKNESS	SiO2 Chl Tm Co3 Bleach	LOC & THICK. QTZ CHL CO3 TM FL PO CPY PY SP AS CASS	QTZ CHL CO3 TM FL AM PO CPY PY SP CASS		REMARKS	DEPTH M
INTERVAL	CORE RECOVERY	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS		INTERVAL

> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 35406

950179

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº C1610

BY P.D.E

DATE 9/3/81

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INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
20	20.5	0										shb	Contact at 45° 21.05	20
	21.5	0.4												
22		0.75						@23.7 10° 0.5 qtz iron						22
	23.5												Weathered and broken - fine grained shale - some coarse bands - iron manganese staining on joints & breakages indicate volcanics.	
24		0												24
	25.0							@25.8 10° 0.5 qtz iron.						
26	26.1	0										vf sh		26
		0.5												
28	28.0													28
	29.6	0.8												
30		0						@30.7 10° 1.4 iron gossan.						30
	31.3													
32		0												32
	32.8													
		0.2												
34	34.3													34
		0												
36	36.0							@36.3 10° 45 iron rich gossan.						36
		0.2											Contact at 37.5	
	37.5													
38		0						@39.0 10° 4.8				shg	Weathered and broken shearch.	38
	39.0													
		0.3												
40														40

DEPTH M	LIFTS	LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	DEPTH M
INTERVAL	CORE RECOVERY		ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY			INTERVAL

> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/80

950180

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610

BY P.D.C

DATE 13/3/81

PAGE 3 OF 20

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
40	40.5											slg	Contact at 40.5	40
	41.2	0.65											Very weathered iron stained iron rich gossans sheared - 42.5	
41	41.2	0												
	42.0	0.1										vt		42
	42.5	0.4												
44	45.0	1.0											Very weathered some iron staining some iron on joints	44
	46.3	0.2												
46	46.3	0												46
	48.0	0.1												
48	48.0	0												48
	49.5											slg		
50	51.0	1.2												50
		0.3												
52	52.5												52.5 Possibly vt/slt from 52.5 to 61.5 but very weathered	52
	54.0	1.4												
54		0.5												54
	55.5													
56	57.0	1.2										vt/slt		56
		0.4												
58	58.5													58
		0.4												
60	60.9													60
DEPTH M	LIFTS	LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	DEPTH M
INTERVAL	CORE RECOVERY		ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY		REMARKS	INTERVAL

NWPS 36406

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CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610

BY: P.D.L

DATE 17/3/81

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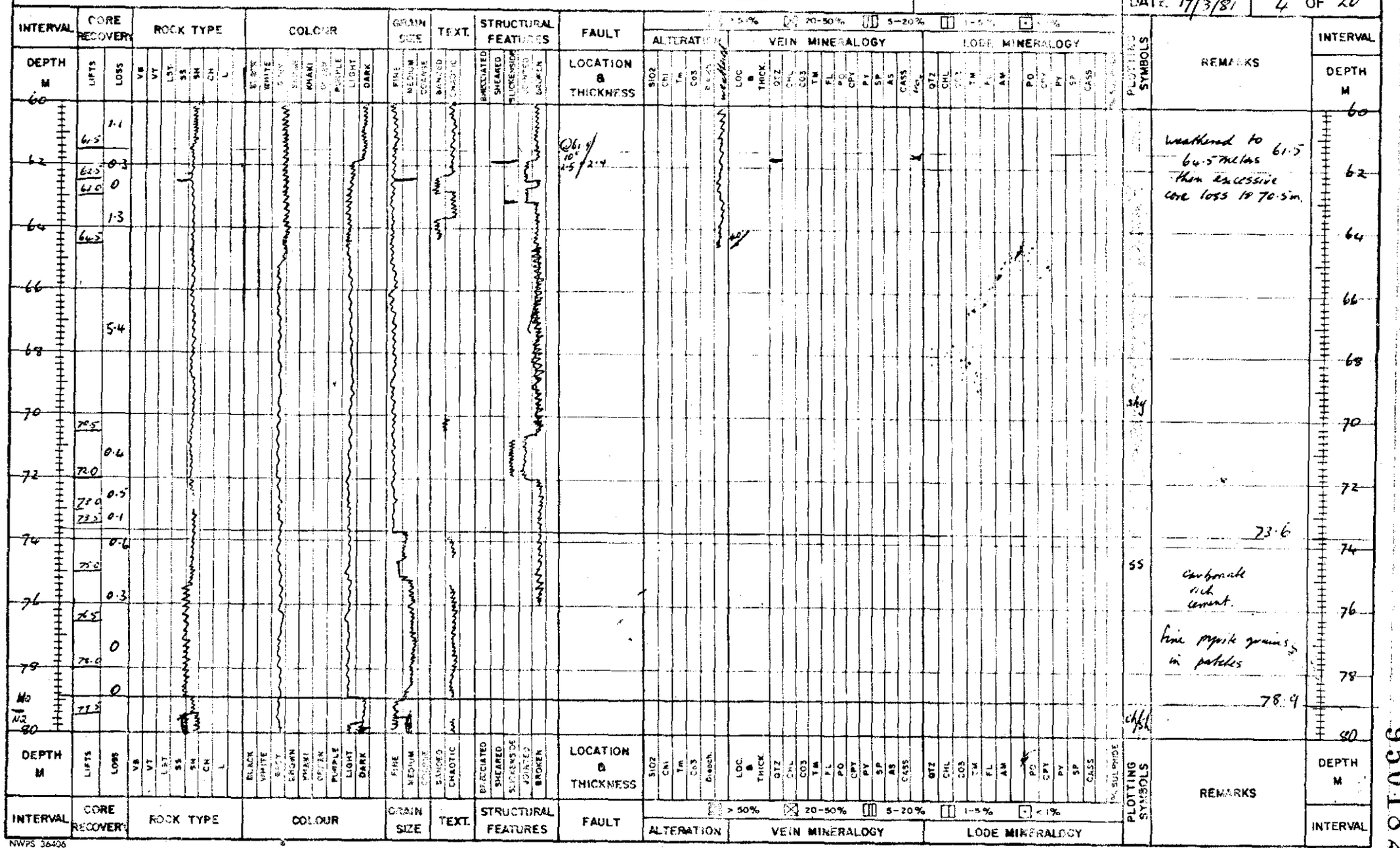
INTERVAL	CORE RECOVERY	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL
DEPTH M	LIFTS / LOSS	VB VT LST SS SH CH L	BLACK WHITE GREY BROWN KHAKI GREEN PURPLE LIGHT DARK	FINE MEDIUM COARSE	BANDED CHAOTIC	BRECCIATED SHEARED SLICKENSIDE JOINTED BROKEN	LOCATION & THICKNESS	SiO2 Chl Tm Co3 Bleach. weathered	LOC. & THICK. QTZ CHL CO3 TM FL PO CPY PY SP AS CASS	QTZ CHL CO3 TM FL AM PO CPY PY SP CASS % SULPHIDE			DEPTH M
60	61.5 / 1.1											weathered to 64.5 meters 61.5 then excessive core loss to 70.5m.	60
62	62.5 / 0.3						@61.4 10° 2.5 / 2.4						62
	62.0 / 0												
64	64.5 / 1.3												64
66													66
68	5.4												68
70	70.5 / 0.4										shy		70
72	72.0 / 0.5												72
	73.0 / 0.1												
74	73.5 / 0.6											73.6	74
	75.0 / 0.3										SS	carbonate rich cement.	
76	76.5 / 0											fine pyrite grains in patches	76
78	78.0 / 0												78
Mo / NQ 80	79.5										ch/sh	78.9	80
DEPTH M	LIFTS / LOSS	VB VT LST SS SH CH L	BLACK WHITE GREY BROWN KHAKI GREEN PURPLE LIGHT DARK	FINE MEDIUM COARSE	BANDED CHAOTIC	BRECCIATED SHEARED SLICKENSIDE JOINTED BROKEN	LOCATION & THICKNESS	SiO2 Chl Tm Co3 Bleach.	LOC. & THICK. QTZ CHL CO3 TM FL PO CPY PY SP AS CASS	QTZ CHL CO3 TM FL AM PO CPY PY SP CASS % SULPHIDE	PLOTTING SYMBOLS	REMARKS	DEPTH M
INTERVAL	CORE RECOVERY	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY			INTERVAL



> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/60

950182

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610

BY P.D.E

DATE 17/3/87

PAGE 5 OF 20

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
80														80
		0.3												
82	82.5													82
		1.1												
84														84
	85.5													
86		0.8												86
	87.4											chl/tm		
		0.3												
88	88.5													88
		0												
90														90
	91.1													
92		0												92
94	94.3													94
		0												
96														96
	96.5													
98		0.2												98
	99.4													
100														100

Most of the shale and sandstone areas have a calcareous cement - many calcareous (calcite) veins throughout.

- fine pyrite occurs throughout as scattered crystals
- darker zones contain more pyrite
- pyrite is <1%.

93.9

94.6

These areas of coarser material maybe limestone - but very dirty

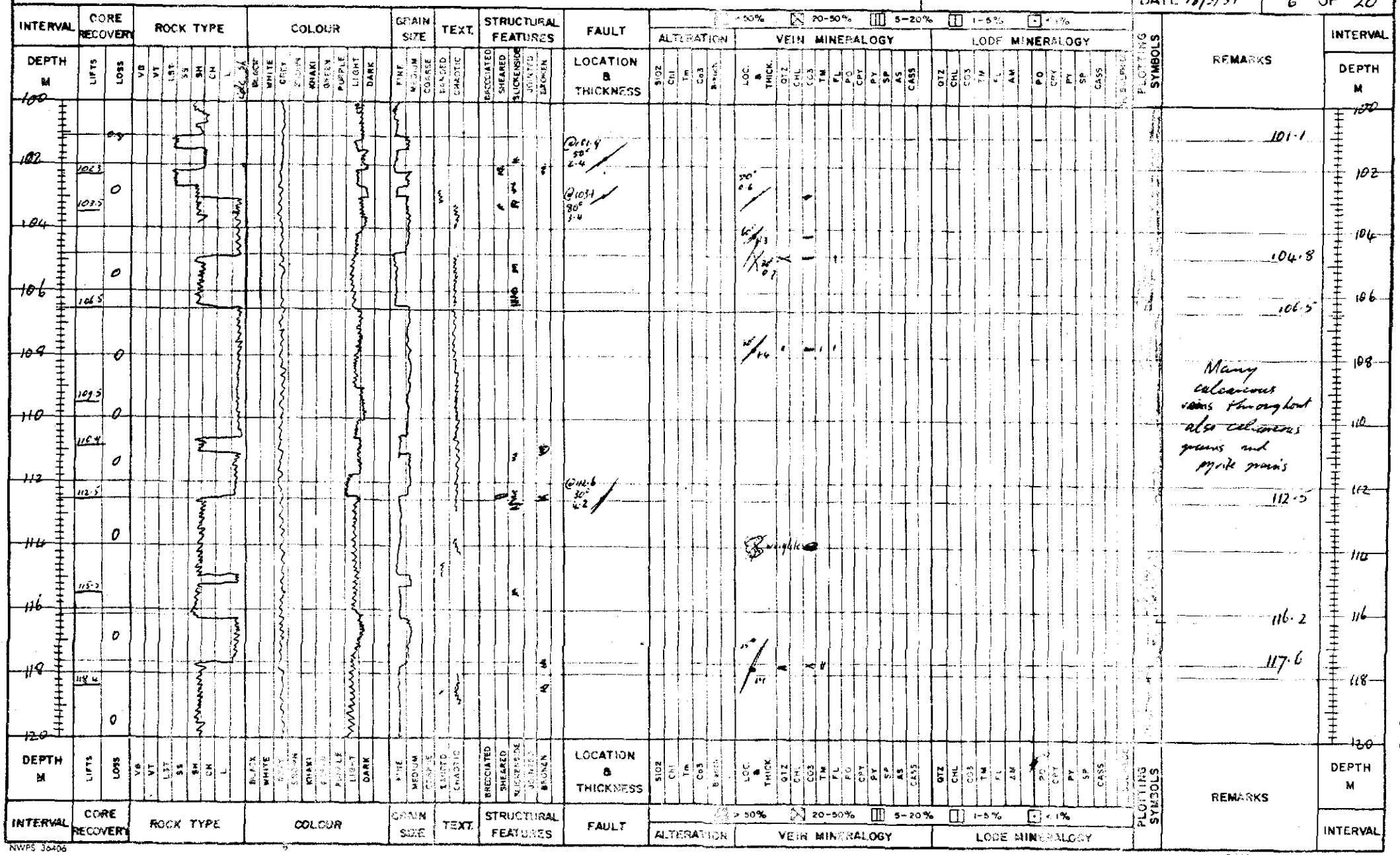
DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M

NWPS 36406

950183

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610 | BY P.D.C | DATE 19/3/51 | PAGE 6 OF 20



NWPS 36406

8/80

950184

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610

BY P. D. E.

DATE 17/3/81

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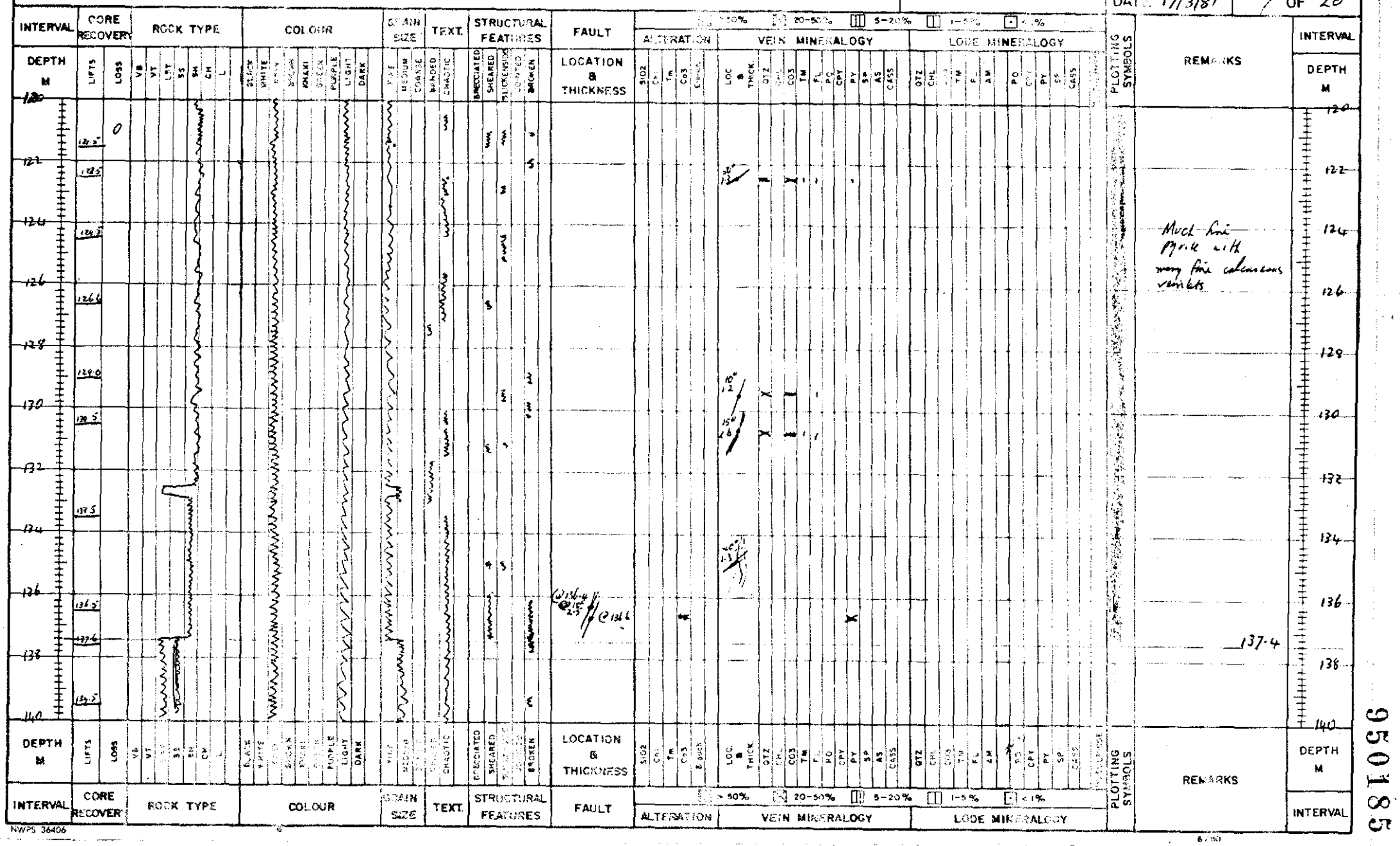


NWPS 36406

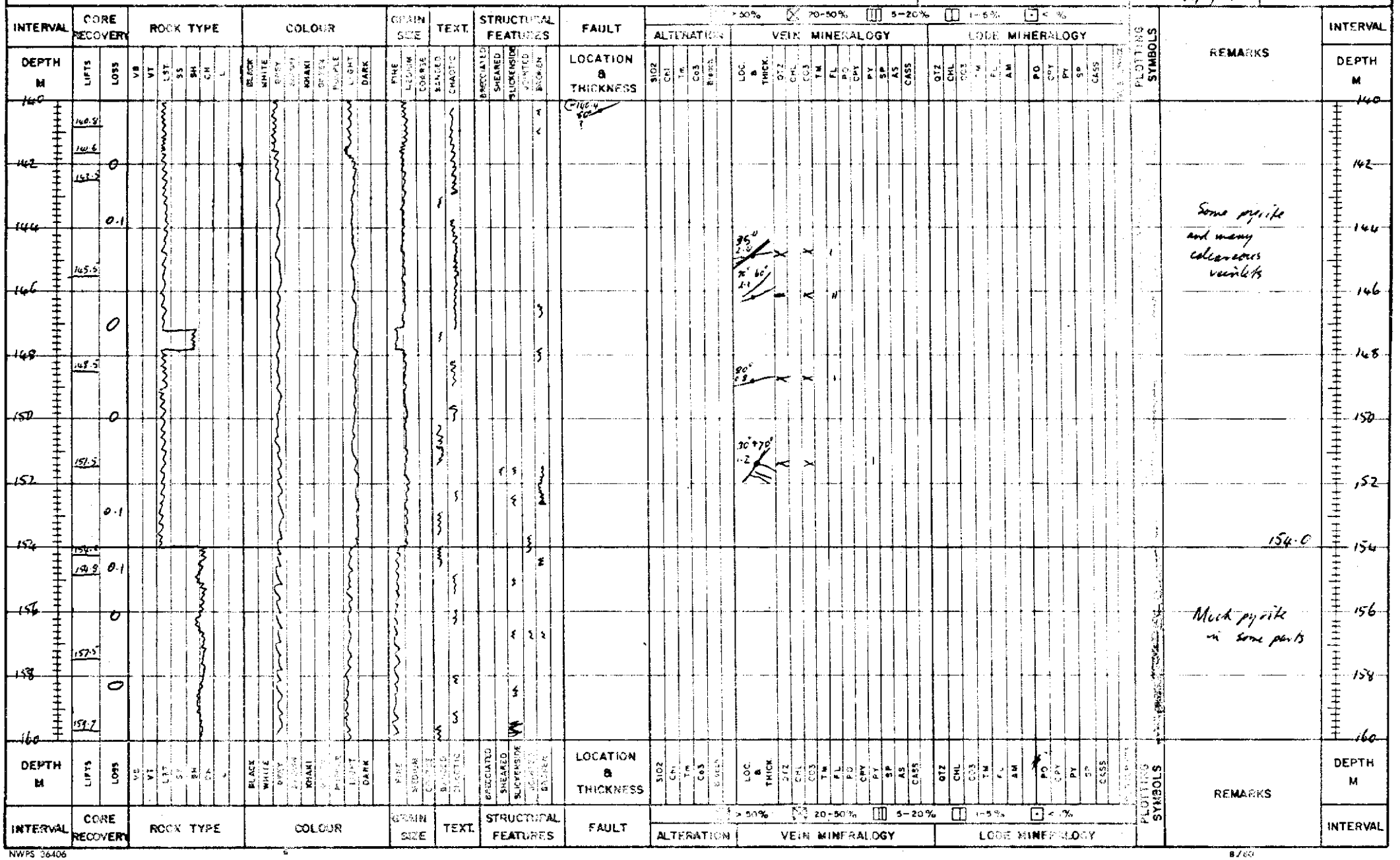
950185

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N°

BY P.D.C.

DATE 18/3/81



950186

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº

BY P.D.E.

DATE 19/3/81

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INTERVAL	CORE RECOVERY	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL
DEPTH M	LIFTS / LOSS	VG VT LST SS SH CH L	BLACK WHITE GREY KHAKI PURPLE LIGHT DARK	FINE MEDIUM COARSE	BANDED CHAOTIC	BRECCIATED SHEARED SLICKENSIDE JOINTED BROKEN	LOCATION & THICKNESS	SiO2 Chl Tm Co3 Bleach	LOC & THICK. QTZ CHL CO3 TM FL PO CPY PY SP AS CASS	QTZ CHL CO3 TM FL AM PO CPY PY SP CASS			DEPTH M
160	161.4	0							20° 2.7			161.4	160
162	163.5	0.2					@162.4 10° 1.5						162
164	165.7	0										165.3	164
166	166.5	0							80° 1.2				166
	167.6	0.1							30° 0.1			Much fine pyrite in chaotic areas as grains and vein-like concentrations	
168	169.5	0											168
170	171.1	0.1										170.1	170
	171.6	0											
172	172.5	0							50 2.5				172
174	175.5	0							40 1.5			Fine pyrite throughout	174
176	178.5	0							70°			177.0	176
178		0											178
180													180

> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/80

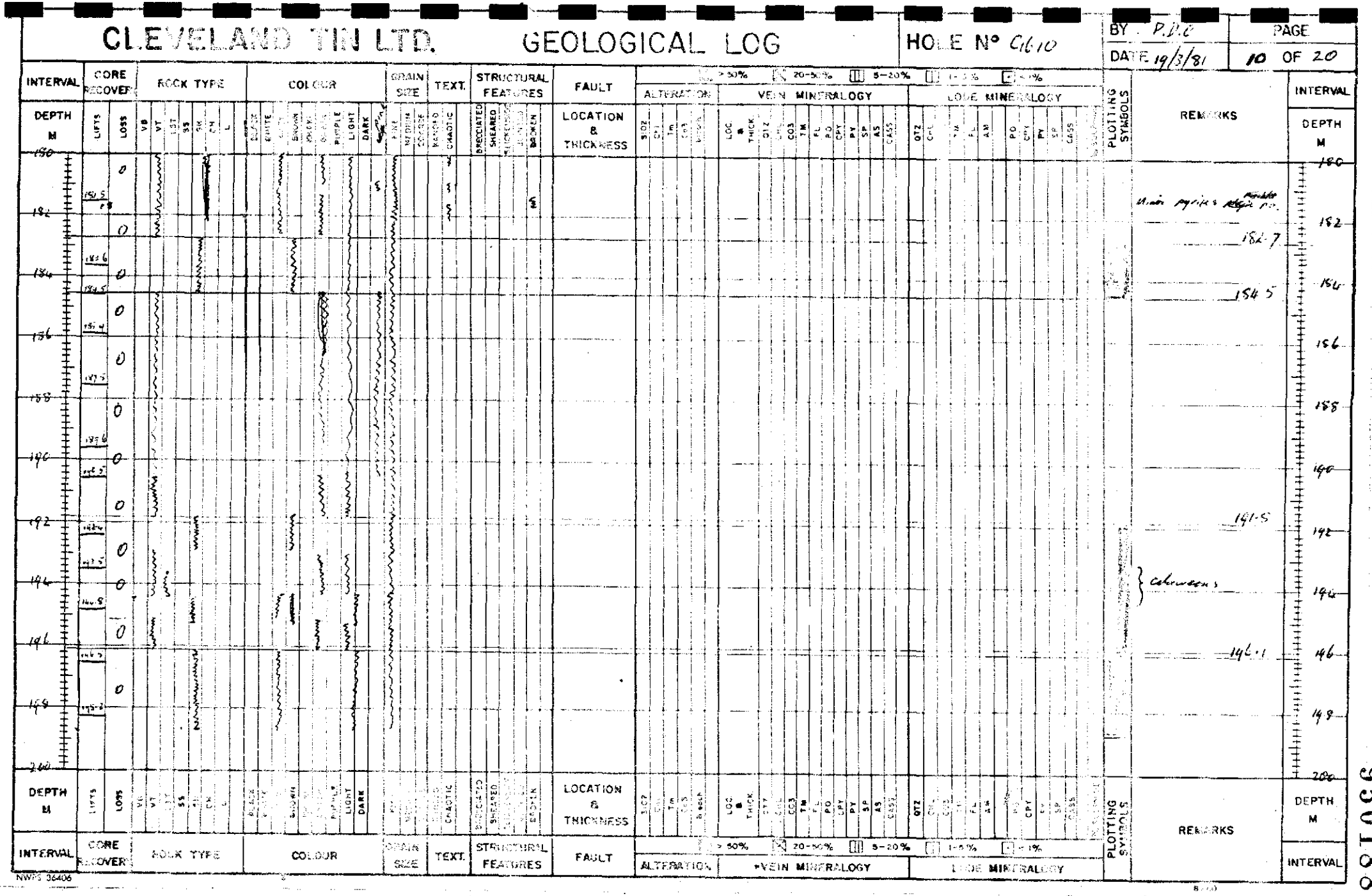
950187

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° C1610

BY P.D.C

DATE 19/3/81



NWPS 36406

9501188

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 1610

BY [illegible]

DATE 10/5/81

PAGE 11 OF 20

INTERVAL / DEPTH M	CORE RECOVERY: LIFTS	CORE RECOVERY: LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT / LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL / DEPTH M
	196.5	0									Sn NC.A. 55° @ 199.7	SH	[illegible]	196
	198.2	0					CALLAWOOD							198
	200.9	0									Sn NC.A. 55° @ 200.9	Vt	CONTINUED [illegible] OCCASIONALLY PRESERVED TRACE PYRITE. CAVERNOUS TEXTURE (PETROLOGY 202.2)	199.1 / 200
	204										Sn NC.A. 45° @ 204	SH		202 / 203
	205.5										Sn [illegible] 35° @ [illegible]	[illegible]	[illegible]	204 / 204.2
	207.3	0.6 / 0.4											TRACE [illegible]	205.1 / 206
	208.5	0										SH	[illegible]	208
	210.0	0									Sn [illegible] NC.A. 30° @ 210			210
	211.6	0												
	213.0	0										LST	TRACE [illegible]	212 / 212.7
	214.8	0									Sn NC.A. 25° @ 214.8	Vt	GRADED BEDDING (?) AT 214.8 INDICATING YOUNGING DOWNHOLE	214 / 216

Legend: > 50% | 20-50% | 5-20% | 1-5% | < 1%

Column headings: INTERVAL / DEPTH M; CORE RECOVERY (LIFTS, LOSS); ROCK TYPE (VB, VT, LST, SS, SH, CH, L); COLOUR (BLACK, WHITE, GREY, BROWN, KHAKI, GREEN, PURPLE, LIGHT, DARK); GRAIN SIZE (FINE, MEDIUM, COARSE); TEXT. (BANDED, CHAOTIC); STRUCTURAL FEATURES (BRECCIATED, SHEARED, SLICKENSIDE, JOINTED, BROKEN); FAULT / LOCATION & THICKNESS; ALTERATION (SIO2, Chl, Tm, Co3, Bleach); VEIN MINERALOGY (LOC. & THICK., QTZ, CHL, CO3, TM, FL, PO, CPY, PY, SP, AS, CASS); LODE MINERALOGY (QTZ, CHL, CO3, TM, FL, AM, PO, CPY, PY, SP, CASS, % SULPHIDE); PLOTTING SYMBOLS; REMARKS; INTERVAL / DEPTH M

NWPS 36406

8/80

950189

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº [illegible]

BY A.[illegible]

DATE 10/[illegible]/81

PAGE 12 OF 20

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
		0										Vt		216
	217.5	0										lst	[illegible]	217.6
	218.[illegible]	0								STRONG THROUGHOUT		Vt	[illegible]	218
	220.5	0									S. A.C.A. 65° @ 221.[illegible]		[illegible]	220
	223.5	0								WEAK THROUGHOUT	S. A.C.A. 55° @ 222.[illegible]	lst Vt	TRACE FINE PYRITE IN LIMESTONE. [illegible]	224
	225.4	0								MED. THROUGHOUT	(PETROLOGY 224.3)	sh	DISTINCTIVE [illegible] LAYERING [illegible]	226
	228.4	0								MODERATE THROUGHOUT	S. A.C.A. 30° @ 228.6	lst	TRACE PYRITE [illegible]	227.0
	230.6	0								STRONG THROUGHOUT		sh		228
	231.7	0								WEAK	S. A.C.A. 45° @ 231.8	lst		229.4
		0									S. A.C.A. 65° @ 231.9	sh	[illegible]	230
										VERY WEAK		lst	[illegible]	230.6
										STRONG	S. A.C.A. 55° @ 233.7	sh		231.0
										STRONG		lst		231.5
										WEAK	S. A.C.A. 35° @ 235.[illegible]	sh		232
												lst	(PETROLOGY 235.0)	232.4
												sh	[illegible]	233.7
												lst		234
												sh		234.3
												lst		234.9
												sh		235.6
												lst		235

Legend: > 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/80

950190

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 1614

BY A.H.

DATE 10/2/81

PAGE 13 OF 20

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
	236.8	0								MODERATE		1st		236
		0								MODERATE		sh	DARK GREY - BLACK SANDY PYRITE	238
	239.6													239.7
										MODERATE		1st		240
										WEAK		sh		240.3
		0								STRONG		1st		240.8
										MOD	S. A.C.A. 15° @ 241.7	sh	241.7 - FINE LAYERS OF [illegible] PYRITE	241.4
	242.6											1st		242
										STRONG		sh		242.4
		0								MODERATE		1st	244.2 - HYDRAULIC BRECCIA	244
	245.7													245.4
		0								WEAK		sh		246
	248.3									WEAK	S. S. A.C.A. 50° AT CONTACT	1st	SEVERAL SMALL PATCHES OF SHALE WITH DISCONFORMAL PYRITE.	248.5
		0								STRONG		sh	CONFORMABLE CONTACT PYRITE	249.7 250
	251.7												[illegible]	250.3
		0								MODERATE	S. A.C.A. 50° @ 253.0	vf	OCCASIONAL CLOTS [illegible] ASSOCIATED UP TO 3mm OF GRANULAR PYRITE.	252
	253.5													254
	255.9									MODERATE				256

> 50% | 20-50% | 5-20% | 1-5% | < 1%

950191

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 1610

BY A.H. | PAGE 14 OF 20

DATE 1/8/81

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
										WEAK		Vt		256
										NEAR		Sh		257.4 / 258
	258.2									258.2/3.0			258.8 – 260.4 – CRACKED TEXTURE ROCK SUFFUSED WITH A DENSE NETWORK OF BLACK FRACTURING VEINS	258
										WEAK		Vt	CRACKS OF GRANULAR VEINS	260
	262.05												263.0 – 264.0 – CHLORITE VEINS.	262
	265.2													264
														265.0
	268.3									WEAK		Vt Sh	"TUFF" MAY BE ALTERED SHALE.	266
	269.2													268
	271.7							271.7/5.0						270
	272.8										S. A C.A. 60° @ 73.4		CONTACT IS GRADATIONAL OVER ABOUT ONE METER AS RED BROWN COLOUR BECOMES MORE INTENSE	272
	274.2 / 274.8 / 275.1											Shb	RED BROWN SAME FINE GRAINED, COLOUR OBSCURES MOST FEATURES EXCEPT FOR OCCASIONAL FAINT PRIMARY LAYERING	274.0 / 274
													A FEW THIN (<2mm) CARBONATE VEINS THROUGHOUT	276

> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/60

950192

CLEVELAND TIN LTD. — GEOLOGICAL LOG

HOLE N° 1610 | BY A.H. | DATE 10/2/81 | PAGE 15 OF 20

| INTERVAL DEPTH M | CORE RECOVERY: LITHS | CORE RECOVERY: LOSS | ROCK TYPE: VB | VT | LST | SS | SH | CH | L | COLOUR: BLACK | WHITE | GREY | BROWN | KHAKI | GREEN | PURPLE | LIGHT | DARK | GRAIN SIZE: FINE | MEDIUM | COARSE | TEXT.: BANDED | CHAOTIC | STRUCTURAL FEATURES: BRECCIATED | SHEARED | SLICKENSIDED | JOINTED | BROKEN | FAULT LOCATION & THICKNESS | ALTERATION: SiO2 | Chl | Tm | Co3 | Bleach. | VEIN MINERALOGY: LOC. & THICK. | QTZ | CHL | CO3 | TM | FL | PO | CPY | PY | SP | AS | CASS | LODE MINERALOGY: QTZ | CHL | CO3 | TM | FL | AM | PO | CPY | PY | SP | CASS | PLOTTING SYMBOLS | REMARKS | INTERVAL DEPTH M |
|---|---|---

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° 1610 | BY | PAGE 16 OF 20 | DATE 17/9/87

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE: VB, VT, LST, SS, SH, CH, L	COLOUR: BLACK, WHITE, GREY, BROWN, KHAKI, GREEN, PURPLE, LIGHT, DARK, dmU	GRAIN SIZE: FINE, MEDIUM, COARSE	TEXT.: BANDED, CHAOTIC	STRUCTURAL FEATURES: BRECCIATED, SHEARED, SLICKENSIDED, JOINTED, BROKEN	FAULT LOCATION & THICKNESS	ALTERATION: SiO2, Chl, Tm, CO3, Bleach	VEIN MINERALOGY: LOC & THICK, QTZ, CHL, CO3, TM, FL, PO, CPY, PY, SP, AS, CASS	LODE MINERALOGY: QTZ, CHL, CO3, TM, FL, AM, PO, CPY, PY, SP, CASS	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
298-2		0												298
299-5 / 299-15		0						299-15				F	CHLORITE ON MINOR FAULT AND JOINT PLANES IN FAULT ZONE	300
301-5		0												302
302-7		G										Slb		304
305-6 / 305-9		0						305-9 / 2.0 45°						306
306-5		0						306 / 1.0 40°; 307.0 / 2.0 25°						308
309-4 / 309-6		0												310
310-2 / 310-7		0						311.0				F		312
312-3 / 313-3		0												314
315-10		0												315.9 316

DEPTH M | LIFTS | LOSS | ROCK TYPE | COLOUR | GRAIN SIZE | TEXT. | STRUCTURAL FEATURES | FAULT LOCATION & THICKNESS | ALTERATION | VEIN MINERALOGY | LODE MINERALOGY | PLOTTING SYMBOLS | REMARKS | INTERVAL DEPTH M

INTERVAL | CORE RECOVERY | ROCK TYPE | COLOUR | GRAIN SIZE | TEXT. | STRUCTURAL FEATURES | FAULT | ALTERATION | VEIN MINERALOGY | LODE MINERALOGY | PLOTTING SYMBOLS | REMARKS | INTERVAL

NWPS 36406 8/90

950194

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 16/0

BY A.R.

DATE 10/2/81

PAGE 17 OF 20

INTERVAL / DEPTH M	CORE RECOVERY: LIFTS	CORE RECOVERY: LOSS	ROCK TYPE: VB	VT	LST	SS	SH	CM	L	COLOUR: BLACK	WHITE	GREY	BROWN	KHAKI	GREEN	PURPLE	LIGHT	DARK	ZONAL	GRAIN SIZE: FINE	MEDIUM	COARSE	TEXT.: BANDED	CHAOTIC	STRUCTURAL FEATURES: BRECCIATED	SHEARED	SLICKENSIDED	JOINTED	BROKEN	FAULT: LOCATION & THICKNESS
	316·2	0																												316·2 / 10·0T
	326·2	0																												
	336·2	0																												
		0																												337·2 / 1·0
	346·2	0																												
		0																												
	356·2	0																												
		0																												
	366·2	0																												
	372·4	0																												372·4 / 80·0
	376·2	0																												375·3 / 3·0
DEPTH M																														
INTERVAL	CORE RECOVERY: LIFTS	CORE RECOVERY: LOSS	ROCK TYPE							COLOUR										GRAIN SIZE			TEXT.		STRUCTURAL FEATURES					FAULT: LOCATION & THICKNESS

ALTERATION	VEIN MINERALOGY	LODE MINERALOGY
SiO2, Chl, Tm, CO3, Bleach	LOC. & THICK., QTZ, CHL, CO3, TM, FL, PO, CPY, PY, SP, AS, CASS	QTZ, CHL, CO3, TM, FL, AM, PO, CPY, PY, SP, CASS

> 50% | 20–50% | 5–20% | 1–5% | < 1%

PLOTTING SYMBOLS	REMARKS	INTERVAL / DEPTH M
Sh	OVER 1 FOOT 2M THE HANGING WALL OF THE GREY CHALK	318
		319·5
		320
Sh	322·6 - HYDRAULIC BRECCIA	322
		324
		326
		328
F		330
		332
		334
		336

PLOTTING SYMBOLS | REMARKS | DEPTH M / INTERVAL

NWPS 36406

8/80

9501195

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° 1610 | BY [illegible] | PAGE 12 OF 20 | DATE 10/8/81

| INTERVAL / DEPTH M | CORE RECOVERY: LIFTS | CORE RECOVERY: LOSS | ROCK TYPE: VB | VT | LST | SS | SH | CH | L | COLOUR: BLACK | WHITE | GREY | BROWN | KHAKI | GREEN | PURPLE | LIGHT | DARK | GRAIN SIZE: FINE | MEDIUM | COARSE | TEXT.: BANDED | CHAOTIC | STRUCTURAL FEATURES: BRECCIATED | SHEARED | SLICKENSIDED | JOINTED | BROKEN | FAULT LOCATION & THICKNESS | ALTERATION: SiO2 | Chl | Tm | Co3 | Bleach | VEIN MINERALOGY: LOC. & THICK. | QTZ | CHL | CO3 | TM | FL | PO | CPY | PY | SP | AS | CASS | LODE MINERALOGY: QTZ | CHL | CO3 | TM | FL | AM | PO | CPY | PY | SP | CASS | % SULPHIDE | PLOTTING SYMBOLS | REMARKS | INTERVAL / DEPTH M |
|---|---|---

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 1610

B[redacted] [redacted]E

DATE 10/8/81 19 OF 20

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
		0												356
	357.5	0										shb		358
	361.3													360
	362.9	0						MAJOR FAULT 362.9 20.0				F	BRECCIA WITH QTZ, MINOR CPY INFILLING	362.8
	364.5	0												364
	365.7	0												366
	368.7	0										Vt	RD BROWN COLOURATION, LESS INTENSE THAN IN UNIT PRECEDING.	368
	370.5	0												370
	373.5	0						373.5 MAJOR FAULT ZONE ↓						372
	374.3	0												374
	374.9	0												
	375.4	0												376

> 50% | 20-50% | 5-20% | 1-5% | < 1%

NWPS 36406

8/80

950197

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE Nº 1610

BY [illegible] | PAGE 20 OF 20

DATE [illegible]/81

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE (VB, VT, LST, SS, SH, CH, L)	COLOUR (BLACK, WHITE, GREY, BROWN, KHAKI, GREEN, PURPLE, LIGHT, DARK, Z COLOUR)	GRAIN SIZE (FINE, MEDIUM, COARSE)	TEXT. (BANDED, CHAOTIC, [illegible])	STRUCTURAL FEATURES (BRECCIATED, SHEARED, SLICKENSIDE, JOINTED, BROKEN)	FAULT LOCATION & THICKNESS	ALTERATION (SiO2, Chl, Tm, Co3, Bleach)	VEIN MINERALOGY (LOC. & THICK., QTZ, CHL, CO3, TM, FL, PO, CPY, PY, SP, AS, CASS)	LODE MINERALOGY (QTZ, CHL, CO3, TM, FL, AM, PO, CPY, PY, SP, CASS, % SULPHIDE)	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
	376.5	0												376
	377.4	0.7												
	378.7	0.4												378
	379.5	0.5												
	380.7	0.9						381.4						381
	382.5	0												382
	385.3	0												384
		0												385.2
	388.2													386
	391.3	0												388
		0												390
	394.4													392
														394
														396

> 50% | 20-50% | 5-20% | 1-5% | < 1%

ALTERATION | VEIN MINERALOGY | LODE MINERALOGY

PLOTTING SYMBOLS: A, Sh

REMARKS: FAULT ZONE: [illegible] AND YELLOW CARBONATE [illegible] MINOR PYRITE AND CHLORITE ASSOCIATED

CONTACT GRADATIONAL OVER 0.5m.

NWFS 36406 8/80

950198

CLEVELAND TIN LTD. GEOLOGICAL LOG

HOLE N° 1610

BY A

DATE 10/2/81

PAGE 21 OF

INTERVAL DEPTH M	CORE RECOVERY LIFTS	CORE RECOVERY LOSS	ROCK TYPE	COLOUR	GRAIN SIZE	TEXT.	STRUCTURAL FEATURES	FAULT LOCATION & THICKNESS	ALTERATION (> 50% / 20-50% / 5-20% / 1-5% / < 1%)	VEIN MINERALOGY	LODE MINERALOGY	PLOTTING SYMBOLS	REMARKS	INTERVAL DEPTH M
397.0 397.5		0 0 0										Shb		396 398
													397.85 E.O.H.	

Column headings:

- ROCK TYPE: VB, VT, LST, SS, SH, CH, L
- COLOUR: BLACK, WHITE, GREY, BROWN, KHAKI, GREEN, PURPLE, LIGHT, DARK
- GRAIN SIZE: FINE, MEDIUM, COARSE
- TEXT.: BANDED, CHAOTIC
- STRUCTURAL FEATURES: BRECCIATED, SHEARED, SLICKENSIDE, JOINTED, BROKEN
- ALTERATION: SiO2, Chl, Tm, Co3, Bleach
- VEIN MINERALOGY: LOC. & THICK., QTZ, CHL, CO3, TM, FL, PO, CPY, PY, SP, AS, CASS
- LODE MINERALOGY: QTZ, CHL, CO3, TM, FL, AM, PO, CPY, PY, SP, CASS, % SULPHIDE

NWPS 36406

8/80

950199

950200

CLEVELAND TIN LIMITED — GEOLOGY DEPT

DOWNHOLE SURVEY — DRILL HOLE C1610

DEPTH	AZIM	DIP	SURVEY GRID NORTH	SURVEY GRID EAST	BATTERY GRID NORTH	BATTERY GRID EAST	RL	
.0	277.0	52.0	14523.39	10933.23	4202.23	5396.59	1470.50	×
6.3			14523.08	10929.41	4201.36	5392.04	1465.57	
12.5	278.0	52.0	14524.40	10925.60	4200.52	5389.08	1460.65	
25.0			14525.52	10917.99	4198.93	5381.56	1450.80	×
37.5	279.5	52.0	14526.74	10910.39	4197.44	5374.01	1440.95	
50.0			14528.04	10902.80	4196.03	5366.44	1431.10	×
62.5	280.5	52.0	14529.41	10895.23	4194.69	5358.86	1421.25	
75.0			14530.83	10887.69	4193.40	5351.30	1411.38	×
87.5	281.0	52.5	14532.27	10880.19	4192.15	5343.77	1401.48	
100.0			14533.67	10872.79	4190.91	5336.33	1391.52	×
112.5	280.5	54.0	14535.06	10865.50	4189.67	5329.02	1381.45	
125.0			14536.38	10858.27	4188.40	5321.70	1371.34	×
137.5	280.0	54.0	14537.67	10851.04	4187.10	5314.55	1361.23	
150.0			14538.94	10843.83	4185.79	5307.35	1351.10	×
162.5	280.0	54.5	14540.21	10836.66	4184.47	5300.18	1340.94	
175.0			14541.43	10829.55	4183.17	5293.09	1330.73	×
187.5	279.0	55.5	14542.58	10822.51	4181.88	5286.10	1320.46	
200.0			14543.65	10815.54	4180.59	5279.18	1310.14	×
212.5	278.0	56.0	14544.66	10808.60	4179.22	5272.33	1299.80	
225.0			14545.63	10801.68	4177.83	5265.50	1289.43	×
237.5	278.0	56.0	14546.60	10794.76	4176.44	5258.67	1279.07	
250.0			14547.58	10787.83	4174.45	5251.84	1268.71	/
262.5	278.0	56.0	14548.55	10780.91	4172.96	5245.01	1258.34	
275.0			14549.55	10774.00	4171.51	5238.17	1247.98	×
287.5	279.0	56.0	14550.61	10767.09	4170.11	5231.32	1237.62	
300.0			14551.63	10760.22	4168.67	5224.53	1227.22	×
312.5	276.5	57.0	14552.48	10753.42	4167.11	5217.86	1216.77	
324.3			14553.00	10747.03	4165.46	5211.66	1206.93	/
336.0	272.0	56.5	14553.43	10740.50	4163.55	5205.49	1197.12	×
336.0			14553.44	10740.17	4163.42	5205.10	1196.49	
337.5	272.0	57.0	14553.46	10739.76	4163.29	5204.71	1195.86	
350.0			14553.62	10733.00	4161.10	5198.31	1185.35	×
362.5	269.5	58.0	14553.64	10726.33	4158.00	5192.05	1174.78	
375.0			14553.57	10719.75	4156.45	5185.91	1164.15	×
387.5	269.0	59.0	14553.47	10713.27	4154.11	5179.86	1153.47	
392.3			14553.43	10710.83	4153.22	5177.59	1149.39	
397.0	269.0	59.5	14553.38	10708.41	4152.34	5175.34	1145.30	/

950201

CONTENTS (CONT'D.)

PLANS

1.	SHEET SG-IN-001 GEOLOGICAL INTERPRETATION E.L. 1/63	1:10,000
2.	SHEET SC-CO-001A SOIL GEOCHEMISTRY	1:5,000
3.	SHEET SC-CO-002A SOIL GEOCHEMISTRY	1:5,000
4.	SHEET SP-DG-004 DIGHEM SURVEY - RESISTIVITY	1:10,000
5.	SHEET SP-DG-005 DIGHEM SURVEY - ELECTROMAGNETICS	1:10,000
6.	SHEET SP-DG-006 DIGHEM SURVEY - MAGNETICS	1:10,000
7.	SHEET SP-DG-007 DIGHEM SURVEY - ENHANCED MAGNETICS	1:10,000
8.	SHEET AX-1000-001 Ax CROSS SECTION - STRATIGRAPHIC TESTING	1:1,000

THESE PLANS ARE AVAILABLE AS TRANSPARENCIES

OPEN FILE

MICROFILMED

Section 8:

CLEVELAND TIN LIMITED

PROGRESS REPORT - EXPLORATION LICENCE 1/63

FOR THE PERIOD JANUARY 14, 1981 to AUGUST 11, 1981.

PLAN 1.

950202

CLEVELAND TIN LTD.

E.L. 1/63

INTERPRETED SURFACE GEOLOGY

BY P.D. ELLIS - APRIL 1981

DRAWING NO SG-IN-001

SCALE — 1:10,000

0 500 1,000

5cm

N

MAG. N

LEGEND

Tb	Basalt	TERTIARY
Sch	Chert	SILURIAN
Sls†	Limestone	
Sss	Sandstone	
Sco	Conglomerate	DEVONIAN
Dg	Meredith Granite	
€vbp	Purple Basalt	CAMBRIAN
€vb	Basalt	
€vt	Tuff	
€shb	Chocolate Shales/Cherts	
€ch	Chert	
€chb	Black Chert	
€sh	Grey Shale	
€lss	Lithic Sandstone	
€ss	Mica Sandstone	
€ba	Black Argillite	
€ub	Undifferentiated Ultrabasics	
€sp	Serpentinites	
€dg	Dolerite/Gabbro	
€mt	Mafic Tuff	
€uvb	Undifferentiated Basalt	

M.L. BOUNDARY

E.L. BOUNDARY

ROAD

TRACK

GRID LINES (1500N)

LITHOLOGICAL BOUNDARIES

FAULTS

SAVAGE RIVER

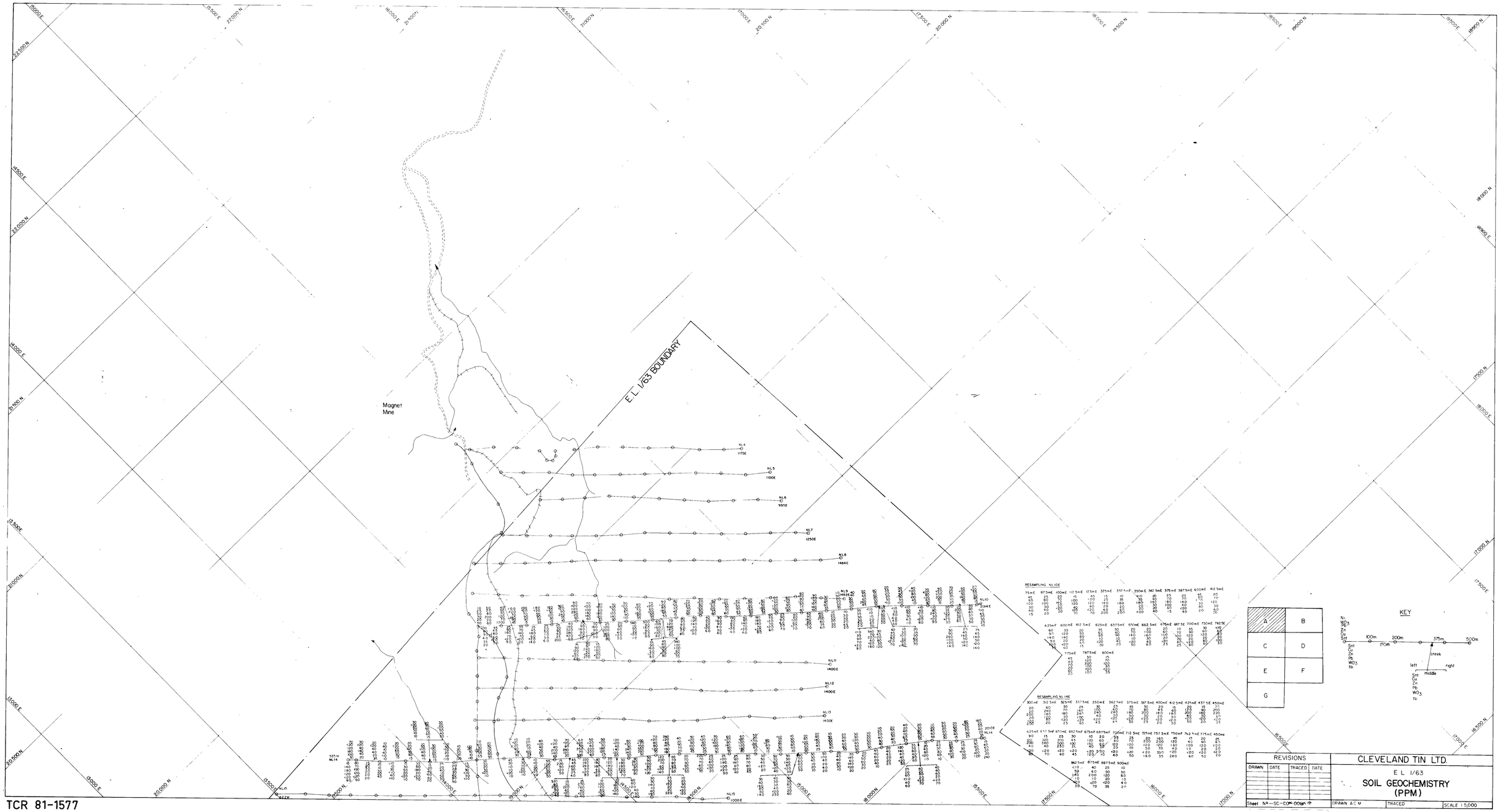
LUINA

BUTLERS ROAD

WARATAH

MT RAMSAY

TCR 81-1577



TCR 81-1577

550293 PLAN 2.

E.L. 1163 BOUNDARY

E.L. V63 BOUNDARY

HALL'S REFERENCE PLANE

MARKET TRAM

To Wonton

WARATAH CORINNA ROAD

WHYTE HILL

NINE MILE CREEK

GORDON TRACK

CROSS TRACK

HYDRO LINE

CLEVELAND TRAM

DEEP CREEK

BADGER LINE

BETTS TRACK

1333 ROAD END

NL14 553W

NL15 822W

NL16 903W

NL17 1007W

NL18 1030W

NL19 1205W

NL20 1207W

NL21 1196W

NL22 1487W

NL23 1103W

NL24 1088W

NL13 1400E

NL14 2010E

NL15 1000E

NL16 1030E

NL17 914E

NL18 2010E

NL19 867E

NL20 980E

NL21 1090E

NL22 1527E

NL23 1334E

NL24E 1300

L7 L6 L5 L4

G18 G17 G16 G15 G14 G13 G12 G11

M01 M03 M05

Y2 Y3 Y4 Y5 Y6 Y1

RESAMPLING NL22W

100mW	975mW	1125mW
15	<10	30
30	180	60
80	120	120
30	20	10
60	<20	<20
15	700	550

KEY

NL 100m W03 Sn 150m Zn Pb W03 Ni

100m 200m 375m 500m

150m

Creek

left middle right

Sn Zn Pb W03 Ni

A B C D E F G

REVISIONS				CLEVELAND TIN LTD.
DRAWN	DATE	TRACED	DATE	E.L. 1/63
				SOIL GEOCHEMISTRY (PPM)
Sheet No.— SC-E01-002a		DRAWN A.C.M	TRACED	SCALE 1:5,000

5 cm

950204

PLAN 3.

TCR 81-1577

DIGHEM^{II} SURVEY

CLEVELAND AREA, TASMANIA

RESISTIVITY

FOR

950205

ABERFOYLE EXPLORATION PTY. LTD.

E.L. 1/63 SHEET Nº — SP — DG — 004

5 cm

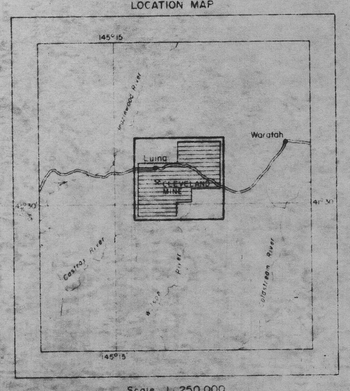
SCALE 1 : 10,000

1/2 0 1/2 Kilometres

1/4 0 1/4 1/2 Miles

PLAN 4.

LOCATION MAP



REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

5 cm

Flight line

Fiducials and numbers

LEGEND

Contours in ohm - m at eight intervals per decade

100
75
56
42
31
23
17
13
10

Note

The numbers face in the direction of increasing value.

JOB 328 ; APRIL

TCR 81-1577

DIGHEM^{II} SURVEY

CLEVELAND AREA, TASMANIA

ELECTROMAGNETICS

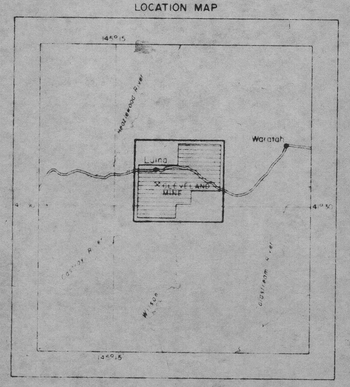
FOR

ABERFOYLE EXPLORATION PTY. LTD.

950206

E.L. 1/63 SHEET N°- SP-DG-005

LOCATION MAP



Scale 1:250,000

REGISTERED PROFESSIONAL ENGINEER
D. E. FRASER
PROVINCE OF ONTARIO

5 cm

5 cm

SCALE 1:10,000

Flight line

Fiducials and numbers

ANOMALY GRADE	EM IMAGE SYMBOL	MMC RANGE
6	●	24 - 100
5	●	10 - 23
4	●	2.5 - 9.9
3	●	1 - 2
2	○	.4 - .9
1	○	≤ .4
	Possible conductor	

DIGHEM anomalies are graded on the basis of conductive thickness product. The product is the conductance (reciprocal resistance in ohms). The latter is a measure of conductivity in a geologic sense. Most terrestrial rocks and soils are not highly conductive, with the notable exception of graphitic, sulphide and saline environments. The conductive thickness product is the multiplication of electrical conductance (conductivity) and thickness of the conductive body. Thus, a thick, poorly conductive body may yield the same conductive thickness product as a thin, highly conductive body. Examples: 4 seamwidths with 10 mhos each, and 1 seamwidth with 40 mhos each, would both yield a conductive thickness product of 40 mhos. Most graphite and sulphide bodies are thin, but can be highly conductive. Most saline environments are thick, but are not highly conductive. Most geologic conductors are thin and poorly conductive. Therefore, the conductive thickness product is a useful way of ranking conductors in terms of their significance as exploration targets.

Depth & width rules: 50 feet, 100 feet, 150 feet, 200 feet

Pattern chart of anomalies on succeeding report for the flight, particularly for clients not familiar with conductor regimes

The symbol plots should be plotted centred on the EM anomaly symbol on the map. The anomaly identifier consists of the flight number (lines of data are generally numbered on the flight record) and the anomaly number. Anomalies are estimated by visual inspection of the profiles, and may be ranked relatively on the basis of their conductive thickness product. Anomalies may be caused by bedrock conductors, but may also be caused by conductive overburden, or by cultural features (fences, pipelines, power lines). Discrimination between bedrock and overburden sources is usually possible on the basis of the shape of the anomaly profile, and the relative amplitudes of the in-phase and quadrature components. Discrimination between bedrock conductors and cultural features is usually possible on the basis of the shape of the anomaly profile, and the relative amplitudes of the in-phase and quadrature components. Cultural features usually have very sharp, narrow profiles (often with reversals), and are usually evident on the magnetic profiles. Discrimination between bedrock and overburden sources is usually possible on the basis of the shape of the anomaly profile, and the relative amplitudes of the in-phase and quadrature components. Bedrock conductors usually have broad, smooth profiles, and are usually evident on the magnetic profiles. Discrimination between bedrock and overburden sources is usually possible on the basis of the shape of the anomaly profile, and the relative amplitudes of the in-phase and quadrature components. Overburden conductors usually have broad, smooth profiles, and are usually evident on the magnetic profiles. Discrimination between bedrock and overburden sources is usually possible on the basis of the shape of the anomaly profile, and the relative amplitudes of the in-phase and quadrature components.

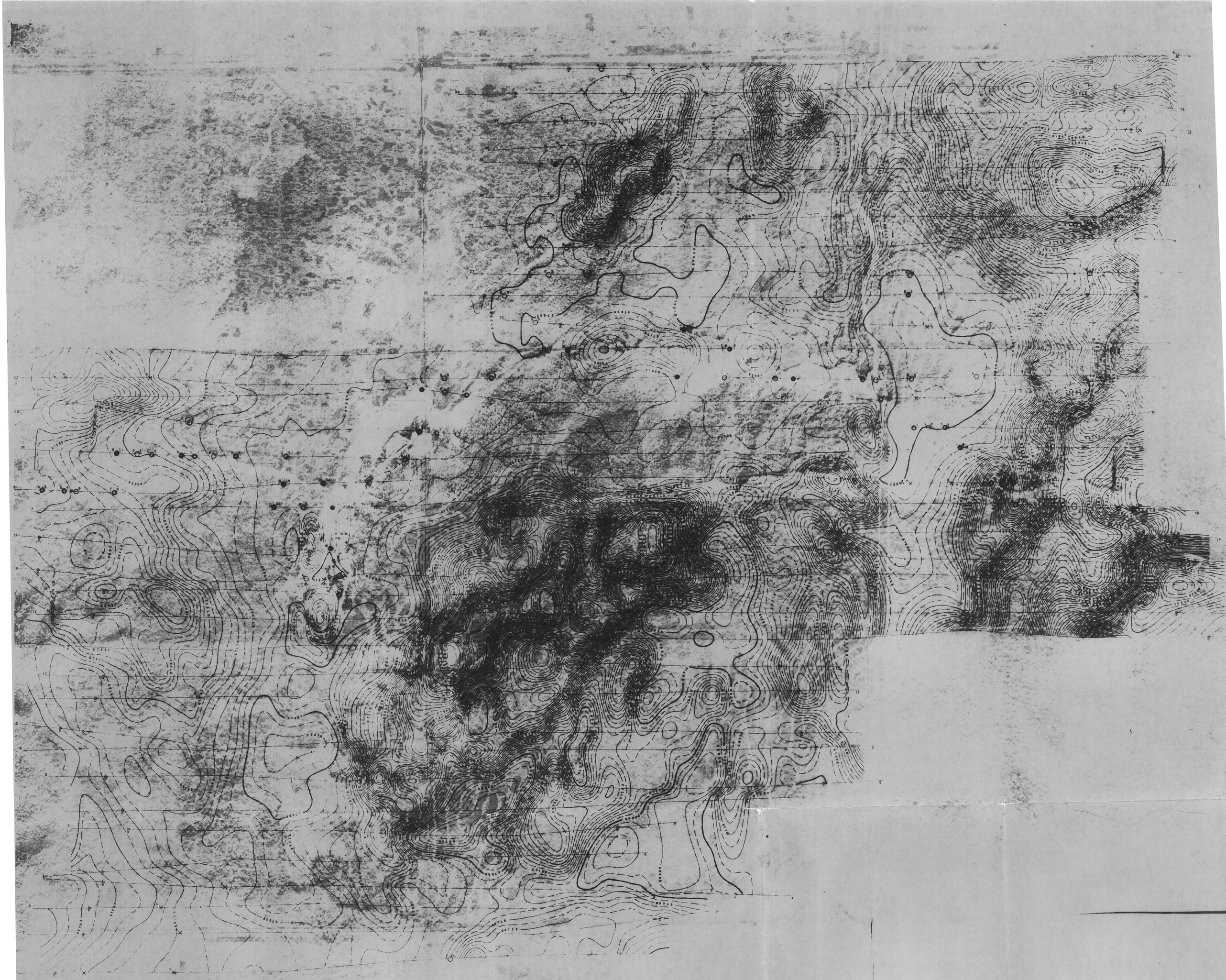
S	Conductive zone
D	Probable bedrock response
d	Possible bedrock response
C	Probable near-surface response
F	Fracture zone
?	Questionable geology
30	Apparent thickness in feet
90	Dip
Wide	Geologic correlation of 100 gamma

DIGHEM anomalies are designed to provide a correct simple conductive quality by means of the conductive thickness product. Conductive symbols from static alone with geologic, which planning, programs the actual anomalies are plotted for the conductive data. The anomaly form for bedrock anomalous data which should not distract from the patterns, when they do not relate to the anomaly.

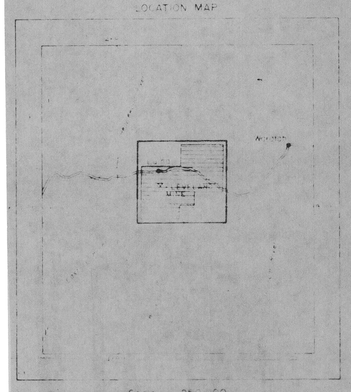
The map provides an interpretation of the conductive length, strike direction, conductance and depth extent. It is comparable to an interpretation from a ground survey using the horizontal loop system.

PLAN 5.

CR 81-1577



LOCATION MAP



Scale 250,000

DIGHEM^{II} SURVEY

CLEVELAND AREA, TASMANIA

MAGNETICS

FOR

950207

ABERFOYLE EXPLORATION PTY. LTD.

E.L. 1/63 SHEET Nº—SP—DG—006

5 cm

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

ISOMAGNETIC LINES

(total field)

1000 gammas

200 gammas

50 gammas

25 gammas

magnetic depression

Magnetic Inclination within the survey area 72°

TCR 81-1577

PLAN 6.

DIGHEM^{II} SURVEY

CLEVELAND AREA, TASMANIA

ENHANCED MAGNETICS

FOR

ABERFOYLE EXPLORATION PTY. LTD.

E.L. 1/63 SHEET Nº—SP-DG-007

950208

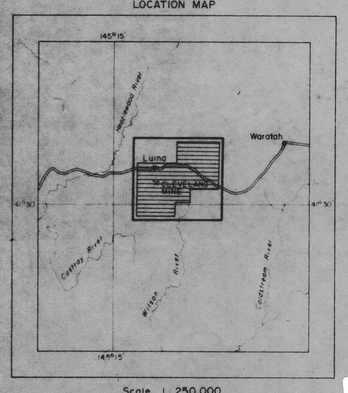
SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

LOCATION MAP



Scale 1:250,000

5 cm

TCR 81-1577

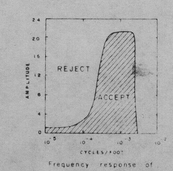
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
D.C. FRASER

Flight line

Fiducials and numbers

ISOMAGNETIC LINES
(enhanced field)

5000 gammas
1000 gammas
200 gammas
100 gammas
magnetic depression



Frequency response of magnetic operator

JOB 328, APRIL 19

PLAN 7.

4700E 4800E 4900E 5000E 5100E 5200E 5300E 5400E 5500E

RL 1500m RL 1400m RL 1300m RL 1200m RL 1100m RL 1000m

WHYTE RIVER

DEEP CREEK

CRESENT SPUR SANDSTONE

HALL'S FORMATION

DEEP CREEK VOLCANICS

EASTERN SEDIMENTS

COLLAR 26-5-81

COLLAR (-52°)

PROPOSED PATH

5000E BATTERY REFERENCE PLANE

LEGEND

ABBREVIATIONS	NAME
ss	sandstone
sh	shale
ch	chert
vb	basalt
vt	tuff
shb	brown shale
Lst	limestone
F	fault

5 cm

	CLEVELAND TIN LTD			DRAWING N°
	PROPOSED DRILL HOLE SURFACE (420IN) Ax-RA1 SECTION			
DATE 19-11-80	DRAWN PDE.	TRACED RJR	SCALE 1:1000	SHEET Ax-1000-001

TCR 81-1577

95509

PLAN 8.