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ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED

West Coast Mines

BULGOBAC EXPLORATION LICENCE EL 12/72

Report on work undertaken from
October, 1978 to October, 1979.

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Geological Department
Report No. 130

J.H.A. Mill.
October, 1979.

Page No.

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SUMMARY OF EXPLORATION ACTIVITY

(Refer to Plan 1 1:50,000 Exploration Completed 1978-79 to October, 1979.)

The following work was undertaken between October, 1978 and October, 1979 in the Bulgobac Exploration Licence.

NORTHERN AREA

A regional mapping programme was undertaken on access and creeks in the northern area.

BOCO AREA

A small extension was added to the south-east corner of the Boco Grid.

WESTERN AREA

Grids were established at North Pinnacles and Silver Falls Extension. Both grids were mapped and soil sampled. An I.P. survey was carried out on the North Pinnacles Grid.

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1.	Exploration Completed 1978-79 to October, 1979.
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A0-525-0012	1:10,000 Geology Sheet 3
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A0-504-0017	1: 5,000 Geology - Farm Creek (5B)
A0-504-0018	1: 5,000 Geology - Farm Creek (6A)
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APPENDIX 1. Scintrex Report Tas-065, August, 1979 "Comments on Dipole-Dipole Surveys over various grids in the Rosebery Area Tasmania, on behalf of Electrolytic Zinc Company of Australasia Limited".

APPENDIX 2. Scintrex Report Tas-065, July, 1979 "Brief Comments on Five Dipole- Dipole setups over the Bulgobac (North Pinnacles) Grid near Rosebery, Tasmania, on behalf of the Electrolytic Zinc Company of Australasia Limited".

APPENDIX 3. C.M.S. Reports 79/1/16
79/3/29
Thin Section descriptions of hand specimens.

APPENDIX 4. "Geochemical Exploration for Base Metals, West Coast Tasmania"
and
"Orientation Studies carried out for Electrolytic Zinc Exploration" by N.J. Marshall, 10th April, 1979.

APPENDIX 5. Cumulative Frequency Plots.
North Pinnacles Pb & Zn.
Silver Falls Extension Pb & Zn.
Scatter Diagrams of Soil & Litter Samples.
Profiles of Soil & Litter Samples.

1.0 INTRODUCTION

Exploration Licence 12/72 of 94 square kms was aquired in 1972, when Comstaff Pty. Ltd. relinquished selected areas from their E.L. 5/63. This resulted in the licence having an irregular shape. Subsequently E.L. 12/72 was joint ventured with Getty Oil Development (Aust.) Pty. Ltd. with E.Z. continuing as operators.

The initial exploration phase was concentrated on the massive lavas and pyroclastics of the Boco area which are similar to the host rocks of the Que River Pb/Zn/Cu deposit, 8km to the north. These form part of the Mt. Read Volcanics which can be traced south to the Mt. Black-Rosebery area and as such represent the most attractive host rocks for Pb/Zn/Cu deposits of the Rosebery-Que River type.

A small exploration programme was then carried out to determine the source of 2 input E.M. anomalies in the northern part of E.L. 12/72. The Boco Grid was also extended to the west.

This report covers work at Bulgobac carried out between October, 1978 and October, 1979 and is concerned with:

1. Regional Mapping in the Northern Area.
2. Compilation of field work in the Boco Area.
3. Initial exploration in the Western Area.

2.0 OBJECTIVES

The main targets for exploration on E.L. 12/72 are:

1. Massive volcanogenic Pb/Zn/Cu deposits of the Rosebery-Que River type associated with thin sedimentary lenses within the Mt. Read Volcanics.

2. More distal Pb/Zn/Cu deposits associated with sediments of the Dundas Trough.

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3. Tin deposits associated with Devonian granite and quartz feldspar porphyry intrusions into calcareous sediments of the Dundas Trough.

3.0 PREVIOUS WORK

Previous work on E.L. 12/72 has been reported in E.Z. Geological Department Reports 128 (1977) and 129 (1978).

4.0 NORTHERN AREA

4.1. WORK COMPLETED

Mapping of the Northern Area was carried out using 1:10,000 scale aerial photographs. Control of the Que River traverse was aided by a topofil distance measuring instrument.

The area mapped included all road and track access to E.L. 12/72 west of the new H.E.C. powerline north of Animal Creek and south of the Que River. The Que River was mapped west from the Murchison Highway to where Tertiary basalt covers the Cambrian Volcanics and Intrusives.

The aims of the mapping were:-

1. To define the Mt. Read Volcanics, which are host for the Que River Pb/Zn/Cu deposit, southwards along the strike into E.L. 12/72 in the Boco Area.

2. To assess the potential of rocks west of the Mt. Read Volcanics at Que River for stratiform Pb/Zn/Cu deposits and to define the structure of the area.

The main access in this area is the Murchison Highway which runs adjacent to the eastern boundary of E.L. 12/72. Other access includes the new H.E.C. powerline which

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runs north from the Bastyan Dam site, crosses the Murchison Highway in the Boco Area and passes about 0.75km to the west of the Que River deposit. Numerous construction tracks and logging tracks were also mapped.

4.2. GEOLOGY

(Refer to 1:50,000 scale Geological Bedrock Plan 2 and No.'s A0-525-0011, A0-525-0012 and A0-525-0007.)

Extensive tracts of the northern area have been covered by thick Tertiary basalt flows and Pleistocene glacial and fluvioglacial deposits. Mapping has been concentrated in areas of least cover.

The stratigraphic sequence is outlined below:

Pleistocene	5 - Glacial moraine and Fluvioglacial deposits.
Tertiary	4 - Olivine basalt.
	3 - Pre-basaltic gravels
Cambrian	2 - 'Que River Volcanics' (feldspar-phyric)
	1 - Acid-intermediate tuffs, lavas and intercalated sediments (quartz-phyric)
Intrusives	Jurassic-micronorite and dolerite.
	Upper Cambrian - Quartz feldspar porphyry.

1. Acid-intermediate tuffs, lavas and intercalated sediment

To the west of the Que River Volcanics and separated from them by a sharp contact is a group of intercalated quartz-rich, ash-flow pyroclastics; vesicular perlitic dacites; tuffaceous sediments and black slates. These rocks have been intruded by a distinctive quartz feldspar porphyry. Rocks from this unit have been described by Fander & Cowen (Appendix 3.).

This group has been mapped as Upper Cambrian by previous workers on fossil evidence and has been

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tentatively placed stratigraphically above the Que River Volcanics. However, it now appears likely that it predates the Que River Volcanics.

Reasons include:

1. No quartz feldspar porphyry has been mapped in the Que River Volcanics.
2. Shale fragments, found ubiquitously in volcanics of the western group are not mapped in the Que River Volcanics.
3. There is close similarity of the contact relationship in the Que River area to those in the White Spur area recently mapped by Corbett who defines a sequence of quartz-phyric volcanics and intercalated sediments and a separate group of feldspar-phyric volcanics with minor sediments. Corbett (personal communication) believes that the quartz-phyric/sediment group is older than the adjacent feldspar-phyric group and postulates a theory of "caldera collapse" to explain the relationship in the White Spur area.

2. Que River Volcanics

The 'Que River Volcanics' form part of the Mt. Read Volcanics which consists of a massive suite of quartz-poor acid and intermediate pyroclastics and lavas which contain the Que River Pb/Zn/Cu deposit. They trend north-north-east from Mt. Black and have been mapped at Farm Creek and Boco. From Boco the volcanics continue north as a massive volcanic unit in which no sedimentary lenses (except for Que River) have been mapped. Thin sections of rocks taken from the volcanics are described by Fander & Cowen in Appendix 3

The rocks include No's P780, P782, and P783 which are recorded on the 1:10,000 geological plan No. A0-525-0007.

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3. Pre-basaltic Gravels

These deposits lie underneath the Tertiary Basalt to the north-west of the mapped area.

4. Olivine Basalt

Thick flows of olivine basalt occur over much of the northern area. The basalts obscure much of the prospective Cambrian and prevent effective exploration north of the Que River.

5. Glacial Moraine and Fluvioglacial Deposits

These unprospective pleistocene deposits also obscure much of the prospective Cambrian. They range from lateral moraines as at Boco to thick fluvioglacial lake deposits such as those gridded to explore the input E.M. anomaly CS27A (see E.Z. Report No. 129).

4.3 STRUCTURE

While poor outcrop and limited access appear to complicate the picture a simple structure is postulated for the area. The western group of volcanics and sediments appear to represent the eastern limb of a synclinorium whose axis trends at 030° Magnetic. The sequence is seen to dip and young to the west.

The Que River Volcanics are thought to occupy a down faulted trough ('caldera' of Corbett) which collapsed some time during the late Cambrian and was quickly infilled with a massive group of lavas and pyroclastics which acted as host for the Que River Pb/Zn/Cu deposit in a similar way to which the Mt. Read Volcanics acted as a host for the Rosebery Pb/Zn/Cu deposit.

Jurassic dolerites were later intruded along a marginal fault plane between the Mt. Read Volcanics and the tuffs, lavas and sediments to the west.

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4.4. MINERALISATION

Mineralisation observed during mapping occurred as:-

1. Disseminated pyrite associated with black shales and carbonaceous (?) reworked tuffs.

2. Epigenetic deposits (e.g. Sock Creek) of vein type Pb/Zn, structurally located in shears and faults and probably genetically related to the quartz/feldspar porphyry intrusives.

4.5. GEOCHEMISTRY

Stream sediments were taken from the Que River and its tributaries. Samples of manganese coated pebbles were also collected from some of these localities. Results are not yet to hand.

4.6. CONCLUSIONS

The massive volcanics of the Boco Area are confirmed as the strike extension of the Que River Host Rocks and as such remain the most prospective for orebodies of the Rosebery-Que River type on E.L. 12/72. The contact between these rocks and the western units of volcanics and sediments may represent a 'caldera' wall as postulated by Corbett or a block faulted margin of a rift valley (Campana and King, 1959) with the Que River Volcanics representing the infilled, down thrown block.

While the western unit contains no known syngenetic sulphide mineralisation mapping in the Que River Area has revealed a much higher volcanic/sediment ratio than previously postulated.

To the west of the mapped area lies a broad regional aeromagnetic anomaly, centred on 5,379,000N 382,000E. The anomaly occurs over mixed sediments, volcanics and

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quartz feldspar porphyrys of unit 1. It is thought to represent a buried granite dome and as such may be a source for tin mineralisation at Bulgobac. To test this assumption it is recommended that a regional stream sediment survey be carried out in the Bulgobac area to:-

1. define areas of tin mineralisation, if present
2. define areas of alteration
3. define areas of prospective calcareous host rocks.

5.0 BOCO AREA

Line 13,720N was extended 2km into the south east corner of E.L. 12/72 and was pegged at 20m horizontal intervals. Line 12,720N was repegged over E.I.P. Anomaly $\overline{V}$ located in an earlier gradient array survey.

5.1 GEOLOGY

(Refer to 1:50,000 scale Bedrock Geological Plan No. 2, 1:10,000 scale Bedrock Geological Plan No. A0-525-0007, & Thin Section Descriptions No.'s 785-789 Appendix 1.)

Part of the line was covered by a thin veneer of glacial overburden predominantly composed of Owen Conglomerate.

The bedrock consists of a suite of rhyodacitic lithic-vitric-crystal tuffs (which are probably ash-flows) and porphyritic lavas of dacitic, rhyolitic and quartz trachytic affinities. (Thin sections P785, P786 and P789 Appendix 3) To the east, and just outside E.L. 12/72 is a band of fine grained poorly sorted peletic and sandy ash. (Thin sections P787 & 788 Appendix 3) This band was not observed 700 metres to the south on line 5,383,500N (E.L. 1/62 Mt. Black) and thus it probably lenses out, or is faulted out against the pyroclastics and lavas. The ash shows local distinct sorting and may be sub-aqueous, however, no bedding was observed in the field.

The pyroclastics and lavas show a pervasive albitization

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and chloritization. Apart from minor disseminated fine grained pyrite, no mineralisation was observed.

The rocks are part of a suite mapped by Hanson (E.Z. Report 128) in the Boco Area. They are northern continuation of the Mt. Black Volcanics and can be traced in an unbroken belt north through Que River.

5.2 GEOPHYSICS

(Refer to Induced Polarisation Plans No. A0-504-0084 and A0-504-0085 and Appendix 1 - Comments on Dipole-Dipole E.I.P. Survey over various grids in the Rosebery Area, Tasmania. Tas-065, August, 1979)

A 100m dipole-dipole E.I.P. survey was conducted over line 13,720N. The survey outlined 3 anomalies centred at 11,300E, 11,700E and 12,250E which are discussed in detail in Appendix 1.

The anomaly centred at 11,300E was drilled during the 1976/77 field season by DDH BBP 208. The hole intersected only minor base metal mineralisation. Refer to Report No. 128 for details of this hole and two others drilled in the Boco Area.

On line 12,720N a 50m dipole-dipole I.P. survey successfully detailed anomaly $\overline{V}$ previously outlined by Scintrex Gradient Array Survey (see Scintrex Report Tas-033) during the 1976/77 field season. The dipole-dipole response was seen as a 20Mv/v chargeability response at N=2 & 3 on a background of 10Mv/v. The anomaly is centred at 10,750E.

5.3 GEOCHEMISTRY

(Refer to 1:5,000 scale Geochemistry Sheets 5B & 6A showing Pb/Zn and Cu/Fe. Sheet No's A0-504-0031 Pb/Zn, A0-504-0032 Cu/Fe, A0-504-0025 Pb/Zn and A0-504-0026 Cu/Fe)

Line 13,720N was soil sampled at 20m intervals to nominal

'C' Horizon and samples were analysed for Pb, Zn, Cu, Fe and Ag after perchloric/nitric digestion.

Absolute values were typically low with non co-incident peaks of 65ppm Pb and 50ppm Zn. Some very low results between 12,300E and 12,560E probably represent glacial overburden. No anomalous results were outlined.

5.4 SUMMARY & CONCLUSIONS

Work carried out in the 1978/79 field season has not succeeded in locating any volcanogenic mineralisation of the Rosebery-Que River type. Soil geochemistry and E.I.P. responses from line 13,720N are typical of the volcanic rocks of the Boco area. The I.P. anomalies located probably represent barren sulphide responses of the type that were previously drilled by DDH's BBP 207, 208 and 209.

No detailed follow-up is recommended for the 1979/80 field season. It is planned to review all information later in the year with a view to possible re-interpretation of the area after an examination of Landsat information.

6.0 WESTERN AREA

(Refer to 1:10,000 Geology Plan 3, Ref. No. AO-525-0012)

Two areas of distinct potential were recognised in the Western Area.

1. A tongue of acid lavas and pyroclastics that trends north from Burns Peak into E.L. 12/72 and terminates just south of line 5,388,300N in the North Pinnacles area.

2. A unit of altered ignimbrite which contains minor Pb/Zn mineralisation at Silver Falls on the western boundary of E.L. 12/72.

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Both areas were gridded during the 1978/79 field season. The grids were soil and litter sampled and the grid at North Pinnacles has been surveyed with 100m dipole-dipole I.P.

Aberfoyle conducted a small programme of gridding, soil geochemistry and I.P. over the Silver Falls area and have made their report available to E.Z.

6.1. North Pinnacles Grid

Seven grid lines totalling 10.94km were cut using the access track north from Burns Peak as a base line. The lines have been pegged at 20m intervals and accurately surveyed along the track using a tellurometer shot from Mt. Bischoff and a distamat traverse.

All information has been plotted onto the E.Z. 1:5,000 scale standard plans and the geology has been reduced onto 1:10,000 scale standard plans.

6.1.1. GEOLOGY
(Refer to 1:5,000 Geology Plan Ref. No. A0-521-0033)

Central to the grid and trending north-south is a tongue of massive quartz-poor rhyolitic lavas and pyroclastics named the Burns Peak Rhyolite by Boscher of Loxton Hunting and Associates.

The rhyolites in hand specimen are massive, incipiently bedded, fine grained rocks containing occasional phenocrysts of feldspar and quartz. Flow breccias have also been observed. In thin section the rhyolites have been called porphyritic sodic rhyolites by Fander of C.M.S.

The pyroclastics are mostly coarse grained, rhyolitic, ash-flow types which have been observed along the Burns Peak access track. Fine grained ignimbrites and coarse grained ashflow breccias have also been

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mapped along the eastern flank of the unit.

The Burns Peak Rhyolite dissects sediments of the Dundas/Crimson Creek Group creating two separate basins to the east and west. To the east the sediments consist of poorly outcropping green to grey siltstone and tuffaceous sandstone and conglomerate in order of decreasing abundance. South of E.L. 12/72 and immediately adjacent to the contact thin beds of quartz rich, coarse grained arkose have been reported. Similar rocks have been seen on the Burns Peak to Boco road. A thin band of fine grained rhyolitic ignimbrite has also been mapped within the sediments in close proximity to the contact. Where bedding is exposed most of the rocks have a predominant west dip and facing although east dips and facings have been mapped near Burns Peak. To the west of the Burns Peak Rhyolite occurs a thick sequence of similar sediments which dips and faces west. Quartz rich arkoses are also present in close proximity to the contact and appear to diminish in abundance to the west.

The contact between the Burns Peak Rhyolite and the flanking sediments is often marked by a coarse grained distinctive quartz-feldspar porphyry intrusive which consists mainly of quartz and feldspar phenocrysts (up to 5mm dia.). These often surround dark green chloritic xenoliths which may represent stoped sediments or zones of alteration.

6.1.2. MINERALISATION & ALTERATION

Mineralisation observed in the volcanics at North Pinnacles consists of sparse fine grained disseminated pyrite. South of the E.L. boundary in the vicinity of Burns Peak vein-type Pb/Ba has been recorded. Mineralisation observed in the sediments has been restricted to minor disseminated pyrite associated

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with black shales and rare quartz veins. The flows and pyroclastics of the Burns Peak Rhyclite are often silicified occasionally epidotised and rarely chloritized. Kaolinization due to weathering is common. The flanking sediments show little or no alteration.

6.1.3. STRUCTURE

The sediments west of the Burns Peak Rhyolite form a broad synclinal trough which plunges NNE at a shallow angle. This structure has been mapped in costeans near the E.L. boundary, on the Silver Falls access track and in the Que River north of E.L. 12/72. It is also a prominant feature on aerial photographs. The western contact of the sediments with the Burns Peak Rhyolite is sheared but possibly represents a marine transgression. Evidence that these sediments are younger than the Burns Peak Rhyolite includes:-

1. Quartz Feldspar porphyry which intrudes the rhyolite but has not been observed in the sediments.
2. Sediments close to the contact with the Burns Peak Rhyolite are often compositionally similar to the quartz feldspar porphyry and may have been derived from that material.
3. Lithic fragments observed in conglomerates within the sediments are composed of fragments of similar composition and texture to the rhyolites.
4. While true basal conglomerate has not been observed large lath shaped blebs of shale and volcanics up to 10cm long occur in sediments close to the contact. These become less frequent up sequence.

6.1.4. GEOPHYSICS

(see Appendix 1 & 2 and Induced Polarisation Plans A0-521-0040 and A0-521-0041)

The entire grid has been surveyed using Scintrex time domain dipole-dipole I.P. with an electrode

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spacing of 100m. Appendix 1 deals with lines 5,387,500N and 5,388,300N while Appendix 2 covers the remainder of the grid. All anomalies are discussed fully in Appendices.

Two encouraging anomalous zones have been outlined by the surveys:

1. The eastern zone is observed on lines 5,386,900N 5,387,100N, 5,387,300N and 5,387,500N where it trends across the acid volcanic sediment contact and into the volcanics from south to north. The response is co-incident with Pb and Zn anomalies on lines 5,387,100N and 5,387,500N.

2. The western zone occurs in the sediments 200m west of the acid volcanic/sediment contact and has been defined on lines 5,386,900N and 5,387,100N and lies to the west of the major geochemical anomaly. The I.P. anomaly was not outlined on line 5,387,300N possibly because the survey did not extend far enough west.

6.1.5. GEOCHEMISTRY

6.1.5.1. Soil Geochemistry

(Refer to 1:5,000 scale soil geochemistry Plans No's A0-521-0024 Pb/Zn, A0-521-0025 Cu/Fe.)

All lines were soil sampled at 20m intervals to nominal 'C' horizon. Soil samples from lines 5,387,500N and 5,388,300N were analysed for Pb, Zn, Cu, Ag, Fe by AAS after perchloric/hydrochloric leach. Samples from all other lines were analysed for Pb, Zn, Cu, Fe and Mn after perchloric/nitric leach.

True 'C' horizon was attained in most cases, however a thin veneer of glacial overburden

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prevented penetration on line 5,387,900N between 379,440E and 379,500E and line 5,387,700N between 379,360E and 379,480E. Sampling on line 5,387,500N may also have been affected east of 379,500E.

Cumulative Frequency Plots of Pb and Zn were prepared and are presented in Appendix 3. The plot for lead indicates 3 populations while that for zinc is more complex. Contour intervals were chosen at 200, 500 and 1,000ppm for both Pb and Zn.

A number of semi-continuous Pb anomalies were outlined with results up to a maximum of 2,500ppm on line 5,387,300N. Zinc values are ½-1 order of magnitude below lead and occur with broadly co-incident highs. Many lead anomalies however do not have co-incident high zinc values.

Most of the base metal anomalies lie within the Burns Peak Rhyolite and along the eastern and western contacts. Highest relief for both Pb and Zn was observed in the sediments immediately west and downslope from the acid volcanic/sediment contact on lines 5,387,100N and 5,387,300N.

Absolute copper values are low with peaks up to only 60ppm on lines 5,386,900N and 5,387,100N.

The 4,000ppm Fe contour closely approximates to the volcanic sedimentary contact and may be a useful mapping tool in areas of soil cover.

6.1.5.2. Litter Geochemistry

(see Appendix 5 Pb & Zn Scatter Diagrams & Profiles)

Litter samples of A_o and A_{oo} horizon (fresh and partly decomposed plant material) were taken at 20m intervals on all grid lines except lines

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5,387,500N and 5,388,300N. Initially only every third sample was analysed but later all samples from line 5,387,100N were analysed for comparison with the soil geochemical results. The samples were analysed for Pb, Zn, Cu, Fe, Mn by AAS after a wet ash perchloric/nitric leach.

As expected average backgrounds were much lower than for soils. Preliminary scatter diagrams of litter values vs soil auger values were plotted for Pb & Zn results. These graphs show no apparent correlation between the two types of results with very widely scattered patterns in all cases. These graphs were based on comparison of results from co-incident sample locations and this quick-check method may be invalid if there is a relative shift (perhaps down-slope) between the superficial litter and the surficial soil. A number of profiles were subsequently plotted to compare results more carefully. The results from line 5,387,100N showed promising correlation for Pb with less encouraging patterns for Zn. Subsequent profiles generally fail to live up to this promise and in some cases a disturbing lack of correspondence is observed in the litters (see 6.2.5.2. Page 20).

6.1.6. SUMMARY & CONCLUSIONS

The appearance of encouraging geochemistry and semi-co-incident I.P. anomalism indicates the presence of two or more mineralised zones close to both the contacts of the Burns Peak Rhyolite with the flanking sediments.

Further work is recommended to ascertain the type of mineralisation and its extent. Refer to Section 9.3.2.

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6.2. Silver Falls Extension Grid

6.2.1. ACCESS AND GRIDDING

3km of 4 W.D. access track was bulldozed from the north end of the North Pinnacles access track to Silver Falls.

A track running west from the Boco Area was up-graded to provide access to the northern part of the area.

A grid totalling 13.78km including 2.5km of base line was cut over the area. A further 1.2km of walking track was cut on the eastern end of the grid.

6.2.2. GEOLOGY

(Refer to 1:5,000 scale Geological Plan No. AO-521-0031

Because of subduded topography over most of the grid, and the nature of the bedrock, surface outcrop was sparse. Most geological information has been obtained from hand auger cuttings and an occasional outcrop in creek beds. E.Z.'s information has been supplemented by Aberfoyle's mapping in the Silver Falls area to the south of the Silver Falls Extension Grid where outcrop is more abundant.

The rocks can be subdivided into four units described from west to east:

1. Micaceous Sandstones

   This unit can be traced from Silver Falls, where it lies immediately to the west of the mineralised pyroclastics, for 3km to the north and although it is poorly outcropping it is easily distinguished in auger samples. It consists of distinctive pale grey micaceous quartzites, sandstones, silt-stones and minor dark grey shales.

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2. Rhyolitic Volcanics

These rocks have not been seen to outcrop on the gridded area but have been observed in auger cuttings in the south west of the grid on lines 5,390,000N, 5,390,100N and 5,390,200N. They are white, fine.grained rhyolitic rocks containing little or no phenocrystal quartz. They are the strike equivalent of welded acid pyroclastics mapped by Aberfoyle to the south, which are the host rocks for the Silver Falls Pb/Zn/Cu/Fe mineralisation.

3. Micro Granite

Distinguished only by coarse grained (3-5mm) quartz phenocrysts in auger cuttings. The rock appears to be associated with the rhyolitic volcanics above and shows a marked similarity to the association observed on the margins of the Burns Peak Rhyolite.

4. Crimson Creek (?) Tuffaceous Sediments

These rocks consist mainly of interbedded shales, siltstones, tuffaceous chloritic sandstones (the subaqueous lithic tuff of Aberfoyle) and rare polymictic conglomerate composed mainly of rounded volcanic fragments and minor quartz. This unit is virtually non-outcropping except on line 5,391, 500N where it is dissected by steep terrain south of the Que River.

6.2.3. MINERALISATION AND ALTERATION

Mineralisation has not been observed on the Silver Falls Extension Grid. At the Silver Falls Pb/Zn prospect approximately 0.75km south of line 5,390,000N mineralisation consists of minor veins, disseminations and aggregates of galena, sphalerite, chalcopyrite and tetrahedrite associated with quartz/carbonate

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impregnations. Barite has also been recorded associated with unit 2. East of the Silver Falls Extension Grid minor syngenetic (?) pyrite has been found associated with dark shales and siltstones of unit 4 above.

Apart from minor veining and pervasive chloritization (?) of sandstones no significant alteration has been observed. In the Silver Falls area quartz-sericite-carbonate (calcite-dolomite) alteration has been noted associated with the altered mineralised ignimbrite.

6.2.4. STRUCTURE

Unit 4 represents the western limb of a syncline, the eastern limb of which flanks the Burns Peak Rhyolite. The rhyolitic volcanics (unit 2) and the altered microgranite apparently underlie unit 4, however the contact may be faulted. The micaceous sandstones of unit 1 are thought by Aberfoyle to be separated from other units by a fault (perhaps an extension of the Owen Thrust) but evidence of inter-tonguing of units 1 and 4 to the north of Silver Falls may suggest that the structural break is of minor consequence.

6.2.5. GEOCHEMISTRY

6.2.5.1. Soil Geochemistry

Soil samples were taken at 20m intervals over the entire grid and along 2km of the main base line. The samples were taken at nominal 'C' horizon and analysed for Pb, Zn, Cu, Fe and Mn by AAS after perchloric/nitric leach.

Cumulative Frequency Plots of the Pb/Zn data have been prepared and are presented in Appendix 5. The plots were very similar to those from the North Pinnacles area and consequently the same contour intervals of 200, 500 and 1,000ppm were chosen for Pb and Zn.

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Anomaly patterns for Pb and Zn are very similar. The most anomalous zone for both Pb and Zn occurs over the acid volcanics and associated microgranites between 5,390,000N and 5,390,500N. Values of up to 1.1%Pb and 1350 Zn have been recorded from separate samples. The anomalism strikes 20°E of north and can be traced 1.5km south of line 5,390, 000N onto Aberfoyle's Silver Falls Grid.

The second zone of anomalism is associated with rocks of unit 4 and can be traced north-east along strike (45°E of true north) for 2km, to line 5,391, 500N where it is represented by only a single sample of 225ppm Pb and 230ppm Zn.

6.2.5.2. Litter Geochemistry

Litter samples at Silver Falls Extension Grid were taken and treated in the same way as litter samples at the North Pinnacles Grid. Scatter diagrams and data profiles of soil and litter values showed poorer correlation than similar data from the North Pinnacles Grid.

6.2.6. SUMMARY & CONCLUSIONS

The encouraging geochemistry of the Silver Falls Extension area is sufficient to warrant further exploration effort. A track will be required to the southern portion of the grid to allow access and to expose outcrop. Further geological mapping, soil sampling and stream sediment sampling are required to define the structure of the area and outline the geochemical despersion. An I.P. survey will also be necessary to help define drill targets in areas of high soil geochem.

7.0 LANDSAT

A preliminary study was made of slides of a digital interactive analysis of the 1972 Landsat imagery of the Bulgobac Area. The slides indicate a number of interesting structural trends. One such lineament runs across the north side of Burns Peak in an ENE direction and appears to cut off the Burns Peak Rhyolite from other volcanic rocks to the south. A detailed study and interpretation will be made when enlarged photographic prints of selected combinations of enhanced images are completed.

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8.0 REGIONAL GEOCHEMISTRY

(see Appendix 4)

Following a field investigation of the E.Z./Getty Oil Joint Venture areas by Mr. N.J. Marshall, consulting geochemist, a detailed report was issued entitled "Geochemical Exploration for Base Metals, East Coast Tasmania". The report was accompanied by a volume of orientation studies for areas of Mt. Black (E.L. 1/62) and Bulgobac (E.L. 12/72).

While the report does not cover E.L. 12/72 in detail, many findings and recommendations in the report are pertinant to the area.

9.0 RECOMMENDATIONS FOR FURTHER WORK

9.1 NORTHERN AREA

Creek mapping and stream sediment sampling will be carried out to give a preliminary assessment of the potential for Sn/W mineralisation.

9.2 BOCO AREA

No field work is proposed for the coming season but a review of all data will be undertaken as part of an overall compilation and re-interpretation exercise allied to a Landsat study.

9.3 WESTERN AREA

1. North Pinnacles Grid

A small programme of creek mapping and associated stream sediment sampling to further define the eastern contact of the Burns Peak Rhyolite is proposed. All I.P. anomalies located by the reconnaissance dipole-dipole I.P. survey will be detailed. Coincident I.P. and geochemical anomalies will be

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diamond drilled after access tracks have been constructed if results warrant.

2km of gridding, geochemistry and I.P. is required to cover the northern end of the Burns Peak Rhyolite between lines 5,387,900N and 5,388,300N.

Litter sampling at Bulgobac is to be discontinued because of poor correlation with soil sample values which are thought to be more reliable.

2. Silver Falls Extension Grid

1km of bulldozed track is required for access to anomalous areas north of Silver Falls. All lines are to be surveyed with reconnaissance dipole-dipole I.P. This will be followed by drill track construction and diamond drilling of co-incident geochem and I.P. anomalies if warranted.

Approximately 7.0km of grid is required to close up the line spacing north of line 5,390,500N and to extend the grid north of line 5,391,500N. This grid will be geologically mapped and soil sampled. Reconnaissance dipole-dipole I.P. will be carried out if necessary.

As with the North Pinnacles Grid litter sampling will be discontinued.

Stream sediment samples will be collected from all creeks where they cross grid lines as part of the routine exploration programme.

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APPENDIX 1.

Scintrex Report Tas-065, August, 1979
"Comments on Dipole-Dipole Surveys over various grids in the Rosebery Area, Tasmania, on behalf of Electrolytic Zinc Company of Australasia Limited".

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COMMENTS ON
DIPOLE-DIPOLE EIP SURVEYS
OVER VARIOUS GRIDS
IN THE ROSEBERY AREA, TASMANIA
ON BEHALF OF
ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.

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PRIVATE AND CONFIDENTIAL

COMMENTS ON
DIPOLE-DIPOLE EIP SURVEYS
OVER VARIOUS GRIDS
IN THE ROSEBERY AREA, TASMANIA
ON BEHALF OF
ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.

BY

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SYDNEY, N.S.W.

AUGUST, 1979

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Data Profiles

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GEOPHYSICAL CONSULTANTS AND CONTRACTORS

SUMMARY

A series of dipole-dipole reconnaissance surveys have revealed a number of zones of anomalous induced polarization which are worthy of further investigation. In most cases they are of the order of twice local background in chargeability, while their sources show little resistivity contrast with the enclosing rocks, so inferring either a disseminated, or if 'massive', electrically discontinuous source.

As the dipole-dipole arrays utilised a large 'a' spacing, detailed surveys will be required to define the zones of interest.

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COMMENTS ON
DIPOLE-DIPOLE EIP SURVEYS
OVER VARIOUS GRIDS
IN THE ROSEBERY AREA, TASMANIA
ON BEHALF OF
ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.

INTRODUCTION

A series of dipole-dipole surveys were conducted over various grids in the Rosebery area during February, 1979 by a Scintrex crew led by B. Ekstrom variously assisted by O. Saeck, P. List and R. Sims. There surveys were carried out at the request of Mr. G. Dunbar Chief Geologist for the West Coast Mines division of the Electrolytic Zinc Company of Australasia Ltd. On site direction was carried out by Mr. R. Williams, Senior Exploration Geologist, and J. Mills, Project Geologist.

EQUIPMENT

The equipment used was a Scintrex Australian built 2½/3 kilowatt transmitter powered by an 8HP Briggs and Stratton motor generator in the more accessible areas, and a 4HP Briggs and Stratton motor generator in the less accessible areas. The resultant primary and secondary potential fields so generated were investigated using Scintrex IPR-8 (analog) and IPR-10 (digital) induced polarization receivers.

DATA PRESENTATION

While three decay curve slices were taken, only $M_3$was plotted. The resistivity and chargeability data is plotted in standard pseudo-section format, however,

the enclosed appendix should be consulted to obtain a visual picture of the volume from which the chargeability and resistivity data is obtained.

DISCUSSION OF RESULTS

BOCO GRID

A - Line 12760N a = 50 metres, n = 1 to 4 (Surveyed 27-2-79)

This dipole-dipole survey was run between 10550E and 10900E to follow-up a gradient EIP response of about 5 to 7 millivolts/volt above the low 6 millivolts/volt background on the original gradient survey line (Described in report TAS-033).

The most significant response was centred at 10750E where on n = 1, 15.5 millivolts/volt and 17.3 millivolts/volt give rise to values at depth at n = 2 and 3 of 20 millivolts/volt as against background to the east and west of 10 millivolts/volt. The interpretation of this feature is that some portion of the chargeable source comes within 50 metres of surface, but at 75 metres $\pm$ the source has *increased* polarization over that closer to the source. As with the gradient array the resistivities remain a high 2000 to 4000 ohm-metres, clearly inferring a disseminated source.

The gradient array data clearly shows a distinct source at 10750E to which the dipole-dipole anomaly described above relates. This anomaly is of secondary/primary interest.

The gradient array shows two related chargeability maxima of 6 millivolts/volt centred at 10625E and 10675E, the latter with a distinct resistivity low at 10720E, correlates to a broad zone of above 10 millivolts/volt values between 10500E and the response centred at 10750E described above. On the extreme western flank, a distinct 14 millivolts/volt maximum was noted centred on n = 2-3 at 10550E(+), which is considered to be related to the interaction of the larger gradient maximum east of 10625E, and a lesser gradient maximum west of 10500E, rather than directly below 10550E. The maximum depth to source is estimated to be about 75 metres at about 10510E. Again, as the resistivities are high, a disseminated sulphide, graphite or increase in mafic mineral source is suggested. This anomaly is of secondary interest.

B - Line 13720N a = 100 metres, n = 1 to 4 (Surveyed 14-2-79)

This line was surveyed from 11600E to 13000E. This area was not covered by the original reconnaissance survey, the most easterly station thereof being 11380E. A number of significant induced polarization responses were recorded which are described from west to east.

The most westerly is 24 and 21 millivolts/volt recorded on the n = 3 to n = 4 spacings on the extreme west of the set-up. These have a source judged to be at, or west of 11300E of which these high values form the down dip section of a double peak anomaly. The gradient data recorded significant chargeabilities of up to 14 millivolts/volt above background between about 11150E and 11300E and this anomaly is considered to relate to this. The depth in this case would be less than the dipole, namely less than 100 metres. The high resistivity clearly infers a disseminated source. Should this response be considered

geologically significant, then further dipole-dipole at a lesser spacing, say 20 metres *or* an on-line gradient array, should be carried out between 11000E and 11600E. This response is of primary/secondary interest.

An n = 1 single station reading of 16.8 millivolts/volt as against a background east and west (and below) of 11 millivolts/volt was recorded centred at 11950E. This anomaly problably represents a narrow chargeable source *within* the current/potential dipole, at a depth less than the dipole. Thus, should this source be of interest, a much smaller potential dipole will be required to more accurately define the source. Of tertiary interest.

At 11700E on n = 1 (and n = 2) a similar source is inferred to that described above. The above background anomaly of 3 to 5 millivolts/volt however, is small and could therefore represent only local variation in mafic minercal content. The anomaly is of secondary/tertiary interest.

The most significant chargeability response recorded was centred at 12250E on the n = 1 spacing, where a 29 millivolts/volt anomaly was defined against a 14 to 15 millivolts/volt background to the east and west. A broad indistinct double peak anomaly is inferred and this is interpreted to infer a source at a depth of less than 100 metres centred at or to the immediate east of 12350E. The associated apparent resistivities are a relatively high 2000 ohm-metres(+) which clearly infers a disseminated or electrically discontinuous source. This response is considered of primary/secondary interest.

Bearing in mind the large 100 metres spacing, this anomaly is considred of

better than secondary geophysical interest. Should the geochemical/geological work infer interest in the area, an on-line gradient array to cover the 200 to 300 metres either side of the anomaly is recommended to define the response. An alternate suggestion would be a 20 and/or 40 metres dipole-dipole survey over the same section.

NATIONAL GRID

A - Line 381500N (Farm Creek) a = 100 metres, n= 1 to 4 (Surveyed 9-2-79)

The dipole-dipole surveyed extended from 384200E to 386900E.

Only one significant response was recorded over the 2000 metres of line covered. This was seen as a sharp 15 millivolts/volt response seen on n = 1 at 385450E and dipping in pseudo-section form to the west, and a similar 18 millivolts/volt on n = 1 at 385650E dipping in pseudo-section format to the east. The interpreted source lies within 100 metres of surface between 385500E and 385600E and is disseminated in origin. Again bearing in mind the large current and potential dipoles, this anomaly is considered of primary interest and should be considered further. The contrast of 15 to 18 millivolts/volt in the double peak response as compared with the 7 to 8 millivolts/volt background is good, while the high 2000 to 3000 ohm-metres resistivities clearly infer a disseminated 'bulk' source.

An on-line gradient array or a 40 metres pole or dipole-dipole detailed survey is recommended as follow-up.

B - Line 382500N (Farm Creek) a = 100 metres, n = 1 to 4 (Surveyed 9-2-79)

This line was surveyed between 384600E to 386900E.

The entire line is marked by high resistivities averaging 2000 to 4000 ohm-metres, with a range between 1000 to 10,000 ohm-metres. The background chargeability ranges about 7 $\pm$2 millivolts/volt.

There are no significant chargeability responses on this line.

C - Line 383500N (Farm Creek) a = 100 metres, n = 1 to 4 (Surveyed 17-2-79)

This line was surveyed between 382200E and 385400E. The background resistivity with only minor exceptions, was about 2000 ohm-metres, while the bulk of the chargeabilities observed were less than 8 millivolts/volt. This background generally decreases from west to east, and represents progressively less mafic mineral content. A number of significant chargeability responses were recorded.

The most significant was a series of 2 to 3 times background chargeability maxima of 24 to 35 millivolts/volt from n = 1 to 4 dipping on the pseudo-section plot to the east and centred at 382250E. This strong feature is interpreted as being due to a source within 100 metres of surface which lies between 382100E and 382200E, the form of the anomaly suggesting the eastern 'leg' of a double peak response. The resistivity data remains a high 2000 ohm-metres(+), however, the increase in resistivity from west to east strongly infers the source of the strong chargeability response lies on or in close proximity to a rock type change. The stronger reading at n = 4 (plotted

below 382400E) may in part be due to the western leg of the double peak anomaly associated with a source centred at 382700E ±50 metres.

This anomaly is considered of primary interest, and providing that geological or geochemical data supports its interest, a detailed on-line gradient array is recommended from 381900E to 382400E on this line using a potential of 20 or 25 metres.

A second zone of interest was recorded on the two n = 1 readings plotted on either side of 382700E, and higher n values trending 40° west on the pseudo-section plot. The twice background values of 20 and 22 millivolts/volt are interpreted to be due to a source whose upper section lies within 100 metres of surface and is centred at, or within 50 metres of 800E. The expected east 'leg' of the double peak is not clearly present, but may be inferred on the n = 1 value plotted between 382800E and 382900E which dips to the east on the pseudo-section plot. As with the anomaly described immediately above, it lies on or close to a change in resistivity and therefore may represent a chargeable source on a contact. The overall resistivity is a high 2300 ohm-metres(+), therefore the source is again disseminated. This anomaly is worthy of follow-up as a target of secondary importance, but detailing by on-line gradient is recommended. This could be done in conjunction with the detailing of the anomaly located to the west of 382200E.

A cluster of higher than background readings were noted between 384000E and 384200E of 12 millivolts/volt(±) as against less than 8 millivolts/volt to the west and less than 2 millivolts/volt to the east. These values have no clear

relationship with resistivity other than generally higher values of 3000 ohm-metres(+) at depth. At this stage these higher values are considered to be more likely due to a more resistive and chargeable rock type, and thus this response is considered of secondary to tertiary geophysical interest.

D - Line 387500N a = 100 metres, n = 1 to 4 (Surveyed 22-2-79)

The dipole-dipole set-up was surveyed between 378500E and 380100E. The overall resistivity level observed is generally lower than that observed on other dipole-dipole set-ups above, while the chargeability level at 10 millivolts/volt ±2 millivolts/volt is somewhat higher. This infers a different bulk composition for the rocks, perhaps more mafic and less siliceous.

The most significant response was defined centred between 379100E to 379200E. Strong twice background double peak responses on all four *n* values to 20 millivolts/volt(±) infer a source which lies within 100 metres of the surface between the two coordinates above. As the apparent resistivities accompanying these double peaks are in the 800 to 2000 ohm-metres range, the source is considered to be either disseminated or electrically discontinuous. This anomaly can be considered of secondary to primary geophysical interest, and should the geological and/or geochemical data confirm its interest, additional detailed induced polarization will be required to define the target. An on-line gradient is favoured by the author, and second best would be a 20 and/or 40 metres pole-dipole or dipole-dipole survey.

A second possibly significant source was inferred by 50% above background readings on *n* = 1 to 4 centred between 380000E and 380100E dipping west on

the pseudo section plot. This *form* is interpreted as being the western 'leg' of a double peak anomaly whose source is centred between 380100E and 380200E, and whose depth to source is shallower than the dipole used, namely 100 metres. The accompanying resistivity data while still high could infer a very slightly *less* resistive source than the enclosing rocks. However, the source is thought to be essentially disseminated or electrically discontinuous if massive. This anomaly is considered of secondary geophysical interest, and any detailing will require an extension of the surveyed line some 200 to 300 metres to the east. As above, an on-line gradient is favoured using a small 20 metre dipole to give both depth penetration (large current dipole) and good resolution (small potential dipole).

E - Line 388300N a *= 100 metres,* n *= 1 to 4* *(Surveyed 27-2-79)*

This line was surveyed between 378900E and 380200E. The background resistivities are quite low at 400 to 800 ohm-metres west of about 379400E with background chargeabilities being 9 millivolts/volt(+). East of this point resistivities are about twice this level, while background chargeabilities are about 4 to 6 millivolts/volt. These noticeable differences are due to bulk changes in the underlying rocks.

One significant response was defined on the western extremity of the array seen at n = 1 as 13.8 millivolts/volt with a pseudo-section 45° east dip. A lack of readings to the west makes the interpretation of this feature uncertain as to position and depth due to the complexities of the array and the size of the dipole. However, the source position looks to be between 378900E and 379000E, while the depth to source is less than the 100 metres dipole employed. There is

no apparent contrast in the resistivity between the chargeable source and the enclosing rocks. The response should be followed up by extending the line to the west should this anomaly of secondary interest be found to have potential economic interest.

CONCLUSIONS AND RECOMMENDATIONS

1 - The series of dipole-dipole 50 metres and 100 metres arrays carried out during February has revealed a number of anomalies considered to be of primary and secondary geophysical interest as set out in detail in the text.

2 - While none of the anomalies are more than 2 to 3 times background, it should be remembered that the very large 100 metres dipole-dipole array averages a vast rock tonnage to produce the observed result, and therefore detailed arrays could well demonstrate far higher contrasts, particularly for mineralisation (or graphite!) of lesser width than the 100 metres dipoles used. Similarly the observed resistivity rarely infers the source to be less resistive than the enclosing material, but again any narrow conduction within a chargeable source would be averaged over the whole volume sampled by the potential dipole (see appendix) and would thus be weighted out. For these reasons, detailing of the anomalies located which are considered on geological or geochemical grounds to have merit, will be required prior to further evaluation.

3 - It is the authors very strong recommendation both on the grounds of penetration/resolution and on the grounds of cost effectiveness, that

the preferred method of detailing be in the following order:-

(a) on-line gradient , which will combine maximum energisation to depth and high resolution (20-25 metre potential) with ease of operation.

(b) pole-dipole which will allow ease of operation, a slightly enhanced penetration due to the remote electrode

(c) dipole-dipole

With the latter two, small 40 and/or 20 metre dipoles are suggested.

4 - As with *all* geophysical surveys, the potential economic interest of anomalies is related to associated geological and geochemical indicators rather than the amplitude of the response alone. However, those anomalies designated here as primary and primary/secondary interest warrant follow-up work, even without ancillary information being available.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.

A.W. HOWLAND-ROSE,MSc,DIC,AMAusIMM,FGS.

GEOPHYSICIST

SCINTREX

APPENDIX

SOME COMMENTS ON THE GRADIENT ARRAY AND DIPOLE-DIPOLE ARRAY IN THE CONDITIONS MET ON THE MT. BLACK, WHITE SPUR (AND CONTIGUOUS AREAS) EIP SURVEYS.

In the case of the surveys discussed in the report it is vitally important that the geologist can relate the geophysical data to the underlying geology, if he is to make the best use of this data. It is the author's opinion that in the present case *only* the geologist will be able to relate the data to geology due to the complexity of the geology, structure and topography at a number of sites, together with the variation in the geophysical signature of the known orezones. For this reason, brief, simple comments follow on the salient features of the various array types used, and how the data relates to the volume of underlying rock which influences it.

Gradient Array:- In this array both current electrodes are distant from the potential dipole. Figure 1 displays the salient features of the *primary* current flow and primary equipotential field generated during energisation and shows the influence of terrain on the current paths. From this diagram it can be seen that the *apparent resistivity* measurement is a summation of a volume of material normal to the local slope, *beneath* the surface and at *right angles* to the line.

The apparent resistivity will be *biased by* the influence of each current electrode, but the *relative* values of *adjacent* readings can be considered to be *reliable*. As each electrode is approached,

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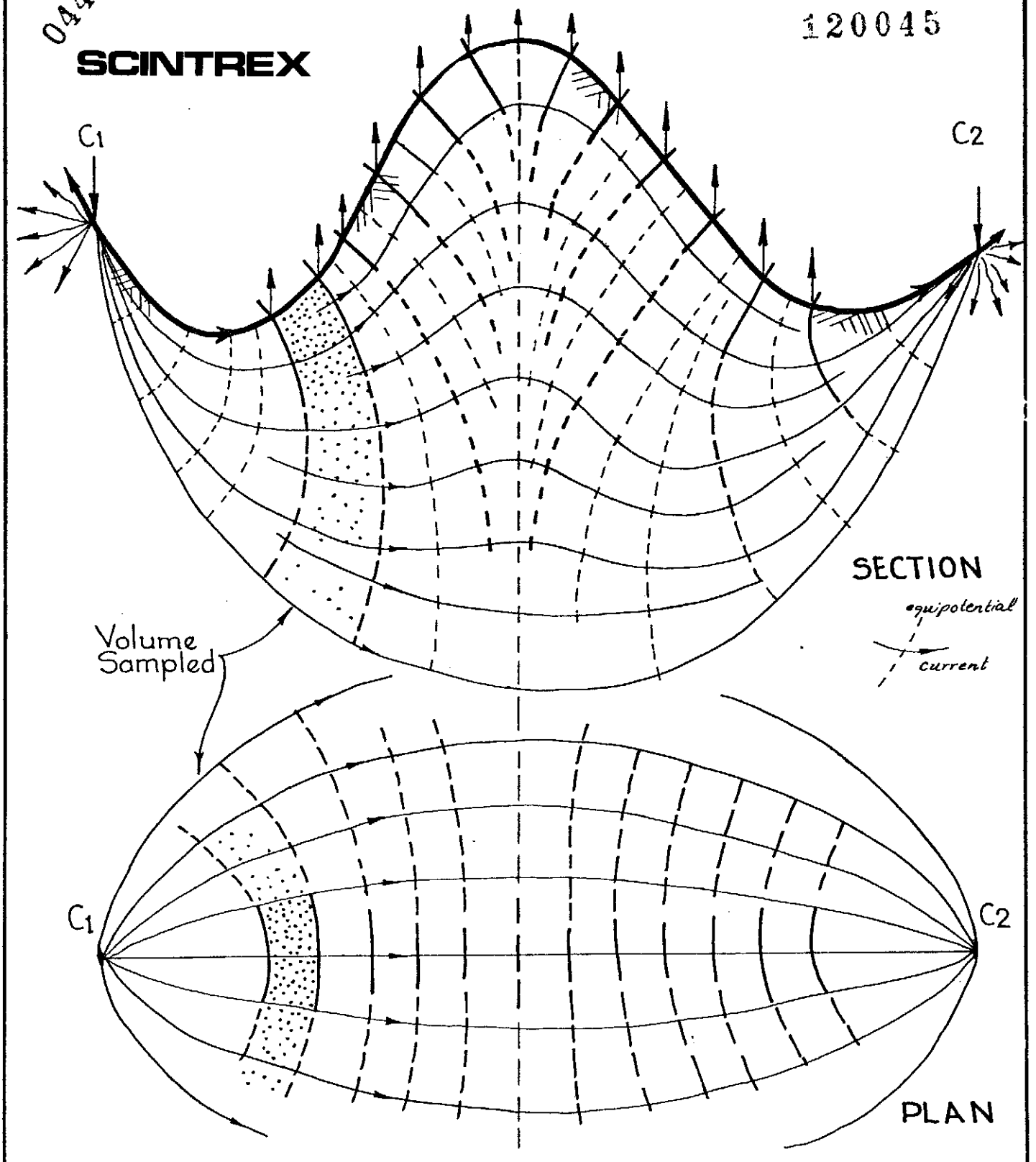

Diagrammatic Representation of Primary Current and Potential Field in Steep Topography.

FIGURE 1.

the readings become *increasingly biased by* that electrode.

Note particularly that the *source volume* is *normal to slope* and not vertically beneath the potential dipole. Therefore all maximum depths refer to depths below surface *normal to the slope*.

Note also that the volume of material *closest to* the potential electrodes will influence the data most. It is difficult to easily quantify the complex relationship between the volume of material sampled and its distance from the potential dipole.

Figure 2 displays the secondary current pattern generated from the decay of induced polarization effect *within* a chargeable sulphide source, together with the equipotential field generated by that decay. Note that due to the necessarily curved nature of the current flow outside the body, the on-surface manifestation is *wider than* the *source width*. Note also that the volume sampled in the primary potential field (apparent resistivity ρa) is not necessarily the same volume as is the secondary potential field (apparent chargeability *Ma*). This is, of course, true for *any* array.

Dipole-Dipole:- In this array the current dipole is generally small, in this case, 40 metres. Figure 3 displays the current pattern in section and in plan for a dipole-dipole array. The equipotentials P_1 and P_2 tap a volume as shown in this diagramm whose characteristics are read on the n = 1 station and plotted as a single point midway

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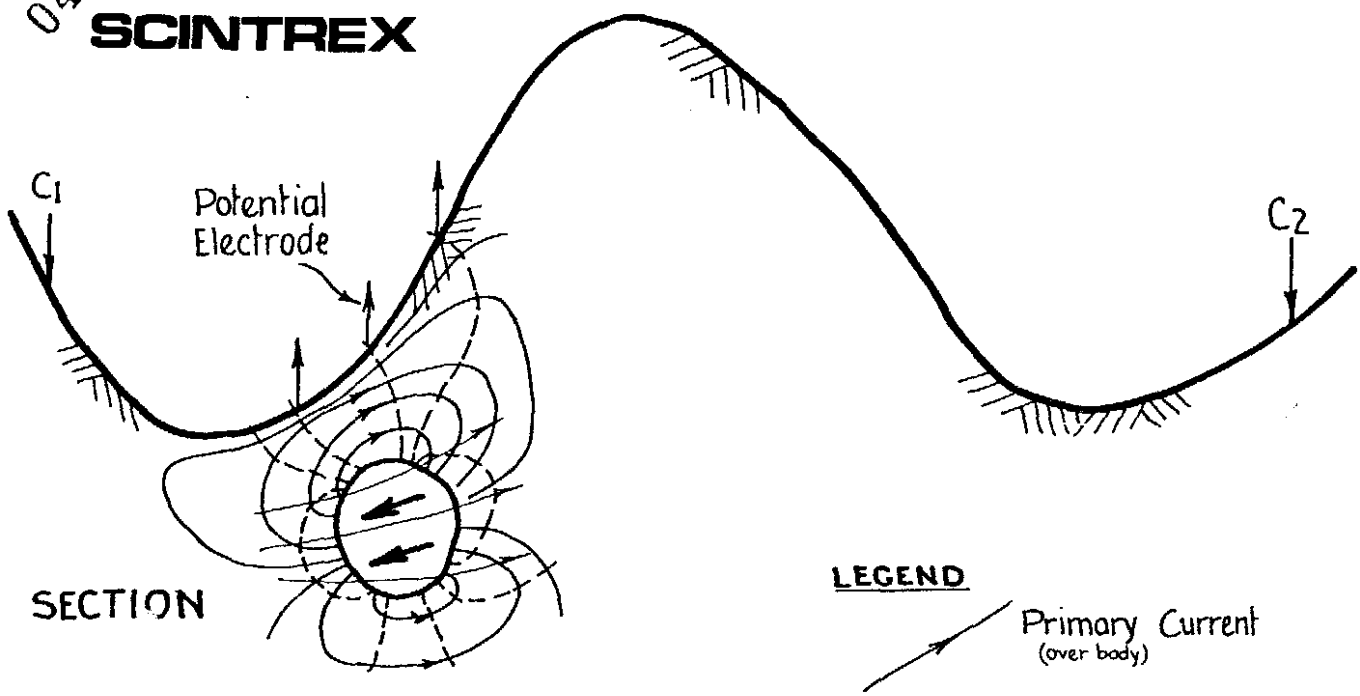

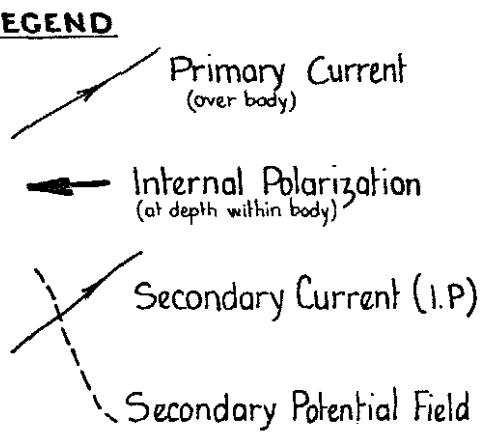

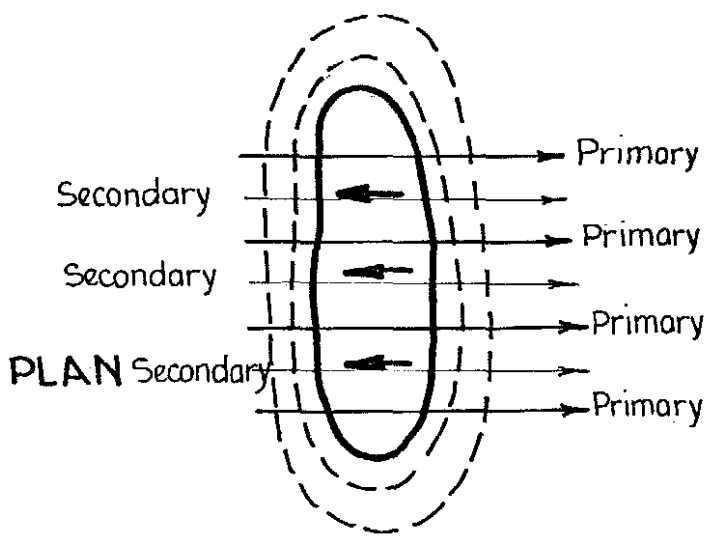

Diagrammatic representation of secondary current (I.P. effect) and secondary potential field in steep terrain.

FIGURE 2.

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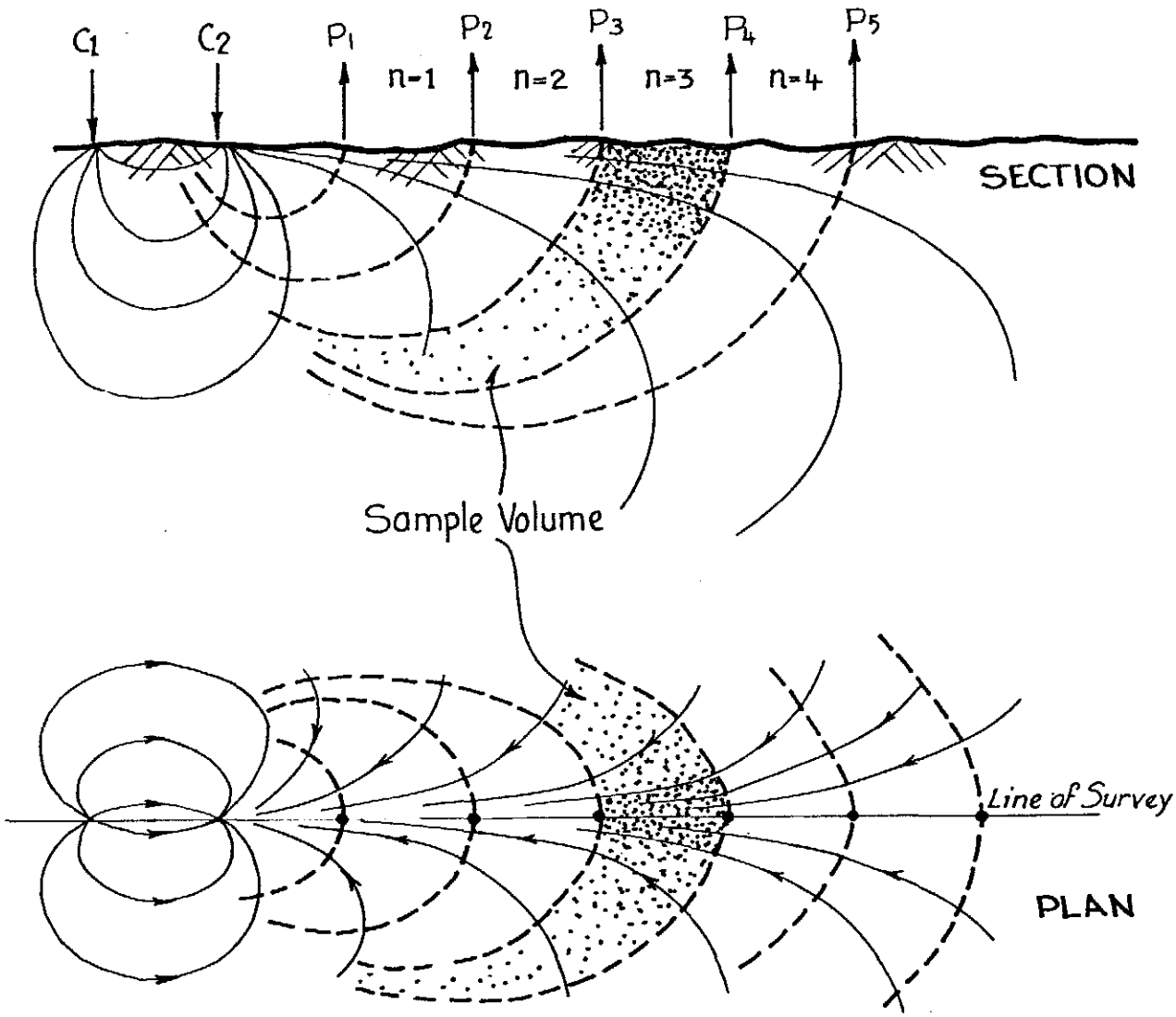

Dipole - Dipole Array
Primary current paths and equipotential field
Showing volumes sampled

FIGURE 3.

between the transmitting dipole C_1 to C_2 and the potential dipole P_1 to P_2. As progressively higher n values are read, a deeper and wider volume of material is sampled, this always being plotted midway between the transmitting and receiving dipole, and at a deeper level in the pseudo-section presentation used in this report. It is *vital* to realise that this data point does not represent the characteristics of the ground at the point plotted, but that of the *total volume* sampled.

A further characteristic of the array is that where the effective spacing ($n \times a$) is greater than the depth to the source, a 'high' (or 'low', depending on characteristics) will occur as each of the dipoles (i.e. transmitting C_1 and C_2, and potential P_1 and P_2) pass over the source of that anomaly. The resultant 45° patterns on the pseudo-section DO NOT represent dip, or even depth extent, but merely represent a complex interface pattern over the source. For a single source, this *double peak effect* can be recognised as it tends to have two maxima displaced by ($n \times a + w$) where w is the width of the source. For multiple bodies this is difficult if not impossible to resolve by dipole-dipole arrays alone.

The enclosed Figure 4 shows the discharge of the energy stored in the body. As can be seen, the area sampled in section is tapped between the equipotentials generated by the discharge of the stored energy. These will not necessarily be of the same form as those for the resistivity data, although they are, for convenience, plotted in the same format as for resistivity. Again, it is vital to note

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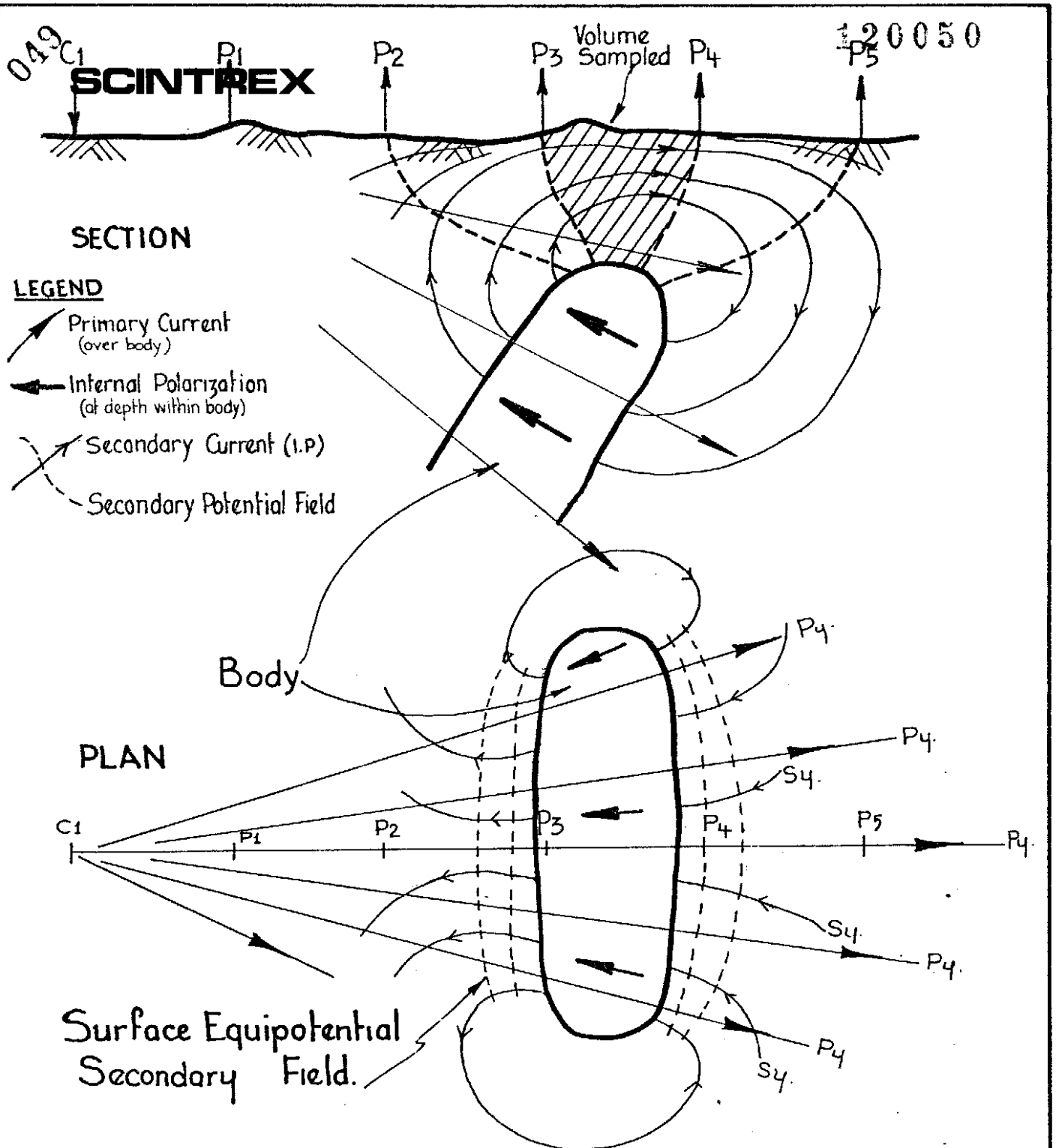

Current path and secondary equipotential field due to discharge of stored energy (I.P. effect) in the case of Pole-Dipole or Dipole-Dipole.

FIGURE 4.

that they represent the volume sampled as shown in Figure 4, *and not* the characteristics of the point at which they are plotted. Double peaks also occur as each of the two sets of electrodes pass over a source, where $n \times a$ is greater than the depth to source. Where $n \times a$ is less than the depth to source, a single maximum will be produced midway between the energising and measuring dipoles C_1/C_2 and P_1/P_2.

Terrain Effects:- The survey area is steep in many places. The enclosed Table I shows the dipole-dipole array is subject to greater topographic effects. Whereas the location of the gradient anomaly sources can be easily deduced, those for dipole-dipole are far more difficult to compute in difficult terrain. However, in the present case, where the slope was fairly uniform over the section of interest, (even when 'steep') and most sources were not greater than twice the a spacing used, no undue distortion should be present.

Depth to Source:- The depths to source are always taken normal to local slope for both arrays.

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TABLE 1
(Table 3.1)

Comparison of IP Survey Electrode Arrays

(after Sumner, 1972)

	Advantages	Disadvantages	Survey Speed	Signal to Noise	EM Coupling Rejection
Parallel Field Arrays Wenner	Anomalies symmetrical Synchronous detector possible Many case histories available	Requires more wire: larger field crew Poor resolution Unfavourable in capacitive coupling situations	Fair	Good	Fair
Schlumberger	Symmetrical array Synchronous detection possible Fewer men required Works well in layered earth Type curves available	Less horizontal resolution Unsuitable for horizontal profiling Capacitive coupling possible	Fair	Fair	Fair
Gradient	Map interpretation easier Less masking by conductive overburden Penetration good: safer Communications easier Can use two or more receivers Less topographic effect Data easily contoured in plan Useful where difficulty in making good current contacts	Poor resolution with depth Poor in low resistivity areas Geometric factor varies complexly	Good	Fair	Poor
Potential-About-a-Point					
Three-Array	Good reconnaissance array Fairly good resolution	Asymmetrical More wire needed	Fair	Good	Good
Pole-Dipole, Collinear	Good resolution Good subsurface coverage	Asymmetrical Asymmetrical	Fair	Fair	Fair
Perpendicular Three-Array, Pole-Dipole, Pole-Pole	Virtually eliminates EM coupling	More wire needed	Fair to Poor	Fair	Very Good
Pole-Pole (Two-Array)	Smaller crew needed Less wire needed than for some arrays Good penetration in nonconductive overburden	Susceptible to masking by conductive over-burden	Good	Fair	Poor
PDR (Potential Drop Ratio)	Sensitive to lateral variations "Common mode" noise rejection	Complex interpretation	Fair	Good	Fair
Dipole Field Array					
Dipole-Dipole Collinear	Symmetrical, good resolution Good penetration Less survey wire needed	Slow unless equipment is portable Resistivity topographic effects Interpretation somewhat involved	Fair	Poor	Fair
Dipole-Dipole, Parallel	Special use for EM coupling interpretation	Not used for routine surveying	Poor	Poor	Fair
Down-the-Hole Arrays					
Azimuthal Array (One Potential Electrode Down the Hole)	Fair for exploration purposes Useful in finding the best search direction	Interpretation complex Negative anomalies Strong geometric effects Mainly measures changes in resistivity	Fair	Good	Good
Radial Array (One Current Electrode Down the Hole, mise-à-la-masse)	Good for exploration purposes Useful in finding the best search direction Hole need not stay open	Interpretation complex Negative anomalies Not good for obtaining rock properties	Fair	Good	Good
In-Hole Arrays					
(More than One Electrode in the Hole)	Good for obtaining rock properties Good for assaying Interpretation simple	Current densities may be too large Possible capacitive coupling problems Not designed for exploration purposes Special equipment, expensive	Good	Fair	Good

Extract from: Geological Survey of Canada - Paper 75-31 "Borehole Geophysics Applied to Metallic Mineral Prospecting: A Review"

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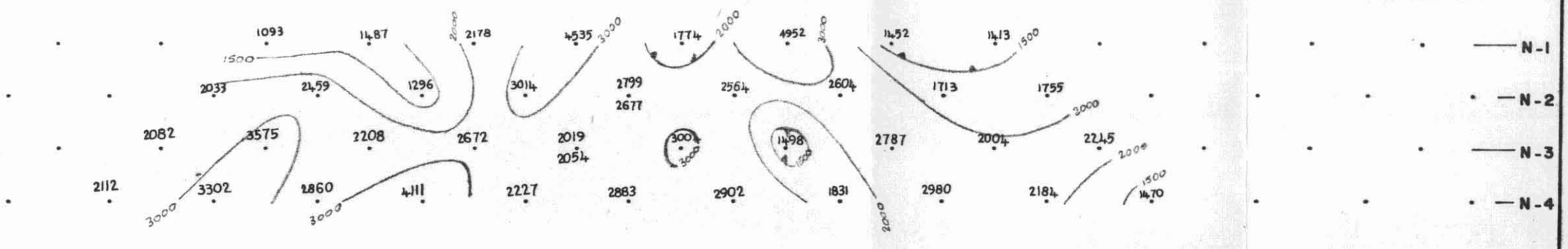
INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

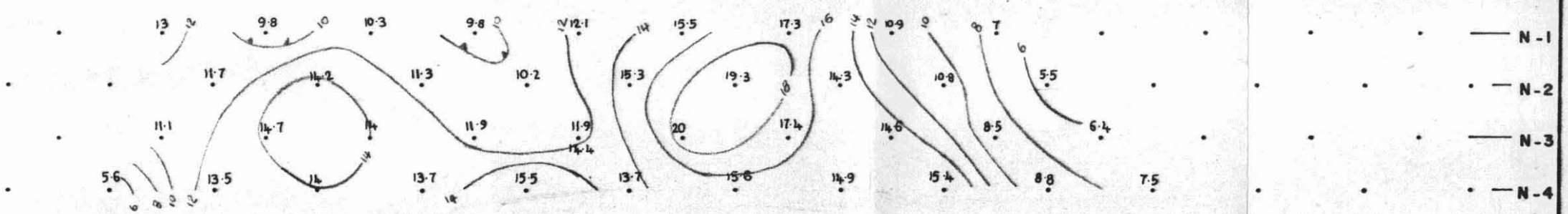
DATE 27-2-79	LINE No. 12760 N
PLOTTED BY	PROSPECT
PULSE 2 Secs / Rx.	JOB No. TAS-065
DIPOLE SPACING 50 M	

RESISTIVITY Ω m.



10450E 10500E 10550E 10600E 10650E 10700E 10750E 10800E 10850E 10900E 10950E 11000E

CHARGEABILITY



5 cm

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INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 14-2-79

PLOTTED BY B.E.

PULSE 2 | Rx.

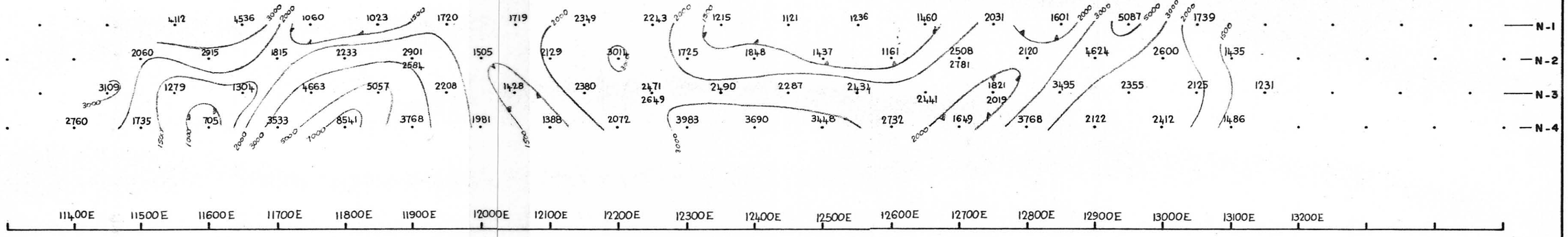
DIPOLE SPACING 100 m

LINE No. 13720 N

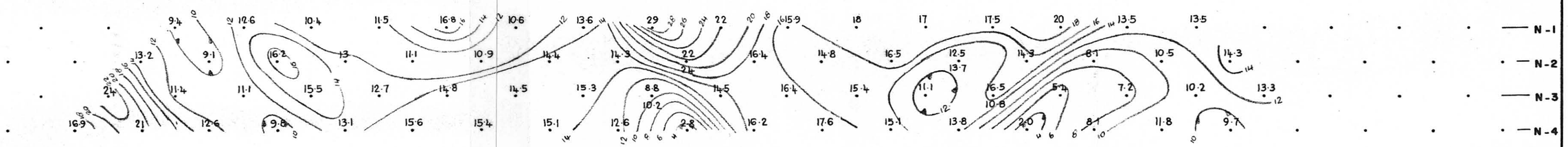
PROSPECT BOCO

JOB No. TAS-065

RESISTIVITY Ω m.



CHARGEABILITY



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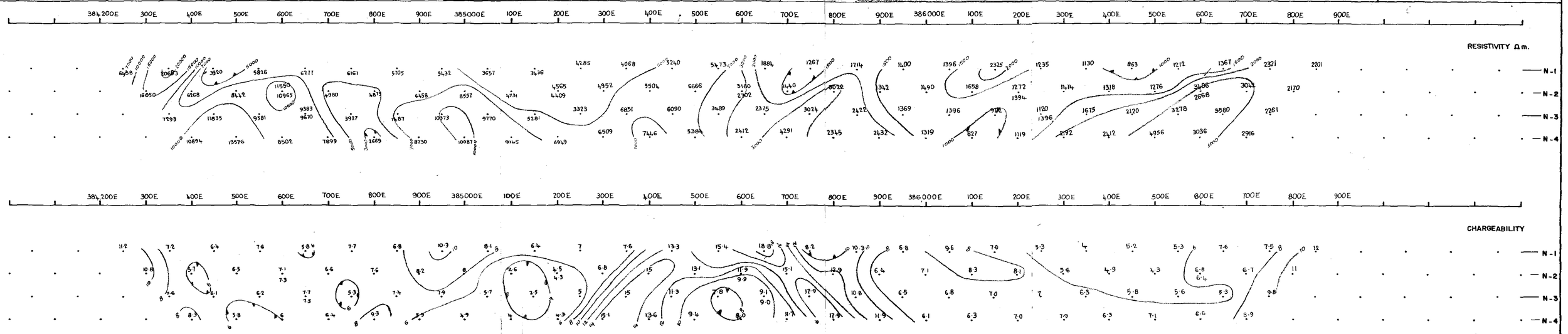
SCINTREX PTY. LTD.
INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

SCINTREX PTY. LTD.
INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

SCINTREX PTY. LTD.
INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

DATE 9-2-79
PLOTTED BY B.E.
PULSE 2 | Rx.
DIPOLE SPACING 100 m

LINE No. 381500N
PROSPECT FARM CREEK
JOB No. TAS-065



5 cm

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SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE	
PLOTTED BY	
PULSE	Rx.
DIPOLE SPACING	

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE	9-2-79
PLOTTED BY	B.E.
PULSE	2 Rx.
DIPOLE SPACING	100 m

LINE No.	382500N
PROSPECT	FARM CREEK
JOB No.	TAS-065

RESISTIVITY Ω m.

N-1 N-2 N-3 N-4

384500E 600E 700E 800E 900E 385000E 100E 200E 300E 400E 500E 600E 700E 800E 900E 386000E 100E 200E 300E 400E 500E 600E 700E 800E

CHARGEABILITY

N-1 N-2 N-3 N-4

5 cm

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INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

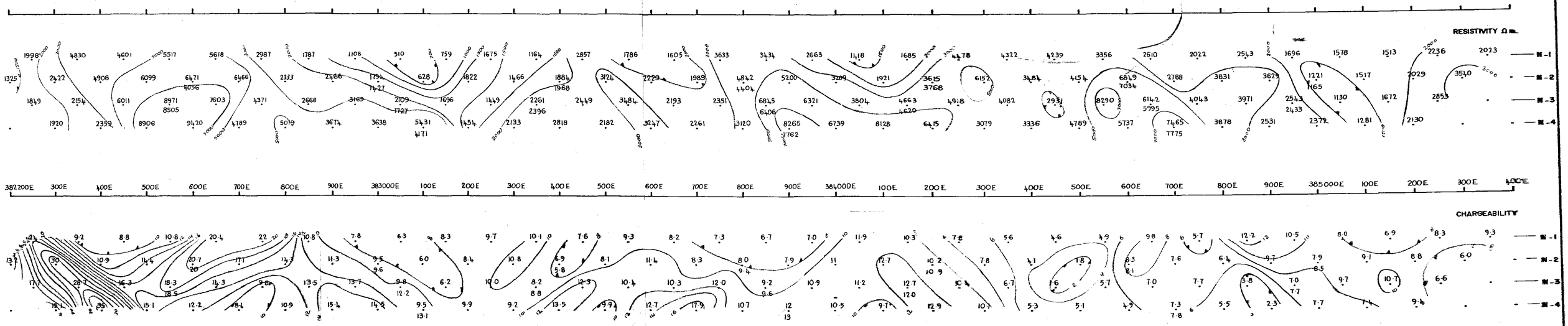
SCINTREX PTY. LTD.
INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

DATE	
PLOTTED BY	
PULSE	Rx.
DIPOLE SPACING	

SCINTREX PTY. LTD.
INDUCED POLARIZATION AND RESISTIVITY SURVEY
DIPOLE - DIPOLE ARRAY

DATE	17-2-79
PLOTTED BY	B.E
PULSE	2 sec Rx.
DIPOLE SPACING	100 m

LINE No.	383500 N
PROSPECT	FARM CREEK
JOB No.	TAS-065



5 cm

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INDUCED POLARIZATION AND RESISTIVITY SURVEY

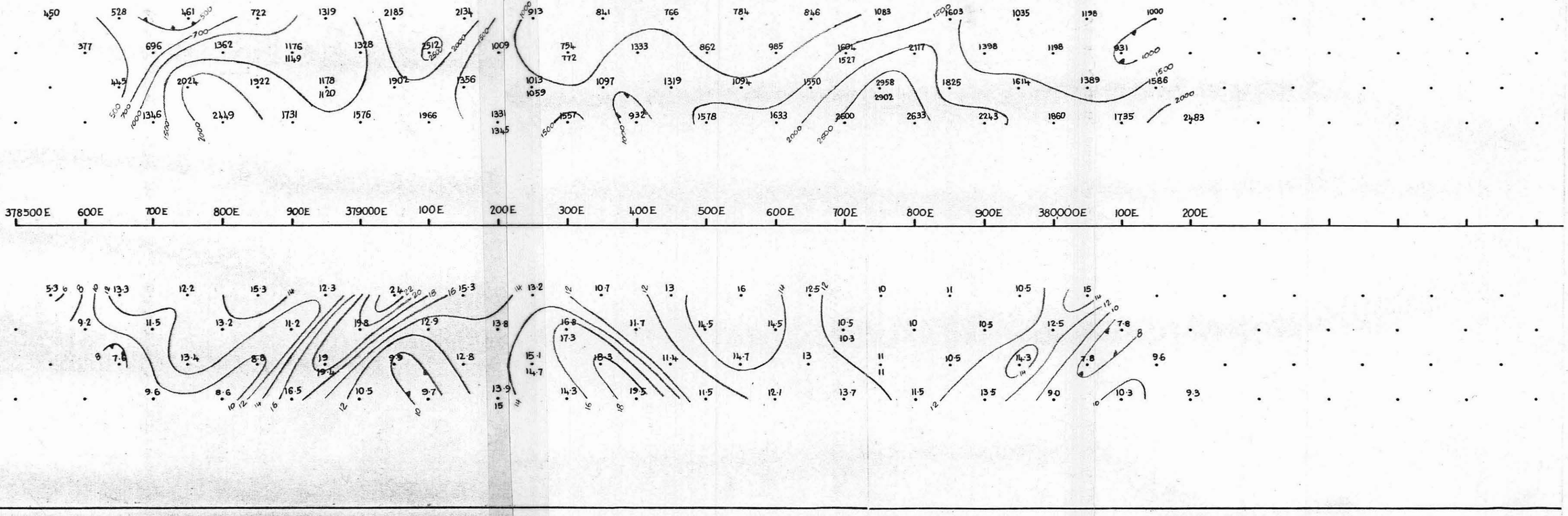
DIPOLE - DIPOLE ARRAY

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 22-2-79	LINE No. 387500N
PLOTTED BY B.E.	PROSPECT
PULSE 2 sec. / Rx.	JOB No. TAS-065
DIPOLE SPACING 100 m	



5 cm

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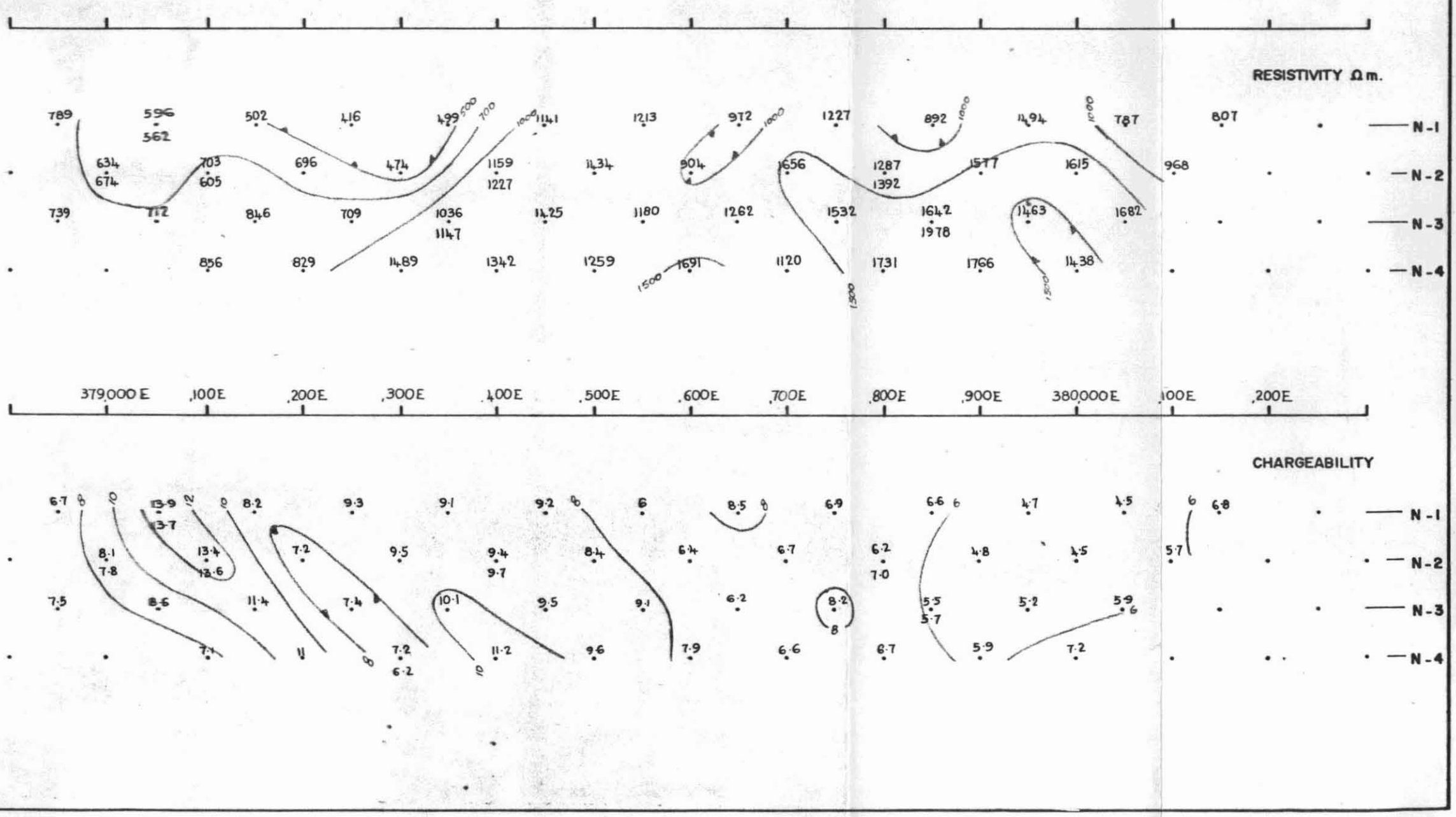
SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 27 - 2 - 79	LINE No. 388,300N
PLOTTED BY B.E	PROSPECT
PULSE 2 secs | Rx.	JOB No. TAS-065
DIPOLE SPACING 100 M	



5 cm

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APPENDIX 2.

Scintrex Report Tas-065, July, 1979
"Brief Comments on Five Dipole-Dipole setups over the Bulgobac (North Pinnacles) Grid near Rosebery, Tasmania, on behalf of the Electrolytic Zinc Company of Australasia Limited".

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SCINTREX

BRIEF COMMENTS ON
FIVE DIPOLE-DIPOLE SET-UPS
OVER THE BULGOBAC GRID
NEAR ROSEBERY, TASMANIA
ON BEHALF OF
ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED

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SCINTREX

PRIVATE AND CONFIDENTIAL

BRIEF COMMENTS ON FIVE DIPOLE-DIPOLE SET-UPS OVER THE BULGOBAC GRID NEAR ROSEBERY, TASMANIA ON BEHALF OF ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED

BY

A.W. HOWLAND-ROSE
MSC,DIC,AMAUSIMM,FGS.
GEOPHYSICIST

SYDNEY, N.S.W.

JULY, 1979

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Summary

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Equipment Page 1

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Appendix

Data Profiles

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GEOPHYSICAL CONSULTANTS AND CONTRACTORS

SUMMARY

Some five dipole-dipole 100 metre set-ups were executed on the Bulgobac area. While four arrays show no significant responses, one shows a response of possible secondary geophysical interest. An on-line gradient follow-up has been recommended to define and resolve the source should the geological data infer the source to have possible economic interest.

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069

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SCINTREX

BRIEF COMMENTS ON FIVE DIPOLE-DIPOLE SET-UPS OVER THE BULGOBAC GRID NEAR ROSEBERY, TASMANIA ON BEHALF OF ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED

INTRODUCTION

Some five dipole-dipole set-ups were surveyed over sections of the Bulgobac grid as part of a series of electrical induced polarization surveys carried out on behalf of the West Coast Mines division of Electrolytic Zinc Company of Australasia Limited.

These surveys were carried out at the request of Senior Exploration Geologist Mr. R. Williams by Scintrex Pty. Ltd. over about four operator days between 4th and 7th June, 1979 by Scintrex operator Mr. D.J.T. Webb,B.Sc.(Hons).

EQUIPMENT

The equipment consisted of a Scintrex 2½ kilowatt time domain induced polarization transmitter powered by a 4HP Briggs and Stratton motor generator. The resultant primary and secondary fields were observed by Scintrex IPR-8 time domain receivers.

METHOD

The method is briefly described in the relevant section of the enclosed appendix.

DATA PRESENTATION

The data is presented in the standard pseudo-section format. However, it is recommended that the relevant section of the appendix dealing with data presentation be studied by those unfamiliar with the meaning of this format.

DISCUSSION OF RESULTS

Each of the set-ups is separately discussed below.

Line 5386900N 378400E-379200E a = 100 metres, n = 1 to 4

Background resistivity ranges from 1000 ohm-metres to 4500 ohm-metres, while chargeability ranges between 6 millivolts/volt and 13 millivolts/volt, the mean being about 10 millivolts/volt.

The only response of possible interest shows as a 11.5 millivolts/volt response at n = 1 between 378500E and 378600E against a background of 6 to 7 millivolts/volt. The high n values 2-4, show values of 12.1, 13.6 and 12.8 millivolts/volt to the east. This can be interpreted as being due to a source centred at, or west of 378550E, and at a depth less than the 100 metres spacing used.

The centre section at 378800E shows low chargeability (7$\pm$ millivolts/volt) and high resistivity (2000 to 5000 ohm-metres) which passes to the east into less resistive and more chargeable rocks.

None of the features on this array can be considered of prime or even secondary interest.

Line 5387100N 378440E-379240E a = 100 metres, n = 1 to 4

The main feature observed was a rock type change at about 378900E, indicated by higher chargeability readings to the east of 14 millivolts/volt(+), and lower chargeabilities of 9 millivolts/volt(-) to the west. The resistivity data does not show a material change, therefore the source is considered to be disseminated and probably formational only.

At 378940E lower chargeability of 5 to 7 millivolts/volt at n = 3 together with higher resistivity of 3000 ohm-metres indicates a more resistive, less chargeable rock unit, say an acid volcanic or granite, at this location.

Higher chargeability of 12 millivolts/volt(+) on the n = 2 and 3 spacings at 378740E(+) as against a background of 8 millivolts/volt show a relatively chargeable unit to be present at this location.

None of the chargeable responses located on this set-up are considered of possible economic significance.

Line 5387300N 378600E-379300E a = 100 metres, n = 1 to 4

The main feature observed on this set-up is a marked contrast in chargeability from the 10 millivolts/volt(+) level west of about 379100E to 15 millivolts/volt(+) east of that point. To the immediate west of this contact the resistivities increase to about twice the average, while chargeabilities are lower than average, which would infer the presence of a resistive silicified acid unit.

Higher chargeability values on the n = 1 spacing of 20 millivolts/volt at 379150E,

together with the usual -45° dip to a high chargeability zone to the west, can be interpreted as the western arm of a double peak anomaly whose source is broad, centred at or slightly west of 379150E, and whose depth is less than 100 metres. This response is of secondary geophysical interest, but a closer spacing (or preferably gradient run on the line) may be able to resolve the source location, width and dip more definitely.

Line 5387700N 378660E-379460E a = 100 metres, n = 1 to 4

The resistivity shows a variation from 550 ohm-metres to 2200 ohm-metres, while the chargeability varies about the 10 millivolts/volt±2 millivolts/volt level. While there are no significant responses of potential economic interest, progressively lower chargeability to 6 millivolts/volt from twice this level with increasing *n* values at 378960E, indicates a less chargeable (more acid?) rock unit at depth.

Line 5387900N 378900E - 379700E a = 100 metres, n = 1 to 4

The resistivity data shows a progressive increase in resistivity from 500 ohm-metres(±) to the east of 379200E to twice this level at depth, indicating more resistive rocks at depth. The chargeability, however, while varying about the 10 millivolts/volt(±) level, shows no definitive pattern other than to infer slightly more chargeable rocks between 379200E and 379400E within 100 metres of surface.

There are no significant anomalies of potential economic interest.

CONCLUSIONS

1 - With the possible exception of the set-up on line 5387300N, no significant induced polarization anomalies were located on the five set-ups reviewed here. On line 5387300N a 'broad' source at a depth of less than 100 metres is suggested at, or just west of 379150E, the 40° west dipping anomaly being interpreted as the western arm of a double peak.

2 - The data infers that no 'very substantial sulphide' occurrence exists over the sections surveyed. However, lesser width (say 20 metres±) may well be diluted significantly on the large 100 metres spacings used. The authors preference is for a gradient array approach, even if this has to be a wholly 'on line' set-up, because (a) the resolution of the array is good, and (b) the survey more rapid, and therefore much more cost effective. Any such anomalies could be followed-up by dipole-dipole (or pole-dipole) arrays of a lesser (say 40 metres) spacing as for the Mt. Black survey.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.

A.W. HOWLAND-ROSE, MSc, DIC, AMAusIMM, FGS.

GEOPHYSICIST

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SCINTREX

APPENDIX

SOME COMMENTS ON THE GRADIENT ARRAY AND DIPOLE-DIPOLE ARRAY IN THE CONDITIONS MET ON THE MT. BLACK, WHITE SPUR (AND CONTIGUOUS AREAS) EIP SURVEYS.

In the case of the surveys discussed in the report it is vitally important that the geologist can relate the geophysical data to the underlying geology, if he is to make the best use of this data. It is the author's opinion that in the present case *only* the geologist will be able to relate the data to geology due to the complexity of the geology, structure and topography at a number of sites, together with the variation in the geophysical signature of the known orezones. For this reason, brief, simple comments follow on the salient features of the various array types used, and how the data relates to the volume of underlying rock which influences it.

Gradient Array:- In this array both current electrodes are distant from the potential dipole. Figure 1 displays the salient features of the *primary* current flow and primary equipotential field generated during energisation and shows the influence of terrain on the current paths. From this diagram it can be seen that the *apparent resistivity* measurement is a summation of a volume of material normal to the local slope, *beneath* the surface and at *right angles* to the line.

The apparent resistivity will be *biased by* the influence of each current electrode, but the *relative* values of *adjacent* readings can be considered to be *reliable*. As each electrode is approached,

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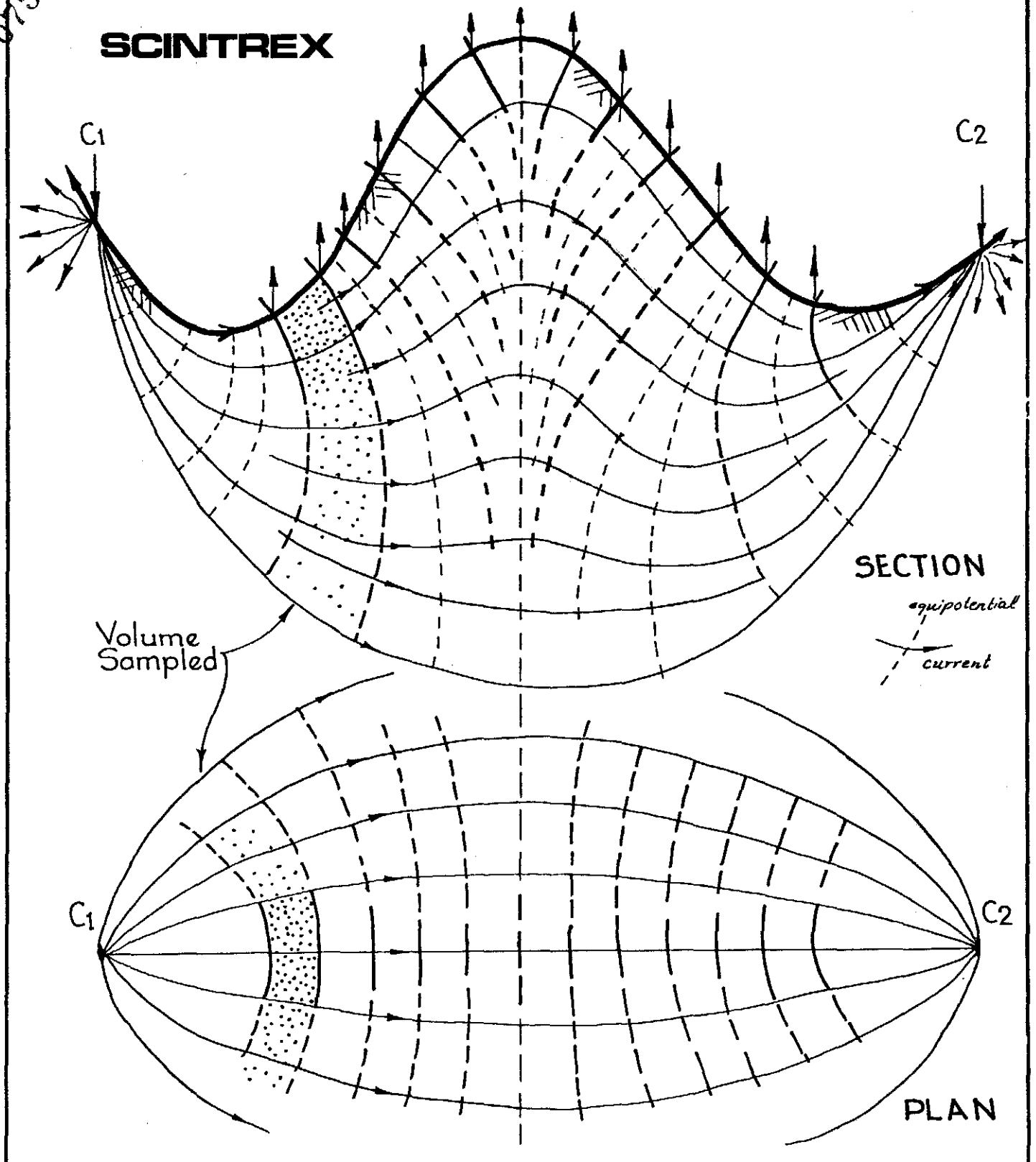


Diagrammatic Representation of Primary Current and Potential Field in Steep Topography.

FIGURE 1.

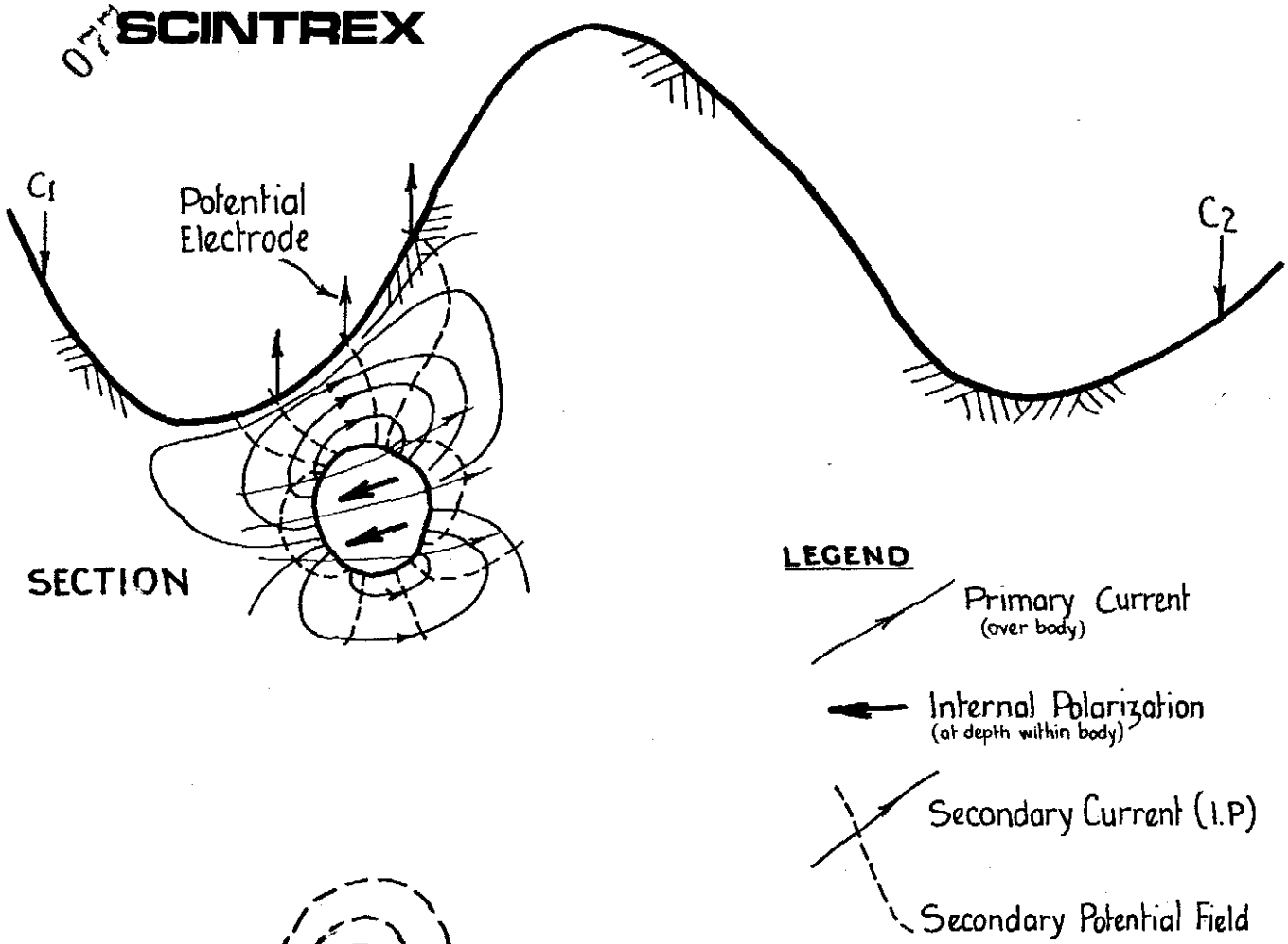
the readings become *increasingly biased by* that electrode.

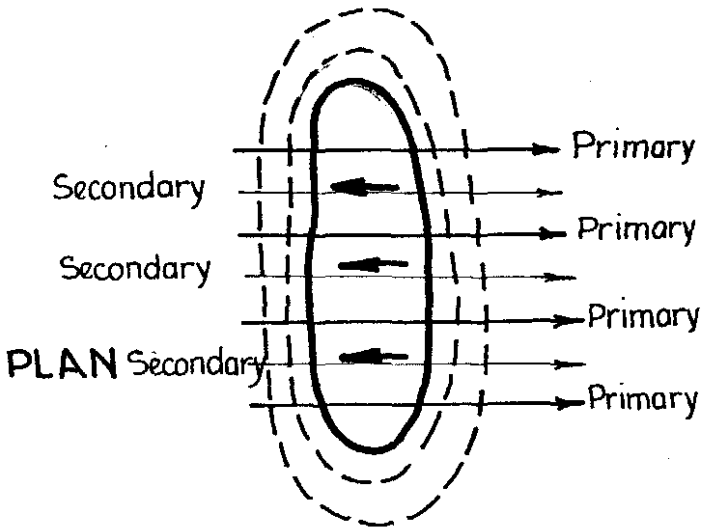
Note particularly that the *source volume* is *normal to slope* and not vertically beneath the potential dipole. Therefore all maximum depths refer to depths below surface *normal to the slope*.

Note also that the volume of material *closest to* the potential electrodes will influence the data most. It is difficult to easily quantify the complex relationship between the volume of material sampled and its distance from the potential dipole.

Figure 2 displays the secondary current pattern generated from the decay of induced polarization effect *within* a chargeable sulphide source, together with the equipotential field generated by that decay. Note that due to the necessarily curved nature of the current flow outside the body, the on-surface manifestation is *wider than* the *source width*. Note also that the volume sampled in the primary potential field (apparent resistivity ρa) is not necessarily the same volume as is the secondary potential field (apparent chargeability *Ma*). This is, of course, true for *any* array.

Dipole-Dipole:- In this array the current dipole is generally small, in this case, 40 metres. Figure 3 displays the current pattern in section and in plan for a dipole-dipole array. The equipotentials P_1 and P_2 tap a volume as shown in this diagramm whose characteristics are read on the n = 1 station and plotted as a single point midway





Diagrammatic representation of secondary current (I.P. effect) and secondary potential field in steep terrain.

FIGURE 2.

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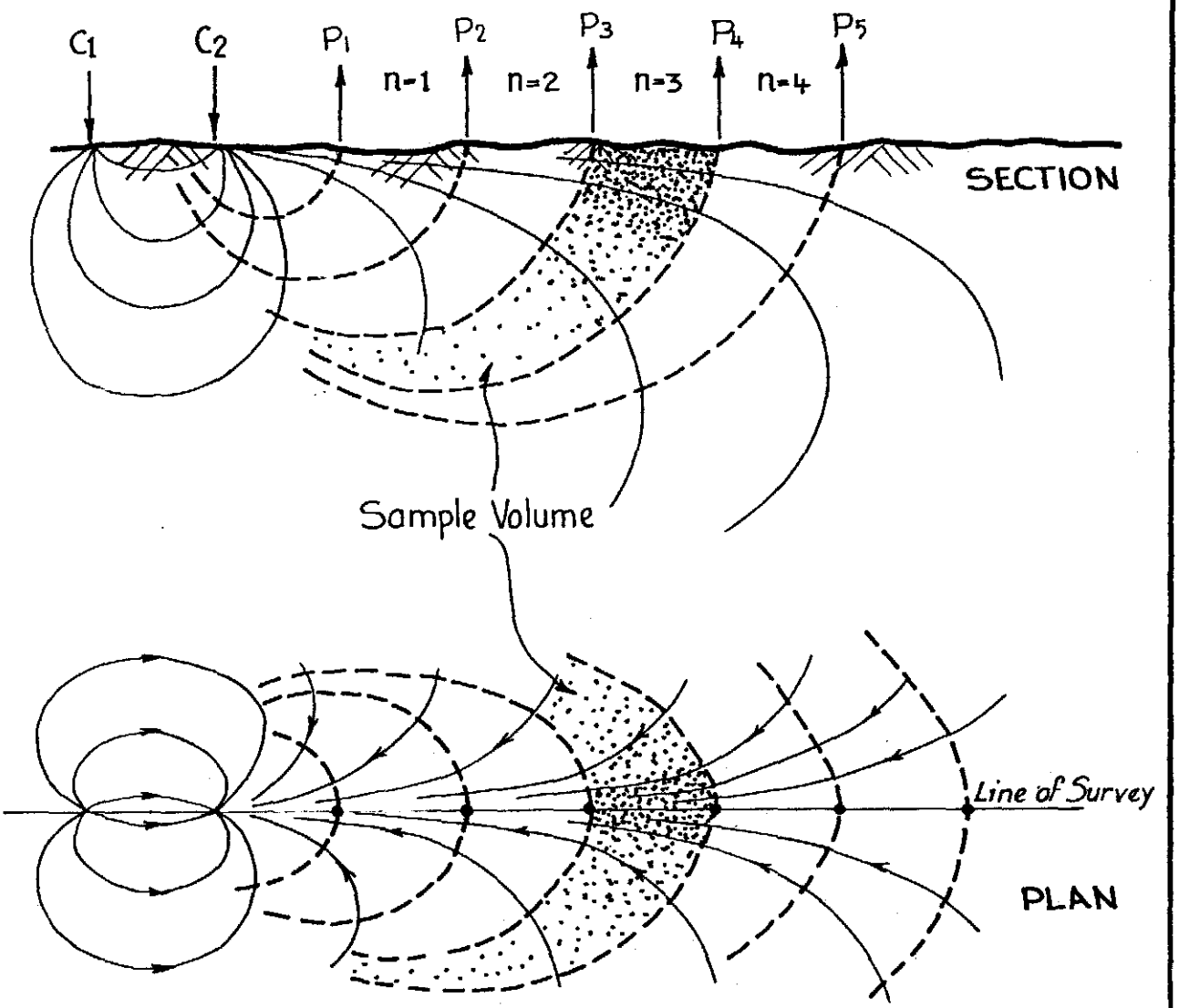

Dipole - Dipole Array
Primary current paths and equipotential field
Showing volumes sampled

FIGURE 3.

between the transmitting dipole C_1 to C_2 and the potential dipole P_1 to P_2. As progressively higher n values are read, a deeper and wider volume of material is sampled, this always being plotted midway between the transmitting and receiving dipole, and at a deeper level in the pseudo-section presentation used in this report. It is *vital* to realise that this data point does not represent the characteristics of the ground at the point plotted, but that of the *total volume* sampled.

A further characteristic of the array is that where the effective spacing ($n \times a$) is greater than the depth to the source, a 'high' (or 'low', depending on characteristics) will occur as each of the dipoles (i.e. transmitting C_1 and C_2, and potential P_1 and P_2) pass over the source of that anomaly. The resultant 45° patterns on the pseudo-section DO NOT represent dip, or even depth extent, but merely represent a complex interface pattern over the source. For a single source, this *double peak effect* can be recognised as it tends to have two maxima displaced by ($n \times a + w$) where w is the width of the source. For multiple bodies this is difficult if not impossible to resolve by dipole-dipole arrays alone.

The enclosed Figure 4 shows the discharge of the energy stored in the body. As can be seen, the area sampled in section is tapped between the equipotentials generated by the discharge of the stored energy. These will not necessarily be of the same form as those for the resistivity data, although they are, for convenience, plotted in the same format as for resistivity. Again, it is vital to note

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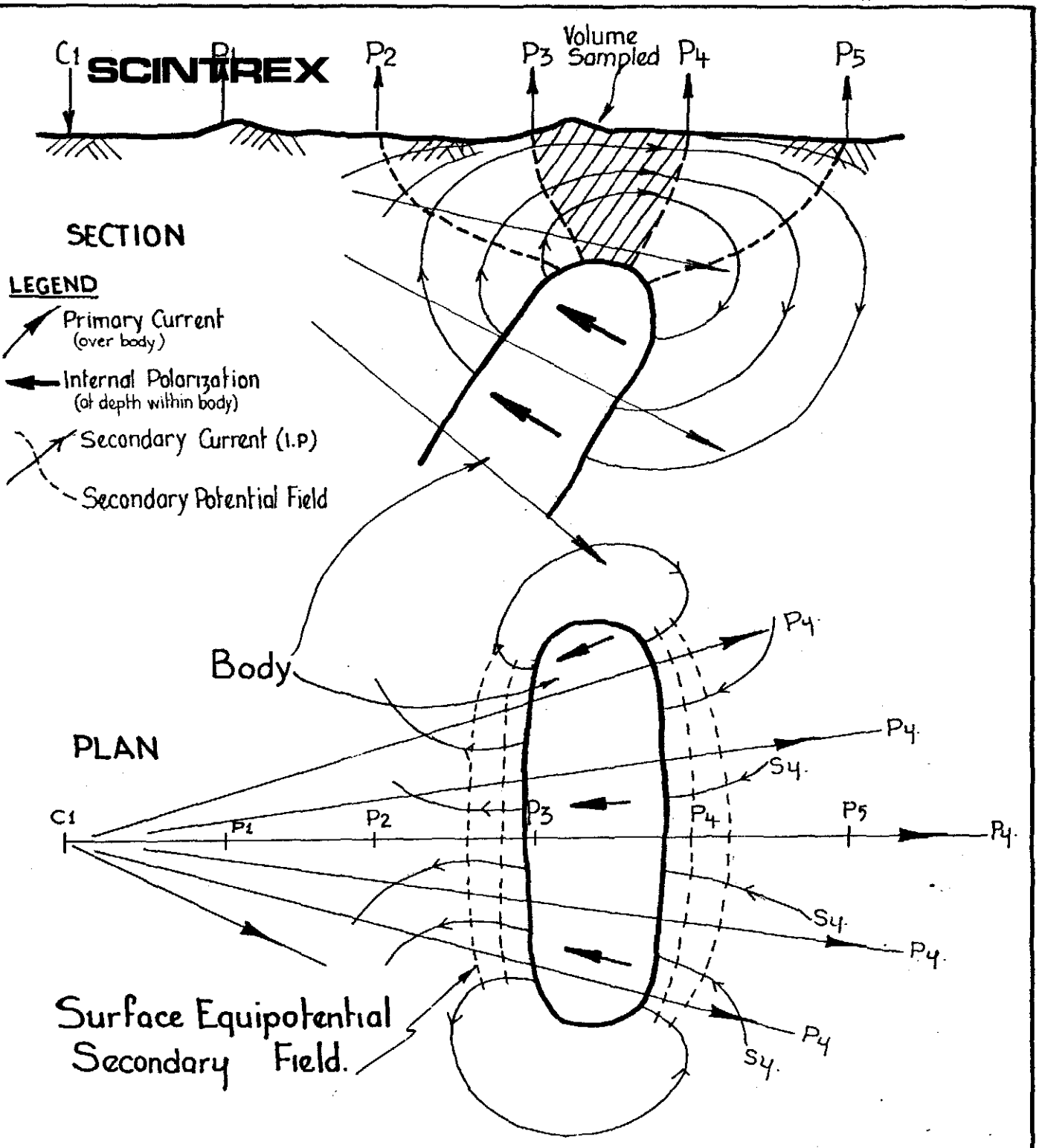

Current path and secondary equipotential field due to discharge of stored energy (I.P. effect) in the case of Pole-Dipole or Dipole-Dipole.

FIGURE 4.

that they represent the volume sampled as shown in Figure 4, *and not* the characteristics of the point at which they are plotted. Double peaks also occur as each of the two sets of electrodes pass over a source, where $n \times a$ is greater than the depth to source. Where $n \times a$ is less than the depth to source, a single maximum will be produced midway between the energising and measuring dipoles C_1/C_2 and P_1/P_2.

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Depth to Source:- The depths to source are always taken normal to local slope for both arrays.

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TABLE 1
(Table 3.1)

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SCINTREX Comparison of IP Survey Electrode Arrays

(after Sumner, 1972)

	Advantages	*Disadvantages*	Survey Speed	Signal to Noise	EM Coupling Rejection
Parallel Field Arrays Wenner	Anomalies symmetrical Synchronous detector possible Many case histories available	Requires more wire: larger field crew Poor resolution Unfavourable in capacitive coupling situations	Fair	Good	Fair
Schlumberger	Symmetrical array Synchronous detection possible Fewer men required Works well in layered earth Type curves available	Less horizontal resolution Unsuitable for horizontal profiling Capacitive coupling possible	Fair	Fair	Fair
Gradient	Map interpretation easier Less masking by conductive overburden Penetration good; safer Communications easier Can use two or more receivers Less topographic effect Data easily contoured in plan Useful where difficulty in making good current contacts	Poor resolution with depth Poor in low resistivity areas Geometric factor varies complexly	Good	Fair	Poor
Potential-About-a-Point					
Three-Array	Good reconnaissance array Fairly good resolution	Asymmetrical More wire needed	Fair	Good	Good
Pole-Dipole, Collinear	Good resolution Good subsurface coverage	Asymmetrical Asymmetrical	Fair	Fair	Fair
Perpendicular Three-Array, Pole-Dipole, Pole-Pole	Virtually eliminates EM coupling	More wire needed	Fair to Poor	Fair	Very Good
Pole-Pole (Two-Array)	Smaller crew needed Less wire needed than for some arrays Good penetration in nonconductive overburden	Susceptible to masking by conductive over-burden	Good	Fair	Poor
PDR (Potential Drop Ratio)	Sensitive to lateral variations "*Common mode*" noise rejection	Complex interpretation	Fair	Good	Fair
Dipole Field Array					
Dipole-Dipole Collinear	Symmetrical, good resolution Good penetration Less survey wire needed	Slow unless equipment is portable Resistivity topographic effects Interpretation somewhat involved	Fair	Poor	Fair
Dipole-Dipole, Parallel	Special use for EM coupling interpretation	Not used for routine surveying	Poor	Poor	Fair
Down-the-Hole Arrays					
Azimuthal Array (One Potential Electrode Down the Hole)	Fair for exploration purposes Useful in finding the best search direction	Interpretation complex Negative anomalies Strong geometric effects Mainly measures changes in resistivity	Fair	Good	Good
Radial Array (One Current Electrode Down the Hole, mise-à-la-masse)	Good for exploration purposes Useful in finding the best search direction Hole need not stay open	Interpretation complex Negative anomalies Not good for obtaining rock properties	Fair	Good	Good
In-Hole Arrays (More than One Electrode in the Hole)	Good for obtaining rock properties Good for assaying Interpretation simple	Current densities may be too large Possible capacitive coupling problems Not designed for exploration purposes Special equipment, expensive	Good	Fair	Good

Extract from: Geological Survey of Canada - Paper 75-31 "Borehole Geophysics Applied to Metallic Mineral Prospecting: A Review"

083

120079

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 5·6·79		LINE No. 5,386900 N
PLOTTED BY DJTW		PROSPECT BULGOBAC
PULSE 2 sec	Rx.	JOB No. TAS-065-D
DIPOLE SPACING 100 m		

8500E 8600E 8700E 378,800E 8900E 9000E 9100E

RESISTIVITY Ωm.

N-1: 918 1215 1760 2092 5183 2851 1617 1226

N-2: 1056 1587 2926 3122 3266 3358 2550 2715

N-3: 1484 3063 4429 4351 2142 2566 2591 3675

N-4: 2629 4461 3011 3612 1737 3506

CHARGEABILITY

N-1: 11·5 7·3 7·7 7·2 11·7 10·5 14

N-2: 6·3 12·1 8·8 6·8 6·8 12 10·2 10·4

N-3: 6·3 13·6 8·1 8·3 10·8 10·1 11·2 11·3

N-4: 8·1 12·8 12 11·3 10·4 11·2

5 cm

084

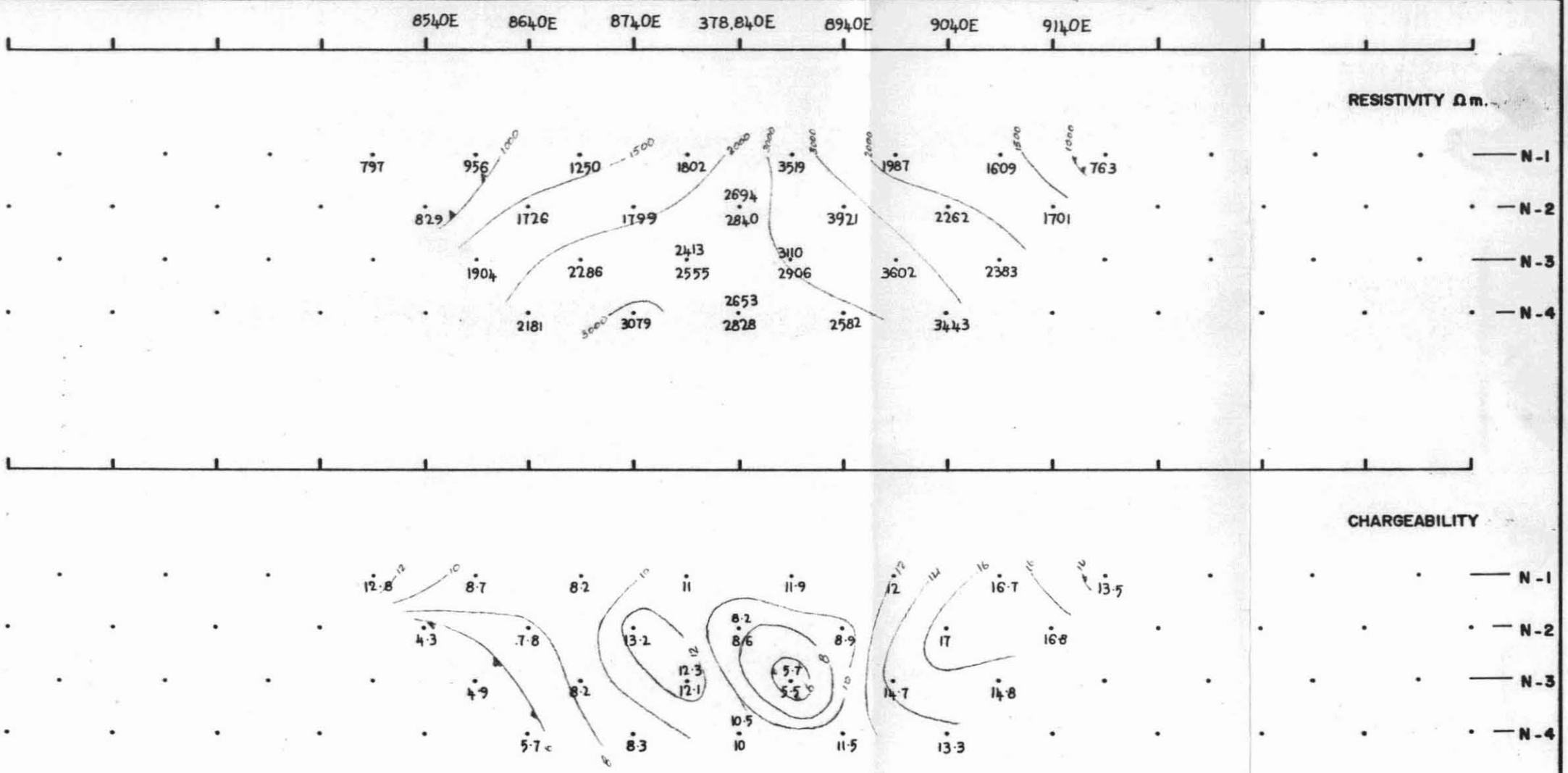
120080

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 4·6·79	LINE No. 5,387,100 N
PLOTTED BY DJTW	PROSPECT BULGOBAC
PULSE 2 sec / Rx.	JOB No. TAS-065-D
DIPOLE SPACING 100 m	



5 cm

085

120081

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 4·6·79 / 5·6·79		LINE No. 5 387 300 N
PLOTTED BY DJTW		PROSPECT BULGOBAC
PULSE 2 sec	Rx.	JOB No. TAS-065-D
DIPOLE SPACING 100 m		

8600E 8700E 8800E 8900E 9000E 9100E 9200E

RESISTIVITY Ω m.

N-1				500	598	978	1828	3477	933	1275	1099	
N-2				741	1500	1167	2743 2784	3438	1825	1752		
N-3				1407	1483	1663 1718	2403 2424	3713	2168			
N-4				1294	2219	1450 1519	2460	4838				

CHARGEABILITY

N-1				10	10·4	10·7	8·5	9	16·5	20	15	
N-2				10·8	10·2	11·1	7·4 7·6	16·6	17·2	16		
N-3				10·6	9·8	9·0 8·4	17·3 18·8	15·3	14·1			
N-4				10·2	7·6	19·0 16·9	13·9	12·8				

5 cm

086

120082

SCINTREX PTY. LTD.

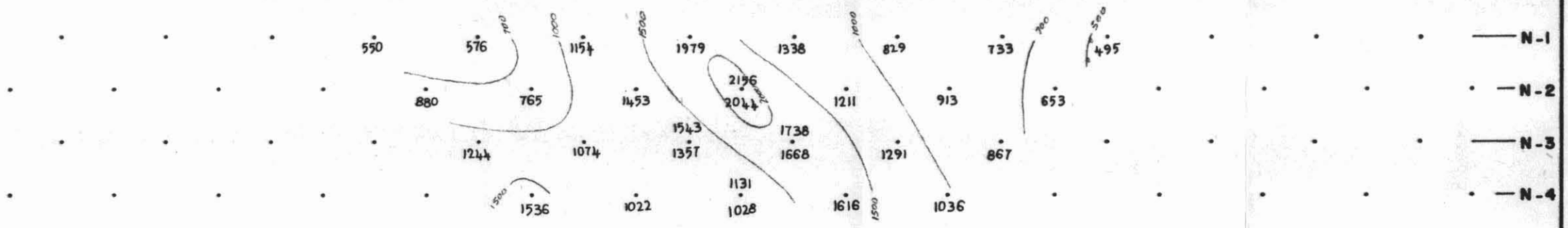
INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

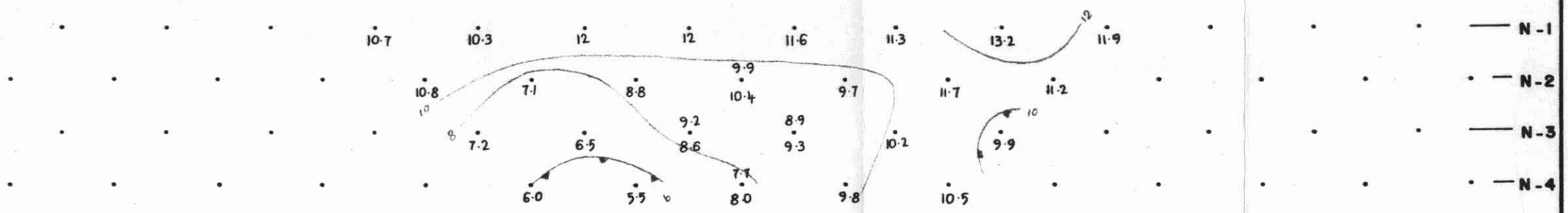
DATE 7·6·79		LINE No. 5,387.700 N
PLOTTED BY DJTW		PROSPECT BULGOBAC
PULSE 2 sec	Rx.	JOB No. TAS-065-D
DIPOLE SPACING 100 m		

760E 860E 960E 379060E 160E 260E 360E

RESISTIVITY Ω m.



CHARGEABILITY



5 cm

087

120083

SCINTREX PTY. LTD.

INDUCED POLARIZATION AND RESISTIVITY SURVEY

DIPOLE - DIPOLE ARRAY

DATE 7·6·79	LINE No. 5, 387, 900 N
PLOTTED BY D.J.T.W	PROSPECT BULGOBAC
PULSE 2 sec. Rx.	JOB No. TAS-065-D
DIPOLE SPACING 100 m	

379,000E 100E 200E 379,300E 400E 500E 600E

RESISTIVITY Ω m.

N-1: 1685 1413 911 1386 553 461 643 411

N-2: 1069 1275 917 550 763 1018 773

N-3: 1085 1010 1074 1058 735 1519 1442

N-4: 1492 819 1087 819 1330 1823

CHARGEABILITY

N-1: 9·9 11·3 9·5 9·8 10·6 10·6 9·9 7·5

N-2: 8·5 6·4 8·7 9·4 12·7 11·7 6·4

N-3: 12·1 6·1 5·0 8·2 11·6 12·7 7·7

N-4: 9·3 8·6 7·4 11·4 12·5 9·1

5 cm

088

120084

APPENDIX 3.

C.M.S. Reports 79/1/16
79/3/29

Thin Section descriptions of hand specimens

FILE BULGOBAC 12/72 44/11G

089

120085

6 copies

Central Mineralogical Services

CMS

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Telephone 42 5659

Mr. D.K. Brock
Manager, West Coast Mines
Electrolytic Zinc Co. of
Australasia Ltd.
P.O. Box 21
ROSEBERY / TAS. 7470

31st January, 1979

REPORT CMS 79/1/16

YOUR REFERENCE:	Order No. 900017
DATE RECEIVED:	15th January, 1979
SAMPLE NOS.:	P 347, P 351, P 380, P 387, P 395, P 457, P 655, P 668, P 669, P 671, P 672, P 673, P 674, P 675
SUBMITTED BY:	J. Mill
WORK REQUESTED:	Petrology

for

H.W. Fander, M. Sc.

120086

090

REPORT CMS 79/1/16

Notes:

The bulk of this suite are volcanics of quartz trachytic (essentially quartz-poor rhyolites) composition, grading into rhyolitic types. This group includes lavas (P 347, 351, 387, 668), tuff lavas (P 395, 457), and pyroclastic types (P 380, 669, 675) with certain ignimbritic features. Alteration is not marked. A sub-aerial origin appears likely for this group as a whole.

A subordinate group of subaqueous tuffs and tuffaceous sediments comprises P 671, 673 and 674. These include some non-pyroclastic components, but the bulk of clastic material can be correlated with Mount Read-type volcanism and it appears the contact (with underlying lavas, tuffs) reflects a change from sub-aerial to sub-aqueous modes of deposition rather than a break in volcanism.

A third group, represented by specimens P 655 and 672, is understood to show intrusive relationships with P 671, etc. These are unusual, sandy-textured clastic rocks with similarities to P 671 and particularly 673 and 674, but characterised by a relatively basic assemblage including abundant hornblende (655) and augite (672). On textural grounds, these cannot be considered as orthodox (i.e. igneous) intrusives, but may represent a sandstone dyke-type paragenesis perhaps associated with an as yet unrecognised andesitic phase.

D. Cowan, B. Sc.

091

120087

REPORT CMS 79/1/16

Petrological Descriptions

P 347 (T.S. 26604) K-stain Positive.
This is a mildly altered porphyritic lava, best categorised as a quartz trachyte.

Boco Grid
12280N 10540E

Major features comprise single and clustered phenocrysts of albite (to 1 mm) and a weakly recrystallized felsitic (devitrified) fine-grained groundmass of albite, K-feldspar and accessory quartz. Sparse recrystallized microphenocrystal grains (to 150 μ) of quartz are present and rare clots (to 200 μ) of extensively chloritised phlogopite appear to represent completely altered microphenocrystal amphibole. Minor accessories include leucoxenised opaques, traces of zircon and very rare apatite.

Quartz veinlets (+ albite, phlogopite) are common and range up to 400 μ in width. The groundmass is weakly but pervasively stained with ultrafine phlogopite flakes which are extensively replaced by chlorite. The rock has been incipiently stressed. Weak Fe-staining reflects degradation of phlogopite and chlorite.

P 351 (T.S. 26605) K-stain positive.
This is an amygdaloidal porphyritic quartz trachyte, mildly altered and rather similar to P 347. In comparison, it is slightly more glomeroporphyritic and relatively potassic.

Boco Grid
12600N 10910E

Phenocrysts are mainly albite (to 1 mm, clusters to 2 mm) with minor altered ?amphibole and spare microphenocrystal quartz (recrystallized) These features are accompanied by frequent small (to 500 μ) amygdales of quartz (+ chlorite), which are weakly flow-orientated in a felsitic-microcrystalline groundmass of alkali feldspar and accessory quartz.

Alteration is marked by weak but semi-pervasive development of phlogopite with subordinate sericite. Feldspar phenocrysts may be weakly epidote-stained. Phlogopite is extensively chloritised and the rock is incipiently stressed.

Minor (primary) accessories comprise leucoxenised opaques, apatite, traces of magnetite and very rare zircons.

P 380 (T.S. 26606) K-stain weakly positive.
This is a mildly altered and partly recrystallized/weakly sheared lithic-vitric-crystal tuff. The rock is of quartz trachytic affinities (i.e. sim. P 347, P 351), but relatively siliceous and trending towards a rhyolite.

AMG 5385000N
383820E

Much of the rock consists of weakly banded micro-felsite and much of the finer textural detail has been obliterated by devitrification and partial recrystallization. However, microscopic shards (mean 20-25 μ) persist in places and are reasonably inferred elsewhere The crystal component comprises 10-20 % of the rock with albite (to 1.5 mm) accompanied by subordinate sanidine-anorthoclase (to 750 μ and accessory quartz (to 450 μ). Poorly defined porphyritic lava clasts (to 2.5 mm) are sparsely disseminated throughout. The fabric is compact and suggestive of a sintered (or possibly welded) tuff.

Alteration comprises weak but pervasive staining with chlorite, sericite and dolomitic carbonate. These phases were introduced in par along microscopic fractures (perlitic in part, locally stylolitic). The partial recrystallization reflects incipient metamorphism.

P 387

AMG 5388470N
383200E

(T.S. 26607) K-stain positive.
This rock is an altered amygdaloidal porphyritic quartz trachyte with similarities to P 347 and particularly P 351.

Phenocrysts comprise around 20-25 % of the sectioned area and are fairly evenly distributed with a weak tendency to clustering (glomerophenocrysts to 2.5 mm). The majority are albite with relatively minor sanidine-anorthoclase, minor traces of altered ?amphibole (shapes are typically non-diagnostic) and rare recrystallized quartz.

The groundmass comprises felsitic K-feldspar enclosing random ultrafi albite microlites and occasional, partly recrystallized quartz microspherulites. Random to weakly flow-orientated amygdales (to 1.2m of quartz, green biotite and accessory amorphous clay are common throughout. Accessories comprise leucoxenised opaques, rare zircon and very rare apatite.

Feldspar phenocrysts are weakly but pervasively stained with sericite and pale green phlogopite-biotite. The groundmass is similarly altered. Biotite semi-pseudomorphs the ferromagnesian (?amphibole) phenocrysts and occurs with quartz in the amygdales.

P 395

AMG
5,392,250N
384 870E

(T.S. 26608) K-stain positive.
This rock is a flow- or autobrecciated rhyolite and best categorised as a tuff lava.

The rock consists essentially of angular to sub-angular clasts (< 1-5 mm) of glassy, porphyritic, rhyolitic lava, partly moulded onto one another and embedded in a texturally and compositionally similar lava matrix (approx. 50 %). Clasts tend to be flow-orientated and the matrix shows a locally contorted microscale flow-banding as do many clasts.

The rock is a sodi-potassic variety with sericite-stained phenocrystal albite, corroded quartz and sparse, completely silicified ?sanidine-anorthoclase in a relatively potassic groundmass. Phenocrysts are partly fragmented due to viscous flow, but the rock as a whole lacks strictly pyroclastic features and probably represents a flow-marginal (?flow-top) breccia.

Apart from sericitisation and silicification of phenocrystal feldspar, alteration is not marked. Patchy sericite and chlorite occurs in small clots in the devitrified groundmass/matrix. Patchy Fe- and Mn-staining is related to late weathering-induced microfractures.

This rock is relatively siliceous (in terms of phenocrystal quartz) and is distinctly rhyolitic in comparison with P 347, 351, 380 and 387.

P 457 (T.S. 26609) K-stain positive.
This rock is a mildly altered hybrid tuff lava of quartz trachytic affinities.

AMG
S 384 180 N
380 040 E

Clasts comprise 30-40 % of the area sectioned with amean diameter about 750 μ (max. 4 mm), angular to subrounded shapes and a moderate flow-orientation. These features contain phenocrysts of albite, subordinate sanidine-anorthoclase and rare (recrystallized) quartz in a pale felsitic quartzofeldspathic groundmass with random to weakly orientated albite microlites.

In contrast, the matrix lava is relatively sodic with albit-e phenocrysts and an albite-rich microlitic groundmass, which may be subtrachytic to trachytic. This phase is preferentially chlorite-stainc and appears relatively dark in hand specimen.

Small quartz- (± chlorite) infilled vesicles are disseminated throughou the rock along with accessory leucoxenised opaques and traces of magnetite.

Textural and compositional evidence indicate this rock to represent an intermingling of two similar but slightly compositionally different lavas. Hybrid lavas of this type are unusual but not particularly uncommon.

P 655 (T.S. 26610) K-stain weakly positive.
This is an unusual rock with little to choose in terms of classificatic between an indurated lithic-crystal tuff and a tuffaceous sandstone.

AMG
S 388 600 N
377 900 E

The rock has a distinctly sandy fabric with an angular, poorly-sorted framework comprising around 65 % of the area sectioned. Sizing is in the silt to grit range (i.e. < 65 μ - 2 mm +) and essentially random with a faint dimensional preferred orientation, outlining "bedding". Major components are albite (60-70 %), quartz (10 %) and green-brown amphibole (10-20 %). Accompanying these are trachytic and quartz-

trachytic lava clasts (sim. P 347, etc.), clastic grains of magnetite, rare apatite, and occasional clasts of chloritic greenschist metasiltstone and K-feldspar.

The matrix consists of microcrystalline quartzofeldspathic material, more or less pervasively stained with chlorite. Clastic feldspar and lava fragments are weakly but variably chloritised, but the hornblende is relatively fresh.

The rock cannot be interpreted as an orthodox igneous intrusive phase. It may represent an intrusive breccia with re-worked Mount Read Volcanic components, and could be considered as a sandstone dyke dependant on field relationships.

P 668

(T.S. 26611) K-stain weakly positive.
This is a perlitic devitrified pitchstone of felsic intermediate character and reasonably correlated with the accompanying Mount Read Volcanics.

AMG
5 392 680 N
386 840 E

The rock is incipiently porphyritic with the sectioned area including a single sericite-stained albite phenocryst (350 μ) and a single quartz-semi-pseudomorphed ?sanidine-anorthoclase microphenocryst. The remainder comprises almost entirely perlite-microstructured felsi Sparse fine-scale quartz amygdales are present and leucoxenic TiO_2 is pervasive in small clots.

The rock has a faint flow fabric. Incipient stress is reflected in strained extinction in the amygdale quartz. Felsite is more or less pervasively stained with cloudy argillic material in response t weathering.

P 669

(T.S. 26612) K-stain negative.
This rock is a devitrified, weakly but pervasively sericitised, and incipiently sheared vitric-crystal tuff. It is of felsic intermediate-acid character and reasonably correlated with the Mount Read Volcanics.

5 393 760 N
386 920 E

The rock consists largely of fine-grained felsitic quartzofeldspathic material with semi-pervasive random to weakly orientated relict microshard textures (mean 20-25 μ). Small crystals and crystal fragments (mean 150 μ) of albite and quartz comprise 10-15 % of the rock and are weakly banded in their distribution. A few vague devitrified lithic clasts (to 750 μ) are present and these may reflec flow- or autobrecciation. The rock as a whole has a certain, but indefinite, ignimbritic character.

Sericite is accompanied by minor traces of chlorite. Late discontinuous quartz veinlets occur sporadically. Accessory leucoxenic TiO_2, partly crystallized as ultrafine anatase, is accompanied by traces of magnetite.

P 671 (T.S. 26613) K-stain negative.
This rock is a polymict silty fine- to medium-grained lithic sandstone

5 388 400 N
377 700 E

The framework (approx. 60 %) is poorly to moderately sorted and weakly bedded with angular to subround grain shapes. Major components are single and composite quartz grains (around 50 %), rock fragments (mainly greenschist pelite, including carbonaceous types, subordinate felsic lava, fine-grained metaquartzite, total 25 %), and mica flakes (10-15 % muscovite, subordinate degraded biotite). Accessories include splintery to angular albite and a heavy mineral assemblage (3-5 %) of leucoxenic semi-opaques with traces of zircon, tourmaline and apatite.

The matrix/cement comprises crypto- to microcrystalline clay and weakly Fe-stained argillaceous matter (?kaolin). The rock is essentiall unmetamorphosed and appears incompletely consolidated, although the finer detail is masked by partial weathering.

Lava clasts and many quartz grains represent a re-worked intermediate-acid volcanic component and are reasonably correlated with the Mount Read Volcanics, as reflected in accompanying specimens (similarly the feldspar, a few grains of which may represent devitrified/partly abraded shards). The remaining framework components largely reflect a fine- to medium-grained greenschist metasedimentary source.

P 672 (T.S. 26614) K-stain weakly positive.
This rock is similar and clearly related to P 655 and is best categorised as a tuffaceous sandstone. As previously, it may represent a "sandstone dyke" if intrusive relationships are confirmed in the field.

5 388 900 N
377 440 E

The rock isweakly banded with angular to subangular framework particles (60-65 %), showing a weak dimensional preferred orientation, parallelle by subtle variations in grainsize. Sorting is in the fine sand to grit range and slightly coarser in comparison with P 655. Major components are saussurite-stained plagioclase (50-70 %), fresh green augite (10-20 %), and magnetite (5-10 %). Accompanying these are sporadic lava clasts (sim. P 347, etc.), grains of green-brown hornblende (sim. P 655), pelitic rock fragments and partly fragmented volcanic quartz crystals.

The matrix consists of very fine chlorite, saussuritic material, patchy crypto- to microcrystalline feldspar, and traces of pyrite. Lava clasts are variably chloritised, but ferromagnesian components (amphibole, pyroxene) are essentially fresh. Some lava clasts are relatively basic (andesitic) types and the rock as a whole is more basic than P 655.

P 673. (T.S. 26615) K-stain weakly positive.
On petrological grounds, this rock is best interpreted as a subaqueous tuff. There are a few non-volcanic components, but little evidence of re-working.

5 389240N
377 050E

The framework (60 %) is poorly to moderately sorted in the silt to grit range and bedded on a coarse millimetric scale with an incipient grading. The major clastic component is angular feldspar grading from andesine (minor) to albite (major), with accessory traces of sanidine-anorthoclase partly pseudomorphed by quartz. Subordinate, partly fragmented volcanic quartz (5-20 %) is present. Accessories include clasts of trachyte (sim. P 347, etc.), metaquartzite, metapelite, leucoxenised opaques, magnetite and mica (muscovite, pale phlogopite).

The matrix consists of fine-grained Fe-chlorite and microcrystalline quartzofeldspathic material in varying proportions. Lava clasts are devitrified and variably chloritised, but the clastic feldspar is relatively fresh.

Excluding the non-volcanic components, which show subrounded detrital shapes, grain shapes are angular with, for example, euhedral feldspar grains and occasional devitrified shards. These tend to confirm a primary pyroclastic origin for the rock as a whole.

P 674 (T.S. 26616) K-stain weakly positive.
This is an altered subaqueous tuff with similarities to P 673.

5386230N
379 ~~050~~E
Ref Book

The framework (50-65 %) is angular, bedded on a millimetric scale, locally graded, and locally slumped. Sorting is in the silt to medium sand range with an alternation of silty fine sand and medium-grained bands. Weakly saussurite-stained albitic feldspar is the major clastic component (70-80 %) with subordinate to minor quartz, K-feldspar, trachytic lava clasts and leucoxenised opaques. Apart from rare chert fragments, there are no non-volcanic components. Finer-grained bands appear to consist in part of devitrified and partly abraded shards and there is thus some evidence of incipient re-working.

The matrix comprises crypto- to microcrystalline quartzofeldspathic material, variably stained with chlorite and microgranular epidote. Quartz veins with selvedges of albite and traces of epidote occur sporadically and irregular patches of secondary chlorite, quartz and albite are disseminated throughout the rock.

P 675 (T. S. 26617) K-stain positive.
This is a devitrified and mildly altered quartz trachytic (trend rhyolitic) vitric-crystal tuff. There is evidence of flow- or auto-brecciation and an ignimbritic origin is considered likely, although devitrification has obliterated much of the finer textural detail.

S 386 230 N
379 050 E

Crystals (to 5 mm) and fragments of sanidine-anorthoclase with subordinate albite and accessory quartz comprise 10-20 % of the rock. These features are embedded in a microcrystalline matrix of albite and quartz with a semi-pervasive microscale flow-banding and patchy, lineated relict shard textures (mean 10-15 μ). Angular clasts (to 7.5mm occasionally with identifiable shards, are disseminated throughout and, locally, these have the appearance of collapsed pumice.

Patchy chloritisation is evident and feldspar crystals are moderately sericitised. Accessory leucoxenic semi-opaques are present.

D. Cowan, B. Sc.

120094 FILE BULGOBAC 44/11 G

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6 copies

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Mr. John H.A. Mill
Senior Geologist
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9th April, 1979

REPORT CMS 79/3/29

YOUR REFERENCE: E-Z Order No. 900027

DATE RECEIVED: 21st March, 1979

SAMPLE NOS.: P 676, 677, 678, 680, 681, 682, 758, 759, 762, 763, 764, 766, 767, 770, 771, 775, 776, 777, 778, 779, 780, 781, 782, 783, 785, 786, 787, 788, 789 } FILE 13720

SUBMITTED BY: John H.A. Mill

WORK REQUESTED: Petrology

H.W. Fander.

H.W. Fander, M. Sc.

099

REPORT CMS 79/3/29

Petrological Descriptions

P 676

(T.S. 27157) K-stain negative.
This rock is an extensively altered microgabbro or more specifically a quartz micronorite. It is unstressed and reasonably related to the Jurassic dolerites of N.W. Tasmania.

AMG
5 392 020 N
388 560 E

The rock is fairly even-grained (mean 200 μ) with a weakly subophitic fabric. Major constituents comprise completely saussuritised/albitised plagioclase with subordinate fresh diopsidic augite and completely altered orthopyroxene in roughly equal proportions. Accessories comprise abundant very fine leucoxenised opaques, traces of apatite, and sparse interstitial quartz.

Orthopyroxene is pseudomorphed by "serpentinous" clay (chlorite, montmorillonite). The fine-grained saussuritic material includes prehnite and zoisitic epidote. Alteration, overall, is of distinctly deuteric character. Extremely rare, very fine pyrite particles were present. The rock is moderately weathered and Fe-stained.

P 677

(T.S. 27158) K-stain weakly positive.
This rock is a devitrified, altered and mildly sheared rhyolitic lithic-vitric-crystal tuff of ignimbritic character and weakly xenolithic.

AMG
5 392 530 N
388 490 E

The pyroclastic material is poorly sorted and weakly to distinctly orientated. Sizing is in the < 100 μ - 2.5 mm range and random. Major components comprise more or less completely sericitised angular lithic clasts (originally glassy, variably flow-banded, rarely microlitic, occasionally quartz-porphyritic, possibly some flattened pumice), silt- to medium sand-sized quartz and subordinate feldspar crystals/crystal fragments and abundant, fairly evenly sized (mean 75 μ) shards.

Feldspar grains (albite, subordinate K-spar) are unalteredto weakly sericite- and carbonate-stained. Shards are devitrified to micro-crystalline quartzofeldspathic material, weakly but variably stained with sericite. Fine-grained sideritic carbonate is common in irregular aggregates and discontinuous films. Fine-grained pyrite is sparsely, but more or less evenly, disseminated throughout.

This rock includes sparse xenolithic clasts of carbonaceous matter and carbonaceous pelite.

P 678

(T.S. 27159) K-stain weakly positive.
This rock is an incipiently sheared carbonaceous sandy argillaceous siltstone, strongly tuffaceous and weakly pyritic.

AMG
5 389 860 N
384 800 E

The rock is weakly bedded, very poorly sorted and shows some evidence of slumping. The framework (50-60 %) consists largely of angular quartz and alkali feldspar grains, accompanied by a variety of lithic clasts (devitrified felsic lava, vitric tuff, impure chert, metaquartzite, carbonaceous shale) and silt-sized white mica flakes and variably abraded shards. Accessories include altered biotite flakes and a sparse heavy mineral assemblage of leucoxenic semi-opaques and rare zircon. The matrix consists of argillaceous material, incipiently recrystallized/orientated, with intergrown microcrystalline quartz and is weakly, but pervasively, stained with ultrafine carbonaceous matter.

Clastic feldspathic material is weakly sericitised and locally overgrown with thin films of adularia. The bulk of this material is angular and primarily pyroclastic, although the shards show some evidence of re-working.

Ultrafine pyrite is weakly, but pervasively, disseminated throughout the rock. Tectonic effects are not marked with partial recrystallization of the matrix and partial re-organisation of carbonaceous matter into semi-continuous films.

P 680

AMG
5391410N
386580E

(T.S. 27160) K-stain weakly positive (sericite).
This is a devitrified and pervasively sericitised porphyritic lava, probably a dacite, although primary feldspar composition is obscure.

Sericite pseudomorphs of feldsparphenocrysts (to 750 μ) are disseminated throughout and several of these show faint relict plagioclase twinning. These features are accompanied by similarly-sized sericitic, angular to subangular amygdales, often with discontinuous marginal zones of fine-grained quartz crystals and show a faint preferred orientation. The enclosing altered groundmass consists of felsitic anhedral quartz stained with sericitised feldspar microlites and accessory fine-grained leucoxenised opaques.

Quartz phenocrysts are absent and this confirms the essentially intermediate nature of the rock. There is no real evidence of shearing.

P 681

AMG
5391180N
387100E

(T.S. 27161) K-stain weakly positive.
This rock is a sandy to pebbly tuffaceous argillaceous siltstone, weakly carbonaceous and pyritic and closely related to P 678.

General features are analogous to those of the previous specimen to the extent that little special comment is warranted. In comparison, however, this sediment is even more poorly sorted with sporadic angular, heavily chloritised megaclastsof porphyritic rhyolite (to 1 cm +). Faint slumped bedding is defined by a weak dimensional preferred orientation of the clastic particles. Altered (sericitised, leucoxene-stained) clastic flakes of biotite and carbonaceous shale fragments are relatively abundant accessory constituents.

The rock is relatively strongly weathered and more or less pervasively iron-stained. Stereobinocular examination, however, reveals relicts of carbonaceous matter, partly concentrated into microscopic films similar to those in P 678. Fe-staining results, at least in part, from oxidation of ultrafine "syngenetic" sulphide.

P 682

AMG
S 390 710N
396 470E

(T.S. 27162) K-stain negative.
This is a devitrified and altered sandy pelitic ash, that is, a very fine-grained tuff. Rocks of this type are often misinterpreted as cherts in the field. There are analogies, for example, with the "tuff marker beds" at Mount Isa.

The rock consists largely of chlorite-stained microcrystalline quartzofeldspathic material with faint, but pervasive, relict microshard textures (mean 10-15 μ). Silt-sized quartz and albite particles are thinly dispersed throughout, along with sporadic megaclasts (to 3 mm including feldspar crystals and poorly resolved (albitised, chloritised) lava clasts. Thinly disseminated clastic white mica and carbonaceous flakes (?graphite) represent the only tangible non-pyroclastic components. The rock is incipiently bedded and subaqueous deposition is inferred.

Chlorite is a Fe-Mg variety and locally oxidised with resultant Fe-staining of the rock as a whole. There is no evidence of sulphides.

P 758

AMG
S396 760N
307 670E

(T.S. 27163) K-stain negative.
This rock is a devitrified, altered and incipiently sheared porphyritic rhyolite.

Phenocrysts comprised 15-20 % of the rock and were of weakly banded distribution. Typical, partly resorbed inverted beta quartz persists. This phase shows characteristic cracking patterns and the coarser grains (to 3.8 mm) have been fragmented in situ during late viscous flow. Phenocrystal feldspar is represented by vaguely pseudomorphous, variably leached patches of clay (?kaolin), appearing as cavities in thin-section.

The groundmass is highly siliceous and faintly flow-banded. The bulk comprises microgranular quartz with faint relict felsitic and micro-spherulitic structures. Sericite is semi-pervasive, variably orientated and, in places, forms vague, leucoxene-stained pseudomorphs after microphenocrystal biotite flakes (biotite rhyolite).

Quartz phenocrysts tend to be selvedged by zones of relatively fine-grained quartz. This is a granophyre-like textural feature and suggests the rock may have been an intrusive phase.

P 759 (T.S. 27164) K-stain weakly positive (sericite).
This rock is a devitrified, altered and deformed fragmental rhylite. Primary details are partly obliterated by a late phase of brecciation and shearing, but relict features suggest the rock should be classified as a lithic-vitric-crystal tuff.

AMG
S 396 730 N
387 780 E

Mineralogically, the rock consists virtually entirely of quartz and sericite with relatively minor accessory leucoxenised opaques and traces of chlorite. Texturally, it has the fabric of a sheared breccia with poorly sorted clasts of rhyolite, often poorly defined, accompanied by variably fragmented volcanic quartz crystals in a poorly resolved, relatively sericitic matrix. Deformed quartz veinlets are evident locally and the bulk of alteration (silicification, sericitisati predated the semi-brittle deformation.

The rhyolite clasts show a variety of textures ranging from porphyritic lava to distinctly fragmental types with a vaguely shard-textured matrix. Overall, there is little doubt the rock represents a brecciated tuff. There are similarities, in terms of the alteration pattern, with P 758 and there is some evidence of minor accessory altered biotite flakes. The sectioned area includes rare oxidised pyrite particles.

P 762 (T.S. 27165) K-stain negative.
AMG
S 396 640 N
387 850 E
This is an altered and mildly stressed sandy-textured lithic-vitric-crystal tuff of biotite rhyolitic affinities and thus evidently closely related to P 758 (and 759).

The bulk of clastic material comprises angular to subangular quartz and poorly resolved altered lithic clasts. Subordinate, completely sericitised angular feldspar is present and the matrix (approx. 40 % of the rock) clearly consists in part ofshards. Accessories include sparse biotite flakes (sericitised, leucoxene-stained) and fine opaques. Sorting is in the silt to coarse sand range, with the bulk in the fine to medium sand fraction.

Lithic clasts appear to have been largely microcrystalline to glassy lava fragments, occasionally microporphyritic.These features are altered (sericitised, silicified) to the extent of poor resolution against the similarly altered matrix. Some of the few clearly identifiable shards show some evidence of abrasion and this tuff may have been mildly re-worked.

Much of the sericite is weakly stained with partly oxidised chlorite. Sideritic carbonate is an accessory alteration phase and is similarly partly oxidised. Minor fine-grained pyrite is present.

P 763 (T.S. 27166) K-stain negative.
This is a devitrified, altered and weakly sheared rhyolitic lithic-vitric-crystal tuff. Of previous specimens, the rock is most clearly related texturally to P 677 and it is similarly considered as ignimbritic. In comparison, it has a more distinctly directed fabric and there is some evidence of flow- or autobrecciation.

AMG S 396 590N 387 840E

The rock consists largely of variably carbonate- and sericite-stained lithic clasts with flattened angular shapes, partly moulded onto one another, and sized in the 500 μ - 3 mm range. These features are typically finely flow-banded, consist largely of microcrystalline quartzofeldspathic material (microfelsite, i.e. devitrified), and range from quartz- or rarely feldspar-porphyritic lavas to clearly fragmental types with relict eutaxitic microtextures and rare pumiceous types. They are accompanied by crystals (to 1.2 mm) and fragments of quartz and accessoryalbite in a similarly altered matrix with semi-pervasive, lineated, devitrified shards (mean 50 μ).

Some of the more featureless lithic clasts may represent collapsed pumice and the fragmental types probably reflect in situ flow-brecciation. In common with P 677, this rock includes sparse xenolithic fragments of carbonaceous pelite, along with rare fragments of pyritic siltstone. The sectioned area includes a single deformed and partly degraded biotite flake (possibly xenocrystal).

The semi-pervasive carbonate is an ankeritic variety and, although it is rather fine-grained and forms spongy aggregates, it is semi-lustre mottled. Sericite grades from muscovite to a distinctly greenish hydromuscovite. This rock is weakly pyritic.

P 764 (T.S. 27167) K-stain weakly positive (sericite).
This rock is a devitrified, extensively altered and mildly sheared porphyritic rhyolite, possibly an intrusive and conceivably related to P 758.

AMG S 396 360N 388 100E

Variably flow-orientated phenocrysts comprise around 60 % of the area sectioned. Variably corroded "high" quartz (inverted, but with characteristic cross-sectional shapes), sized to 3 mm, is accompanied by virtually completely sericitised feldspar in roughly equal proportions. Accompanying these are occasional small leucoxene-stained clots (to 250 μ) of sericite afteracorroded, titaniferous, microphenocrystal phase, probably titan-amphibole in the absence of biotite-derived sectional shapes.

The groundmass consists of heavily sericitised microfelsite with a faint relict flow fabric and a coarse perlitic structure, outlined by films of sericite. Accessory leucoxenised opaques are present and there are occasional clay-infilled vesicles.

Fe-carbonate was an accessory alteration phase with sericite replacing feldspar phenocrysts, but is completely oxidised and is represented only by limonitic stainings. These aggregates also include sparse, extremely fine-grained oxidised pyrite.

The coarse and abundant phenocrysts in this rock suggest an intrusive origin despite the originally glassy flow-structured groundmass.

P 766 (T.S. 27168) K-stain negative.
This is a problematical rock in terms of classification. It has the appearance of a sandy-textured lithic-crystal tuff, but is best considered as a strongly tuffaceous greywacke.

The rock is moderately sorted in the medium to coarse sand range and is essentially unbedded, at least on thin-section scale. Grain-shapes are angular to subangular with no real evidence of detrital abrasion.

AMG
S 396 300N
388 310E

The framework (70 % approx.) consists largely of weakly, but pervasively sericite-stained albite (60 %) with subordinate volcanic quartz and poorly defined rhyolitic lava clasts (20 % each). The matrix consists of crypto - to microcrystalline quartzofeldspathic material of authigenic origin and poorly resolved against the similarly-textured lava clasts.

Close inspection reveals the matrix to contain extremely fine devitrified shards in places. It is also weakly stained with very fine clastic white mica flakes, and contains thinly disseminated fine silt-sized particles of carbonaceous matter and carbonaceous petite. Thus, there are similarities with the sandy pelitic ash (P 682), the major contrast being this rock's high framework/matrix ratio. As previously, subaqueous deposition is inferred.

This rock has been weakly stressed. Sporadic microfractures are healed with quartz and films of carbonaceous matter and oxidised sulphide (?pyrite). Sparse oxidised pyrite crystals, locally concentrated into small clusters, are present in the matrix.

P 767
AMG
S 396 280N
388 420E

(T.S. 27169) K-stain negative.
This rock is a devitrified, extensively sericitised and essentially unsheared rhyolitic lithic-vitric-crystal tuff. In comparison with P 677 and P 763, it is distinctly finer-grained and relatively shardy. However, it is similarly weakly xenolithic and possibly of ignimbritic origin.

The rock consists largely of random to moderately orientated shards (mean 30 μ), devitrified/replaced by microcrystalline quartz and untwinned albite, and embedded in random to incipiently orientated sericite. Angular to subangular quartz- and subordinate albite-crystal fragments (<50-250 μ) and thinly disseminated throughout. Lithic clasts are not common and are poorly resolved, being extensively sericitised microcrystalline types and generally featureless. A few of these features (to 500 μ), however, show quartz microporphyritic textures, others have the appearance of collapsed pumice and a few contain detectable shards.

The sparse xenolithic component comprises random clasts of carbonaceous pelite. The rock is not distinctly eutaxitic, but this does not negate an ignimbritic or ash-flow origin.

Fine-grained carbonate is a minor accessory alteration phase, partly in discontinuous sericitic veinlets. Fine-grained, partly oxidised pyrite is sparsely disseminated throughout.

P 770
AMG
S 396 580N
388 310E

(T.S. 27170) K-stain negative.
This rock is similar to P 766 and P 682 and is texturally intermediate between them. It is best considered as a tuffaceous greywacke, although the distinction from a weakly xenolithic sandy ash is tenuous and academic.

In this case, the rock consists of sand-to pebble-sized, angular to subangular "framework" particles and poorly determinate crypto-crystalline matrix in roughly equal proportions. The framework comprises devitrified and variably altered (silicified, albitised, sericitised, chloritised) rhyolitic lava clasts, fragments of rhyolitic tuff, and quartz and albite crystals/crystal fragments. The matrix contains thinly disseminated, splintery quartz and albite with the appearance of devitrified shards embedded in ultrafine quartzofeldspathic material. Fine silt-sized clastic mica flakes and clots of carbonaceous matter are present and, by analogy with the previous specimens, the quartzofeldspathic material represents pelitic ash, at least in part.

This rock is essentially unstressed. Minor, partly oxidised ultrafine pyrite impregnates some of the altered rhyolite fragments. Patchy Fe-staining appears related to oxidation of accessory alteration carbonate.

P 771
AMG
S396 650N
388 400E

(T.S. 27171) K-stain negative.
This is an extensively sericitised and incipiently sheared rhyolitic fragmental. It consists essentially of closely packed, poorly sorted lithic clasts with subordinate quartz and albite crystals and crystal fragments. Sizing is in the 50 μ to 4 mm range and essentially random.

Lithic clasts are microcrystalline and pervasively sericitised to the extent that many are featureless. However, others show faint contorted flow-banding and several appear to be clasts of vitric-crystal tuff. A few can be interpreted as quartz-porphyritic lava.

The rock fragments tend to be moulded onto one another, indicating they were unconsolidated when incorporated. A sparse sericitised matrix is present and includes sparse fragmented and devitrified shards

Overall, this rock is best classified as a lithic-crystal tuff. It may represent a brecciated ignimbrite. Sparse, partly oxidised, fine-grainec pyrite is present.

P 775

AMG 5396 370N 388 800E

(T.S. 27172) K-stain negative.
This rock is a weakly xenolithic lithic-vitric-crystal tuff, similar and closely related to P 767, but slightly coarser-grained.

As previously, the bulk of the rock (75 % +) consists of random to moderately orientated shards (mean 50 μ), devitrified to microcrystallin sericite-stained quartzofeldspathic material and with sericitic interstices. The remainder comprises diseeminated quartz and albite crystal fragments (to 750 μ), and pervasively sericitised lithic clasts (mainly collapsed pumice) with accessory xenolithic carbonaceous particles and carbonaceous shale fragments. Lithic clasts are sized to 3 mm diameter and appear as "megaclasts" in an otherwise moderately sorted rock, essentially unbedded, but weakly directed.

Patchy Fe-staining reflects oxidation of fine-grained accessory alteration carbonate. In additon, this rock includes sparse, but more or less evenly disseminated, fine-grained oxidised pyrite.

P 776

AMG 5 396340N 388 870E

(T.S.27173) K-stain negative.
This is a silicified breccia, consisting essentially of poorly sorted (<100 μ - 5 mm) angular to subangular rock fragments and accessory quartz grains, cemented and partly corroded/replaced by cherty micro-crystalline quartz.

Rock fragments represent a variety of altered (devitrified, silicified, sericitised) rhyolite, typically tuffaceous types closely analogous to the associated specimens (lithic-crystal-, lithic-vitric-crystal-, and vitric tuff, weakly xenolithic with small clasts of carbonaceous pelite). Devitrified quartz-porphyritic lava is represented, but only as an accessory. The quartz grains are of volcanic character and there are no non-volcanic lithologies represented.

The matrix is rather featureless, consisting entirely of fine inter-locking quartz, incipiently stained with clay (sericite) flakes. The rock is best interpreted as a quartz-cemented tectonic breccia.

P 777 (T.S. 27174) K-stain positive.
This is a sandy-textured xenolithic rhyolitic lithic-vitric-crystal tuff considered as mildly re-worked and of subaqueous deposition.

The rock is very poorly sorted and shows a vaguely slump breccia-like fabric. The main constituents are angular to rounded clasts of altered (sericitised) rhyolite, including porphyritic and non-porphyritic lava (sometimes perlitic), and a variety of pyroclastic types including vitric and vitric crystal tuff. These features are sized to 5 mm diameter and are accompanied by disseminated quartz and albite grains and occasional fragments of carbonaceous pelite.

AMG
S 3964 10N
389920E

The matrix is poorly resolved in thin-section, but comprises up to 40 % of the rock. It consists largely of random sericite with subordinate, closely intergrown, microcrystalline quartz, and is weakly, but more or less pervasively, stained with carbonaceous matter. Vague relict shardy microtextures are semi-pervasive and these features show some evidence of abrasion as do some of the clastic rock fragments.

Partly to completely oxidised pyrite occurs sparsely disseminated throughout the rhyolitic debris and, particularly, the shale clasts. Occasional, partly oxidised grains, clusters (to 1 mm) and thin films occur within the matrix and may be partly detrital in origin.

P 778 (T.S. 27175) K-stain negative.
This rock is a devitrified, fractured and moderately altered porphyritic lava of dacitic affinities.

AMG
5396 500N
389160E

Microphenocrysts and phenocrysts (50 μ - 1mm, sporadic feldspar glomerophenocrysts to 2 mm) comprise around 15 % of the rockand are more or less evenly disseminated. The majority are mildly corroded oligoclase (near albite) with quartz and completely chloritised ferromags (?pyroxene) as accessories. These features are enclosed in a weakly, but pervasively, chlorite-stained homogeneous groundmass of microfelsitic quartz, enclosing ultrafine feldspar microlites and accessory leucoxenised opaques.

Frequent intersecting fractures are healed with quartz and postdate the chloritisation. There is some evidence that chlorite, pseudomorphing pyroxene, is secondary after phlogopite or biotite alteration. The rock carries sparse oxidised fine-grained pyrite.

P 779 (T.S. 27176) K-stain positive.
This rock is a sericitically altered xenolithic, rhyolitic lithic-crystal tuff. There are similarities with P 777 but, in comparison, there is no real evidence of re-working and the fabric is suggestive of subaerial deposition.

AMG
5396 480N
389 200E

The rock consists largely of closely packed angular to cuspate lithic fragments extensively moulded onto another. Accessory albite and quartz crystals/crystal fragments are present, but in contrast to P 777, there is no real matrix phase. Sorting is in the 500 μ to 2.5 mm range and random to faintly bedded. Carbonaceous shale fragments are an accessory component.

Rhyolite clasts are microcrystalline and variably sericitised, but can be defined as ranging from porphyritic lava through flow-banded glassy types to tuffaceous varieties (vitric and vitric crystal tuff). Some are distinctly perlitic.

Apart from sericite, fine-grained secondary albite is common, typically in thin films parallelling the flow-banding in the various clasts. A few fragments, relatively unaltered, contain relict K-feldspar (sodi-potassic rhyolite). Sparse oxidised pyrite is present.

P 780 (T.S. 27177) K-stain positive.
This rock is a devitrified and mildly altered lithic-vitric-crystal tuff of dacitic composition and with the appearance of a flow- or auto-brecciated ignimbrite.

AMG
S 390 100N
386 840 E

The rock consists essentially of single and clustered plagioclase crystals and fragments (albite, sodic oligoclase), rare 100 μ quartz grains, and frequent microcrystalline lithic clasts embedded in a weakly sericite-stained microcrystalline quartzofeldspathic matrix. Lithic clasts (to 3 mm) and the matrix show more or less pervasive contorted and fragmented microscale flow-banding and very faint but semi-pervasive relict shardy microtextures. These are similar to the extent that the clasts can be considered as representing in-situ brecciated fragments of the matrix. These features are partly moulded onto one another.

Quartz crystals are conspicuous by their near absence. Similarly, K-feldspar is absent, although the rock is relatively quite fresh. Xenolithic shale fragments, virtually ubiquitous in the associated rhyolitic tuffs, are also absent.

Secondary albite and chlorite are minor accessory alteration phases. Feldspar grains are incipiently sericitised and mildly stressed.

P 781 (T.S. 27178) K-stain negative.

AMG
5390 700N
387 350E

This is a mildly altered porphyritic, weakly amygdaloidal lava. Primary feldspar composition is partly obscure, but the rock appears related to P 778 and is considered as dacitic, although verging on a sodic rhyolite.

Prismatic plagioclase phenocrysts are disseminated throughout and tend to be weakly clustered. These features (to 500 μ) are zoned with preferentially sericitised-chloritised cores and thin albitic marginal zones. Core composition is obscure but, by analogy with P 780, was probably oligoclase (hence dacite). Alternately, (if albite) the rock would be regarded as a sodic quartz trachyte (trending towards sodic rhyolite). This is a good example of the problems of "pigeon hole" classification of igneous petrology as applied to naturally continuousl variable rocks.

Phenocrystal quartz is absent, the quartz aggregates seen in hand specimen being amygdales, weakly chloritic and elsewhere with cavities (after ?carbonate). However, the rock contains sparse chlorite aggregates, vaguely pseudomorphous after a ferromagnesian micro-phenocrystal phase (?pyroxene, shapes are non-diagnostic) and these enhance correlation with P 778.

The groundmass comprises anhedral, weakly interlocking, cloudy quartz "stuffed" with albite microlaths and microlites and is weakly but pervasively chlorite-stained. The rock has an incipient flow fabric and was vitric in part.

P 782

AMa

5 389 830N

387 020E

(T.S. 27179) K-stain positive.
This rock is a moderately altered porphyritic lava, similar to P 781 (and by inference P 778), but relatively siliceous and distinctly potassic in comparison. As such, it can be classified as a sodi-potass quartz trachyte or quartz-poor rhyolite.

Feldspar phenocrysts are relatively frequent and tend to be clustered (to 2 mm). The bulk are weakly sericitised/incipiently zoned albite, but these are accompanied by rare inverted/exsolved sanidine-anorthocla- represented by albite with exsolved K-feldspar. Sparse, partly resorbed quartz phenocrysts are present along with occasional chlorite-pseudomorphed pyroxene phenocrysts (sim. P 778). These occur with sparse quartz amygdales (to 1.2 mm) in a weakly but pervasively chlorite stained groundmass, texturally near-identical to that in P 781, but slightly coarser-grained and with alkali (K) feldspar microlaths embedded in intersertal quartz and feldspar.

Fine-grained, cloudy epidote is a minor accessory alteration phase. Accessory leucoxenised opaques are relatively abundant.

P 783

AMa

5390 380N

387 700E

(T.S.27180) K-stain positive.
This porphyritic lava is rather similar to P 782, but relatively alkalin in comparison. It can be classified as a quartz-poor rhyolite and can be distinguished from the relatively siliceous rhyolites comprising the bulk of this suite.

Feldspar phenocrysts (mean 400 μ, clusters to 2 mm) are completely replaced by sericite + quartz. On the basis of shape, these comprised single laths of sanidine and clusters of plagioclase (?albite) in roughly equal proportions. Rare corroded quartz phenocrysts (to 350 μ) are present along with sparse sericitic leucoxene-stained altered intermediate ferromags.

The groundmass comprises weakly but pervasively sericite-stained felsitic anhedral quartz, stuffed with ultrafine alkali feldspar microlites and is texturally similar to that in P 778, P 781 and P 782. Accessory leucoxenised opaques are present and thin discontinuous quartz-sericite veinlets occur sporadically.

P 785 (T.S. 27181) K-stain positive.
This is a "volcanic breccia" of dacitic-rhyolitic affinities and probably a flow-top breccia.

AMG
5385 050N
384 190E

The rock consists essentially of poorly sorted angular to subangular lava clasts (1 mm - 1 cm+), closely packed and extensively moulded onto one another with no tangible matrix phase. This fabric is typical of flow-marginal breccias formed in a relatively viscous lava.

Clasts are of essentially similar composition and were almost entirely glassy types, which have devitrified to felsitic and not infrequently perlitic textures. Single and clustered albite phenocrysts are virtually ubiquitous and the majority of fragments include phenocrystal sanidine-anorthoclase (inverted, partly albitised). Phenocrystal quartz is absent apart from isolated microphenocrysts. Groundmasses range from sodic to sodic-potassic and potassive types and, overall, the clasts exhibit a similar compositional range to that reflected in P 778, 781, 782 and 783.

Alteration is not marked. Perlitic structured clasts tend to be preferentially chloritised initially along the perlitic cracks. Feldspar phenocrysts are incipiently sericite-stained and a few clasts are preferentially pervasively sericitised. Zoisitic epidote is a minor accessory alteration phase and the rock has been mildly stressed.

P 786 (T.S. 27182) K-stain weakly positive.

AMG
5384 320N
384 950E

This is an extensively altered and mildly sheared "feldspar porphyry" or strongly feldspar porphyritic lava. There are textural similarities with P 758 and P 764, suggesting an intrusive origin, although there are no close compositional affinities.

Abundant feldspar phenocrysts are represented by partly weathered pseudomorphous aggregates (to 2 mm) of saussuritic material and albite These include relics of zoisitic epidote and the nature of alteration indicates the phenocrystal phase was a plagioclase with at least some Ca (?oligoclase). Phenocrystal quartz and ferromags (and their alteration products) are absent and primary dacitic composition appears likely. Thus, the rock appears more closely related to P 778, etc. than to the associated rhyolites and biotite rhyolites.

The groundmass is strongly sericitised, but shows faint relict felsitic microtextures. Sparse, clayey amygdales are present and may include small patches of chlorite and green biotite. Leucoxenised accessory opaques are relatively abundant.

P 787
AMG
5384 240N
385 010E

(T.S. 27183) K-stain negative.
This is a devitrified and pervasively sericitised pelitic ash, essentially similar to the previous examples (e.g. P 682), but distinctly better sorted and more homogeneous.

The rock consists largely of chlorite-stained sericite aggregates with accessory cryptocrystalline ?quartz. Microscopic relict shard textures are pervasive. Silt-sized clastic angular grains of quartz, albite and (leucoxenised) opaques are disseminated throughout and subtle variations in the proportion of these features define very faint bedding laminations.

Sparse, altered (chloritised) indeterminate fine sand-sized rock fragments are present. Detrital white mica flakes and small fragments of carbonaceous pelite are present, but represent no more than minor accessory constituents.

P 788
AMG
5384 190N
385 010E

(T.S. 27184) K-stain negative.
This rock is a relatively strongly altered sandy ash with similarities to P 682. It consists essentially of fine sand- to grit-sized clasts of feldspar and altered rock fragments with accessory quartz randomly disseminated throughout a dolomite-stained sericitic matrix with faint but pervasive vitroclastic microtextures (sim. P 787).

The matrix requires little special comment except to note that it shows a relatively marked slaty cleavage. "Framework" particles are extensively altered to chlorite, sericite and dolomite-ankerite,but were mainly feldspar and felsic lava clasts with sporadic fragments of carbonaceous sediment. Probably some of the coarser dolomitic fragments are clastic rather than dolomitised in-situ. Sparse clastic white mica flakes are present.

This rock is weakly but more or less pervasively stained with fine-grained Fe-sulphide (mainly pyrrhotite). This preferentially impregnates the altered rock fragments and is pretectonic.

P 789

AMG
S 384 050N
385 210E

(T.S. 27185) K-stain positive.
This rock is a mildly altered porphyritic lava, weakly amygdaloidal and of quartz trachytic affinities. It is texturally similar and closely related to P778, etc.

Abundant phenocrysts of weakly sericite-stained oligoclase (near albite) are present and, as in the previous specimens, these tend to be clustered (glomerophenocrysts, glomeroporphyritic texture) in aggregates up to 2 mm diameter. There is no phenocrystal quartz apart from sparse corroded relics (to 300 μ), which have recrystallized. Sparse, completely chloritised ferromag microphenocrysts are present and were probably pyroxene, although the semi-pseudomorphous shapes are non-diagnostic.

Sparse amygdales (to 2 mm) consist of granular quartz with accessory patches of chlorite. The groundmass comprises anhedral patchesof quartzofeldspathic material, stuffed with random alkali feldspar microlites, and is weakly but pervasively chlorite-stained. In contrast with the associated felsic (as against rhyolitic) volcanics, this rock includes notable accessory amounts of magnetite in addition to sparse leucoxenised opaques. The rock has been very incipiently stressed.

D. Cowan, B. Sc.

APPENDIX 4.

"Geochemical Exploration for Base Metals, West Coast Tasmania"

and

"Orientation Studies carried out for Electrolytic Zinc Exploration" by N.J. Marshall, 10th April, 1979.

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CONSULTANT'S REPORT TO

ELECTROLYTIC ZINC CO. OF A'ASIA LTD.

"GEOCHEMICAL EXPLORATION FOR BASE METALS, WEST COAST TASMANIA"

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April 10, 1979.

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ABSTRACT

The West Coast province occupied by Mt. Reid Volcanics has seen intensive activity in base metal exploration for Rosebery type, massive Pb-Zn mineralization, over many years.

In this rugged terrain with its high accessibility costs, "traditional" geochemical exploration has met with varying technical success, which is often compromised by the variety of soil conditions encountered. Follow-up costs are high, and greater discrimination is needed for geochemical targets prior to drilling.

Following an in-depth study of this area, several novel approaches to geochemical exploration are recommended. These have been tested by orientation sampling and should be applicable for any reasonably sized targets of the Rosebery type.

Cost savings should also be effected through increased sampling speed and efficiency using a suitable combination of the recommended procedure of phased (sequential) geochemical sampling This approach may also reveal blind mineralization, and permits a faster coverage of areas.

The key features are:

1. heavy mineral reconnaissance drainage sampling.
2. analysis of Mn/Fe oxide coatings on stream pebbles. These have superior contrasts to conventional stream sediments, and permit effective sampling at a wider interval.
3. analysis of surface litter or A_0 organic samples where B horizon is difficult to collect consistently. These are effective for both reconnaissance and detailed grids, save the tedium of augering, and ensure a more consistent sampling medium than has previously been obtained.
4. analysis of "plumbing system" samples (wads and Fe oxides filling joints, fractures, and seepage areas). These may be a guide to blind mineralization.
5. analysis of rock samples for alteration assemblage elements and elements related to mineralization; Mn, Ba, Na/K ratios, Rb, F. Relative carbonate abundance and potassic alteration may also be logged in the field.
   Such rock analysis is applicable at both detailed scales (for following up base metal anomalies and assigning priorities to them) as well as broader scales. These elements give a diagnostic signature in footwall alteration for a considerable distance beyond the influence of sulfide mineralization.

6. field kits for on-site follow-up in regional prospecting of inaccessible areas.

Some interpretation is reported for areas visited, but the emphasis has been on more general aspects applicable to the region as a whole.

Routine grid results should be machine plotted as single element stacked profiles on transparent base map overlays. This is a superior approach to interpretation, using visual "pattern recognition" of anomalous trends, to the currently used approach.

To instigate this, a computerized data bank must be set up, to record all field and laboratory parameters and grid references in a systematic fashion. This will have other benefits also, in allowing data to be sorted, screened, retrieved and manipulated at will.

It is hoped that this very detailed write-up will act as a reference source to raise the cost-effectiveness of geochemical exploration in this region.

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April 10, 1979.

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SUMMARY OF MAJOR CONCLUSIONS AND RECOMMENDATIONS.

I. EXPLORATION.

Geochemical exploration in the joint venture areas is at several stages on various targets. Activities range from proposed new regions which have seen little previous work, through previously stream sediment sampled areas, to areas which have had detailed auger sampling carried out on grids. These are usually the result of follow-up of I P anomalies, and many soil anomalies have subsequently been complemented by costeaning and drilling.

1. Stream sediment reassessment.

A prime (winter activity) recommendation for future work is that all previous stream sediment data be compiled on standard (simple) drainage base maps as colored "worm diagrams" (one for each element). These should be overlaid on a photogeologic map base such as 1:40,000.

Careful interpretation and reassessment, with some re-sampling of critical areas may be needed to evaluate the validity of the data. In this context, previous stream sediment responses and anomaly distribution relative to known anomalous soil grids should be critically examined. This may indicate whether soil grids should have been extended, and whether known stream sediment anomalies adequately reflect known soil anomalies. If this is confirmed, then any untested stream anomalies in the old data would assume more priority for follow-up.

2. Phased geochemical exploration.

The section on "Sample Types on the West Coast of Tasmania" details all useful sample media which can be used, and their distribution, significance, collection, analysis and interpretat Specific details are discussed in the following sections on results of various orientation studies. This section also discus geochemical responses in these various media, and problems which may arise in field collection and interpretation. Detailed response diagrams, sample discriptions and analytical results ar given in the data volume accompanying this report.

Different data volumes have been prepared for the relevant Mt. Lyell and E Z orientation areas.

A general approach of phased geochemical exploration is suggeste for new or little worked areas, following the sequence developed in the section on "Sample Types".

Work on areas at a higher stage of activity (detailed soil grids, may by-pass the earlier, more regionally oriented phases listed below, and procede where warranted to higher level phases of follow-up.

These include rock sampling for alteration element assemblages to classify mineralization (Rosebery type) and to trace the source of hydromorphically displaced anomalies (those lacking bedrock mineralization).

3. Geochemical Exploration Sequence.

The following steps list the complete geochemical exploration sequence for the region:

1) Heavy Mineral Panning.

Constant sized samples should be panned to a standard volume as a regional reconnaissance program. Sampling should be carried out from readily accessible sites at the necks or confluences of several major drainage basins, representing several sq. km. of watershed.

Examination of the concentrates by binocular microscope for mineral assemblages is then carried out. The samples are also examined by ultraviolet lamp for fluorescent minerals such as scheelite.

Any magnetite should be removed, weighed and submitted as a separate sample for emission spectrographic analysis for Cu, Pb, Zn, Ag, Bi, Co, Ni, Cr, Ba, Mn, Ti, V, Mo, and Nb., and results normalized to relative magnetite abundance.

The non-magnetic fraction should be analyzed by emission spectrograph for Cu, Pb, Zn, B, Ba, Sn, W, Cr, Nb, Ti, Zr, and Mo.

Data are best interpreted with the aid of a regional photo-geologic base map with drainage overlay at the same scale.

2) Mn and Fe oxide coatings on stream pebbles.

Rather than traditional stream sediment sampling, collection of oxide coated stream pebbles, and analysis by hydroxylamine leach on the uncrushed material is proposed.

Orientation studies have conclusively demonstrated that pebble coating surveys give superior contrasts and probably longer dispersion trains compared to conventional stream sediments, and the problem of finding sufficient -80# material is overcome.

Sampling can probably be carried out at 1 km intervals, even along major streams, although of course sample density should be dictated by access, as all tributaries encountered during a traverse should be sampled.

An orientation study proposed along Itat Ck., draining the Beatrice prospect, should give further information on the length and intensity of anomalous dispersion, on which to base future surveys.

The leach solutions should be analyzed routinely by atomic absorption for Cu, Pb, Zn, Mn, Fe, and Co. Initially the Cu, Pb, Zn data should be plotted and examined for obvious anomalies, rather than using ratios.

Splits of the samples should be retained so that anomalous samples can be treated by acid leach (50% HCl) and re-analyzed for acid soluble Ba (by AAS), Ag and arsenic.

3) Stream sediment samples.

Because the prime exploration cost is access, conventional -80# stream sediment samples (as a composite from several adjacent sites) should be collected in conjunction with the pebble samples. (or where pebble coatings are not available.)

These should be analyzed for "total" Cu Pb Zn Mn Fe Ni and cold extractable (1 N HCl) Cu Pb Zn Mn, by atomic absorption.

Anomalous samples only should be re-analyzed for As, Ag and Ba.

Both total and Cx results should be plotted on a series of separate base drainage maps. The former are useful in reflecting combined effects of mineralization and lithologic variation (for "Mapping") whilst the Cx results are simpler to interpret for mineralization. They also tend to give higher contrast anomalies in this environment of chemical weathering.

Interpretation should be based on colored "worm diagrams" as drainage overlays to a photogeological map base.

Recording data on a computer accessible file will aid final interpretation because of the ease with which populations can be classified according to drainage basin lithology.

4) Stream sediment and pebble coating follow-up.

In areas of difficult access, field kits are proposed to enable follow-up to proceed in situ, and define the limits of the anomaly.

Instructions on preparation and use of a simple total heavy metals field kit are given in Appendix A.

Further follow-up, involving ridge and spur, and base of slope soil sampling, can also be done with these kits using non organic soil components.

5) Regional soil sampling.

Sampling of surface litter, A_0 or A_1 horizons (whichever is most prevalent) is recommended on semi-cut lines.

This is particularly important in critical areas where an adequate drainage network is lacking.

Samples should be taken at intervals of 50 meters on parallel lines from valley to top of each ridge, at approximately 200 meter line spacing.

Lines should favour breaks in slope (parallel to contours), commencing above creek banks, with the object of locating hydromorphically displaced anomalies.

These would be a "lead-in" to more detailed systematic grid sampling, followed by augering, costeaning and drilling.

Thus much tedious and expensive systematic auger sampling of barren areas would be avoided, allowing coverage of the E L's to proceed at a more cost-effective rate.

Such sampling would be particularly rapid if the point location equipment discussed in this report proves practicable in field use, as formal line cutting and pegging would be minimized. These samples should be wet-ashed (perchloric/ nitric acids) and the elements Cu Pb Zn Mn determined by AAS. Anomalous samples to be re-analyzed for Ag Ba and As.

6) Regional wad and talus sampling.

Any samples of Mn wad formed in seepages, and -80# samples from the base of talus slopes, should be collected and sampled during the course of the regional soil sampling. Analysis of wad should include the above elements plus Co.

7) Reconnaissance rock sampling.

Rock samples, particularly from favourable stratigraphic horizons or where tectonically disturbed and visibly altered, should be sampled and analyzed for elements characteristic of the Rosebery assemblage.

This will aid in selecting favourable zones for mineralization, as the Hercules orientation study has demonstrated that bedrock, wallrock alteration signatures extend far beyond the limits of base metal anomalous values in the bedrock.

Where bedrock base metals are anomalous, the alteration assemblage may help classify the area for the purpose of assigning priorities.

In the field, a Mn association (staining) should be looked for (Hercules, Beatrice and Henty River type). Carbonate presence and abundance can be readily logged in the field with the use of acid.

A portable gamma ray spectrometer used in the field can "map" zones of higher potassium content.

The presence of fluorite, tourmaline, sphene and barite is an important guide to ore proximity.

Rock samples should be analyzed for Cu, Pb, Zn, Mn and in addition K, Na, Rb, and Fe. These can be done by HF/ aqua regia attack and atomic absorption. Details are given elsewhere in this report. Ba, B, Zr, Ti are best scanned by emission spectroscopy, with Ba re-analysis by XRF where more accuracy is desired.

Arsenic should also be determined (from AAS solution digest), and fluorine run by alkaline fusion and selective ion electrode.

The most diagnostic parameters are likely to be high Ba, B, Rb, and F, with decreasing Fe, increasing Mn, and increasing K/Rb and K/Na ratios approaching ore. High carbonate is also important.

8) "Plumbing system samples".

These are useful for detecting blind mineralization, particularly in glacial debris covered areas.

Samples of ironstone and Mn wad in seeps and as fracture fillings should be analyzed by an acid dissolution procedure and AAS for Cu, Pb, Zn, Mn, Fe, Co, Ba. Anomalous samples to be re-analyzed for Ag and As.

9) Detailed rock samples.

These are applicable in costeans, drill core, outcrops among soil grids, and auger bedrock chips as soil grid follow-up.

They are necessary in locating the bedrock source of soil anomalies, particularly where hydromorphic dispersion has caused a displacement of anomalous soil values downslope.

The same philosophy applies as for reconnaissance rock samples, and the same element assemblage should be run as discussed above.

Plumbing system sampling is also applicable at the detailed, follow-up stage, particularly in areas of thick glacial cover.

10) Detailed soil grids.

A wide variety of soil types is developed on both glacial debris and bedrock throughout this region, and causes complications with varying backgrounds and geochemical response.

The types of soils are discussed at length in the following section on "Sample Types", and some typical profiles are illustrated in the text and in the relevant sections on specific orientation sites.

Appendices to the orientation work describe individual samples collected.

There has been some confusion on soil classification in previous sampling, and in some areas attempts to hand auger to bedrock in difficult terrain have added to this confusion. For example, " C horizon " bedrock chips were encountered and the sample then sieved to -80#, resulting in B horizon samples, or augering has been stopped by boulders and C horizon assumed when the sample is still in the A profile.

Field crews should be instructed to recognize soil types, if possible, with the aid of reference samples.

Soil variations should be mapped prior to final interpretation of grids.

In areas where B horizon is readily and consistently available, this should be sampled in preference to C horizon, which is strictly weathered bedrock. Fresh bedrock (D horizon) is more common and can give rise to erratic values requiring very close sampling. Bedrock sampling is only necessary at the final stage of follow-up for siting drill targets.

B horizon samples should be analyzed by aqua regia or perchloric/nitric digests, and Cu Pb Zn Mn determined by AAS. Anomalous zones should be re-analyzed for the same elements via a 0.5 N HCl cold extraction, to help diagnose hydromorphically displaced anomalies.
Anomalous samples should also be tested for Ba Ag and As.

In complex sub-areas where B horizon is not consistently available, it is preferable to sample the surface litter, A_0 or A_1 horizons. The advantage of this approach is that difficult and time consuming augering is minimized.

These should be analyzed by a wet ash ($HClO_4/HNO_3$) procedure for Cu, Pb, Zn, Mn, with re-analysis of anomalous samples for Ba, Ag and As. With A_0 sampling, care must be exercised to maintain a constant organic/inorganic ratio, or else the variable organic component must be allowed for.

11. Hydromorphic Soil Anomalies.

In this steep terrain with high rainfall, anomalies due to chemical dispersion downslope can be expected. Movement away from the bedrock source can occur for considerable distances (300 meters at W. Hercules).

Thus all anomalous zones in soils should be followed up-slope for a mineralized bedrock source, if the source cannot be located in underlying bedrock.

The following section on "Sample Types" details methods of recognition and follow-up of displaced soil anomalies.

II DATA PLOTTING FOR INTERPRETATION.

1. Stream sediments and pebble coatings.

These should be located on aerial photographs, using stereoscopy, and sample numbers transferred to simple drainage base maps showing cultural features. Maps should be transparent overlays to a photogeologic base map.

A series of separate colored "worm diagrams" of arbitrary anomalous drainage for each element should be prepared after single element raw values are plotted (preferably by machine). This will serve for preliminary interpretation during work progress.

Final interpretation will use the same maps with single element raw data values, except that the colored anomalous "worm trails" are drawn in using locally adjusted, variable thresholds at each point. This is done by using a computerized data bank to sort samples into populations according to local lithologies and drainage basin. More sophisticated data processing and analysis may be desirable in the final stages, to extract the maximum information from the multi-element data, including geologic variation.

2) Soil grids.

These should be machine plotted as simple stacked profiles using vertical bars to designate sample position and relative intensities of values. The profiles must be plotted with their true spatial relationships preserved, on transparent overlays to the geologic map base.

Separate overlays should initially be prepared for the elements Cu, Pb, Zn, Mn.

Visual pattern recognition of these map profiles overlaid to geology is probably the most effective way to interpret data, by drawing in anomalous zones. This technique goes some way toward compensating for changes in background due to lithologic and soil variations.

The present system of manual plotting multiple data values at each site gives little visual impact and is confusing in detail.

Coloring in spot values and contouring them tends to assume a constant background and may be distorting in detail, especially where shifting backgrounds occur.

A quotation has been obtained for this plotting, and is approximately $660 per series of 4 A_0 map sheets covering approximately 1000 sample points. This is a minor interpretation cost relative to the overall exploration effort.

It is recommended that a trial plotting exercise be carried out on the N E quadrant of the Mt. Lyell White Spur Grid.

III DATA BANK.

For routine grid plotting and interpretation of regional stream sediment surveys a computerized data bank is highly desirable.

The present system of recording data would be very time consuming and prone to error if put on computer.

Therefore combined field and lab. data sheets should be instituted, so that all parameters additional to sample no., grid reference and analytical results can be stored, sorted or retrieved (listed) at will.

Discussions have been held on this aspect with both joint venture operators and it was agreed that forms which are flexible, practical and simple to use should be designed for handling their requirements.

These will be prepared and issued separately.

IV LABORATORY.

There may be an increased work load on the Mt. Lyell laboratory if it is to undertake the greater variety of analyses recommended.

Alternatively, increased cost would be incurred if the work is done by custom laboratories, as is the practice for E Z.

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There are, however, advantages in time, convenience and cost in carrying out as much work as practicable "in house". The Mt. Lyell laboratory, although primarily funded as a mine lab. is competently staffed and reasonably well equipped to carry out most of the recommended analyses.

Some upgrading of facilities, such as installation of a good fume cupboard and purchase of a small jaw crusher is recommended.

With acquisition of several minor items of glassware, suitable test tube racks and labor-saving devices such as an automatic dilutor and dispensing pipettes, geochemical throughput could be significantly increased through greater efficiency.

A few days on-site training is recommended to introduce a more "batch production oriented" attitude to geochemical analysis without sacrificing accuracy.

Some training is also recommended for new techniques including analysis for elements not currently determined on a high throughput basis.

It may be desirable for both joint venture operators to pool resources toward establishing a joint geochemical analysis facility at Mt. Lyell.

Any increased analytical costs should be more than offset by the more cost-effective phased sampling procedures recommended above.

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II. SAMPLE TYPES ON THE WEST COAST OF TASMANIA.

Resulting from orientation studies and field inspection of both joint venture areas, the following sample types are suggested as being the most useful at varying stages of geochemical exploration.

II 1. Reconnaissance Drainage Basin Studies. - heavy mineral panning.

1) Collection, plotting and recording data.

The most rapid assessment of mineralized drainage basins can be done at the reconnaissance scale by heavy mineral panning of drainage basins, typically representative of up to 10 sq. km. in this environment of rugged topography, complex drainage and high dilution.

Fig. A illustrates a typical area of about 20 sq.km. for which up to 12 heavy mineral sites could be sampled. Such sampling density should be adjusted according to the geological and drainage complexity, and the potential for mineralization within parts of each exploration licence.

Initially, samples should be collected at readily accessible sites from the mouths of major drainage basins.

Samples should be wet screened to about -10# from several composite sites across the stream bed, and every effort should be made to start with a constant sized sample and pan slowly and carefully to a "grey fraction" (crude concentrate) of constant volume. eg.) a bucketful panned down to a 20 ml plastic vial full. "Overpanning" to favor only the heaviest grains, as for gold panning, should be avoided.

Sampling should be carried out in the portions of streams of approximately constant hydraulic load (eg. predominant fist sized cobbles), and the predominant float lithologies noted.

This can give a knowledge of rock type distribution upstream in poorly mapped areas, and also serves to check on geological contacts and lithologies in mapped areas.

Positioning should be done on aerial photographs in the field, with localities transferred to simplified base maps such as fig. A, showing only drainage, cultural features and the metric grid.

Prints of topographic base maps, showing contours are too confusing and should be avoided.
All stream parameters (width, contamination upstream etc.) should be noted for subsequent computer coding.

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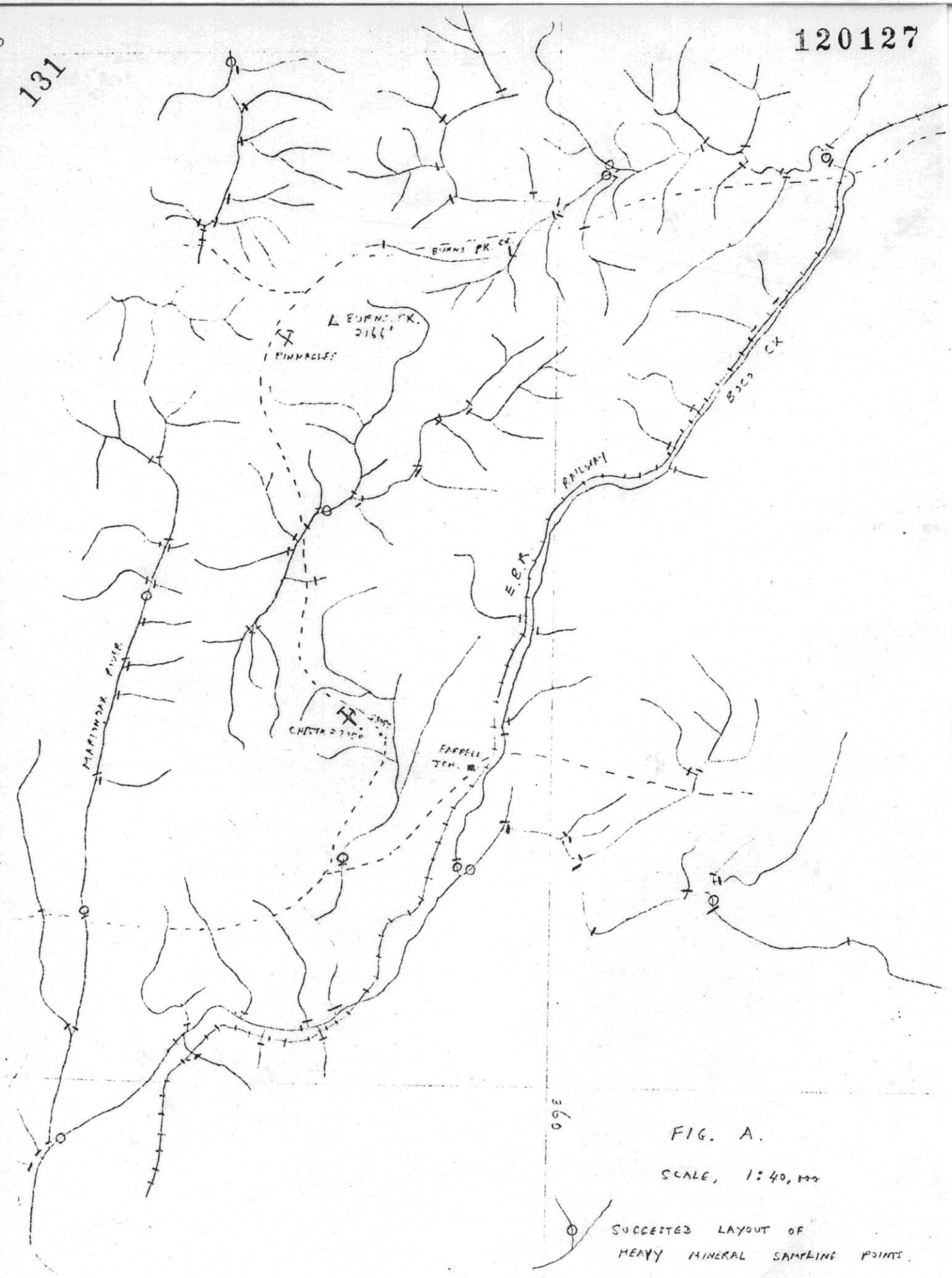

FIG. A.

SCALE, 1:40,000

SUGGESTED LAYOUT OF HEAVY MINERAL SAMPLING POINTS.

SUGGESTED LAYOUT OF STREAM SEDIMENT SAMPLING POINTS

5 cm

2) Examination.

Initially, the concentrate samples should be examined at base with a binocular microscope, noting relative abundance of any unusual minerals.

The samples should be examined by ultraviolet lamp for fluorescent minerals such as scheelite.

Samples should then be despatched for fine grinding in a small mill, (such as a Spex mill) and analyzed by semiquantitative emission spectroscopy for: Cu, Pb, Zn, B, Ba, Sn, W, Cr, Nb, Zr, Ti.

3) Analysis of magnetite fractions.

If on binocular examination, magnetite is seen, this should be separated out with a hand magnet and weighed. The magnetic concentrate fraction should be finely crushed, and the following elements analyzed by emission spectrograph: Cu, Pb, Zn, Ag, Bi, Co, Ni, Cr, Ba, Mn, Ti, V, Mo, W and Nb. Results can be normalized to relative magnetite abundance if the panned fractions are constant.

W. Overstreet of the USGS (pers. comm,1971) in a study of a large area of Alaska successfully identified every one of 24 known Cu deposits, often 10 miles downstream from mineralization using trace elements in magnetite.

The attached Appendix C details results of this survey, and gives some supplementary information.

Similarly, a study by Theobald, Overstreet and Thompson (1967) on "Minor Elements in Alluvial Magnetite from the Inner Piedmont Belt, North and South Carolina" (USGS Prof. Paper 554-A) states:

1) " a general partition of many of the trace elements favours magnetite over most other rock-forming minerals"

2) " the amount of metal attracted and retained by the magnetite will be strongly influenced by the amount of metal available. The availability of the metal is controlled by the absolute quantity of metal in the system, the nature of the system, and the nature of the individual elements".

3) "magnetite, particularly separates from alluvium, is an almost ideal medium for the study of the distribution of trace elements on a regional scale - a form of geochemical census".

4) " stream sediments, however, vary in metal content not only with the metal content of bedrock in the drainage basin but with erosion, transportation, and sedimentary history of the sediment. The effects of this variation are minimized, however, because only a single component of the sediment, magnetite, is used".

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5) " there can be no doubt from the data presented that the regional distribution of some trace elements can be studied by the analysis of detrital magnetite".

The non-magnetic heavy mineral concentrates will serve as regional samples for Sn, and W mineralization.
Barium and boron contents will serve to outline zones of favourable host rock lithology for Rosebery type mineralization. These should be followed up by closer spaced drainage sampling using stream sediments and pebble coatings.

Conventional stream sediment samples and pebble coatings should also be collected at each heavy mineral site.

II. 2. Detailed Drainage Basin Studies.

Stream Sediments.

1) Collection and analyses.

In this environment of chemical weathering and rapid dilution, -80# stream sediments should be collected at fairly close intervals, and analyzed for "total" ($HClO_4/HNO_3$) Cu, Pb, Zn, Mn, Fe, Ni (AAS) and cold extractable (1 N HCl) Cu, Pb, Zn, Mn (by AAS). Ba
Anomalous Cu Pb Zn values should be re-analyzed for As and Ag. The total base metal values will tend to reflect the combined influence of lithologic variation and mineralization, and thus result in overlapping populations. Some weak anomalies may be masked by higher background values due to changing lithologies.

Nevertheless, the total base metal values, supplemented by Mn, Fe and Ni, can give some insight into up-drainage lithologies and changing backgrounds if careful interpretation is carried out, aided by sophisticated techniques such as factor analysis. This can aid regional mapping in unknown areas.

The cold extractable values are a more direct indicator of chemical dispersion from mineralization, and are less sensitive to lithologic variation. Anomalies due to mineralization will tend to have Cx values approaching total values.

2) Recording Data.

As with heavy mineral sampling, stream parameters including stream order, width, dominant lithologies in pebbles and cobbles, upstream contamination etc. should be noted. These should be coded onto computer compatible forms with analytical results to provide a systematic data bank. This can be updated at will if follow-up sampling or extra analyses are carried out.
The data bank would serve as the basis for future more sophisticated interpretation procedures (regression on Mn, sorting backgrounds into lithologic groups, factor analysis etc.)

3) Sample density.

All stream systems, including those draining glacials, should be sampled at approximately 1 km intervals.

Large streams should also be sampled to provide average background data.

Each sample should consist of a composite of several sites across and along the stream, placed in the one pre-numbered wet-strength Kraft envelope, with sample no. recorded on aerial photos for transference to drainage base maps.

The actual sample density should vary with geologic complexity (presence of fault zones, favourable contacts etc.), which is roughly proportioned to the locus for any likely mineralization.

Sample density should always be guided by practical considerations of access (ie. the costly component of exploration). Thus all side tributaries should be sampled if encountered during a traverse. Fig. A gives a suggested sampling layout for close coverage of a complex area containing known mineralization - this is an example only (area is outside E L).

In areas where coarse gravels predominate, fine fractions may collect under the roots of moss-covered stream boulders, but this type of sample should be noted,as organic enrichment may occur.

In routine survey, it may prove convenient to pre-number sample sites on aerial photographs and Kraft envelopes, and insist that field assistants flag each site with tape.

4) Duplicate sampling for errors.

During the course of a survey at least 30 regular, easily accessible sites should be re-sampled en route by different operators throughout the season, and submitted as new analyses.

Subsequent computer "analysis of variance" will establish total analytical + sampling error. This can prove useful for investigating weaker anomalies during second-pass follow-up, as an "error band" can be assigned around each threshold value in each lithology.

5) Progress Maps.

All access tracks such as timber cutting trails, as well as cultural features and known mineralization upstream should be located on the simplified drainage base maps using air photographs and local knowledge.

During the progress of sampling, colored "worm diagrams" using a scheme such as red, yellow, green for strong, moderate and weak values (tentatively assigned) should be used to monitor progress of the survey.

6) Anomaly follow-up.

All isolated anomalies should be re-sampled, preferably with the aid of field kits.

Closer fill-in stream sediment sampling is advised around anomalous areas to delineate their true limits, with the aid of stereo air photographs. In the author's experience, soil grids are often put in as follow-up at too early a stage, such that the grid is too large, or needs to be progressively extended when anomalies are not closed off.

At this follow-up stage, soil sampling of ridges and spurs, as well as along breaks in slope (above and parallel to creek banks) is recommended in conjunction with detailed stream sediment sampling. Any talus slopes should also be sampled at their base, as well as "plumbing system samples" such as Mn wad, and rock samples for alteration elements, at this stage.

Having ascertained the limits of the anomaly, the next stage is grid sampling, guided by geological and geophysical parameters.

Finally, it is desirable to keep a -20+80# fraction of the washed stream sediment mounted on chip cards, for subsequent binocular microscope examination of drainage lithology at each site.

II. 3. Detailed Drainage Basin Studies.

Mn/Fe coated pebbles.

1) Introduction.

Analysis of the soluble (reactive) stream sediment coatings in stream pebbles has been reported in the recent North American literature and at recent symposia of the Association of Exploration Geochemists, but has been ignored in this country. Key references include those by Whitney (1975), Carpenter et al (1975), Chao and Theobald (1976), Carpenter and Hayes (1978), Carpenter et al (1978), and Carpenter (1978, Golden, Colorado AEG symposium).

The principle of the method is that iron and manganese in solution will precipitate on increase in Eh and pH and coprecipitate trace elements in solution, onto any convenient surface.

This occurs when reduced, humic acid rich waters such as occur in the West Coast Tasmania region, are oxidized in shallow swift-flowing streams flowing over shingles. Aeration causes precipitation of Fe and Mn oxides onto pebble surfaces, via oxidation of Fe^{2+} and Mn^{2+} ions in solution. Fe oxide precipitation occurs first. In partially buried pebbles, the upper, exposed surface is often coated with black Mn oxides while the lower surface, if under water and in contact with organic matter, is clean, (reducing conditions).

The process of precipitation and scavenging of metals in solution from the stream water (ie. coprecipitation of chemically dispersed elements) is akin to the process of gossan formation, and the amount of scavenging is proportional to the amount of metal available. Thus analysis of coatings reflects the amount of metal in ground-water entering the stream.

This phenomenon has long been known in analytical chemistry, where, for example, trace elements including gold in sea water can be determined by adding Fe or Mn as a carrier to a large volume, followed by precipitation, collection and analysis of the solid phase. Manganese nodules in deep-sea sediments are a natural analog.

2) Advantages.

The main advantage of this technique is that it gives superior anomaly contrast and hence detectable anomalies at wider sample intervals, compared to conventional stream sediments where dilution by barren material is a problem. Sampling is also more constant, and the technique is reported as useful in glaciated terrain. This is because only hydromorphic, not mixed hydromorphic and clastic, components are favoured.

3) Analysis.

The samples are leached in a cold extractant such as hydroxylamine hydrochloride solution. This is a selective extractant of Mn, due to its reducing action.
Numerous other extractants have been proposed, and a thorough evaluation of which is best in this environment would require extensive laboratory trials. This is best done on orientation sampling proposed along Itat Ck., draining the Beatrice Prospect. (Mt. Lyell E L).

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4) Orientation Results.

These orientation studies have demonstrated that even apparently Fe coated pebbles (red-brown) rather than black Mn coated ones give excellent contrasting anomalies - eg. at Sock Ck., and around the Hercules mine workings.

Carpenter (pers. comm. 1978) proposed a normalization procedure for variations in Mn content by using ratios such as Zn/Mn, Zn/(Mn+Fe) and Zn/Co. (Co is scavenged most by Mn and if a constant, low background prevails, the Co levels will reflect intensity of scavenging). He also states that Pb is scavenged by Fe rather than Mn (this is known to be the case for As), and proposes the use of Pb/Fe ratios of the pebble leach solutions.

Barium is also scavenged by Mn oxides, the secondary mineral hollandite (occurs in the Dundas area) being a natural example.

Whitney (1975) noted some ambiguous relationships for Pb, with a tendency to follow Mn in those samples with high Pb concentrations, and Fe in samples with lower Pb values.

In the joint venture areas, Mn availability is not necessarily related to mineralization. Metal ratios to Mn and (Mn + Fe) have been intensively studied by the author in the orientation data, and, whilst showing up obvious anomalies, there are some ambiguities in detail. This is similar to the findings of Wagner et al (1978), who disagree with the ratio procedure proposed by Carpenter. They found that clasts of (excess) Mn ore in stream sediments would lower the base metal/Mn ratio, and that where abundant Mn is present, a high Mn and base metal content should be considered as indicators of mineralization rather than high base metal/Mn ratios.

These reports are in accordance with this West Coast orientation data, in that relative values of Cu, Pb, Zn and Mn in pebble coating leaches provide the most obvious and practical guide to mineralization, rather than ratios.

Consistent sample weight/volume relationships and leaching times must be maintained, however.

5) Routine survey usage.

Therefore, for routine survey application, hydroxylamine leach with routine analysis for Cu,Pb,Zn and also Mn, Fe, Co is proposed. Initially, the data for (Cu) Pb, Zn only should be plotted and obvious anomalies determined by inspection.

If results are stored on a computer data bank, it becomes a simple matter to try ratios (or combinations) to Mn, Fe and Co if desired, for re-interpretation.

Splits of the samples should be retained for any follow-up work, such as analysis of anomalous (Cu) Pb, Zn samples by acid leach for Ba, Ag and As. (on uncrushed pebbles).

Sampling density can be at least halved, relative to equivalent stream sediment surveys. More information on optimum sample density will be forthcoming after orientation along Itat Ck. (Beatrice prospect) is carried out.

In the initial stages of exploration, whilst the technique is still relatively new, conventional -80# stream sediment samples should also be collected at each pebble sample site, and results kept under review. Conventional samples are still needed if lithologic variations are to be "mapped" by multi-element geochemistry, although sampling density need not be as close.

All pertinent data on stream parameters, drainage lithologies etc. described under -80# stream sediment surveys should be recorded, and the data treated in the same fashion. Follow-up of anomalies is also as for stream sediments.

II. 4. Reconnaissance Soil Sampling.

Reconnaissance soil sampling is particularly useful in areas of high potential where a drainage network to permit reasonable coverage is lacking.

1) Litter sampling.

There is ample evidence that sampling of the organic surface litter (a form of recycled and homogenized vegetation sample) will reflect anomalous sub-soil values. Such evidence includes

a) the work of Farrell and Orr (1977) in Western Tasmania.

b) Thesis work by Russell (1976) at W. Hercules.

c) numerous overseas publications, plus the author's own experience, in similar soil types elsewhere.

d) earlier work by EZ (in conjunction with mercury analysis, which was spurious due to analytical interferences) over the Mackintosh (Que River) prospect.

e) results of orientation sampling carried out at W. Hercules and the Mt. Lyell areas by N.J. Marshall.

If any further litter sample orientation is desired over a known, strongly mineralized area, this could be carried out on lines 11500 N (anomalous) versus 10700 N (background) of the Rosebery Mine Grid. Line 11500 N gave good C horizon anomalies with supporting I P results.

The litter samples should be sieved free of mineral grains (or washed), dried at 120°c, pulverized and then analyzed by a wet ash ($HClO_4/HNO_3$) procedure for Cu, Pb, Zn, Mn.

Anomalous samples should also be checked for Ba and As in the same sample solution.
Litter samples are highly enriched in base metals, particularly Pb, relative to underlying soils, and must be consistently collected and compared only among themselves.

Litter samples(best developed in rain forest) provide a near-ubiquitous sampling medium in this environment, whereas soil profiles show a tremendous variation from place to place. Thus B or C horizon samples are not consistently available (or obtained by field assistants) in a regional survey, and, besides being more time-consuming to obtain by augering, are a source of high potential sample variability.

In areas where litter samples are poorly developed, such as bare rocky slopes, A_0 humus samples can be substituted, and also analyzed by a wet ash procedure. The change in sample type should be noted,however.

As illustrated by the Basin Lake orientation, care must be taken with A_0 samples to ensure consistency in the amount of (variable) barren quartz grains relative to active organic component. Otherwise false anomalies may result.

As with conventional soil sampling, gross changes in litter type must be noted - eg.) on line 800 W in the W. Hercules orientation, where thick rain-forest litter changes to thin ti-tree scrub litter on the higher, bare rocky slopes.

Reconnaissance litter sampling should be carried out on lines (which need not be cut), along breaks of slope; that is, above creek banks and parallel to contours.

A sample spacing of 50 meters along lines is suggested, with each site marked by flagging tape. Parallel lines should be placed from valley to top of each ridge, preferably along breaks in slope picked out from contour maps or stereo air photos.

The W. Hercules orientation data (hydromorphic anomaly in litter) suggests that spacing between lines of 200 meters should be adequate to detect this mineralization.

2) Detection of hydromorphic anomalies.

The objective of this sampling is to detect residual and/or hydromorphic (downslope displaced anomalies. Thus displaced anomalies can be detected in litter over glacial overburden. Such anomalies may find their way into streams by groundwater movement, and therefore this phase of sampling is a logical follow-up to detection of stream sediment anomalies - particularly pebble coated ones in glaciated areas.

Any terraced peat deposits or bogs should be sampled and parallel (contour) lines should be sampled above these. (Such micro-environments can act as a trap to prevent further dispersion down-slope).

3) Wad and talus sampling.

In addition, -80# samples and any Mn wad deposits should be collected from the base of any talus slopes, as these are also loci for the emergence of break-in-slope hydromorphic anomalies.

Such reconnaissance soil sampling would be particularly rapid and cost-effective if only a minimum of scrub cutting is done, and the suggested field positioning equipment proves to be practical. (Appendix B)

5. Reconnaissance Rock Sampling.

1) Wall-rock alteration and ore/gangue associated elements.

Sampling for Cu,Pb, Zn, Mn, Fe, carbonate, and the alteration elements K, Na, Rb, Ba, Zr, F, B, Ti, is advocated to detect wall-rock alteration and element association of the Rosebery footwall schist type.

There is good evidence from the W. Hercules orientation rock samples that Mn, K/Na ratios, Rb, K/Rb ratios, Ba and F are excellent guides to proximity of ore in the footwall altered host rocks.

All these rocks were reported by Beevers (pers. comm.) to be "highly reactive" with acid, due to abundant carbonate.

In the field, carbonate presence and relative abundance can be measured and logged on a relative basis by use of acid. Relative K content can be estimated by using a portable gamma spectrometer (K^{40} channel).

Tourmaline, sphene, fluorite and barite are known gangue minerals at Rosebery, (Braithwaite, 1969). Barium also occurs in altered wallrocks as a Ba rich muscovite mica (Gee, 1970), where Ba substitutes for K, as well as occurring as barite in gangue and in a zoned barite orebody.

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Hence B, Ti, F and Ba are potential guides to favourable host rocks.

Unfortunately, much of the detailed thesis work on Rosebery and environs concentrated on traditional silicate analysis and a few trace elements amenable to simple atomic absorption determination. These are not very diagnostic in view of the environment of rapid volcanic/pyroclastic deposition.

The more diagnostic elements such as Ba, B, F, As, Rb tend to have been overlooked, whereas major silicate elements are by definition confined to narrow compositional variations within an acid volcanic environment. Attempts by several theses authors to solve classification using sophisticated methods such as multivariate factor analysis were unsuccessful because the variables chosen (eg. SiO_2) had little diagnostic power and the data formed a closed array (added to 100%).

In this report, alteration rock studies have been suggested on Mt. Lyell ground in the White Spur and Beatrice grid areas, to define "more favourable" sub-areas within Cu-Pb-Zn anomalous zones.

If further orientation work is desired on rock alteration elements, the Rosebery mine grid, lines 11500 N and 10700 N may provide a suitable case history.

2) Routine analyses recommended.

The most cost-effective approach to alteration rock analysis is:

a) Emission spectroscopy scan for B, Ba, Ti, Zr.

b) Follow-up of anomalous Ba by XRF (more accurate).

c) HF/aqua regia digest and atomic absorption for K, Na, Rb, Mn, Fe, Cu, Pb, Zn.

d) As from above solution by hydride evolution (if base metals are low - these interfere by suppressing As evolution) or colorimetry, using digest solution c).

e) F by NaOH fusion and selective ion electrode.

f) The analyst should be requested to note carbonate reactive samples. Quantitative carbonate analysis can be done by Leco induction furnace and weighing of evolved CO_2.

6. <u>"Plumbing System Samples."</u>

These are also a useful guide to proximity of blind mineralization, particularly in glacial covered terrain.

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These consist of Fe, Fe/Mn and Mn (wad) secondary oxides developed in fault planes, joints, and shear zones in rocks. They also occur on exposed seepages in creek banks and glacials, and as recent material cementing rock scree.

These should be collected and analyzed by an acid dissolution procedure for Cu, Pb, Zn, Mn, Fe, Co, Ba (by AAS). Anomalous samples should also be checked for Ag and As. The Co values are a guide to relative enrichment by scavenging, as Co is a low background element in this terrain. Any anomalous base metal values are likely to be valid unless Co is highly enriched (50-100 ppm) in the sample. Orientation studies have shown that this is not the case, and "scavenging" to produce false anomalies is not as great a problem as previously assumed. In fact secondary Mn oxides are a valuable sampling medium in this environment.

7. Detailed Rock Samples.

These should be collected from drill core, costeans and outcrops encountered during follow-up grid survey.

The usual rock alteration elements discussed previously should be determined, at least at fairly regular intervals to give sufficient samples (say 10-20) from each costean, drill section or grid area to help classify associated Cu Pb Zn mineralization. The base metals Cu, Pb, Zn and Mn should also be determined, along with Ag and As.

Total sulfur values (by Leco induction furnace and iodimetric titration) may also be useful.

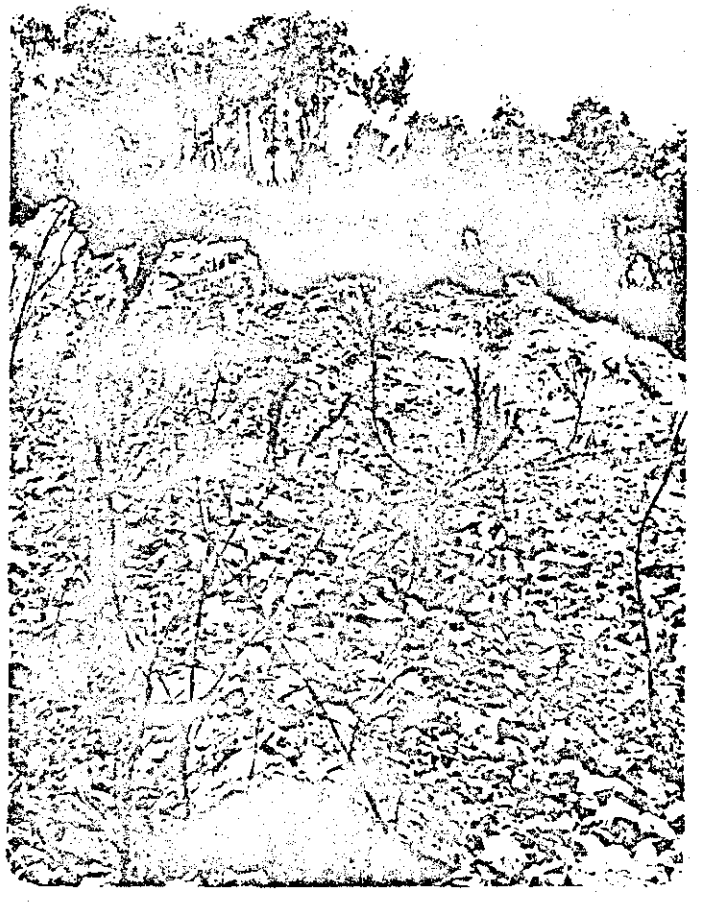
All drill core should be logged with acid for carbonate content, and thin and polished sections made where appropriate.

In sampling drill core, a core shaving device such as that built for CRA Exploration Pty. Ltd., by the EBR railway workshops in Burnie may prove useful.

Representative sections of drill core host rock lithologies should be sampled in addition to mineralized sections, and analyzed for base metals, Mn and alteration element assemblages. In this way, a case history file will evolve which will enable more confidence to be placed on future classification procedures.

If the data are recorded on a computerized data bank, it can be readily updated with future information such as extra analyses (all samples must be retained). Any sophisticated multivariate classification procedures can be readily tried at any stage once the data are in this accessible form.

"Plumbing system"sampling is also applicable at this detailed scale.



II. 1. Queenstown - Strahan Road. Litter (A_{00}) overlies thin A_0 and A_1 on bedrock siltstones. Juvenile soil -stony lithosol.



II.2. Queenstown - Strahan Road. Closeup near II.1. Stony lithosol (skeletal mountain talus soil), juvenile, with poor profile development (azonal) except for overlying A_0.

120139



II.3. Queenstown - Strahan Road. (halfway) Thick peaty, wet soil A_0 horizon under cutting grass (swampy), overlies slightly bleached A_1 organic soil at hammer point. Soil is juvenile and sits directly on bedrock siltstones.



II.4. Queenstown - Strahan Road near Strahan. 50 m E of 2/7. A_0 A_1 soils on B horizon over partly consolidate C horizon parent glacials. B horizon development is very localized in this area.

120140



II.5. Glacial soil profile, Beatrice drill site access road. Parent boulder clay overlain by leached A_2 horizon with thin cover of litter.



120141

II.6. Relict placosol podzolic soil
Queenstown -Strahan Road, near Strahan. A_0 and A_1 dark humus soils overlying leached A_2 horizon on C horizon boulder clay (glacial) grading into less weathered parent glacial (D horizon) at depth. Incipient B horizon development below A_2. Dark band is placon of Fe/Mn oxides.



II.7. 3 km. W of Queenstown.
Complex example of localized fossil soil horizons due to scour and fill. Bedrock is black shale, leached toward top (incipient C horizon development). Overlain by layer of transported quartz rubble filling depressions in bedrock surface. Overlain by strong A_0 soil poorly differentiated into a lower A_1 zone.

Hammer point - overlain by weathered, Transported shale rubble, which in turn is overlain near surface by A_0 poorly differentiated into a lower A_1 zone.

1201142



II.8. 6.0 km. S of Zeehan junction, on Queenstown highway. Highly weathered sediments (C horizon) with large patches of Mn wad (on right - sample 24537). note A_0 horizon and lack of B horizon.



II. 9. Henty River - note tannic and humic acids producing deep brown color.

1201143

II. 8. Detailed Soil Grids.

These are carried out at the penultimate stage of follow-up, (prior to costeaning) on geophysical anomalies, and/or follow-up of more widespread geochemical sampling as previously described.

II.8.1. Barren sulfide responses.

Where soil sampling over prominent I P responses fails to produce well defined anomalous zones in base metals, it must first be ascertained by examination of soil profiles that the sample medium is valid for reflecting any bedrock mineralization. ie.) thick glacials, or placosol soils are absent. It may be necessary to dig several pits to ascertain the true nature of the profile.

If the sampling appears valid, then re-analysis of one or two critical lines should be carried out for As, Fe and $SO_4^=$. Anomalous arsenic, iron and soil sulfate, unsupported by base metal anomalies, will help explain any I P responses due to barren pyrite. Relatively anomalous Ni values (for acid volcanic terrain) may relate to pyrrhotite.

2 Soil types.

A great variety of local soil types exists in this complex environment, due to changes in topography, rock type and vegetation. A complicating factor is that these changes can occur several times over any one grid, and each change may alter relative background levels and responses to anomalies.

It is imperative to interpretation that these changes be recognized, coded on the recommended computer data bank forms, and mapped. Digging of pits over several sub-areas of a grid may be necessary, as reliance on hand augering can be risky.

Some of the soil profiles are illustrated in the photos accompanying this text report. Further profiles are illustrated in the data sections of the Mt. Lyell and E Z reports in connection with specific orientation surveys in these areas, and reference should be made to these.

The following soil types have been recognized.

II. 8. 2. 1) stony lithosols, or azonal soils.

These juvenile soils are characterized by a lack of profile development, except perhaps for a thin veneer of litter and A_0 humus, overlying a grey, somewhat bleached sandy loam. This is generally thin, rests directly on fresh bedrock, and contains numerous fragments of rock scree.

The Beatrice "Porphyry Hill" area and the upper slopes of the W. Hercules orientation line are typical examples.

Apart from any litter (A_{00}) or A_0 organic horizon which may be developed, sampling of any part of this azonal profil will give equivalent results, and augering is not necessary. "Bedrock chips" obtained by augering are probably largely transported down-slope, as is much of the soil, by solifluction.

Thus soil anomalies should be followed up-slope and backed up with extensive rock sampling of outcrop.

See photos II.1, II. 2.

2) glacial cover and overlying soils.

Valley glaciation gives rise to scour and fill local boulder deposits (usually Owen Conglomerate) in a matrix of water-worn quartz sand and boulder clay. The latter usually makes the soil impervious and water-logged.

The glacial cover may be thick and extensive near the Owen Conglomerate source, as at Basin Lake, or variable and patchy (filling local depressions), as at White Spur and Beatrice.

A variety of soil types can develop on top of the glacials, which, like bedrock, are regarded as "parent material" in soil terminology.

Depending on local conditions and soil maturity, soils developed on glacial cover can range from azonal lithosols (virtually bare, exposed glacials), through moor peats on glacials, (Basin Lake grid, especially N W area; also photo II.3) to a full profile of A and B horizons as in photo II.4

The latter situation appears to be rare, however, and most glacials are overlain by moor peats or azonal, immature soils with a leached A_2 horizon below A_0 and litter - see photo II.5

Fluvioglacial varve deposits also occur (eg. near Howards Anomaly). These are likely to form a barrier to geochemical dispersion, unless thin enough to give a response in any overlying litter or A_0 via vegetation recycling.

(i) Sampling.

Ideally, glacials should be sampled for -200# fine material at the base, just above bedrock, and cold extraction analysis carried out to detect hydromorphic dispersion from bedrock. This is difficult to achieve in practice, although the suggested auger device detailed in the reprint in the Appendix may help.

Panning glacials to detect heavy minerals (galena, sphalerite and barite) may also assist, but this is a more regional technique.

Most glacials are best sampled by using the litter or A_0 fraction. Hence augering is unnecessary unless substantial penetration, almost to bedrock, can be achieved.

(ii) Dispersion mechanisms.

Even where vegetation cannot penetrate glacial cover, as at Basin Lake, there is a possibility that any substantial underlying orebody will set up an electrochemical cell causing metal ions to migrate upward and outward from the deposit, to form a "rabbits ear" double anomaly. (low zone over the deposit). This has been well documented in recent overseas literature. Accompanying electrochemical migration of base metal ions, there will be an increase in other (including major element) ions in the pore fluid, such that soil conductivity readings will increase and also form a "rabbits ear" anomaly. These chemical manifestations of the self potential effect can be detected by taking soil conductivity readings with a simple meter, and by analyzing for cold extractable base metal in the soil.

Any base metal ions in the pore fluid of glacial soils should also be fixed and enriched in the overlying organic horizon.
Unfortunately the Basin Lake orientation failed to give unequivocal evidence of conductivity anomalies or "rabbits ear" metal anomalies, presumably because mineralization is too weak. A response to the altered and weakly mineralized zone was detected, however.

To more definitively test the application of electrochemical migration through glacials, as an exploration technique, orientation over massive mineralization such as at Koonya (E Z mine lease) should be carried out.

Local glaciation as at Beatrice may physically redistribute mineralized bedrock such that it is caught up in the till itself. This would give a surface geochemical response similar to that from mineralized bedrock as parent material. Such situations can be identified (as anomaly follow-up) by panning to look for mineralized boulders in the till.

Hydromorphic anomalies can occur in glacial cover, where ground-waters containing base metal ions flow downslope near the glacial/bedrock interface and emerge at the break in slope.
Frequently, these groundwaters carry Mn which precipates as Mn wad in seepages in glacials and coprecipitates metal ions. Such "plumbing system sampling" is invaluable as a guide to proximity to mineralization in glacial terrain. (eg. Beatrice, sample 24527, photo II. 1 in Lyell rept. part II).

(iii) Recommended routine approach.

Despite the problems associated with valley glaciation, surface geochemistry does work in a general sense, due to a combination of the discussed factors. The Beatrice grid results are evidence of this, as is the recent publication by Farrell and Orr (1977), and various reports in the overseas literature.

As a routine survey application, sampling of litter or A_0 soils over glacials is recommended. Samples should be collected so as to maintain a constant proportion of organic component (see Basin Lake results), or else gross variations in the proportion of organics to inert glacial sand must be allowed for. There is probably no useful purpose to be served by augering into glacial material unless it can be penetrated to the base. The samples should be wet-ashed ($HClO_4/HNO_3$) and analyzed by AAS for Cu, Pb, Zn, Mn, Fe.

In areas where glacial development is sporadic, care must be exercised to recognize and map these. The presence of rounded Owen Conglomerate boulders on surface is a good indicator where exposed profiles are lacking. In doubtful cases, washing the clay from suspected glacials will reveal rounded, poorly sorted quartz fragments.

When routine litter or A_0 sampling is undertaken, sample variability is further reduced. The practice of augering to "B" or "C horizon" has introduced much data variability where sporadic glacial cover occurs.

II. 8.2. 3) Placosol soils. (see photo II. 6)

These probably occur fairly extensively on glacial cover. They are defined as "an accumulation of humified organic material above a leached near-surface mineral soil horizon underlain by an impermeable iron oxide layer"....."The most important feature of placosols is the placon, a thin (1-30 mm) iron oxide layer, that forms 20-150 cm below surface. The placon is essentially impervious to water and effectively divides the soil into two separate hydrologic and chemically dissimilar environments. Due to strongly acid conditions above the placon, base metals are leached from the soil and severely depleted or completely absent in the -80# fraction. Below the placon, chemical conditions are reducing and neutral to slightly basic; metals are relatively stable and distribution patterns reflect those existing before placon development". (Tilsley, 1977).

Placosols form under cool, abundant rainfall conditions where pre-existing soils (particularly glacial boulder clays) become water saturated. This generally occurs down-slope from freely drained soils. Humic acids from the overlying vevetation will leach metals downward from the underlying soil to form a bleached A_2 zone, (podzolic soil development) and precipitate an impermeable limonite layer (placon).

This prevents drainage and promotes water-logged soil, anaerobic conditions and development of peat.

The soil below the placon may be relatively dry. Blanket peats, "perched ponds" on glacial deposits and perched water tables are usually the result of an underlying impervious placon.

Placon development is a transient condition in immature soils, and Tasmanian situations are probably relict placons, which can be localized and sporadic. These would give rise to a low geochemical response occurring as a "window" of low background in a soil survey.

(i) Chemical dispersion - distribution of anomalies.

Below the placon, groundwater movement downslope can take place, and hydromorphic anomalies will develop in streams and at seepages in breaks of slope, as well as where placons are breached (relict placons) by subsequent soil development. The placon is absent at the spring line.

The peat layer may act as a metal collector in such situations, whereas organic or inorganic soil samples collected above relict placons will be ineffective due to metal depletion through leaching, and isolation from any mineralized pore water by the impermeable membrane.

(ii) Recommended follow-up in routine survey.

The practical effect during routine soil surveys is that any anomalous responses must be examined for hydromorphic dispersion below a placon layer. Anomalies in water-logged soil should be followed upslope by depth profile sampling, digging pits if necessary, to recognize any placon layer upslope of the surface anomaly. This layer must then be penetrated to sample the C horizon to locate the source of the anomaly.

II.8. 2. 4) Podzol soils.

These are the normal mostly residual soils which are well developed at Howards Anomaly, Henty River, White Spur, Beatrice and the lower slopes of W.Hercules. They can, however also develop on glacial material (see photo

In a local sense, the soils may be somewhat transported downslope by solifluction.

Hydromorphic displacement of anomalies for large distances downslope, as at W. Hercules, can be a problem.

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Thus any anomalies must be followed upslope to their source by sampling to bedrock.

Podzols are defined as leached soils with good profile development, and form in wet, temperate to cold climates. They are characterized by an A_1 organic rich soil layer (often overlain by A_0 humus and A_{00} litter), underlain by a generally thin bleached A_2 horizon of sandy loam, which in turn is underlain by a red-brown or yellow (or mottled) clay rich layer - the B horizon. This is underlain by C horizon weathered rock and D horizon bedrock. Not all layers may be obvious in any one profile, however.

Humic acid rich solutions and high rainfall cause a downward leaching from the organic layers (A_0 and A_1), and strongly leach the A_2 layer, which is the zone of maximum eluviation of clay, iron oxide and organic matter.

(i) A_2 horizon - avoid sampling.

The A_2 layer is easily recognized as a light colored (off white to pale grey) sandy horizon.
Sampling of A_2 must be avoided at all costs, as negative responses may result. Sampling crews must learn to recognize this horizon so that it is not inadvertently sampled during a routine survey.

(ii) B horizon sampling.

The B horizon is the zone of maximum accumulation of clay minerals and iron oxides, and is characterized by a reddish color and prismatic or blocky structure. In poorly drained, water-logged soils, anaerobic conditions prevail and the normally red ferric clay may take the form of greenish ferrous clay. To assist soil sampling crews in recognizing these profiles, small plastic vials containing undried whole soils should be carried for reference.

The top of the B horizon provides the ideal sample medium for geochemical surveys, and is preferable to C horizon rock samples as it gives an elevated response, is easier to collect, and is easier to prepare. Drying and sieving to -80#, with analysis by AAS from a simple acid digest is all that is required to give excellent results.

(iii) C horizon sampling.

Bedrock samples, where comparatively unweathered, (strictly D horizon) tend to give a very erratic and spotty distribution of metals due to their extremely localized influence relative to soil. In a disseminated mineralization environment, base metal C horizon responses can be erratic due to presence and absence of stringers of sulfide. Alteration element responses will be more uniform, however. C horizon sampling for base metals therefore requires closer spacing than equivalent B, A, or A_0 sampling.

Thus C horizon sampling for base metals (as opposed to "alteration elements" and Mn) is only recommended at the final follow-up stage, such as examining soil anomaly sources upslope for hydromorphic displacement, or narrowing down residual soil anomalies.

(iv) Recommended routine soil sampling.

Orientation sampling, as well as extensive documentation, has demonstrated that sampling A_{00} (litter), A_0 or A_1 organic soils can give equivalent survey results to B horizon sampling. Background levels may be elevated,and not as uniform, due to organic enrichment, and contrast may not be as great, however, as in B horizon soils.

However, unless B horizon can be consistently and readily sampled in practice (as at Henty River Grid), sampling of the organic rich surface horizons may be preferable.

(v) Types of podzols in this area.

In the areas studied, true podzols, grey brown podzolic soils, yellow podzolic soils and gley podzols (groundwater podzols) have been recognized.

True podzols have a highly leached, whitish A_2 horizon with little dark A_1 development.

Grey-brown podzolic soils are less severely leached,occur in warmer microclimates, and have a thin, dark A_1 horizon and a greyish-brown leached A_2 horizon. They are commonly developed on glacial soils in the region.

Yellow podzolic soils occur in the more humid rain-forest on well drained slopes, and are characterized by yellow, limonitic B horizon. Henty River grid is a good example.

Groundwater podzols are water-logged soils with a peaty layer and predominately reducing conditions. Thus the B horizon is a greenish or bluish-grey color due to Fe^{2+}, although seasonal wetting and drying may cause mottling of ferric iron oxides to develop.

II. 8. 3.
Summary Statement.

The soil variation in this area is quite complicated and can vary locally in any one grid area.

Every attempt should be made by examination of profiles, digging pits where necessary, to recognize, code and map soil variations, and particularly the occurrence of glacial cover.

Field crews should be instructed to recognize these variations if possible. Standard reference vials of whole, undried soil profiles may assist.

In areas where B horizon is readily and consistently available, this should be sampled in preference to C horizon.

In more complex areas, sampling of litter, A_0 or A_1 (consistently!) will generally suffice, and has the advantage over augering in speed and reliability. B horizon sampling, using augers, should be done where possible as follow-up of anomalous zones.

C horizon (weathered bedrock) and fresh bedrock sampling (D horizon) is recommended where practicable, at the final follow-up stage, for delimiting broader A or B anomalous zones, and defining the source of hydromorphic soil anomalies.

A_2 horizon sampling must be avoided.

II.9. Hydromorphic Anomalies in Soils.

As discussed in the previous section, hydromorphic anomalies in soils (as at West Hercules, where displacement from source is 300 meters) are likely to develop, particularly on steep slopes or where complex conditions (placosols) or thick glacial cover prevails.

1) Recognition.

Hydromorphic anomalies can be recognized by:

(1) Their distribution and relation to topography. (breaks in slope).

(2) Their pattern - dispersion tends to be fan-shaped, becoming weaker and wider downslope.

(3) A Cx/total (1 N HCl versus $HClO_4/HNO_3$) ratio approaching 1.0. This is only applicable for loosely bonded metals in B horizon soils, as metals in organic rich soils are more strongly bonded and clastic components tend to be absent.

(4) Values along the zone will tend to be more uniform (low variance) than residual values near the source, due to the effect of the homogeneous solution front.

(5) There may be an association with Mn wad formation.

(6) Displacement downslope from I P anomalies.

(7) Soil conductivities and cold extractable soil metals may give an asymmetric (downslope)"rabbits ear" anomaly where electrochemical dispersion prevails.

(8) Hydromorphic anomalies will tend to be highest in the finer fractions, whereas residual anomalies are more uniform in all size fractions.

(9) Hydromorphic anomalies in B horizon soils will be greater for mobile elements in the fine fraction but resistates such as Ba, Sn, B and Ti will favor coarser fractions further uphill.

(10) Metal ratios characteristic of ore will differ when fractionation occurs due to secondary processes. Fractionation will increase with distance travelled.

2) Tracing hydromorphic anomalies to source.

The following procedures are suggested for tracing hydromorphic anomalies at their source.

(1) Use any upslope geophysical response as a guide.

(2) Use any favourable mapped contacts or tectonic features upslope as a geological guide.

(3) Carry out sampling to bedrock or take outcrop samples where possible on one or two lines across the anomaly. Analyze for base metals and alteration assemblage metals and follow up-slope.
For example, the W. Hercules orientation demonstrates that the major hydromorphic soil (in B horizon and litter) base metal anomaly is unrelated to bedrock source. The bedrock source, although low in base metals throughout, (one minor exception) shows systematic decrease in Fe, and increase in Mn, carbonate, Ba, Rb, F and K/Na ratio as the orebody source is approached. This effect persists well beyond anomalous Cu Pb Zn bedrock.

(4) Sample soil profiles systematically with depth and follow-uphill on one or two lines across the strike of the anomaly. Within any one soil horizon, values will increase with depth as the residual source is approached.

(5) In the immediate proximity to ore, bedrock sampling will reveal base metal mineralization, as can soil sampling. This is more localized than the alteration assemblage effect discussed in (3) above.

(6) If two parallel anomalous soil zones occur, the uphill one may represent residual anomalies in underlying bedrock, and the downhill one the same anomaly displaced hydromorphically.

II. 10. Data Recording and Plotting.

All samples collected routinely should be coded and filed in a computerized data bank, with relevant parameters such as lithologies soil type, downslope direction and grid coordinates. Coordinates should preferably be the Australian Metric Grid, or alternatively some large local grid system referenced to a remote south-west origin. (all lines are eastings and northings only). Sub-grids, local use of shifting base line references, references to west and south directions etc. should be avoided as these can lead to confusion with machine plotting.

1) Digitizing coordinates.

Old grids, those where sample lines are not ideal, and stream sediment surveys can be coded to a universal grid reference system for subsequent machine plotting with an on-line computer and digitizing table.

In the case of stream sediments, digitizing is readily done from a simplified drainage map showing sample numbers.

Soil grids with irregular lines can be digitized at the ends of each line and at any points of inflexion; thence true intermediate sample grid references calculated and plotted by computer.

2) Computer Forms.

Suitable computer compatible combined field and lab. sheets for all routine soil, rock and stream sediment surveys in this area will be prepared separately, at the local request of the joint venture operators.

3) Sample submission requests.

A simple multiple choice format should also be designed for sample submission to the laboratory, specifying analyses and methods requested.

4) Plotting and interpreting stream sediment and pebble leach data.

Initial interpretation of stream data would consist of data bank listings, and hand drawn, colored "worm diagrams" on simplified drainage base overlays (at geological or photogeological map scale). Separate transparent base overlays to the photogeologic map base should be used for Cu, Pb and Zn, using some arbitrary color code for these worm diagrams, such as red, yellow, green for "strong", "moderate" and "weak" anomalies, with values plotted against each location.

Machine plotting of raw data is convenient on separate overlays. Further interpretation from the data bank would involve automatic sorting of geochemical values related to various drainage basins and lithologies, with plotting of histograms and simple statistical parameters.

Final interpretation may invoke more complex multivariate statistical processing such as plotting ratios, linear regression to correct for varying Fe and Mn contents and stream rank, factor analysis to "map" lithologic variations, etc.
All this is easily and cheaply accomplished, relative to the cost of sample collection, once a suitable data bank is devised.

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5) Plotting and interpreting soil grid data.

Initial interpretation of soil grid data is best done by machine plotting (using corrected, digitized grid references) separate Cu, Pb, Zn and Mn stacked profile maps on mylar overlays to the geologic base map and topographic map.

Plotting of actual raw data values is not recommended as this is of no use for pattern recognition, and raw values can be referred to on the data listings. Machine wise this is difficult and expensive.

Contouring is also not recommended, as it invokes the use of arbitrary threshold values which may distort the pattern due to changing backgrounds and geochemical responses. This is particularly a problem over large grids with complex lithology and variation in soil type. Machine contouring can also be relatively expensive.

Stacked profiles, either as line profiles or, preferably, small vertical bars along each line at each sample point, are recommended.

These have the advantage that patterns such as anomalous zones and lithologic changes can be readily seen and mapped from line to line, despite shifting background levels.

A major advantage in complex areas is that anomalous patterns can be seen through background variations (unlike contour maps), and sample variability effects are minimized.

Moreover, the dimension of data variance is introduced, which is difficult to assess on a large sheet of raw number values, and is artificially smoothed out in machine contouring.

Further interpretation such as examination of element ratio plots merely involves the cost of machine plotting another stacked profile map; a task which one would hesitate to try by manual methods.

Such machine plotting is rapidly and cheaply accomplished at rates competitive or cheaper than tedious manual drafting.

6) Progress Maps.

During a lengthy survey, individual lines can be machine plotted on paper strips on a regular turn-around basis. These can be pasted onto a base sheet to provide an up-to-date progress map.

III. DEFINITION OF GEOCHEMICAL ANOMALIES - discussion of pattern recognition.

These have often been defined as values in excess of mean + 2 standard deviations, the data having first been converted to logarithmic values (or plotted on cumulative log-probability paper). Trace element data often appears log-normally distributed; however there is no a priori reason why this should be so, and other distributions such as the gamma distribution may give a closer fit, but are difficult to manipulate. Also, an appearance of log-normality can be due to artificially truncated data where values have a lower cut-off due to analytical detection limit. Overlapping populations due to geochemical dispersion processes can distort log-normal data toward a more normal distribution (Central Limit theorem).

For example, in the Lake Beatrice annual report, Hutton defined thresholds as values in excess of 100 ppm for Cu and Zn, and 300 ppm for Pb, on the basis of cumulative log-probability plots.

However, the cumulative percent frequency graphs for Pb and Zn show a complex structure due to overlapping populations, which is due to the various rock types covered, plus the extra complication of changes in soil type (stony lithosols over the quartz-feldspar porphyry, mature soils in the valley).

There is also the local presence or absence of glacials, and whether sampling was of A_0 , A_1, or B horizon (depending on profile development and the ability of the auger to penetrate).

Hence this "global" statistical approach is not advocated where this type of problem occurs.

Hanson (1977, "fig 6" series) plotted cumulative plots for Cu,Pb and Zn on the Boco grid. The Pb and Zn plots show several straight line segments indicating a series of non-overlapping, well separated log-normal populations.

Overlapping populations can be sorted out and threshold values assigned to each, using the methods of Sinclair (1976) .

Figs 7a and 7b are frequency/probability plots for Pb on the Lake Beatrice Grid, on lines 14 N to 20 N, (predominately residual soils) and lines 8 N to 12 N (predominately over glacials - M.J. Hutton, pers. comm. N.B. glacials not shown on map for sampled portions of these lines).

These plots were also done without prior separation of rock type, and several overlapping populations can be seen.

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Population A is clearly defined in both figures, whereas B,C (and D) have a large amount of overlap. In fact on fig. 7a, populations B,C and D, although probably real, are contained within the 95% confidence belt as defined by Lepeltier, (1969), so can to a first approximation be treated as one.

In plotting figs 7a and 7b the recommended practice of assigning about 15 equal (log-normal) class intervals throughout the range has been followed, (after disregarding a few extreme high values) with cumulation from highest to lowest value. This avoids losing the important anomalous values through inability to plot them on probability paper.

Many such graphs can be drawn, for each element, element ratios, over each rock type, soil type etc.

To do this by hand is very time consuming and was therefore not pursued further - such data manipulation is best done by computerized methods between field seasons.

The definition of anomalies as mean + 2 standard deviations is purely a statistical concept without any necessary significance in the geological sense.

Thus if all samples were taken from the one site, a cumulative curve could be drawn which would show only one population, a steep slope (ie narrow spread of values, small variance due to analytical + sampling errors) and define 2½% of samples as anomalous.

The main use of such graphs is in defining populations (including overlapping ones), which can then be related to lithology changes and mineralization. This can be useful when working in areas of deep cover where geology is inadequately known, or in regional stream sediment work where drainage geology is not well mapped.

Since the Beatrice Grid is over well mapped geology, there is no point in using such graphs to define populations.

The important point is that geochemical anomalies are best defined by a pattern recognition process, considering all variables (geology, geophysics, structural disturbances, and all elements together) simultaneously.

It is not only what values are high, (eg over 100 ppm) but where they occur on the map, with their spatial relationship to geologic elements and to all other significant geochemical elements.

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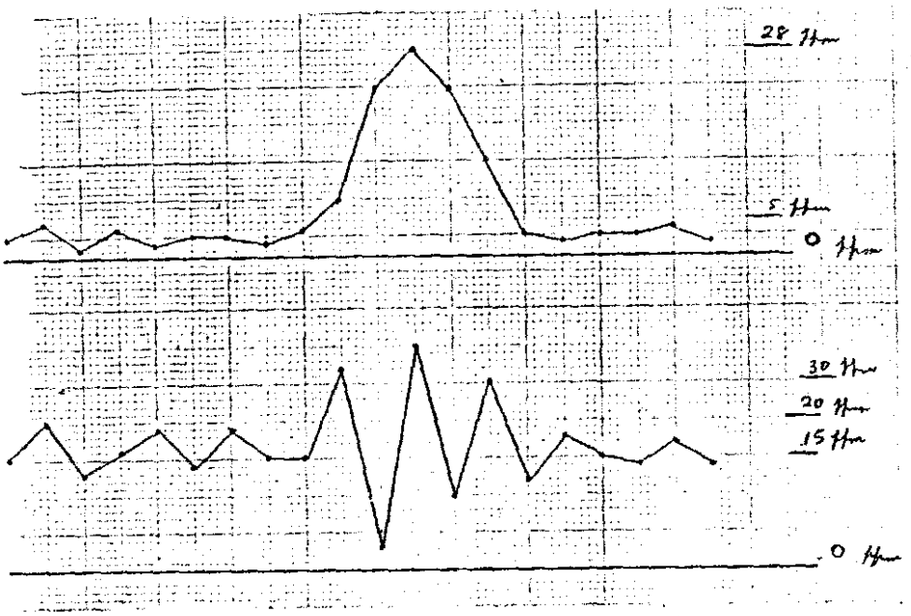
Another feature which is often not considered by global application of univariate statistics is that anomalies over mineralization tend to have a higher variance, (ie are more "noisy") than those over background areas. This is apart from high values occuring as such. The diagrams below show the effect of signal/noise ratio on anomalies.



idealized anomaly concept of a high zone

variance anomaly concept

In the variance anomaly concept, the anomaly forms a zone of individual high and low peaks, but the highs are not necessarily obvious if taken as numbers in isolation from their surroundings.

Similarly, metal ratios may be highly correlated over one rock type (eg Pb/Mn in altered tuffs at Beatrice) and not correlated over another (eg Pb/Mn over quartz-feldspar porphyry at Beatrice - see plots for line 16 N; figs. 10a,10b,11a,11b).

A global statistical approach could distort this Pb/Mn correlatic depending on the relative proportions of samples taken over each rock type.

Hence in the first instance, stacked line profile plots at map scale are advocated as a pattern recognition process. A separate map should be prepared for each element, and overlays all compared with each other and the geological (and topographic map base at the same scale to visually recognize anomalous zones and trends.
This is also a fairly time consuming process, and best done by computer plotting once a data management file has been established.

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IV. COST ESTIMATES FOR PLOTTING STACKED PROFILES

Discussions were held with Earth Science Computer Corporation, of 556 Princes Highway, Rockdale, NSW. (telephone (02)5972241) on this subject.

This organization is experienced in plotting magnetic profiles, contours, and stratigraphic sections and produce a high quality product at rates which are difficult to match by manual drafting of equivalent quality.

To carry out an initial trial on a small area, such as the N E quadrant of the Mt. Lyell White Spur Grid, which involves about 250 data points for 4 elements (Cu Pb Zn Mn), the cost breakdown is:

1) Digitizing.

Ends of lines and points of inflexion would be digitized from the base map provided, and referred to an arbitrary grid origin such as the S W corner of the map. (unless an AMG grid reference is provided).

Cost = $30.

2) Program development. (once only charge for this and subsequent work).

A small program must be developed to calculate grid references for intermediate sample points between the digitized ends of lines and points of inflexion.

Cost = $50.

3) Punch data onto disc file from result sheets; 250 points for 4 variables.

For small jobs this is usually sub-contracted out at cost price, which is 14 cents per punch card, including verifying, and the data transferred to disc.

Cost = $35. (alternatively, these data can be punched at Queenstown or Rosebery.

4) Plotting program development. (once only charge for this and subsequent work).

A small program will be developed to enable optional line profiles and/or bar profiles to be plotted at a suitable vertical scale. eg.) 1 cm. = 100 ppm. Scales can be changed optionally. Off-scale results, which would cross onto the next line, can be identified by using a system such as one or two arrow-heads at the upper plotting limit to identify relative strengths of off-scale anomalies.

Cost = $100.

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5) Plotting.

It is suggested that initially two elements be plotted as line profiles and two as bar profiles to see which method gives the better presentation.
Cost is $30 per plan (per element) for each small mylar transparency, irrespective of whether line or bar profiles are produced. Thus for $120, 1,000 data points have been accurately drafted.

6) Ratio plots.

Plotting of ratios such as Zn/Mn or (Cu+Pb+Zn)/Mn can be done at no extra cost save the standard $30 per plan. For plotting production sized jobs, such as the entire White Spur Grid (approx. 1,000 sample points), costs are:

1) card punching and verifying at 14 cents per card — $140 - 00

2) digitizing end points and inflexion points on lines, at $2.50 per line for digitizing, plus $1 per line to interpolate intermediate stations.
35 lines at $3.50 per line — $122 - 50

3) Plotting profiles on mylar, at $100 per A_0 sheet
Cu Pb Zn Mn — $400 - 00

total — $662 - 50

4) Ratio plots - at $100 per sheet.

This is a comparatively small outlay for the interpretation of 4000 data values, considering the collection and analysis costs of the 1000 samples involved.

Costs for the E Z Mt. Black sheet 7 would be on a similar basis for plotting, with variations depending on number of cards punched and lines digitized.

V. BRIEF OVERVIEW OF PREVIOUS E.Z. GEOCHEMICAL EXPLORATION.

1. Introduction.

Two joint venture areas are currently being investigated with Getty Oil Development Company Limited. These are:

1) The Bulgobac E L
2) The Mt. Black E L, which abuts Mt. Lyell's E L including the White Spur area, to the south.

Of these, the Bulgobac area is the smaller, and has seen the most previous activity, mainly geophysical, with some further stream sediment and soil sampling envisaged. Several reports are available on this E L, going back to activity before the Getty joint venture was undertaken.

Due to time considerations, and the fact that specific sites within these areas were not visited by the author, a detailed evaluation of data has not been undertaken. This can be done, on request, as a further assignment, but for the purposes of this report, it was felt more desirable to concentrate on more general aspects of West Coast geochemical exploration, as exemplified by the orientation case histories carried out.

The Mt. Black area is the subject of a major joint venture program ($200,000 spent since April 1, 1978), and approximately 50 line km. of "C horizon" geochemical sampling and analyses have recently been completed. A summary report on this work is not yet available.

2. Sample Collection.

Previous geochemical work on the Primrose clastics (possible equivalent of Queenstown pyroclastics) involved "C horizon" auger sampling to obtain (weathered) bedrock chips at 100 ft. intervals on cut lines 800 ft. apart.

Some fill-in lines were sampled at 50 ft. centers along 400 ft. line spacing.

The comment was made that in many cases no major difference in patterns was obtained between "A" and "C" horizon samples, both having been sieved to -80#. Sampling was carried out by field assistants.

However, an examination of the logged descriptions, (Appendix B in rept. 128 by N.H. Hanson on the Bulgobac E L) confirms that there is a variety of samples of different colors, ranging from peat to clay and sand.

These can not be C horizon, and seem to represent a mixture of various types including A_0, A_1, A_2 and B.

This can only give rise to an erratic distribution of backgrounds and responses.

Thus detailed interpretation of plotted results is not possible, until soil types are separated out and compared consistently.

Any A_2 samples included may give negative responses even over mineralized ground.

Glacial cover is of course, a further problem, but has been recognized in the broader sense.

Hammer siesmic surveys may prove effective in determining thickness of glacial cover, where the underlying bedrock is fresh and hard.

The W. Hercules orientation study demonstrated that bedrock chips, which are usually fairly fresh, are sieved out and the resultant sample can range from B horizon to azonal A_0 soils depending on conditions along the line; not "C horizon". Hence the displaced anomaly (300 meters downslope) is not reflected in bedrock.

The Mt. Black (Mt. Sale) data recently collected has been analyzed by Analabs for Cu, Pb, Zn, Fe, Ag.

Silver analysis is not recommended, except as a confirmation of base metal anomalous samples, and Mn would be a more useful indicator than Fe. (oolitic Mn carbonates are associated with ore). Arsenic and sulfate analyses may be useful to confirm barren base metal zones having anomalous I P response.

Samples (Mt. Black) were collected at 20 m. intervals on E-W grid lines, 1 km. apart.

These lines are generally of a high standard, with only a few "dog-legs" due to topography (rivers), as there are not many steep areas.

Lines are put in by tape and compass, and slope corrected. All lines are located on the Australian Metric Grid, except for the three "Pieman lines".

Stream sediment sampling (-80#) on the Mt. Black E L was carried out in 1970-71 by students controlled by the mine exploration staff. However, the results are highly suspect (up to "170,000 ppm Zn" in headwaters of the Ring River!), and check sampling of the area east of Williamsford, carried out by Williams in 1973-74 failed to duplicate other anomalies. Hence this work has been disregarded, and the approach of 1 km. spaced soil lines taken.

Future stream surveys using non-staff labor must institute a system of checking, such as marking sample sites with flagging tape. Some type of bonus incentive scheme for locating anomalies which lead to validated targets might ensure a conscientious responsibility among non-staff labor.

All soil samples are taken as 200-300 gm. samples in wet strength Kraft envelopes, then dried and airfreighted to Analabs in Perth for sieving and analysis.

Exploration drill core is sawn and assayed (for mineralized sections), and all barren core is chip sampled and tested for Cu,Pb,Zn.

As previously discussed, sampling and analysis of barren sections for alteration elements, and Mn, would be more useful in addition to Cu,Pb,Zn. Carbonate rich zones in drill core should be logged with acid.

3. Sample Plotting.

The recent Mt. Black soil grids are plotted as raw data values on two map series, one for Cu Fe, and the other for Pb Zn, at 1:5000 scale.

High values are colored in, then zones joined up as contours, and the maps reduced to 1:10,000 scale.

The W. half of the Mt. Black E L is plotted on 1:5000 sheets, and the E. half has been reduced to 1:10,000.

With the newer grids, where the AMG system is used and lines are generally straight and parallel, machine plotting of results (as profiles) could proceed directly.

The older data are plotted on 1:2,500 scale as idealized grids as Cu,Ag (one map) versus Pb,Zn.

Ag should be dropped from routine sampling as it is an unnecessary expense.

These old grids in some cases need to be converted to the AMG coordinate system now adopted, and correction is necessary where the lines depart from ideal grids.

This can readily be done by digitizing, with calculation of interpolated values by computer.

Cumulative frequency plots were done on all values on each grid as well as on total data for all grids. Populations came out very similar, and 4 populations were taken at inflexion prints. The upper population was due to contamination from the EBR railway.

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Based on these population breaks, a color spectrum was used to produce colored contour maps and look for anomalous zones.

However, in my opinion this approach may be somewhat misleading because:

1) The low values are "censored" by the analytical detection limit, thus introducing greater skew into the data than may be present.
A log-normal distribution is assumed but this may not be a good model.

2) No attempt was made to classify data into lithology and soil type. The variations in soil type (they are not consistent C horizon) and presence of glacials is a contributing reason for the different populations. Hence subtle anomalous responses within each population may be masked by assuming that only higher values are anomalous.

3) Background is probably not constant from line to line over such large areas.

Replotting of these data as stacked bar profiles may go some way toward overcoming the effects of sample inconsistencies and shifting backgrounds.

All data are entered as sample no., grid coordinates, and analytical results on 80 column computer sheets, and the unpunched sheets filed.

This is an excellent start, but expansion to a flexible data bank with descriptor codes for field parameters is ultimately needed.

4. Results.

1) In the Cutty Sark soil grid, new, fill-in line samples collected within the last year were analyzed by Analabs, to give Cu, Pb, and Zn backgrounds of 20-30, < 5, and 15-20 ppm respectively.
This trend is at variance with the old line samples, analyzed by ALS Laboratories, which gave backgrounds of < 2, 2-5, and 5-10 ppm respectively.

It was recommended that sample sets from a high and adjacent low line be sent to both laboratories, to check for discrepancies.
If this shows that the pattern still stands, then variation in sampling method (auger penetration) between the old and new data sets must be assumed. This should be field checked - it could be that the very low lines correspond to A_2 horizon samples.

2) Fe analysis (also used by Cominco) shows glacials and river gravels (low), and more andesitic versus rhyolitic units
However, glacials and river gravels should be recognized in the field, and Mn soil analysis, rather than Fe, is probably more useful (cf. Mt. Lyell results).

3) Mercury whole rock analysis (1973) showed high values (average 45 ppm Hg) associated with Rosebery and Hercules ore (Cambrian), but only low values (0.26 ppm) in Devonian ores. Host rocks and footwall rocks were anomalous in Hg, but data are apparently lacking on the level of base metals for equivalent samples.

Where multi-element data were available, the Hg trends follow the Pb Zn trends, as is nearly always the case.

These samples were run by the old McPhar Labs. (Beevers) using a wet chemical Hatch and Ott procedure for Hg, and can therefore be regarded as valid.

Following this work, extensive Hg analysis of surface litter samples was carried out using the Scintrex mercury detector. This uses a direct sample pyrolysis approach, and under such conditions it is not surprising that results were totally erratic. The organic interferences are so extreme that no atomic absorption based system (logarithmic response) can hope to give viable results where the signal/noise ratio is unfavourable. The same comment applies to all mercury detection systems using the simple, convenient (but error prone) approach of directly heating a sample.

In doubtful cases, test samples should always be checked by the classical Hatch and Ott preparative procedure. This wet chemical method prepares the sample so that Hg can be presented in a pure, separated form, and then determined viably by any detector system.

That is, the problem is not to detect mercury, but to eliminate interferences, and there are limits to how effectively this can be done by instrumental methods for some samples.

In this terrain I would not expect mercury to provide any unique information - it will follow Pb and Zn by chemical solution dispersion, but probably give smaller dispersion.

4) The litter samples from Que River were wet-ash analyzed for base metals by Analabs (R.E. Williams, pers. comm.) and gave Pb results from 15 ppm to 7500 ppm, and Zn results up to 1.5%. The highs correspond to two I P chargeability zones. Silver (background corrected) ranged from < 0.3 to 14.0 ppm in the litter.

At 7350 N/5250 E, the $>$ 2000 ppm "C horizon" Pb contour coincided with 7500 ppm Pb in litter, over ore at 2 ft. depth.

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This is further evidence of the viability of litter sampling as a more general technique in the region.

5) Que R. geochemical signature.

Drill hole analyses of Que River samples suggest that mineralization is geochemically different to the Rosebery type, in that Ba values are low.

Further analyses for carbonate, and the elements Mn, F, As, B, K, Na, Rb, characteristic of the Rosebery type, are needed to confirm this.

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APPENDICES

APPENDIX A.

FIELD TESTS

1. Introduction.

Colorimetric based field tests, which are simple but only semiquantitative have become somewhat of a lost art since the establishment of central laboratories using instrumental techniques almost 15 years ago.

Nevertheless, in the rugged environment of the West Coast, there is a place for simple semiquantitative tests for follow-up of stream sediment, and base of slope soil anomalies in remote areas. These can help position and define the limits of detailed grid sampling using laboratory procedures.
Moreover, water sampling can be tried in situ at superior sensitivities.

The joint venture companies have an advantage in that both have access to mine laboratories which can supply and prepare reagents for field use.

In this environment, colorimetric tests for Cu, Pb and Zn are of potential interest. The copper test using 2:2 biquinoline is the most reliable, whereas specific Pb and Zn tests require the use of pH control and masking agents such as cyanide (for Pb test - suppresses Cu and Zn) and thiosulfate(for Zn test - suppresses Cu and Pb at this pH).

However, in the interests of simplicity in this difficult terrain only one test, a variant of the Bloom (1955) cold extractable "total heavy metals" test is advocated.

The usual ammoniacal citrate buffer and hydroxylamine extract used by Bloom and others doubles as a weak cold extractant for Cu,Pb and Zn and also suppresses the potential interference from iron by reducing it to the ferrous state where it is complexed by the alkaline citrate. The pH of 8.5 is optimal for simultaneous complexing and solvent extraction of Cu,Pb and Zn with dithizone.

Two problems are anticipated with this approach.

1) this citrate buffer is a very weak cold extractant for loosely bonded (adsorbed) heavy metals. Equilibrium studies by Beevers (pers. comm.) and the author have shown that extraction equilibrium is slow (up to 10 days). Variations in grain size, organic matter content, clay mineralogy etc. cause great variations in the amount of available metal extracted from sample to sample, in the first few seconds of the reaction. Thus anomalies can be "manufactured" by relative differences in extraction rates when not working near equilibrium.

2) humic acids are extracted by alkaline solutions as used in the buffer. These can impart a yellow color to the organic solvent layer, and also cause frothing and emulsification.

Hence the use of HCl prior to buffer addition, is advocated as an extractant to rapidly remove heavy metals and attain equilibrium. Humic acids are precipitated in low pH solutions.

2. Extractable Heavy Metals in Soils and Stream Sediments

operating field instructions.

1) Scoop 0.1 g of wet -80# sample into a Corning 9826 screw top culture tube.
2) Dispense 1 ml of 6M HCl into tube and agitate contents gently for 60 seconds.
3) Dispense 10 ml of buffer solution into tube, and mix contents.
4) Dispense 1 ml of 0.002% dithizone solution in toluene into the tube, fit screw cap and shake thoroughly for 10 seconds, then allow phases to separate.
5) Observe color of top layer; if it is green, blue-green or blue, record results as 0,½, or 1 respectively. If the color is blue-purple or red, titrate in further 1 ml increments of dithizone, shaking gently for a few seconds only, after each addition to mix contents of upper organic layer.
6) Keep adding 1 ml increments until a blue upper layer results, and record results as 2,3,4,,,, etc.

3. Field Apparatus.

1) Scoop for dispensing nominal 0.1 g sample. Usually, a small hole is drilled in a plastic bar and a dry -80# sieved sample is packed level. Experience has shown that weight reproducibility is better than ± 10%. With wet samples, it may prove more convenient to wet sieve a portion into a plastic beaker, allow the mud component to settle (organic matter will float) and insert a small length of glass tubing of about 5 mm bore into the sediment to a graduation mark, equivalent to about 0.1 g. A piece of 4 mm thick plastic rod or wire (not Cu Pb or Zn) can be inserted as a plunger to dispense the "core" of sample into the reagent tube.

2) 1 ml plastic "Eppendorf" or equivalent ("Repipet", "Finnpipette") dispensing pipettes with disposable tips are used for adding the HCl and dithizone (keep separate).
A 5 ml (adjustable 1-5 ml, set at 5.0) plastic Finnpipette is used for dispensing buffer.
These are available from Laboratory Supplies Pty. Ltd. 48 Sydenham Road, Marrickville N.S.W. phone (02)5196626 and cost approximately $50 each. They are unbreakable and should last indefinitely.

3) plastic bottles for storage of buffer solution and 6M HCl. A plastic container for water may be useful, or stream water can normally be used to wet sieve and rinse out the tubes.

4) Corning cat. 9826 culture tubes, 20x150 mm, with screw tops and teflon liners.

5) Thermos flask for storage of refrigerated dithizone solution.

4. Reagents - prepared in laboratory.

1) 6M HCl; a 50% solution of analytical grade (preferably "low in lead" "Pronalys", "Suprapure" or equivalent) in distilled and de-ionized water.

2) 0.002% dithizone working solution in toluene (reagent grade).
Prepare fresh every day by 50:1 dilution of 0.1% stock solution with toluene. This can be done in the field (if the stock solution is kept cold in a thermos), by using the 1 ml Eppendorf dispenser and a 50 ml measuring cylinder to measure the toluene.

3) 0.1% dithizone stack solution in chloroform.
Dissolve 0.1 g of fresh, purified dithizone in 100 ml chloroform (reagent grade), by shaking vigorously over an extended period. Cover with a layer of 1% ascorbic acid in water, to minimize oxidation, refrigerate, and store in thermos flask. Prepare fresh every 1-2 months.

4) distilled and de-ionized water. Test purity of water used for making buffer solution, by applying the "heavy metals in water" test.

5) buffer solution - 4 liters. (keeps indefinitely).
200 g of ammonium citrate (purest grade available).
32 g of hydroxylamine hydrochloride and 30 g of ascorbic acid are dissolved in about 1 l. of metal-free water in a large beaker.

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Dilute to 2 liters, and add a small amount of thymol blue indicator (in alcohol). Add conc. NH_4OH (about 100 ml) until the solution just turns blue, indicating pH = 8.5
Transfer to a large separating funnel, and remove heavy metal impurities by extraction with 20 ml portions of 0.1% dithizone in chloroform (shake for 2 minutes).
If the dithizone turns red, remove the organic phase and repeat extraction until a mixed green color remains, indicating that all metal has reacted and excess reagent remains. Excess dithizone is soluble in basic solutions (orange color) and must now be removed by extracting first with pure chloroform (in which it is more soluble), and finally with portions of carbon tetrachloride until the organic phase (discarded after each extraction) is almost colorless. (The blue color of the indicator will remain in the aqueous phase).
Dilute buffer to a final volume of 4 liters with distilled and deionized water.
(Alternatively, if water of suitable purity cannot be obtained, dilute to 4 liters initially and purify the whole amount with dithizone extraction. Then add about 50 ml of a saturated solution or dispersion of silicon antifoam (eg. Dow Corning) in acetone to the buffer solution.
Store in a polyethylene container which has been thoroughly rinsed in acid, then water.

6) Purification of dithizone.
Dissolve fresh, high purity dithizone (diphenylthiocarbazor (eg. Merck) in hot chloroform to make an almost saturated solution. Filter through fritted glass, place solution in clean (with acid) vacuum desiccator and evaporate under reduced pressure until reduced to about ¼ of original volume. Collect the precipitate in a sintered glass filter crucible, wash with a few small portions of carbon tetrachloride, and dry in air. Store under refrigeration in the dark.
Use this reagent to prepare the stock solution.
If the dithizone is sufficiently free of oxidation products this purification may not be necessary. Test by extraction of a 0.1% chloroform solution in metal-free water containing a little metal-free NH_4OH (pH 9-10). The green color will be removed and the chloroform phase should be colorless (not yellow).

5. Notes.

1) Silicon antifoam is incorporated in the buffer to minimize emulsion of organic phase from humic acids in the sample.

2) If emulsion problems persist, try alternative solvents such as xylene or methyl isobutyl ketone in lieu of toluene.

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(Benzene is often recommended but this emulsifies readily). Add more antifoam (to each sample) if necessary.

3) A lighter-than-water solvent is used for dithizone in the field test, so that sediment particles will settle. If problems are encountered with sediment remaining in the organic phase, try keeping sediment at the bottom of the tube by adding a plug of (acid washed) glass wool after step 3) of operating instructions.

4) Ascorbic acid is incorporated in the buffer to maintain reducing conditions over and above those normally recommended (hydroxylamine only). Otherwise, the abundant MnO_2 present in many Tasmanian samples may cause oxidation of dithizone.

5) Dithizone, when oxidized to diphenyl-thiocarbazone, fades to a yellow color and such solutions are useless. Partial oxidation will give a yellow-green color, different in hue to pure, fresh dithizone solutions. Partially oxidized solutions should be discarded. (to test for partial oxidation, extract with dilute, metal free NH_4OH - the dithizone will go into the aqueous phase, and the solvent should become colorless, not yellow.)

6) Minimize dithizone oxidation by keeping solutions cool (thermos), and away from strong sunlight. Working solutions are prepared fresh, daily by dilution of stock solution.

7) The ammonium citrate will be found to contain appreciable heavy metal impurities - hence the necessity for purification of buffer.

8) The field test is extremely sensitive - for example, shaking the test tube with a thumb over the top will give a positive reaction if coins have been handled! Hence scrupulous cleanliness is necessary - (wash all reagent containers and tubes with dilute acid and then metal free water before use.) However, once in the field, each reaction is "self-cleaning" and thorough washing between tests is not necessary.

9) The colors observed range from pure green of unreacted dithizone (no heavy metals) to red for completely reacted (excess base metals) dithizone. Intermediate metal concentrations produce a mixed green-blue to grey color due to combinations of green and red end-members. Hence "titrate" by incremented additions to a standard mixed color.

10) The test reacts to Zn + Cu + Pb combined, the relative contributions being about 3:2:1.
If desired, independant laboratory calibration using a standard solution of Zn can enable the readings to be expressed as "acid extractable Zn equivalents". However, a relative scale of 0, ½, 1,2,3.... etc. will suffice for field work.

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11) Sensitivity can be adjusted upwards or downwards to suit local conditions by varying the amounts of sample, and strength of dithizone solution. This can be determined by experience, or by trial orientation on a known area such as Itat Ck. at Beatrice.

6. Total Heavy Metals in Waters - field operating instructions.

A similar test can be used for Cu + Pb + Zn in stream waters, with sensitivities of about 2 ppb. (.002 ppm) for Zn, and 10 ppb for Pb and Cu, in a 50 ml sample. (ie far below routine atomic absorption sensitivities).

Organic complexes in the West Coast waters may cause some problems with emulsification, however. Precautions must be taken against Zn contamination.

1) 50 ml of water in a 100 ml plastic stoppered measuring cylinder, rinsed at the site.
2) Add 5 ml of buffer solution.
3) Add 2 ml of 0.001% dithizone in toluene, cap the cylinder and shake vigorously for 1 minute.
4) Observe color of solvent phase - if red, excess metals are present, and repeat test using a smaller volume of water.
The colors will range from green - blue-green - blue-grey - purple-red with increasing metal concentration.
5) If a green color was obtained, sensitivity can be increased by then adding 2M NH_4OH slowly until the thymol blue indicator incorporated in the buffer solution changes from yellow (pH 5.5 buffer) to blue (pH 8.5). Then add a few drops excess NH_4OH.
Shake again vigorously for 15 seconds - excess dithizone will dissolve in the now alkaline buffer, leaving metal dithizonates in the solvent forming a mono-color series from colorless to weak pink. (a yellow organic phase indicates that dithizone has oxidized).
6) Relative colors can be compared to laboratory standards of weak Zn solutions, or assigned some arbitary scale for field work.

Apparatus.

Eppendorf type dispensing pipettes, and containers as before.

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Reagents.

1) dithizone solutions as before. If emulsification is a problem, carbon tetrachloride could be substituted for toluene.

2) 2M NH_4OH; metal free. Purify if necessary as for the alkaline buffer solution used in the previous test.

3) buffer solution: pH 5.5. (keeps indefinitely).
2M acetic acid. 114 ml glacial acetic acid to 1 liter of metal-free water.
2M sodium acetate solution: 164 g of anhydrous sodium acetate in 1 l. of metal-free water.
Mix 900 ml of 2M sodium acetate with 100 ml of 2M acetic acid. Add 2 g of sodium fluoride (to inhibit effect of Al ions at this pH), 2 g of ascorbic acid (to inhibit oxidation) and 10 ml of a saturated solution (or emulsion) of silicon antifoam in acetone (to inhibit emulsification and frothing from humic acids). Add a few ml of thymol blue indicator in alcohol.
Purify the buffer as described previously.

Note:

If frothing and emulsification from the humic rich waters persists, try adding a few drops of silicon antifoam dispersed in acetone directly to each sample prior to step 3).

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APPENDIX B.

GRID POSITIONING TECHNIQUES

1. Terrain Difficulties

Because of the dense rain forest cover in much of the area, and lower ti-tree (leptospermum nitidans) scrub on more stony, higher altitude slopes, line cutting is mandatory for both access and pegging. These lines provide access for geophysical (mainly gradient array I P) and soil (auger) geochemical sampling at pegged stations. The flatter moraine covered areas typified by the Basin Lake grid pose less of an access and line pegging problem.

A major difficulty with this approach is that line-cutting and pegging costs $250 - 300 per line km with a typical productivity of ½ line km per crew-day.

Slope corrections are applied in the field, and pegs are flagged and labelled with aluminium tags.

Subsequently, the lines are surveyed and plotted onto enlarged topographic (contour) base maps.

Fill-in lines are cut where warranted by geophysical and/or geochemical results.

The recent EZ line cutting appears to be geometrically accurate, resulting in parallel lines with stations referenced to the Australian Metric Grid, plotted on enlarged topographic sheets.

The earlier Mt Lyell lines,perhaps because of local terrain difficulties, are often diverging and contain local "dog-legs" - slope corrections in steep terrain cause a further problem.

Added to this is the extra cost of staff surveying all lines as a check on line cutting (usually done by contractors) by tape and compass.

2. Nominal vs. true grid coordinates

Mt. Lyell sometimes uses a local grid reference system for each grid, with each base line zero referenced to an intersection with an access track, which itself can be highly irregular due to topographic constraints. (eg White Spur Area, EL 9/66) .

This results in eastings and westings grid references, which can pose a problem if computer plotting of results is to be done.

Moreover, nominal grid locations would result in a computer plot of parallel lines which may bear no spatial relationship to the actual grid as plotted on the base maps.

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Thus digitizing techniques would need to be used to convert all positions to their true, corrected grid references on the Australian Metric Grid, if computer plotting is undertaken.

3. Location methods

There are three potentially rapid methods of locating lines and access tracks, costeans etc to Australian Metric Grid coordinates.

1) orthophotography.
2) the Mini-Ranger electronic positioning system.
3) the Magnavox MX 1502 satellite surveyor.

4. Orthophotography

This relies on locating features on stereo air photographs, which are then optically modeled to produce a map base. The equipment used involves a stereoplotter with orthophoto attachment, and produces a rectified, "true to scale" photograph upon which the AMG grid (or any arbitrary grid) and contours may be superimposed, along with inked-in access tracks, bench marks, annotations of grid lines and numbers etc. This can be done at any convenient scale such as 1:10,000 or 1:5000, with the final orthophoto negative screened to produce a half-tone sepia on standard AO mylar sheet.

Thus dyeline copies of the photomap base, showing cultural features with superimposed contours and grid references can be produced at will and used for adding geological and geochemical information.

The number of stereo models and control points to be used increases with terrain complexity, but there should be ample H.E.C. benchmarks, trig. stations etc. in the area to provide good control from existing high-level photography without further surveying.

In practice the orthophoto device optically scans a narrow strip of terrain on the stereo-plotter, and electronically transposes the strip scene to rectified scale on a new negative. The complete image is built up of adjacent scan strips, the width of which (hence plotting speed and cost) is a function of terrain complexity and accuracy desired.

The accuracy obtained is more than adequate for exploration purposes.

A disadvantage of orthophotography in this terrain, is that in densely forested areas features such as cut lines and minor streams may not show up (if not seen on the normal air-photographs). Major features such as rivers, access roads and costeans would still be seen, however, and grid lines may be tied in to these.

Possibly the Hydro-electric Commission may already have orthophotomaps of some areas.

Orthophotomaps at regional scales (1:50,000) should provide a superior alternative to regional geologic compilations using mosaics.

Orthophotography services can be obtained from contractors such as Hunting Geology and Geophysics.

5. The Mini-Ranger System

This system, designed by Motorola (USA) is supplied through Marine and Aerospace Engineering Pty. Ltd., Suite 501A, 220 Pacific Highway, Crows Nest, N.S.W. 2065 (Mr. Ed. McCutchean, manager).

It works by triangulation of C band radar signals from a receiver/transmitter unit with built in antenna, referencing to two base stations which must all be in direct line of sight. The reference stations can be placed on hills (trig points), and the receiver/transmitter unit connected to its range console constitutes the mobile field station.

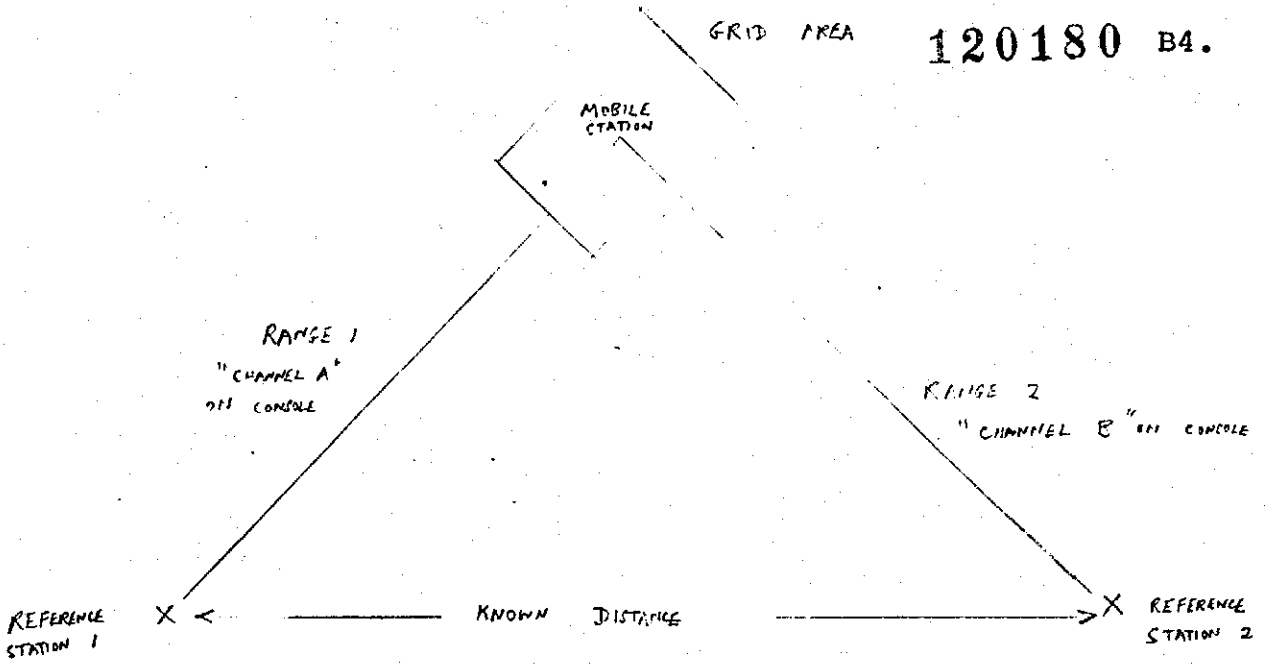
Maximum reliable range of the basic system is 37 km line of sight, where in free air conditions (no attenuation), range error is less than 3 meters.

The ranges to each base station appear as a digital readout in meters virtually instaneously on the range console (which, with the receive/transmit unit and connecting cable forms the mobile station).

If the grid area is comparatively small (say 2 km square) and triangulation is done to distant base (reference stations) of the order of say 20 km away, a single calculated slant range to the center of the area should be sufficiently accurate, irrespective of local topographic deviations within the grid.

Grid locations can then be obtained by calculation.

Alternatively, to go to nominated grid reference positions, the distant reference stations should be placed at right angles to the mobile station, range settings can be pre-calculated,and the mobile station moved accordingly.



Extra reference stations are available with the basic unit so that any two of up to 4 stations can be interrogated - for example, where the first two stations are in a radar shadow due to topography.

Many sophisticated options, (described in the brochures) are available to expand this basic arrangement. eg) automatic plotting, up to 16 reference stations, extended range, airborne steering indicators for flying pre-set lines, data processors, printers and remote data links etc.

A major disadvantage is that the range console and its attendant receiver/transmitter unit, power supply and cables constitute the heavier and bulkier equipment relative to the lightweight reference stations.

1) Tracking mode.

An optional, but more expensive alternative, is to use the system in tracking mode. Here the 6 lb. reference station, with its attendant lightweight cable and mast, is operated with lightweight batteries (10 lb.) as the mobile station, and the heavier range console system with its heavier cable is located "permanently" as a base station. Range information is then produced at the distant site by an optional printer, or alternatively by remote data link back to the mobile (grid) site or office. Another means would be to have an assistant at the range console reference station in radio communication with the mobile crew, as a manual "data link".

2) Attenuation problems.

Rain forest canopy, particularly when wet, can cause severe attenuation of the radar signal, such that range error can be as great as 20-30 meters. If the attenuated signal is too weak for satisfactory operation, this will be displayed on the range console.

Attenuation can be handled as follows:

a) a hydraulic mast/tripod arrangement is available to hoist the 6 lb. receive/transmit unit with cable up to 30 ft above the ground. This should provide clear line of sight in many instances and overcome attenuation problems.

b) a signal strength meter can be supplied optionally and calibrated against signals supplied from a variable attenuator, to produce a nomogram of range corrections vs. signal strength. Then during routine operation, range results obtained are corrected for the signal strength measured at each site.

3) Equipment weight and configuration.

a) base stations - minimum of two required.

i) 6 lb. weight with built-in antenna, + 10 ft light-weight cable + tripod + power supply.

ii) Power supply: one pair 10 amp/hr. motor-cycle or aircraft type batteries on each station will operate for 1 day. These are connected in series for 24V operation.
A pair of 100 amp/hr. batteries (24V mode) will operate for 1 week, as the system switches to standby mode if readings are more than 30 min. apart.

b) mobile station (in normal use)

i) range console weighs 28 lb. and can be supplied in a heavy duty aluminium carrying case (22" x 22" x 11" dimensions) which also holds the transmitter/receiver cable for the R/T unit (mounted on mast). A light weight 50 ft cable is available. Total weight in case = 45 lbs.

ii) R/T unit with built-in antenna, in aluminium carrying case weighs 10 lb.

iii) telescopic (hydraulic) mast/tripod base with 30 ft extension (to mount R/T unit above tree canopy). This folds down to about 7 ft, and weighs 25 lb.

iv) power supply: two 24V aircraft batteries (approx 30 lb total weight) would supply one day's operation.

4) Prices.

a) basic system: 2 base stations and 1 mobile plus cables and mast = $31,000

b) spares: $ 5,000

c) extra base stations: $ 6,000 each

d) batteries - supplied by client.

e) tracking version (remote data link) available from overseas only (60 days delivery) for extra $15,000.

The basic unit is available ex stock, and can be leased or rented at 15% of equipment cost per month (90 days or greater) or 18% per month for less than 30 days.

The standard positioning system can be rented for demonstration purposes for as little as 1 week, at a cost of $225 per day. Training would be supplied in Sydney free of charge.

6. Recommendation

The equipment is expensive and may prove cumbersome if used in the normal mode in typical West Coast terrain.

However, when off-set against the cost of line cutting, it may prove more cost-effective in the long run if used in the tracking mode in conjunction with rapid reconnaissance geochemical surveys using A_0 or litter samples on uncut lines.

Such surface sampling can provide a rapid first pass coverage of new areas. Sample sites can be flagged, located by grid reference, and re-located with the positioning system where anomalous zones need to be followed up by detailed survey. Some less rigorous line cutting would still be required for access in many areas, but only those which prove anomalous need to be systematically line cut and pegged.

How well the system performs in actual field conditions remains to be seen. The basic system could be hired for 1-2 weeks with costs and performance trials shared by both joint-venture groups. This could be done in the tracking mode by having an operator relay the range information from the base station by radio to the mobile station. Only light equipment need then be carried.

Should it prove cost-effective, a longer term lease arrangement or purchase shared by both parties may be worth while.

7. The Magnavox MX1502 Satellite Surveyor. (see brochure sent with report)

This system requires an antenna-receiver assembly only, as it receives signals from any of 6 TRANSIT navigational satellites positioned by the U S Navy in 1964, and available to all users since 1967.

The satellites orbit the earth in fixed circular polar orbits at 1100 km altitude and 107 minutes duration, forming a "birdcage" enclosure around the rotating earth. Thus the observer passes under the orbit of each satellite, in sequence.

The satellites transmit signals at 150 and 400 MHz, the dual frequency allowing the removal of ionospheric refraction effects.

Each satellite pass is in view (horizon to horizon) for about 15 minutes, during which time it has moved approximately 7000 km.

The orbital pass is very accurately known and the ground receiver obtains the orbital parameters during each 2 minute interval (satellite navigation message). Estimated position is entered into the receiver via the keyboard (which incorporates a microprocessor). The receiver then computes the satellite position, calculates satellite-to-receiver ranges at the beginning and end of each Doppler frequency of the passing satellite until calculated and measured range differences agree.

The final output is that a digital readout of latitude and longitude is displayed on the first satellite pass to an accuracy of about 30 meters RMS.

Subsequent orbital passes will give a read-out of elevation as well as position, and the accuracy improves with each successive orbit to about 3-5 meters RMS error, after several passes.

At latitude 40^0 , normal time between successive satellite passes is about 75 minutes.

The microprocessor section of the receiver will convert positions to any datum (ie AMG, or local grids if desired).

The advantages of the system are its portability and ruggedness (receiver/processor = 19 kg, plus antenna unit 7.7 kg including tripod and case, plus a 12v car battery) - no reference stations are required.

Major disadvantages are high cost (US $48,500) and the waiting time between orbital passes. However, an extra series of NOVA satellites is due to be launched at the end of 1979, and this will reduce orbital intervals.

The system could probably be used best for locating key reference points or base lines, but would be too slow for positioning at each station.

The representatives in Australia are Hawker Pacific Pty. Ltd., P.O. Box 172 Yagoona, N.S.W. 2199 (Mr. David Cook).

APPENDIX C

Some notes on Magnetic Fractions of Heavy Mineral panned Concentrates, from discussion with Dr. W. C. Overstreet, U. S. G. S. Denver, April, 1971.

The theory of the method is that magnetics will, because of their crystal structure, contain substituted trace element impurities which reflect the geochemical background of the source rock. Unlike the normal stream sediments, the magnetite from weathered rocks ("saprolites") will not be as subject to loss by dilution as it is stable, forms long dispersion trains, and can be readily concentrated by panning and magnetic separation.

Drainage basins of the order of 10-30 sq. miles are selected on aerial photographs and the necks of these drainage areas selected as sample sites.

Locally, at the sample site, one usually selects alluvium in or adjacent to an active stream which is likely to have dropped its heavy mineral load due to sudden widening, presence of back-wash induced by rock bars or change of course. etc.

Thus one samples at a suitable site as one would for gold.

To maintain comparative results from stream to stream, portions of streams should be sampled such that hydraulic loads are always comparable; a good rule of thumb being to always select the portion where the largest 10% of cobbles is fist sized.

The alluvium is then sampled, discarding the pebbles. A large lipless pan is then 2/3 filled with about 25lb of alluvium which has been wet sieved in the stream to -10 mesh through a large steel punch plate. The clay is carefully dispersed by kneading and washed out until a gritty sand only remains. Panning must be done slowly and carefully, with little tilting and no jigging through screens, as some magnetite is very fine, and the aim is to retain all magnetite. Generally, the time taken is about four times greater than that for panning gold. It is possible to use a mechanical super-panner provided clays have been removed and

APPENDIX C (Cont'd.)

and the feed kept constant.

Panning is gradually reduced to a grey fraction where magnetites and spinels can no longer be readily retained. The concentrate is then cleaned out three times with a hand magnet, which will remove magnetite and highly magnetic ilmenite, gradually with a grain size of about 150 mesh.

The magnetic fraction ("magnetite") is then dried, finely ground if necessary, digested in hydrochloric acid and analysed in the geochemical laboratory.

A recommended USGS procedure for magnetite analysis has been given to me by Fred Ward of USGS Denver.

I would also suggest the further refinement of using a standard size container, such as a bucket, to consistently measure the same amount of -10 mesh sieved sample. Then, if the laboratory weighs the magnetite extracted, subsequent trace element contents can be normalised to take care of varying magnetite abundance. i.e.) 100 ppm in 1% magnetite is no more significant than 50 ppm in magnetitie comprising 2% as in both cases the partition of trace elements between silicate and oxide phase during igneous rock formation indicates the same original quantity of background trace element.

At the same time, the heavy mineral fraction, after magnetic separation should be stored in a container for future reference.

Binocular microscope examination for resistates such as andalusite, staurolite and garnet can give a clue to the presence of certain rock types and metamorphic aureoles up drainage, and in fact, Overstreet has developed techniques for rapid grain counting and mapping of metamorphic zones in highly weathered terrain using this approach. - Further details on this approach can be made available on request through N. J. Marshall.

345 samples of detrital magnetite from panned concentrates of alluvium from tens of thousands of square miles of Alaska were analysed for Cu, Ni, Pb, Zn, Ag, Bi, Co, Ni by the U.S.G.S.

APPENDIX C (Cont'd.)

Many samples came from known mining camps, often 10 miles downstream from the mineralisation.

In the whole area, 24 known copper deposits occurred; and of the 24, 17 sample sites were anomalous in copper and the rest anomalous in either Pb, Zn, Ag, Bi, Co or Ni. Some difficulty was experienced with bismuth due to the very low backgrounds of 0.2 - 1 ppm and consequent difficulty in analysis.

The following table by Overstreet, (not yet published) shows the relationship between the known mineralisation and the anomalous element contents in the Alaskan magnetites.

Anomaly/ Known Mineral-isation	Cu	Pb	Zn	Ag	Bi	Co	Ni	Total deposits	No. of deposits showing only background (i.e. not anomalous)
Cu	17	9	16	9	1	6	5	24	7 N.B. all anomalies for other than Cu
Pb	9	7	7	7	1	2	2	11	4 all 4 anomalous for other than Pb
Zn	12	6	10	7	2.	3	3	12	2
Ag	9	5	8	6	1	5	4	14	7
Bi	1		1		1			4	3
Co	1		1	1	1		1	1	1
Ni	1			1	1		1	1	0

The frequency relationship between known metal deposits (Classified as Cu-Pb-Ag etc. according to the prospectors estimate of the situation from old records) and anomalous element content in magnetites is shown below.

Anomaly/ Known Mnrlisation	Cu	Pb	Zn	Ag	Bi	Co	Ni	Total Deposits
Cu-Zn	2		2					2
Cu-Ag	2		1	1		2	2	4
Cu-Pb-Ag			1			1		1
Cu-Zn-Ag	1		1			1	1	1
Pb-Zn-Ag	1	1						1
Cu-Pb-Zn-Ag	6	4	5	5				6

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A Modified Staining Technique for Carbonates in Thin Section

Potassium ferricyanide and alizarin red *S* are frequently used as stains for distinguishing between carbonate minerals. Potassium ferricyanide in acid solution produces Turnbull's blue with ferrous iron and it used to be thought that dolomite could be distinguished from calcite on the basis that dolomite alone contained ferrous iron. Recently this has been shown to be incorrect[1], and it is now known that any carbonate mineral containing small quantities of ferrous iron will stain with potassium ferricyanide providing the carbonate can be made to react with an acid medium. Recent work[2,3] shows that alizarin red *S* in solution is probably the best method of distinguishing between the common carbonates.

Boiling, 30 per cent sodium hydroxide solution, as used by Freidman[2] for staining blocks and chips, has been found unsuitable for staining thin sections, as the mounting medium (Lakeside 70, Canada balsam) tends to dissolve. A weak hydrochloric acid solution does not attack the mounting medium. I have obtained satisfactory results with the procedure described here. A concentration of 3 per cent hydrochloric acid, or greater, at room temperature dissolves away the more soluble carbonates and hence is undesirable. At room temperature alizarin red *S* is most selective as a stain in a concentration of hydrochloric acid which falls between 1 per cent and 2 per cent. At the 1·5 per cent plus level the thickness of the thin section is greatly reduced and the staining becomes pale. At lower concentrations, the stain becomes so thick that it obscures the fine detail of the thin section. An important feature of the stain at the 1–2 per cent acid concentration is that with calcite a surface parallel to the *C*-axis is more deeply stained than one normal to that axis. This is important in fabric analysis where optic orientation patterns are required.

The potassium ferricyanide stain is successful over a range of acid concentrations, and as this solution is mixed with the alizarin red *S* solution the same acid concentration (1–2 per cent) is used. At room temperature, at these low concentrations, potassium ferricyanide does not react with siderite.

Distilled water must be used for making up all solutions and for washing off surplus stain from the thin sections after each stage of the procedure. Much more reliable results are obtained if the thin section to be stained is etched first (stage I of procedure). This pre-staining etch removes all grinding dust from the carbonate surface and is carried out for at least 10 and not more than 15 sec using 1·5 per cent hydrochloric acid. The etched section is then immersed in an acidified mixture of the two stains (stage II). Each stain works independently, and there is no mutual interference. If the now partially stained section is immersed in an acidified solution of alizarin red *S* for a few seconds the colour differentiation of the carbonates is increased further, but it is important not to leave the section longer than 15 sec in the solution (stage III). After rapid but careful washing of the section in distilled water it is important to dry the stained surface as quickly as possible because the stain is relatively soluble in water. It is important not to touch the stained surface when drying as it is purely a surface precipitate and is easily rubbed off. To preserve and protect the now dried stain, during mounting or remounting, a layer of 'Durofix' is painted on to the surface with a soft camel-hair brush. The 'Durofix' is diluted with amyl acetate, in the ratio 'Durofix' : amyl acetate = 1 : 3, which readily evaporates, and when this layer is completely dry it has a refractive index very close to 1·54.

The details and consecutive stages of the procedure are shown in Table 1.

The distinction between dolomite and calcite, of which most ancient limestones are composed, is of considerable importance in limestone petrology. The modified staining technique described not only gives positive colour differentiation of these two important carbonate minerals but also, because of their different solubility in hydrochloric acid, gives a difference of thickness in thin section. Calcite is etched to approximately 15μ thickness while dolomite remains at 30μ thickness; this difference is readily observable with polarized light.

J. A. D. Dickson

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Table 1

Procedure		Time	Carbonate	Result
Stage I	Etching 1·5% HCl	10–15 sec	Calcite Ferroan calcite	Considerable etch
			Dolomite Ferroan dolomite	Negligible etch
Stage II	Staining* 0·2 g A.R.S. per 100 c.c. 1·5% HCl 2·0 g P.F. per 100 c.c. 1·5% HCl Mixed in ratio A.R.S. : P.F. = 3 : 2	30–45 sec	Calcite	Very pale pink—red depending on optical orientation
			Ferroan calcite	Very pale pink—red Pale blue—dark blue Two superimposed give Mauve—purple—royal blue
			Dolomite	No colour
			Ferroan dolomite	Pale—deep turquoise depending on ferrous content
Stage III	Staining 0·2 g A.R.S. per 100 c.c. 1·5% HCl	10–15 sec	Calcite Ferroan calcite	Very pale pink—red
			Dolomite Ferroan dolomite	No colour

* A.R.S. = Alizarin red *S*. P.F. = Potassium ferricyanide

METALLURGY

Identification of a Beta-Tungsten Phase in Tungsten–Rhenium Alloys

Phase diagram equilibrium studies in the binary tungsten–rhenium system show the presence of two phases over the range 0–65 wt. per cent rhenium at 1,500° C (ref. 1). A terminal solid solution having a body-centred cubic structure exists from 0 to about 27 wt. per cent rhenium, and a phase having a tetragonal sigma-type structure is found in the composition range 43–65 wt. per cent rhenium. In this investigation, alloys containing 13–45 wt. per cent rhenium prepared by vapour deposition

ACKNOWLEDGEMENTS

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COLORIMETRIC DETERMINATION OF ARSENIC IN GEOCHEMICAL SAMPLES

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ABSTRACT

Marshall, N.J., 1978. Colorimetric determination of arsenic in geochemical samples. J. Geochem. Explor., 10: 307–313.

A colorimetric method and apparatus for the determination of arsenic in batches of geochemical survey samples is described. The powdered material can be digested with a perchloric/nitric acid mixture, or most conveniently by an HF/aqua regia attack utilizing aliquots from the same acid solution as used for routine multi-element atomic absorption analyses. Aliquots are treated with potassium iodide and stannous chloride to reduce arsenic to the trivalent state, and arsine is liberated by the action of zinc pellets. The arsine is absorbed in a solution of silver diethyldithiocarbamate in chloroform-quinoline, the reaction being carried out in batches using very simple, inexpensive apparatus which is easily constructed. Detection limits are variable according to aliquot quantities taken, but in routine use working ranges of 1–800 ppm As are readily achieved. Coefficient of variation is 6.6% at the 5 μg As level. The method is shown to be virtually free from matrix interferences commonly encountered in gossans, soils, rocks and many ores. At least 100 powdered samples can be analyzed per man-day.

INTRODUCTION

Arsenic is a widespread constituent of many types of mineral deposits and under many conditions is a suitable indicator for over twenty elements with which it may be associated (Boyle and Jonasson, 1973). Arsenic geochemistry thus has widespread application in investigation of primary dispersion, as well as in secondary dispersions where it is usally fixed in gossans, soils and stream sediments as ferric arsenate. In this form it is fairly resistant to leaching and is therefore capable of giving excellent high contrast anomalies in highly weathered terrain such as the Western Australian Shield. It is an almost ubiquitous associate, often with tin and barium, of volcanogenic massive sulfide deposits whose geochemical signatures can be recognized by studies of gossan geochemistry.

An excellent review of arsenic geochemistry has been given by Boyle and Jonasson (1973).

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Although atomic-absorption-based procedures via hydride evolution through the use of sodium borohydride reductant have become popular in recent years (Thomson and Thomerson, 1974; Aslin, 1976), colorimetric methods offer certain advantages in batch productivity and simple instrumentation.

However, little has been published on geochemical applications and the effect of potential interelement interferences at the levels likely to be encountered in real geochemical samples, apart from the work of Gastinger (1972) who established concentration limits for Fe, W, V, Hg, Co, Ni and Cu in solution, and noted serious interferences from Hg, Co and Ni.

Colorimetric methods necessitate a prior separation/concentration step; and of the available approaches such as solvent extraction, halide distillation, coprecipitation or hydride evolution, the latter seems most convenient where it can be reacted directly with a colorimetric reagent to form a strongly colored complex.

Of the several colorimetric methods proposed, the old Gutzeit and Marsh tests are only semiquantitative, the modified molybdenum blue method (Portmann and Riley, 1964) is complex and subject to serious interferences from traces of phosphate and silicate, and the silver diethyldithiocarbamate in pyridine method (Vasak and Sedivec, 1952; Liederman et al., 1959) is the most convenient and popular.

In the latter method, the carrier solvent, pyridine, plays an essential role in acting as a nitrogen lone pair donor in the reaction between silver diethyldithiocarbamate (AgDDC) and arsine.

More recent variants of this reaction avoid the use of pyridine, with its unpleasant, pungent vapor by substituting other donor group compounds such as brucine (Geological Survey of Canada — in Aslin, 1976), *l*-ephedrine (Kopp, 1973) or quinoline (this paper) in chloroform as solvent.

EXPERIMENTAL

Quinoline (C_9H_7N) (with an extra benzene ring) is the next cyclic amine after pyridine in the series, and because of its higher molecular weight it is an oily viscous liquid with a rubber-like odour. In use it is diluted with chloroform, and gives identical sensitivity and behaviour to AgDDC in pyridine with none of the inconvenience of that reagent. The pale yellow reagent solution absorbs strongly at wavelengths below 430 nm but is virtually optically transparent at 545 nm, the wavelength at which the red-brown arsenic complex is determined.

Arsenic in the sample solution is brought into solution with an oxidizing acid attack, under which conditions potential losses by volatilization of the trichloride are prevented. Either aqua regia or perchloric/nitric acids can be used, but it has been found most convenient to take aliquots of a 10% HCl leach following total solution and subsequent evaporation to dryness at 110° C by an HF/aqua regia digest.

In the presence of matrix elements, recoveries are identical with this procedure, which has the advantage that it is amenable to large batch processing using inexpensive polypropylene vessels. Since total solution of the sample takes place (except for traces of resistant minerals such as graphite, cassiterite and spinels), the resultant solution is suitable for determination of a wide spectrum of major, minor and trace elements in addition to arsenic.

Certain types of silicified gossans sometimes leave a brown, iron-rich residue after perchloric/nitric digest, and since arsenic and other trace elements in gossans are usually coprecipitated with iron, the presence of an iron rich residue introduces a degree of uncertainty. For such situations, the HF/aqua regia attack is preferred.

In routine practice, 0.200 g of finely pulverized sample is heated with 4ml of a mixture of 2 parts HF (40%) and 1 part aqua regia (3 + 1 conc. HCl/HNO_3). Solution generally takes place within 30 minutes, this is then allowed to evaporate slowly (110° C hot-plate temperature) to dryness over a period of about 2 hours, with volatilization of SiF_4 and excess acid. The residue is then taken into solution by adding 10 ml of 10% HCl and warming. This operation is conveniently handled in large batches using custom made polypropylene vessels of 15 ml capacity with appropriately designed racks and heating blocks.

A 5 ml aliquot of this solution is placed in the arsine generator test tube, and 2 ml of Fe/KI solution followed by 2 ml of $SnCl_2$ solution added to reduce As^{5+} to As^{3+}. In the presence of high ferric iron matrix, we have found erratic recoveries of arsenic which were traced to incomplete reduction to trivalent arsenic at this step.

Siemer et al. (1976) studied the reduction of As^{5+} to As^{3+} by KI and found it to be time dependent with the concentration of HCl present. For example, a 1.3 M HCl solution took 11.3 minutes to reduce 10^{-7} M As^{5+} to As^{3+} using 0.14 M KI.

Gastinger (1972) found that Fe concentrations as low as 0.19 mg/ml interfered unless $SnCl_2$ exceeded 7.27 mg/ml in the final solution.

By warming the solution during the addition of Fe/KI and $SnCl_2$ reagent solutions, complete reduction is assured and consistent recoveries were obtained.

After cooling, 5 ml of 10% HCl/1.5% EDTA solution is added, followed by four Zn pellets (arsenic free, Merck).

Arsine (AsH_3) and hydrogen are then evolved by the action of zinc on the acid solution.

Excess ferrous ion is incorporated with the potassium iodide as this acts as an antipolarizing agent and promotes continued formation of nascent hydrogen in the presence of matrix heavy metals.

The use of glass wool impregnated with lead acetate to scrub the gas stream of H_2S is not necessary as any sulfides present will be oxidized to sulfate in the acid attack.

The generated arsine is bubbled through an 8-mm thick-walled capillary glass tube of 1–2 mm bore which is almost closed off at the end to form a pin-hole aperture. This tube fits inside a 12 (O.D.) X 150 mm test tube containing 3 ml of the AgDDC solution which it displaces well up the tube to pro-

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ide a long, efficient absorbent column (see Fig.1). The same absorbent tube an be used, with a ½" adaptor, as an absorption cell for optical density eadings in a Bausch and Lomb "Spectronic 20" spectrophotometer, thus providing a convenient system for rapid geochemical survey analysis.

Comparative tests with more eleborate gas absorption apparatus confirmed hat absorption is virtually complete using this simple and convenient apparatus.

A routine batch of 50 standards showed that the coefficient of variation was 6.6% at the 5 μg As level.

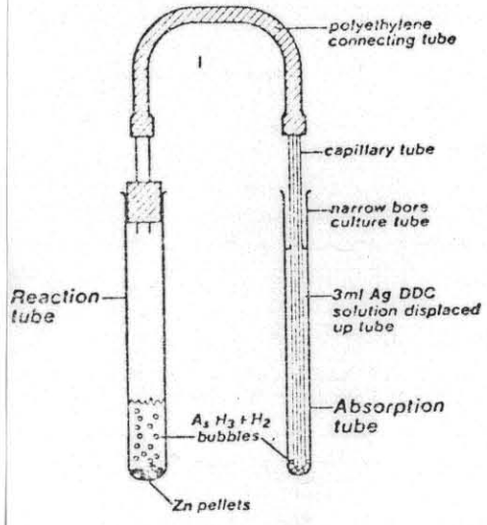

Fig.1. Arsine generator/absorber apparatus.

INTERFERENCE STUDIES

An amount of 2 μg As (as 1 ml of 2 ppm standard As^{5+} solution in 10% HCl) was added to a series of test tubes to which 2000 μg (as 2 ml of 1000 ppm solution) of each of Cu, Co, Ni, Pb, Mn were separately added, followed by 2 ml of the Fe/KI solution, 2 ml of $SnCl_2$ solution and 5 ml of 10% HCl.

The solutions were treated by the procedure described above, and optical densities of AgDDC solutions in chloroform/quinoline measured relative to that obtained by evolution from a pure 2 μg As standard in the absence of matrix addition.

Only 80% recovery was obtained for the Ni matrix solution and 75% for the Pb matrix solution under these conditions — other recoveries were within the experimental error of the technique. Gastinger (1972) reported severe interferences, however, for Ni and Co in his procedure.

To extend the capability of the technique to ores and high base-metal gossans without the need for preliminary separations, EDTA (1.5%) was then incorporated in the 10% HCl addition to act as a complexing agent for matrix cations.

As this does not involve any extra manipulative steps the use of EDTA was proposed in the routine procedure and interference tolerances were then tested for a wider range of elements.

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METHOD

Add 2 ml of matrix interferent solution + 1 ml of 2 ppm As^{5+} standard in 10% HCl to test tubes. Add 2 ml of Fe/KI solution and warm, followed by 2 ml of $SnCl_2$ solution whilst hot. Allow to cool, add 5 ml of 1.5% EDTA in 10% HCl. Add four Zn pellets and absorb arsine generated in 3 ml of AgDDC solution (see Fig. 1). Determine absorbance of solution in reagent tube at 545 nm after 45 minutes gas evolution. Calibrate by evolving arsine from standard As^{5+} solutions containing 0—15 μg As and plotting a straight-line Beer's Law graph of absorbance vs. concentration.

For routine determinations on geochemical samples, take 1—5 ml aliquots of the sample digest (× 50 dilution factor) previously described and follow with additions of Fe/KI, $SnCl_2$, and EDTA solutions.

Optimum working ranges are 1—160 ppm As in the sample for a 5 ml aliquot, and 5—800 ppm for a 1 ml aliquot.

RESULTS

Table I lists the percentage recoveries for 2 μg As with various levels of potential interferents using the above method.

TABLE I

Interferent	Level (μg)	% As recovery
Na, K, Mg, Ca, Al, Fe^{3+}	20,000	95—100
Ti, V, Cr, Mn, Co, Ni Cu, Pb, Ba, Sr, P Mo, Bi, U	2000	90—100
Ag, Au	200	95—100
Ni + Cu + Zn + Mn + Pb	200 of each	90—100
Hg	200	120
Sb	200	120
Sb	100	95—100
Se	200	20— 50
	100	50
	50	70— 90
	10	95—100
Te	200	55
	10	80
	5	100
W	2000	45— 65
	1000	70
	500	80

Excess Cl^-, I^-, SO_4^{2-}, NH_4^+, Sn^{2+}, Fe^{2+} and Zn^{2+} are already present in the analyte solution and do not interfere.

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...ence ranges are indicated.

Under the recommended operating conditions, and in the presence of EDTA, only Se, Te and W caused severe suppression at the levels tested above, whereas a slight enhancement was noted for Sb and Hg.

1000 μg Sb gave a reading equivalent to 0.8 μg As; however, after allowing for this impurity an enhancement of 120% was obtained.

Similarly, an enhancement was noted for Hg which on blank testing proved to be arsenic free. The reason for these enhancements which were consistently reproduced is not known, but in practice such As/Sb and As/Hg levels would not be a problem in normal geochemical samples.

DISCUSSION

If a 5 ml aliquot of sample solution is taken from the recommended digest (0.200 g in 10 ml) a dilution factor of 10× applies.

Thus the interference studies demonstrate that 20 ppm As in the sample can be determined in a sample matrix containing at least 20% of Na, K, Mg, Ca, Al of Fe^{3+} or 2% Ti, V, Cr, Mn, Co, Ni, Cu, Pb, Ba, Sr, P, Mo, Bi, U or 0.2% Ag or Au.

A gossan or low-grade ore containing 20 ppm As and 2000 ppm each of Ni, Cu, Zn, Pb, Mn would present no problem for trace arsenic determination.

In practice, it would be most unusual for samples to contain more than 5 times more selenium than arsenic, or 2½ times more tellurium, and analysis can be undertaken provided these interferent/arsenic ratios are maintained. High amounts of tungsten as in tungsten ores could present a problem, however.

Productivity is of the order of 200—300 samples per day if operators work in pairs and use rapid reagent dispensing equipment.

REAGENTS

(1) *$HClO_4/HNO_3$*. Three parts 72% perchloric acid plus 1 part concentrated nitric acid AR grade.

(2) *Fe/KI solution.* 14 g ferrous ammonium sulfate hexahydrate plus 20 g potassium iodide dissolved in 400 ml of approximately 3% H_2SO_4. Add trace of ascorbic acid to prevent oxidation.

(3) *$SnCl_2$ solution.* Prepare a 5% solution of $SnCl_2 \cdot 2H_2O$ in 50% HCl by dissolving in hot concentrated HCl first and then adding equal volume of water. Store in presence of tin metal.

(4) *Zinc.* Arsenic-free grade pellets, Merck.

(5) *HCl/EDTA solution.* Dissolve 1.5% EDTA, disodium salt in hot distilled water and then add hydrochloric acid to bring acidity to 10%. Prepare fresh daily as EDTA crystallizes out on standing.

(6) *Arsine reagent solution.* Dissolve, with warming, 1.000 g of silver di-...thyld...carb...ate (...k) in 200 ml chloroform + 100 ml quinoline. Store under refrigeration and keep away from light.

N.B. The reagent solution should be pale yellow in color; avoid the use of old stocks of quinoline (brown), or silver diethyldithiocarbamate (dark yellow powder).

Silver diethyldithiocarbamate can be readily prepared in pure form as follows: Dissolve silver nitrate and sodium diethyldithiocarbamate in water in separate beakers. Add an excess of sodium diethyldithiocarbamate to the silver nitrate solution and filter off the creamy yellow precipitate using Buchner funnel. Wash with distilled water and dry in desiccator — keep away from strong light.

Purify as follows: Dissolve to make saturated solution in hot chloroform, then filter through siliconised (phase separating) filter paper to remove solids and water. Add excess ethyl alcohol to cold filtrate, allow compound to crystallize out, filter through Buchner funnel and suck dry. The product is a pale yellow crystalline solid with a soapy feel, and is similar in appearance to the sodium salt. It should be stored in the dark.

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Journal of Geochemical Exploration, 10 (1978) 193—194

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Short Note

A TUBULAR-SCOOP SAMPLER FOR STREAM SEDIMENTS

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(Received May 16, 1978; accepted June 21, 1978)

ABSTRACT

Curtin, G.C., 1978. A tubular-scoop sampler for stream sediments. J. Geochem. Explor., 10: 193—194.

A stream-sediment sampling tool is described.

INTRODUCTION

The sampler described here was developed for use in deep-channeled streams draining permafrost areas in Alaska. It has, however, also proven useful for stream-sediment sampling in swiftly flowing streams draining rugged, mountainous areas. The sampler has an extendable handle that allows samples to be collected from depths of more than 2 m (6 ft). It is also sturdy enough to be used to pry cobbles from "armored" stream beds, so that the fine sediment trapped between the cobbles can be collected. The sampler allows the collection of stream sediment with a minimum loss of sample — especially in deep, swiftly flowing streams.

DESCRIPTION

The sampler, shown in Fig. 1, consists of: (1) an 18-cm (7-in.) length of seamless steel tubing that has an outside diameter of 7.6 cm (3 in.) and a 1.7-mm (0.065-in.)-thick wall; (2) a 1.7-mm (0.065-in.)-thick steel plate to close one end of the tubing; and (3) an extendable tubular-steel tent pole with set screw. The sampler scoop is constructed by cutting one end of the 18-cm piece of tubing at an angle of approximately 60° (Fig.1), and then welding a circular piece of 1.7-mm-thick steel plate to the other end of the tubing. The collapsible tent pole is welded to the scoop as shown in Fig.1. A small hole is

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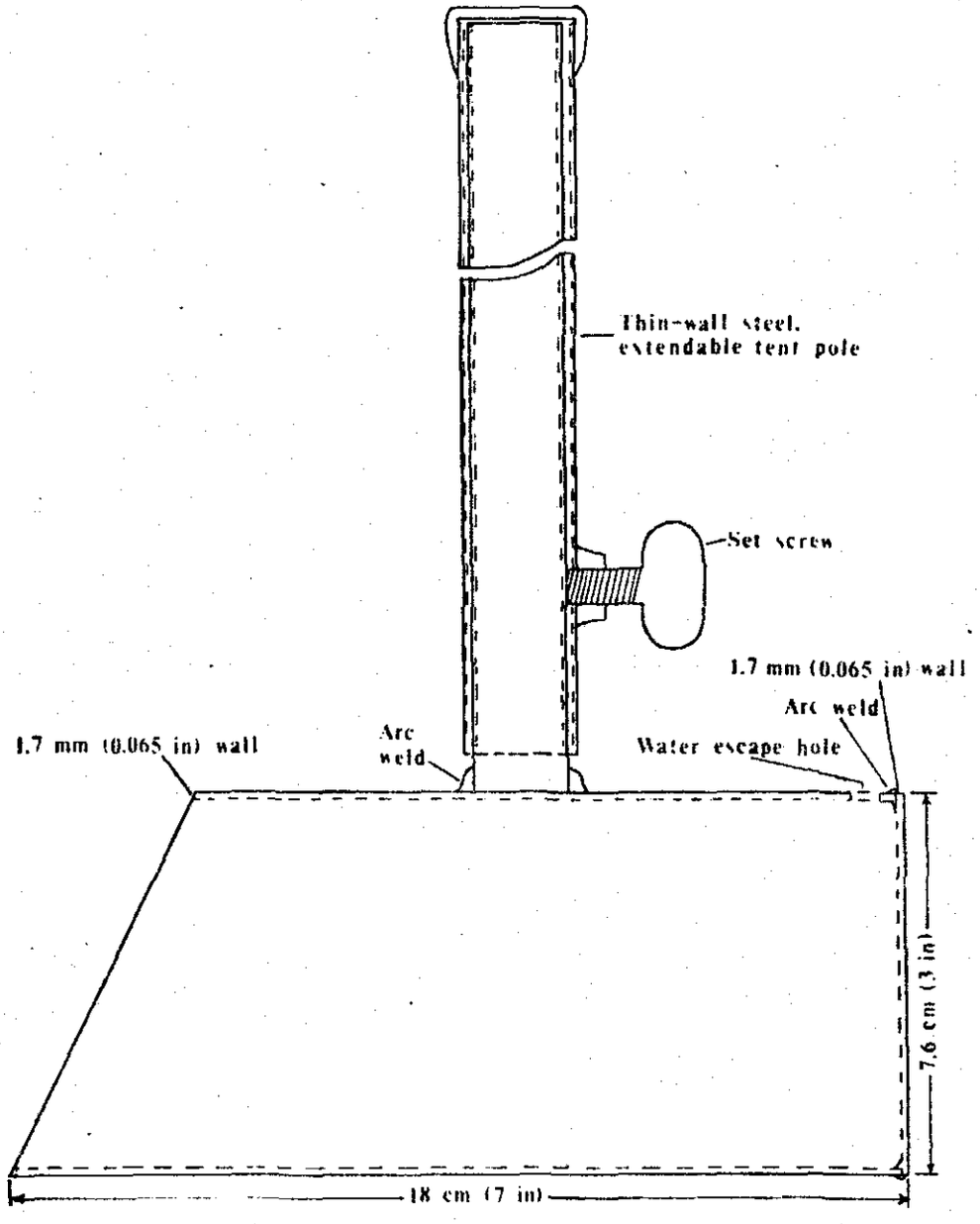

Fig. 1. Plan view showing dimensions of sampler.

drilled through the top of the scoop near the rear plate to allow the escape of water as the sediment sample is being collected. Before the sampler is used, the welds are smoothed to remove any small pieces that could break off and contaminate the samples.

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AN AUGER-SLEEVE SAMPLER FOR STONY SOILS*

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U.S. Geological Survey, Denver, Colo. (U.S.A.)
(Accepted for publication September 1, 1972)

ABSTRACT

Curtin, G.C. and King, H.D., 1972. An auger-sleeve sampler for stony soils. *J. Geochem. Explor.*, 1: 203–206.

A sleeve-type auger for sampling in stony soils is described.

INTRODUCTION

An auger-sleeve soil sampler was developed by us as an improvement over existing barrel-type samplers to facilitate the collection of alpine and subalpine soils during geochemical exploration. These soils characteristically are poorly consolidated, have weakly developed profiles, and contain a high percentage of pebbles and cobbles – as much as 60% in places (Retzer, 1962, p.34). In such soils, we have found it difficult to use ordinary soil augers to collect soil samples from known depths that are free from contamination by material from above. The auger-sleeve soil sampler described here solves this problem in geochemical sampling.

DESCRIPTION

This sampler consists of: (1) a probe (Fig.1A, 2A) made from ½-inch-diameter aluminum rod; (2) a sleeve (Fig.1B, 2C and D) of welded steel tubing, $2^3/_8$ inches in outside diameter with walls $^1/_{16}$ inch thick, and a removable collar for the sleeve; and (3) a 2-inch-diameter barrel auger with a removable handle (Fig.1C, 2B) which was obtained from Soiltest, Inc., Evanston, Ill., U.S.A. To reduce weight the auger was altered by substituting an aluminum shaft, 27 inches in length, for the steel shaft. The collar (Fig.2D) was made by cutting a 4-inch section of the welded steel tubing along its length, then inserting a 1¾-inch section of the tubing inside the split section as a flange to fit the top of the sleeve, and finally welding the two sections together and welding a plate ($^1/_8$ inch thick and ¾ inch wide) over the split. Two 5½-inch sections of ¾-inch-diameter steel pipe were welded to the collar as handles. The removable collar makes it easier to pack and carry the sampler. If compactness

*Publication authorized by the Director, U.S. Geological Survey.

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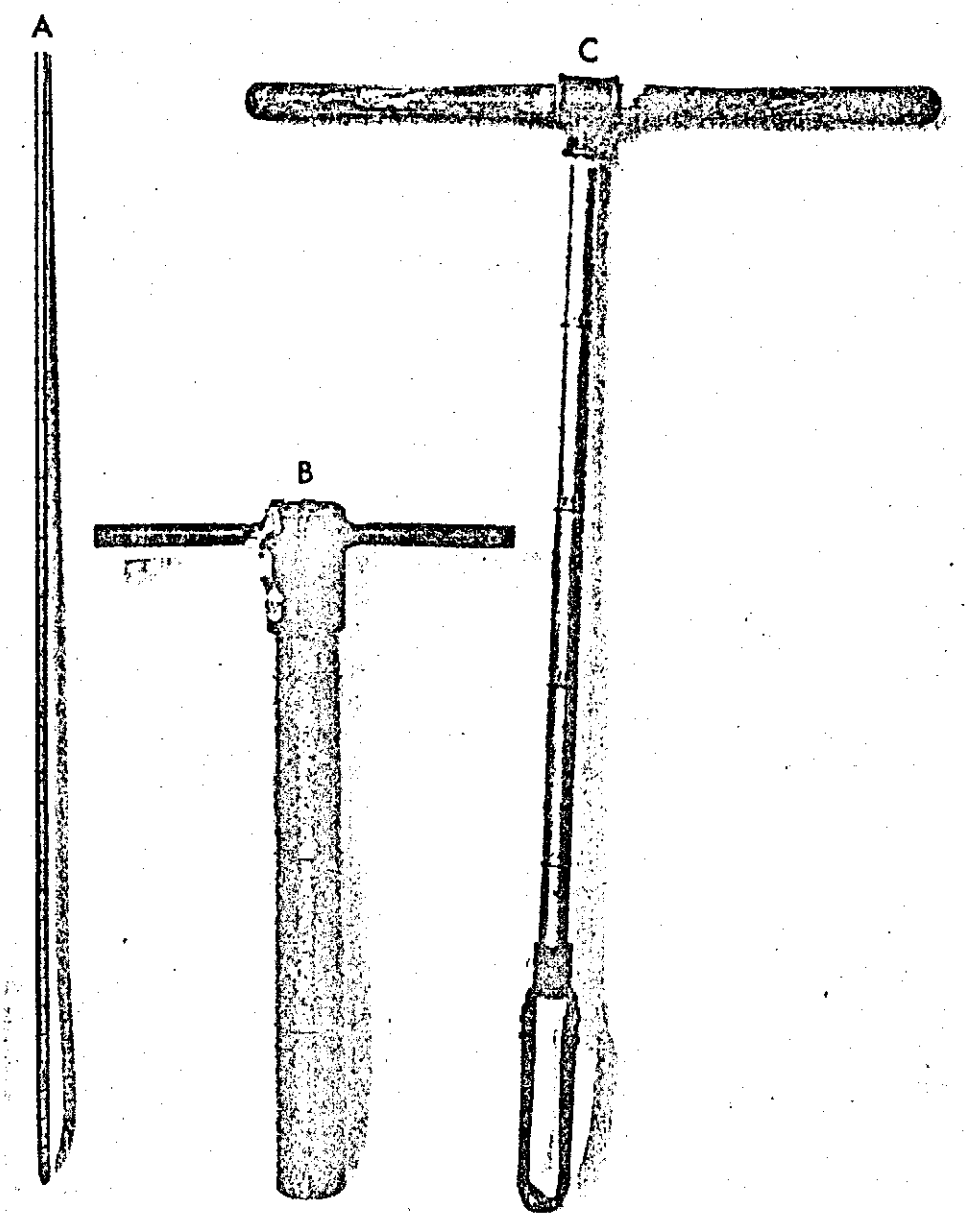

Fig.1. Parts of the sampler: A, aluminum probe; B, sleeve with removable collar; C, auger.

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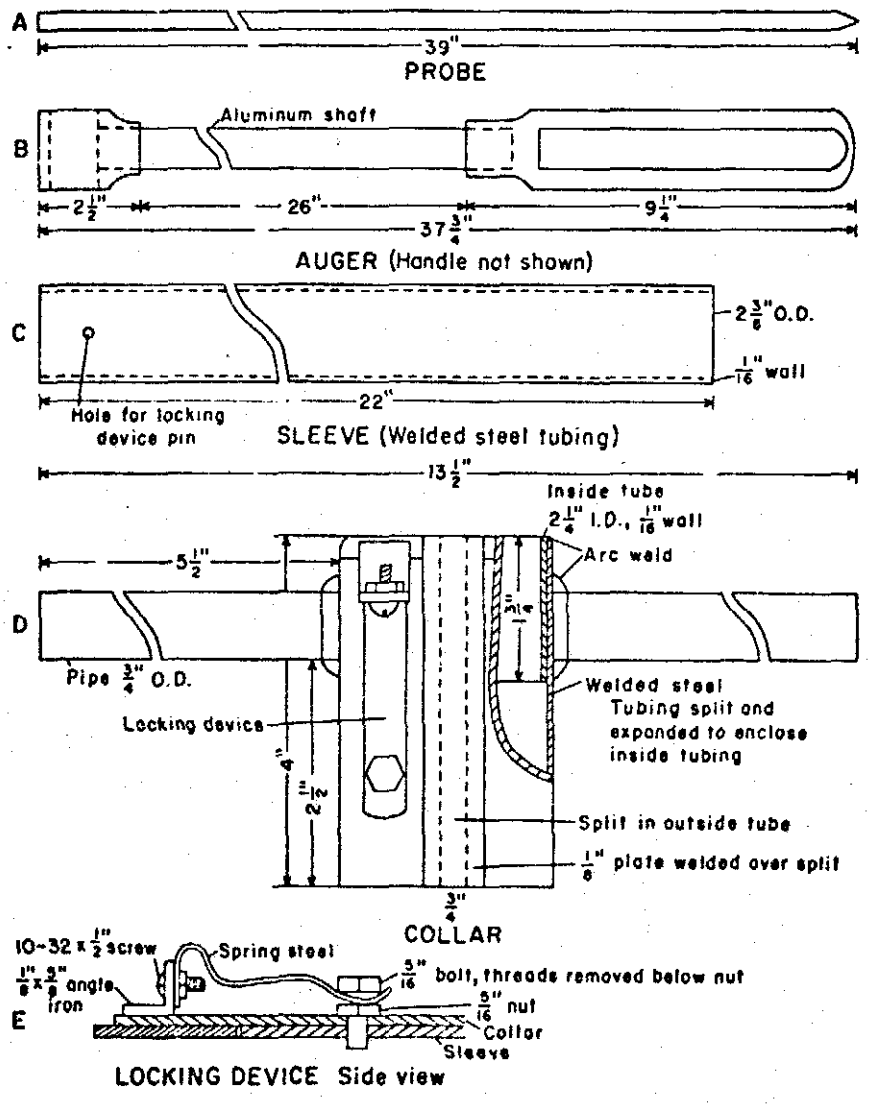

Fig.2. Plan view showing dimensions of the sampler assembly.

is not a consideration, however, a simplified collar and handles can be welded directly to the sleeve.

A locking device (Fig.2E) is used to lock the collar to the sleeve. It consists of a pin which penetrates matching holes in the collar and the sleeve. The pin is mounted on a piece of spring steel and the unit is attached to an angle bracket which is welded to the collar. When the collar and sleeve are locked together, the sleeve can be easily removed from the hole or rotated during insertion into the hole. An inch–foot scale was scribed on the probe, the sleeve, and the shaft of the auger.

120198

202

The use of this sampler expedites collection of uncontaminated soil samples because the relatively small diameter of the auger allows it to be driven easily between cobbles and to push them out of its path so that the sleeve can be inserted to the bottom of the hole.

Samples of soil are collected by first probing the soil with the aluminum rod to find a spot which is free of large cobbles or boulders within the depth range to be sampled. The auger is then inserted into the sleeve and turned until it has penetrated the soil the length of the auger barrel. The sleeve is then forced to the bottom of the hole by pushing on the collar handles, the auger is removed, and the sample is collected. The auger is re-inserted in the sleeve and the process is repeated.

REFERENCE

Retzer, J.L., 1962. Soil survey of Fraser alpine area, Colorado. *U.S. Dept. Agric., Forest Serv. and Soil Conserv. Serv., Soil Surv. Ser.* 1956 (20), 47 pp.

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COPY 1

WITH PHOTOS

PART II

ORIENTATION STUDIES CARRIED OUT FOR ELECTROLYTIC ZINC EXPLORATION

Services Available
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PART II

ORIENTATION STUDIES OF SPECIFIC AREAS FOR

ELECTROLYTIC ZINC EXPLORATION

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PART II - separate volume

ELECTROLYTIC ZINC ORIENTATION APPENDICES

APPENDIX I

W.Hercules Orientation

1. Field notebook descriptions
2. Plates I.1 and I. 2.
3. Analytical results
4. Figs. 8 - 12 series, showing line profiles along 800 N for various elements in different sample types.

APPENDIX II

Orientation Stream Drainage

1. Field notebook descriptions
2. Plate II.1.
3. Analytical results
4. Figs. 1 - 7 showing stream sediment and pebble coating results on drainage maps.

ORIENTATION STREAM SEDIMENT DRAINAGE

NORTH OF ROSEBERY.

See also Appendix I and II.

1. Results

1) Sample 23001 (Appendix I) gives Cu Pb Zn values of 25, 100, 80 ppm with cold extractable (N HCl) values of 20, 120, 45. (Thus experimental error with Pb - Cx = total).

As noted previously, the Pb and Zn values, although low, are probably influenced by some contamination, as most background Pb values are of the order of 20 ppm.

A sample of Mn wad at this site (23002) was leached for hydroxylamine extractable manganese by the Mt. Lyell laboratory using the recommended procedure and gave, as expected, background values.

Cu = < 0.01 ppm, Pb = 0.03 ppm, Zn = 0.3 ppm, Co = 3.5 ppm, Fe = .6 ppm, Mn = 2620 ppm in solution.

2) Samples 23048 - 50 (Appendix I) were of iron stained pebbles draining mine contamination in the Hercules mine area. Conventional stream sediments were not collected here as there was a dearth of fine material.
The following results were obtained, (as ppm in the hydroxylamine leach solution) for the soluble coatings.

	Cu	Pb	Zn	Co	Fe	Mn
23048	2.45	74	69	0.05	60	360
49	0.37	9.9	1.3	0.10	52	23
50	0.34	58	2.1	0.01	40	3.4

- = probably anomalous value, ═ = highly anomalous.

Note that these samples are highly anomalous in Pb and also Cu and Zn, indicating the efficacy of this sampling medium and analytical technique.
Results of spectacular contrast were obtained where conventional -80# sampling is difficult.
Some idea of background values can be obtained by comparing these results with those for the wad (23002) and the background values subsequently taken in the Chester, Pinnacles, Burns Ck.and Sock Ck. areas.

3) Southern area - Chester, Pinnacles, Burns Ck. region. See figs. 1-3, and Appendix II.

a) Site 1 was sampled to get some idea of dilution levels in an obviously contaminated area. The 30 m wide Boco Ck., drains mixed lithologies and is influenced by contamination from the Emu Bay Railway (concentrate trains).

Despite this, Cu Pb and Zn values in -80# stream sediment is only 10,20 and 20 ppm, and heavy mineral panning revealed only traces of tarnished pyrite. This is attributed to the combined effects of heavy dilution and the instability of sphalerite and galena in the humic acid environment. See also fig. 2, and compare trace element levels with surrounding samples.

The Mn pebble leach results for Cu, Pb and Zn are 0.05, 2.8, and 1.9 ppm in solution. Whilst fairly low, these results are anomalous relative to the other background values on fig. 3, as well as those obtained elsewhere and on Mt. Lyell's leases.

Thus this technique demonstrates that it can give results in areas of high run-off and dilution, where conventional -80# fails.

A coarse fraction (-20 + 80#) sample at this site gave equivalent low results by conventional and cold extractable analysis.

A split of this coarse fraction, when treated with the Mn leach procedure, also gave low results.
Contrast is reduced for Mn leach in all the non-pebble fractions tested on E Z and Mt. Lyell areas, because of abrasion and the influence of reducing humic acids in the stream water. Thus, Mn coatings are not well developed in sediment fractions, whereas the hand-picked pebbles show their best Mn development at the sides of streams near the high-water mark, where aerial oxidation can take place to precipitate Mn from solution.
Tourmaline in the heavy mineral panning is possibly an indicator of boron metasomatism from regional wall-rock alteration, or of tourmaline rich rock facies upstream.
Barium analyses on such samples would be of interest.

b) Site 2 is ½ mile downstream from the Chester pyrite deposit.
This deposit contained 2.8 million tons of 40% pyrite, less than 0.1% Cu and traces of Pb and Zn (C. Burton, E Z rept. 121), in pyroclastics. Subsequent exploration work by Comstaff Pty. Ltd., (Burton rept. 121) showed weak A_0 and very weak " C horizon" anomalies for Cu, Pb, Zn and Ba, and diamond drilling revealed only weak disseminated mineralization.

Confined

Hole CP3 intersected 2.4 m of 22% Zn, 5.2% Pb, 0.09% Cu and 8.8% Ba.
A dump sample of transported (site 4) gossan, no. 23057 (see Appendix I for results), gave 250 ppm Cu, 30 ppm As, and very low values for other elements, consistent with its genesis from a barren pyrite source.
Sample no. 23058 of massive fine-grained banded pyrite from the Chester "rock slide" gave 390 ppm Cu, 30 ppm As, and 14,300 ppm Ba. K and Rb values are suggestive of some significant potash feldspar or sericite mica component in the "chert" matrix, and the higher Sr value of 50 ppm (for an acid rock) may be due to carbonate component.

Heavy mineral panning at site 2 revealed abundant pyrite with traces of possible tourmaline.

The conventional stream sediment sample (Cu = 50, Pb = < 20, Zn = 55) is somehwhatanomalous in Cu and weakly anomalous in Zn relative to background values on Fig. 2, whereas the Mn coated pebbles are barren.

c) Site 3 contains abundant rounded tourmaline with background stream sediment values. The tourmaline is probably derived in this case from the Rosebery Group sediments. Some minor Pb influence (relative to site 2) in the Mn coating may be due to weathering of sediments containing higher background Pb.

d) Site 5 gives a background stream sediment value of 5 ppm Cu, < 20 Pb and 10 Zn in acid hitric crystal tuffs.

e) Site 6 (see photo II.1),draining mixed lithologies including pyritic units gives a slightly elevated Pb reading of 60 ppm in the stream sediment, and this is duplicated in the cold extractable Pb. The Mn coatings appear to give background results. A sample of locally derived wad in the creek bank, no. 23061, returned very low hydroxylamine extractable values (Cu <.01, Pb = .03, Zn = .3, Co = 3.5, Fe = 0.6 and Mn = 2620 ppm in solution). This, and work in the Mt. Lyell areas, substantiates that false anomalies due to Mn scavengingare not a problem.

f) Site 7 contains tourmaline and the stream sediment (Cu = 10 ppm, Pb = 60, Zn = 55) is possibly anomalous in Pb and Zn. This is supported by the Mn coating results of 4.9 and 2.4 for Pb and Zn respectively.

It is suggested that the tourmaline (in volcanic drainage - no sediments) and the weak stream sediment and Mn coating anomalies represent some influence from the Pinnacles zone of weak, disseminated mineralization.

g) Site 8, draining altered acid volcanics north of Burns Pk. contains tourmaline and weak Pb values of 60 ppm total and 40 ppm cold extractable in the stream sediment. (1.9 ppm in the Mn coating leach solution.) This may represent some regional expression of alteration and slightly elevated Pb values associated with the Chester-Pinnacles zone.

h) Site 9 and 10 both contain tourmaline and background values of stream sediment Cu, Pb and Zn (5, <20 and 15-20 ppm).

4) Northern Area - vicinity of Sock Ck. (see figs. 4-7)

Mineralization at Sock Ck. (investigated by Comstaff Pty. Ltd.,) occurs as weak Zn-Pb in fracture fillings (mineralized fault breccia) in quartz-feldspar porphyry. This occurs in a shear zone in volcanics at a contact with shales. (C.Burton, rept. 121).
The mineralization is probably structurally controlled and of small extent. Drilling revealed some minor intersections of up to 10% Pb, with lesser Zn and negligible Cu, over a strike width of 300 m with a width of 4.0 m.

In my opinion, this has analogies with the Henty Fault Zone mineralization. Comparative studies of wall-rock alteration elements—Ba, F, B, Mn, K, Rb and carbonate would be of interest to help classify both deposits relative to the Rosebery and Hercules models.

However, the absence of obvious black Mn coated stream pebbles (pebbles were only weakly iron-stained) and of tourmaline in the heavy mineral concentrates draining this area (low B analyses) suggests that a manganese and boron association is lacking. This is consistent with the above suggestion.

a) Sites 12, 11 and 15 are upstream of this mineralized zone and representative of barren background values. These give background values in conventional stream sediments as well as in pebble coatings.

b) Sites 13, 14 and 17 are progressively further from the Sock Ck. mineralization.
The site nearest to mineralization (13) is highly anomalous in the -80# stream sediment for Pb (280 ppm) and Zn (140 ppm), and the Cx Pb value equals the total value, signifying chemically dispersed and absorbed Pb in the sediment.

Anomaly contrast relative to site 11 is 14 x for Pb but only 2 x for Zn, whilst contrast relative to site 15 is 4.6 x and 1.4 x respectively.

By comparison, the leached pebble coatings give anomaly contrasts for Pb and Zn of 90 x and 9.5 x relative to site 11, with 67.5 x and 10.4 x contrasts relative to site 15.

The next site, 300 m further downstream, has conventional stream sediment values of 80 ppm Pb and 130 ppm Zn, which are not much greater than the background values at site 15. The Pb value in the leached pebble coating is still 30 x greater compared to site 15.

At site 17, the conventional stream sediment values are almost identical to site 14, signifying that a (higher) background plateau may have been reached downstream in this stream system.
The pebble coatings are still highly anomalous, however, but now Zn > Pb, reflecting its greater mobility.

c) Site 16 is downstream from Sock Ck., but influenced largely by dilution from the 15 m wide Bulgobac River, whose background values are given by site 15.

Conventional stream sediment values show identical results - only background values, due to dilution, are being determined.

The pebble coatings, however, still report twice as high in Pb and Zn despite dilution from the Bulgobac River.

d) Heavy mineral panned concentrates from sites 15, 16 and 17 reported no anomalous boron or barium, suggesting that a barite-tourmaline association is lacking at Sock Ck.

2. Conclusions.

1) Conventional -80# stream sediment sampling, with both "total" and cold extractable (1 N HCl) analysis for Cu, Pb and Zn is applicable for detecting mineralization in this area, but close sampling is required in this region of complex drainage topography.

2) However, analysis of leached Fe and Mn coated pebbles by selective hydroxylamine leach for Cu, Pb and Zn gives far better contrast.

Moreover, this anomaly contrast can be recognized further downstream from drainage, even after dilution by major streams.

3) Panning to obtain heavy mineral concentrates on a regional basis, using widely spaced samples, can be useful to outline areas of high boron (tourmaline) and barium (barite) concentration.

Panning should be done using consistent sample to concentrate ratios, so that emission spectrographic analyses for Cu Pb Zn and resistates (B, Ba, Sn, W, Cr, Nb) can be assessed on a comparative basis.

This can be useful at the first pass, regional level, in outlining boron and barium rich host rocks which are potentially favorable for Rosebery type mineralization.

As further back-up, some heavy mineral orientation sampling around the Hercules area would be useful.

II. WEST HERCULES (WHITE SPUR) ORIENTATION.

See Appendix I.

Although outside the joint venture areas, orientation sampling was carried out here to test the response of wallrock alteration (footwall type), as a model for future exploration in the region.

A prominent displaced, hydromorphic anomaly developed in soils on steep terrain at W. Hercules was also sampled along line 800 N to test bedrock mineralization, the alteration halo, and the response of various soil profiles encountered. This area has been the subject of a detailed thesis study by Russell (1976). Russell's thesis, however, was biased toward biogeochemical sampling of various species, and although he carried out soil studies, he failed to test for alteration assemblages in the bedrock, and to suggest a follow-up procedure for such displaced anomalies.

N.B. Although not shown on these results, the analyst, Dr. J.R. Beevers, reported verbally that all rock samples were extremely reactive in acid due to high carbonate.

1. West Hercules Mine Area.

1) samples 23044 and 23046, of brick red, highly fractured and weathered rock are so altered as to almost have the appearance of C horizon soils derived from gossan. Earlier analyses (R.E. Williams, pers. comm.) failed to identify these as gossanous. The reason for this is not understood, as these analyses (Appendix I) show both samples to be highly anomalous in Pb (2650 and 3370 ppm) and also Mn, although Zn and Cu are suppressed, presumably due to leaching. As is low.

   Barium is also anomalous in 23044 (not analyzed in 23046 which was treated as "soil"), F is high, especially for such a leached rock, (800 ppm), as is potassium, rubidium, and the K/Na ratio (33.3).

   These parameters are characteristic of wall-rock alteration and mineralization.

   23045, in which this gossanous pod of mineralization occurs is relatively low (750 ppm) in Pb but higher in Zn 490 ppm (- no leaching). It is anomalous in As (200 ppm), Mn, Rb, possibly in fluorine (350 ppm), and Ba (8660 ppm). The K/Na ratio is high (19.1).
   These parameters are diagnostic of wall-rock alteration, in the vicinity of mineralization, even where mineralizati itself is weak.

2) sample 23047 is a carbonated, altered tuff. Although a barren sample (deliberately collected for this reason) with only background base metal values, it is somewhat anomalous in Mn (600 ppm), and K (3.2%), and highly anomalous in F (1500 ppm), Rb (450 ppm) and Ba (6680 ppm). The K/Na ratio is 17.8.

2. Line 800 N traverse. (see figs. 8-11 series.)

1) previous routine sampling.

This line was sampled at 100 ft. intervals, from 1100 W to 100 W, and is the site of former routine "C horizon" sampling.

It is clear that the samples collected in the routine survey were not C horizon. Bedrock chips (or possibly talus) was present, but was sifted out and the -80# sample would have consisted of B horizon at the western, downslope end, and azonal, skeletal soil at the eastern, or upper end.

The original sampling (fig. 8a-c) showed highly anomalous Pb, and to a lesser extent Zn and Cu in the 700 W - 900 W section.

There is an abrupt change in vegetation from low ti-tree scrub on bare rocky slopes (skeletal soils) to lush rain-forest and horizontal scrub, on deeper, more mature soil profiles, between 600 and 700 W.

2) base metal bedrock values.

At 530 W, an old trench with altered, somewhat gossanous crystal tuff was encountered.

This was the only rock sample to give weak, but distinctly anomalous Cu,Pb,Zn values. Other rock samples, even at 100 W, approaching the mineralization, are all low in base metals. This sample probably represents a minor occurrence of mineralization, and Stone (1975, E Z rept. 120) notes that some old workings have been found within the (displaced) anomalous zone.

It is suggested that the change in soil type, to a deeper, mature residual soil profile from 700 W on, acted as a trap for base metals dispersing in solution from the W. Hercules mineralization and accumulating in the 700-900 W region. Above (east of) this zone, the thin skeletal soils consist essentially of rock detritus and allow metal rich solutions to percolate through without being absorbed to any significant degree. (see figs. 8 and 11, also fig. 12).

3) litter samples -(see fig. 9 series).

These also change in character, from thick rain forest leaf mold to thin, dry ti-tree leaves above 700 W, where the vegetation changes to ti-tree scrub.

However, unlike the stony detrital "soils", the organic litter, through biogeochemical recycling, has managed to accumulate anomalous amounts of metals on the upper slopes, as well as on the 700-900 W area.

This results in a double anomaly distribution. The upslope litter anomaly, at 300 W, is due to enrichment from solutions which in the absence of true soil profile development, can not form a soil anomaly. The source is not the bedrock, which is barren in base metals (figs. 10a-c), but hydromorphic dispersion of the W. Hercules mineralization further upslope. The downslope litter anomaly, at 800 W, is derived by biogeochemical cycling from the well developed B horizon soil anomaly here.

Pb gives strong, one station anomalies at 300 W and 800 W (fig. 9c) whereas the Zn responses are subdued, probably due to the mobility of this element.

There is not much Cu available, (low in B horizon soils) and what little there is has been fixed to give a single anomaly in litter at the upper site only.

Arsenic gives two distinct anomalies, following Pb.
Mn is also anomalous at both sites.
Fe behaves differently in being higher in the upper zone - this may be a species effect.

4) bedrock samples for alteration elements and Mn. (fig.10 series).

Only the mineralized pit sample at 530 W is anomalous in Cu,Pb,Zn,As,B, and Fe, although Mn is anomalous here and also at 100 W.

The"alteration elements" are interesting:

Fe shows a general decrease approaching ore.
F, and to a lesser extent, Ba and Rb increase toward ore and reach anomalously high values for this rock type.
The trends for Ba,F,Rb are remarkably similar.

Potassium values are more erratic across the zone, with some anomalously high values occurring.

Sodium decreases toward ore (from 600 W to 100 W) to quite low values.
Two high sodium values at 1000 W and 600 W may be due to facies changes to a more basic rock type, but the accompanying high K and low Sr values do not support this.
These high Na values may be zones of albitization.

The K/Na ratio shows a spectacular increase toward ore over a distance of at least 400 ft., from 500 W to 100 W. Ratios rise from a background of about 2, to a peak of 49. The peak of 75 at 1100 W is due to a change of rock type to grey siliceous shale, whereas other samples, for which the trend is valid, are all pyroclastics

3. Conclusions.

1) A hydromorphic anomaly occurs at least 800 ft. downslope from the W. Hercules mineralization, at the point where thin stony soils change to mature B horizon soils in rain forest.
Therefore any anomalies encountered in future situations must be checked by bedrock sampling for an underlying source. If this is absent, and a similar terrain change occurs, they must be traced upslope.

2) Litter sampling at surface is an effective medium for locating hydromorphic anomalies, particularly for Pb and As.

3) Analysis for wallrock alteration elements is an effective guide to ore proximity within one rock type, even outside the zone of base metal influence. Important parameters are increasing K/Na ratios, and high Rb, F, Ba, Mn.

High carbonate occurs throughout these footwall rocks.

120212

APPENDICES

APPENDIX I

W. Hercules (White Spur Grid area)
Orientation.

Sampled with R. Williams, P. Komyshan, 20.2.79

1.

23001

Stream sediment sample (for - 80#), 20 m upstream from Williamsford Rd, 300 m N of Jupiter prospect. 1 m stream in crystal tuff of Rosebery Gp. sediments. Aerial ropeway nearby (possible contamination.)

23002

Mn wad, submitted as Mn leach sample, up to 2 cm thick. Broken off as loose coating on waterfall in stream at 23001 site. Potential sampling medium for drainage surveys.

Soil profile in nearby road cutting (not sampled) shows:

A_{00}	forest litter
A_1	grey,organic soil
A_2	bleached, sandy clay - zone of maximum leaching.
B	mottled clay zone - accumulation of iron oxide.
C	weathered rock clay (saprolite)
D	bedrock

2.

White Spur Grid (W Hercules) line 800 N (studied in Russell thesis)

(distances in feet)
All downslope to W.

1100 W

In rain forest horizontal scrub, local flattening of slope.

23003 "R" (rock sample) outcrop of grey siliceous shale

23004 B horizon mottled light brown (buff) clay, 10 cm thick to hard bedrock.

23005 "L" (litter) 0-2 cm depth (= A_{00})

1000W

in rain forest.

23006 "R", m.g. acid crystal lithic and vitric tuff, with some weathered out disseminated carbonate.

23007 B horizon from 15 - 20 cm, dark brown and orange mottled loam.

23008 A_1 chocolate brown clay soil from 3 - 15 cm depth.

23009 L sample,

900 W	in rain forest, horizontal scrub
23010	R, m.g. ash flow (crystal-lithic-vitric) tuff outcrop 20 ft E (uphill) of peg.
23011	B horizon brown clay, 30 cm thick, with hard bedrock chips.
23012	A_0 humus
23013	L sample
800 W	in rain forest
23014	R, acid crystal vitric tuff fragments from bottom of Russell's pit at 50 cm depth
23015	B horizon loam from 30 cm depth
23016	A-B transitional zone, brown clay, 2-10 cm depth
23017	L, 0-2 cm
700 W	in rain forest
23018	R, fragments (to be washed) of lithic ash flow tuff as above, in B horizon clay at 60 cm depth in Russell's pit.
23019	B horizon red-brown mottled clay from 30 cm.
23020	A_1 horizon dark brown soil at 3-8 cm depth.
23021	L sample.
600 W	Now in secondary growth (ex bush fires) and alpine scrub (not geologically controlled) of ti-tree (leptospermum) and grass. - out of rain forest. Drastic soil type change here.
23022	R, outcrop of more lithic crystal tuff, somewhat more siliceous than before; subtle change in rock type with chlorite veins and lithic fragments. Slope is steeper than before but not a sudden change in slope.
23023	A_2 sandy clay soil leached, off-white, white fragments of quartz-feldspar phenocrysts, from 20 cm depth.
23024	A_1 - A_2 transitional (juvenile soil), mid grey darker (more organic) than 23023 with more clay and less fragments.
23025	L sample. This is now poorly represented (cf. rain forest) and consists of some fibrous fine rootlets and dried (but not decaying) ti-tree leaves.
N.B.	Need to sieve out - 30# mineral grains and discard proir to grinding and wet ash analysis of litter.

530 W

23026 R. at side of old tranch. Sample of crystal tuff as before, but more kaolinized, with some pyritic cavities and carbonate weathering.

500 W

23027 R, Acid quartz crystal tuff, white, quartzo-feldspathic; f.g. sericite, some grey lithic fragments and elongate thin lenses of vuggy material - possibly weathered carbonate. Now in F W of the hanging wall/footwall contact for W Hercules.

23028 A_2 bleached sandy clay as before with abundant rock fragments. A skeletal lithosol (immature) soil 20 cm thick.

23029 A_1 - A_2 transition, 0-8 cm depth; poorly differentiated stoney alpine soil.

23030 L sample (thinly developed).

400 W

23031 R, feldspar-quartz crystal tuff strongly altered to carbonate-quartz-sericite schist, strongly cleaved. Carbonate weathering holes on surface outcrop, and abundant lensoid vugs lined with f.g. sericite.

23032 A_2 skeletal, azonal soil as before.

23033 A_1 - A_2 transition as before.

23034 L sample, rather transitional to A_0 humus development.

300 W

23035 R, white f.g quartz-sericite schist outcrop on steep rocky hillside with bare skeletal soils and low ti-tree and "cutting grass" bushes.

23036 (A_1-A_2 ?) thin (8 cm) grey skeletal, azonal sandy clay with no profile development.

23037 L sample, ti-tree leaves and moss roots.

200 W

23038 R, outcrop on steep bare slope. White f.g quartz-sericite schist as before.

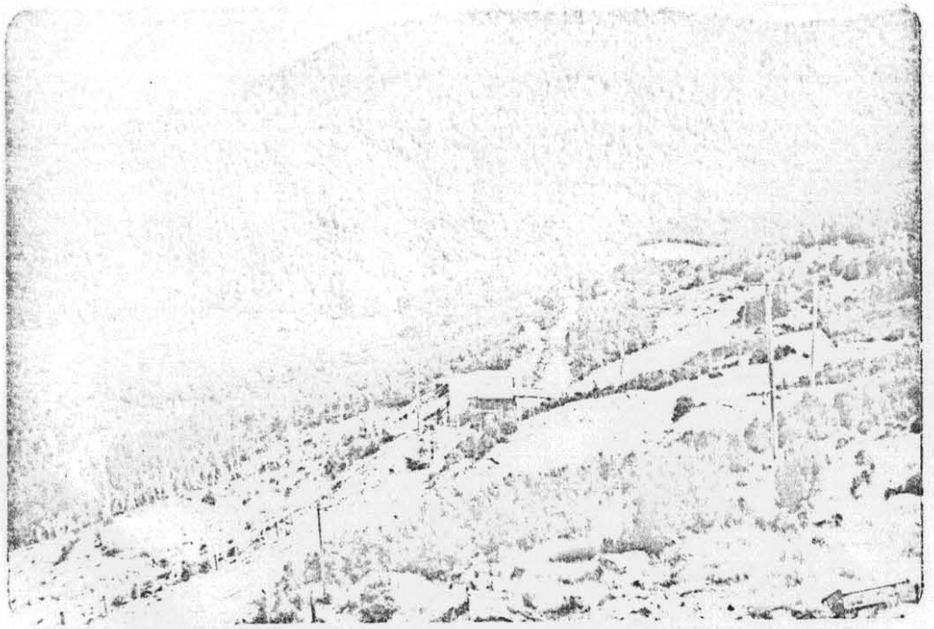
23039 grey stony azonal soil, 0-10 cm thick.

23040 L sample; very sparse ti-tree leaf litter.

100 W	just below W Hercules road.
23041	R, outcrop forming steep bluffs, f.g quartz-sericite schist as before, with occassional Mn and limonite stains, fine euhedral pyrite cavities, and coarse weathering carbonate holes on surface.
23042	grey thin skeletal soil, 0-15 cm.
23043	L sample, ti-tree litter.

3. W Hercules Mine Area.

23044	W Hercules access road, lower sample. "R"; Brick red, highly weathered chlorite schist with some pyrite cavities and Mn stained bands - gossanous appearance.
23055	10 m E of 23044 "R"; 1 mm euhedral disseminated fresh pyrite in silicified W Hercules host rock. Some blebs of galena present but avoided sampling these. Check for S, As, alteration elements, base metals.
23046	W Hercules access road, upper sample. "R"; Highly weathered (to clay) fractured tuffaceous volcanic, mottled brick red and orange, with Mn filled fractures, weathered feldspar phenocrysts and chloritic fragments.
23047	Crest of hill on access track between LM lode and W Hercules. "R", grey, shered, porphyritic feldspar tuff with sericitized groundmass and abundant 1-2 cm weathering holes after carbonate, some of which are infilled with Mn wad.
23048	Fe stained pebbles from contaminated creek N E of LM lode. For Mn leach studies.
23049	side creek draining mullock heap and glory holes (barren) Fe stained pebbles for Mn leach studies.
23050	Baker's Ck. at no. 4 level - Fe stained pebbles for Mn leach studies.



I.1. Hercules Mine
from ore pass down haulage way
- Renison Bell in background
top left



I.2. W. Hercules (White Spur) grid orientation at 800 N/300 W looking to W Hercules levels Typical ti-tree scrub and cutting grass on thin stony lithosol soil on quartz-sericite schist. Typical of upper part of orientation line.

120217

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MANLY, N.S.W. 2095

50 Mary Street,
(P.O. Box 3),
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ANALYTICAL RESULTS

Samples from: Electrolytic Zinc Co. of A'asia ltd. **120218**

Area:

Samples of: Litter

Preparation: Dry; sieve#20,reject-20#;pulv.+20# Sheet No.: 1

Batch No.: S A2838. Date: 16/3/79.

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ppm ✓	Pb ppm ✓	Zn ppm ✓	Mn ppm ✓	Co ppm	Fe % ✓	As ppm ✓
23005	20	75	150	1450	10	0.64	40
9	15	90	75	1050	<5	1.04	10
13	20	140	110	1700	<5	0.59	<5
17	25	1160	170	4250	5	1.10	30
21	25	370	110	900	<5	1.13	40
25	20	250	100	750	<5	0.85	<5
30	30	95	60	800	<5	2.50	<5
34	30	100	100	500	<5	1.48	10
37	100	1360	180	500	<5	1.86	60
40	20	120	120	2250	<5	2.00	<5
23043	20	70	110	700	<5	4900ppm	<5

ANALYTICAL METHODS: Cu, Pb, Zn, Co, Mn, Fe, by AAS; As by Colorimetry.

DISTRIBUTION: Electrolytic Zinc Co. of A'asia Ltd.

Signed .....

ADELAIDE
Tel.: 272 5733

SYDNEY
Tel.: 977 6495

63 ALEXANDER STREET
MANLY, N.S.W. 2095

50 Mary Street,
(P.O. Box 3),
UNLEY. 5061. SA.

ANALYTICAL RESULTS

223

Samples from: Electrolytic Zinc Co. of A'asia Ltd.

Area:

Samples of: Rock.

Preparation:

Batch No.: S A2837

120219

Sheet No.: 1

Date: 14/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ✓ ppm	Pb ✓ ppm	Zn ✓ ppm	Co ppm	Mn ✓ ppm	Fe ✓ %	As ✓ ppm
23003	15	30	60	5	90	1.68	20
6	<2	55	130	10	830	2.50	10
10	10	45	195	<5	900	2.50	10
14	10	190	60	<5	730	1.19	20
18	10	90	90	<5	240	1.38	20
22	5	70	40	<5	190	1.01	10
26 530 W	30	525	360	10	1600	3.20	200
27 500 W	5	50	25	<5	75	0.71	40
31	10	80	80	<5	330	1.28	20
35	5	25	15	<5	50	0.16	20
38	10	85	55	<5	25	0.21	<5
41	10	140	35	<5	2500	0.46	30
44	145	2650	610	5	1.27%	8.50	10
45	50	750	490	10	1300	7.50	200
47	10	80	50	10	600	1.20	10
57	250	70	20	25	15	51.00	30
23058	390	<20	15	60	30	23.70	30
Repeat and check -							
23031	15	90	80	<5	330	1.28	

ANALYTICAL METHODS: Cu, Pb, Zn, Co, Mn, Fe, by AAS; As by Colorimetry.

DISTRIBUTION: E.Z.Co. of A'asia Ltd., Rosebery, Tas.
Hurstville,

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224

ANALYTICAL RESULTS

50 Mary Street,
(P.O. Box 3),
UNLEY. 5061.

Samples from: Electrolytic Zinc Co. of A'asia Ltd. 120220

Area:

Samples of: Rock.

Preparation:

Sheet No.: 2

Batch No.: S A2837.

Date: 14/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Na ✓ ppm	K ✓ %	Rb ✓ ppm	B ✓ ppm	F ✓ ppm	Sr ppm	Ba ✓ ppm
23003	400	3.00	370	100	450	<10	3600
6	2.70%	1.50	190	10	160	15	2120
10	8400	2.40	300	30	400	<10	2930
14	1.18%	2.20	295	30	450	<10	2320
18	1.38%	1.43	220	30	270	<10	1830
22	2.40%	4.60	140	3000	80	<10	1320
26 530 ω	8050	0.75	165	300	160	<10	1380
27 500 ω	4250	2.10	280	30	550	<10	1840
31	5500	1.87	345	30	1100	15	5280
35	1100	1.81	310	10	1200	<10	2740
38	450	1.01	225	10	350	<10	1730
41	550	2.70	425	10	1550	<10	2580
44	780	2.60	185	<10	800	15	2940
45	1050	2.00	315	10	350	20	8660
47	1800	3.20	450	30	1500	<10	6680
57	600	0.20	20	10	<50	170	170
23058	780	1.25	130	20	50	50	14300
Repeat and check -							
23031					1100		

ANALYTICAL METHODS: Na, K, Rb, Sr, by AAS or Flame Photometry on $HF/HClO_4$ leach.

DISTRIBUTION: E.Z.Co. of A'asia Ltd., Rosebery, Hurstville,

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SYDNEY
Tel.: 977 6495

A.C.S. Laboratories Pty. Ltd.
63 ALEXANDER STREET
MANLY, N.S.W. 2095

50 Mary Street,
(P.O. Box3),
UNLEY. 5061.

225

ANALYTICAL RESULTS

120221

Samples from: Electrolytic Zinc Co. of A'asia Ltd.

Area:

Samples of: Soils, B & A-horizon

Preparation: 0.5 NHCL leach for 4 hours.

Sheet No.: 3.

Batch No.: S A2837

Date: 16/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ppm	Pb ✓ ppm	Zn ppm	Mn ppm	Co ppm	Fe ppm	As ppm
23004	10	100	25	35	10	8000	30
07	10	80	60	250	<5	2.70%	<5
08	10	100	50	250	<5	1.70%	10
11	80	950	410	4290	10	2.70%	<5
12	15	190	80	200	<5	1220	<5
15	25	3200	50	7500	<5	3.40%	40
16	25	3000	70	6600	10	2.70%	30
19	10	1100	30	1650	15	5.40%	40
20	10	1700	70	7000	10	4.00%	60
23	<2	110	5	20	<5	340	<5
24	<2	150	10	100	<5	560	<5
28	<2	70	5	20	<5	170	<5
29	<2	110	10	50	<5	180	<5
32	<2	80	10	10	<5	130	<5
33	5	80	10	20	<5	200	<5
36	10	200	20	30	<5	240	<5
39	<2	160	10	80	<5	260	<5
42	10	160	10	10	10	160	<5
23046	125	2350	120	5650	<5	4.40%	<5

ANALYTICAL METHODS: Cu, Pb, Zn, Co, Mn, Fe, by AAS; As by Colorimetry.

DISTRIBUTION: E.Z.Co. of A'asia Ltd., Rosebery, Tas.
Hurstville.

Signed .....

ADELAIDE
Tel.: 272 5733

SYDNEY
Tel.: 977 6495

6 ALEXANDER STREET
MANLY, N.S.W. 2095

50 Mary Street,
(P.O. Box 3),
UNLEY. 5061

226

ANALYTICAL RESULTS

Samples from: Electrolytic Zinc Co. of A'asia Ltd.

120222

Area:

Samples of: Rock.

Preparation: Perchloric Nitric leach

Sheet No.: 4.

Batch No.: S A2837

Date: 16/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ppm	Pb ppm	Zn ppm	Mn ppm	Co ppm	Fe ppm	As ppm
23004	<2	100	20	30	5	8000	30
07	10	70	55	260	10	3.20%	10
08	20	100	60	250	5	1.70%	10
11	90	940	450	4500	20	3.00%	<5
12	70	240	90	200	<5	1500	<5
15	25	3400	50	8500	15	3.40%	40
16	30	2850	70	7500	10	2.80%	30
19	10	1100	30	1700	20	5.40%	100
20	10	1700	70	7100	20	4.00%	60
23	10	90	10	20	<5	400	<5
24	5	140	30	120	<5	700	<5
28	5	65	15	20	<5	150	<5
29	5	80	20	40	<5	250	<5
32	5	65	10	<5	<5	200	<5
33	5	70	20	20	<5	250	<5
36	10	190	25	30	<5	300	<5
39	5	150	30	80	<5	350	<5
42	5	160	10	<5	<5	200	<5
46	150	3370	210	1.20%	30	8.00%	<5

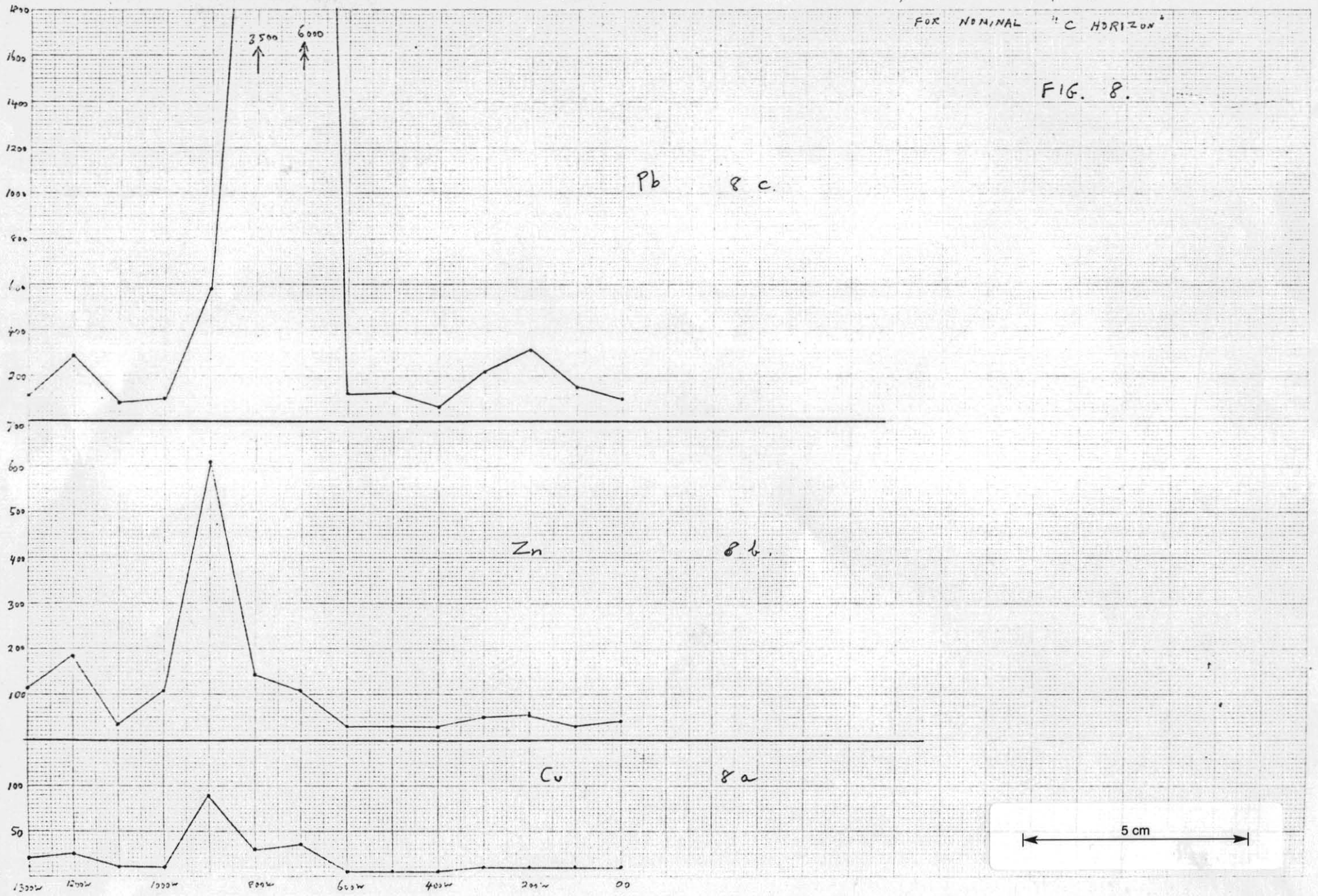
ANALYTICAL METHODS:

E.Z.Co. of A'asia Ltd. Rosebery, Tas.

DISTRIBUTION: Hurstville, Sheet 4

W. HERCULES (WHITE SPUR) LINE 800 N, ROUTINE SURVEY RESULTS FOR NOMINAL "C HORIZON"

FIG. 8.



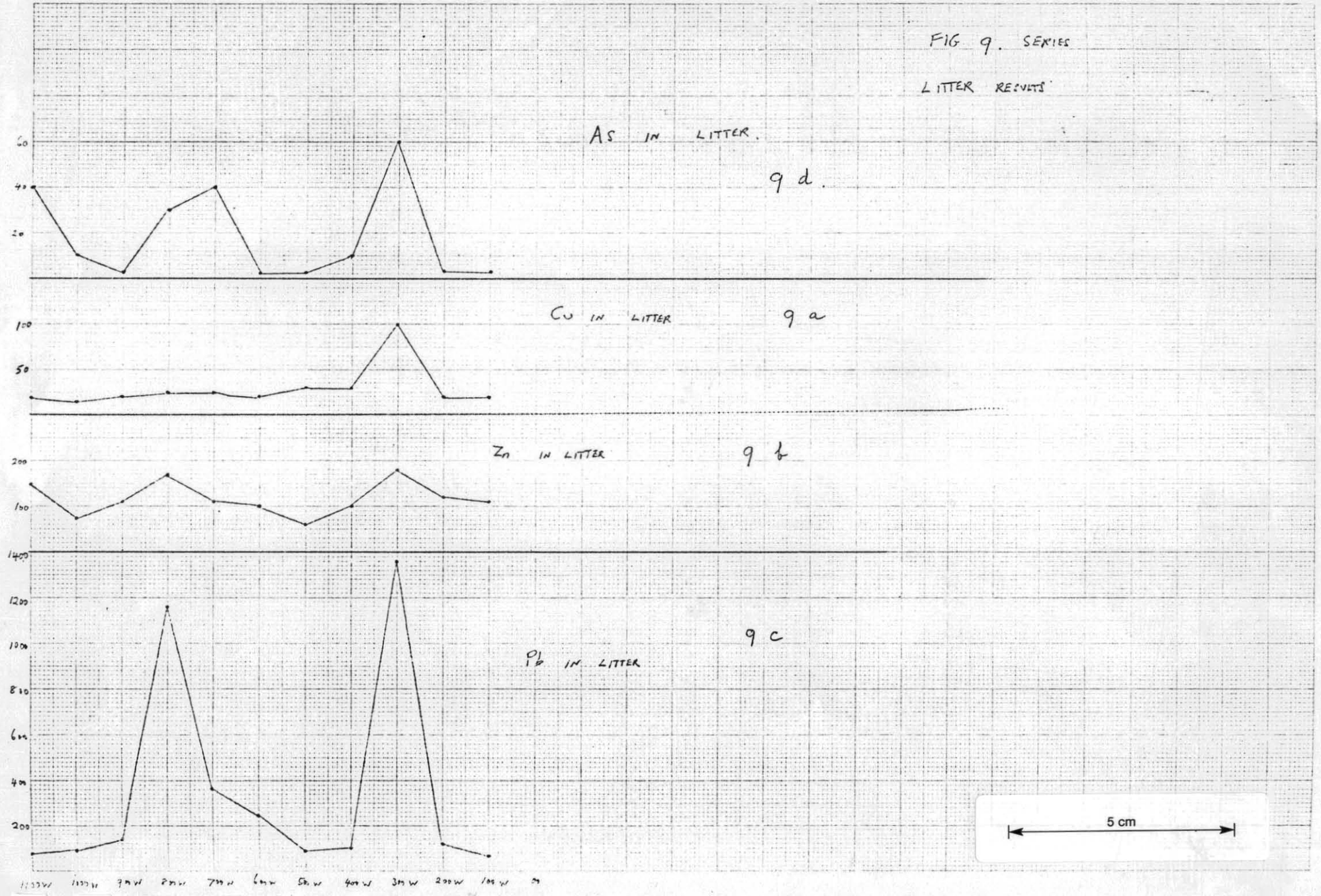
120223

120224

W HERCULES LINE 800N

FIG 9. SERIES

LITTER RESULTS



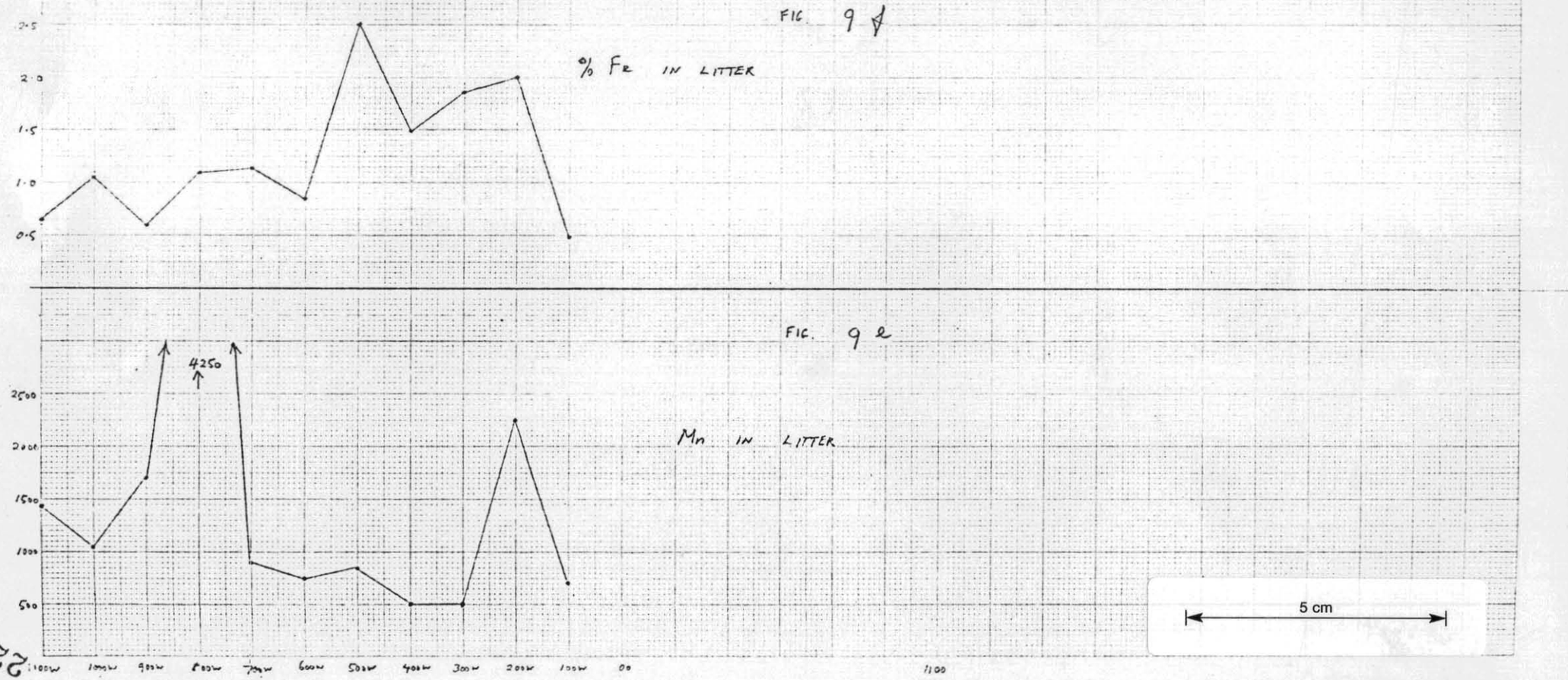
822

120225

W. HERCULES LINE 800 N

FIG 9 (continued) SERIES

LITTER SAMPLES

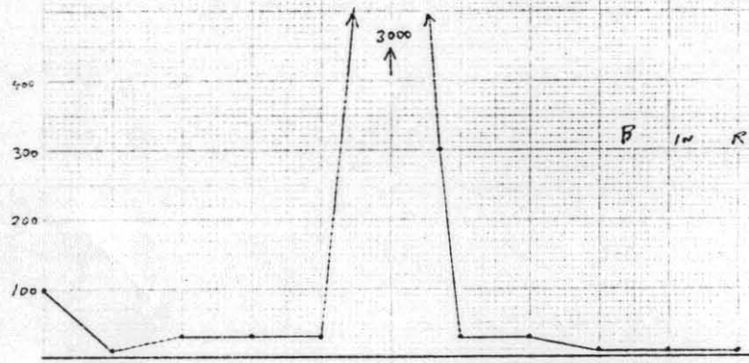


229

120226

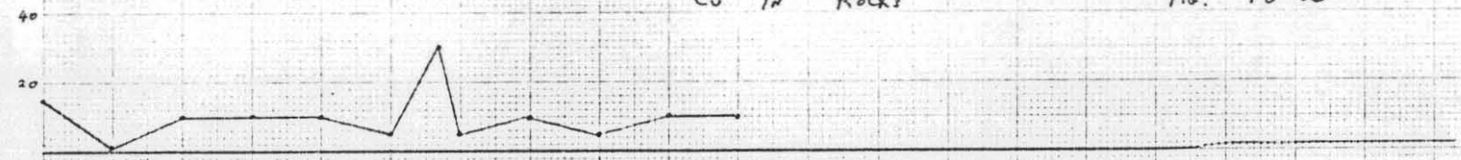
W HERCULES, LINE BOT II

FIG 10 SERIES (ROCK RESULTS)



B IN ROCKS

FIG. 10 g



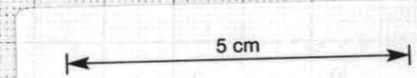
Cu IN ROCKS

FIG. 10 a



FIG 10 b.

Zn IN ROCKS



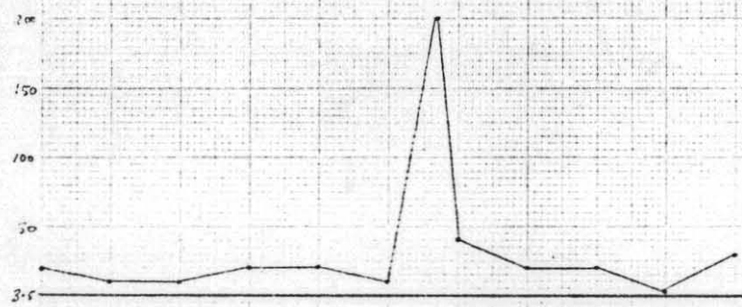
1100W 1000W 900W 800W 700W 600W 500W 400W 300W 200W 100W 0

230

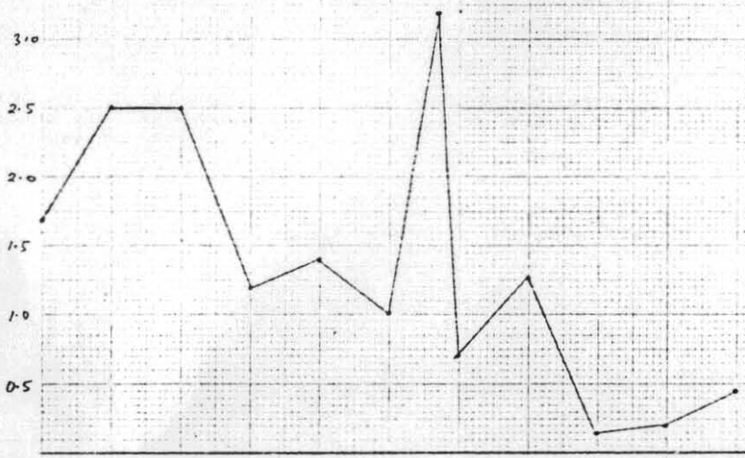
120227

W. HERCULES LINE POST N

FIG 10 SERIES (continued)
ROCK RESULTS



As IN ROCKS
FIG 10 d



% Fe IN ROCKS
FIG 10 f.

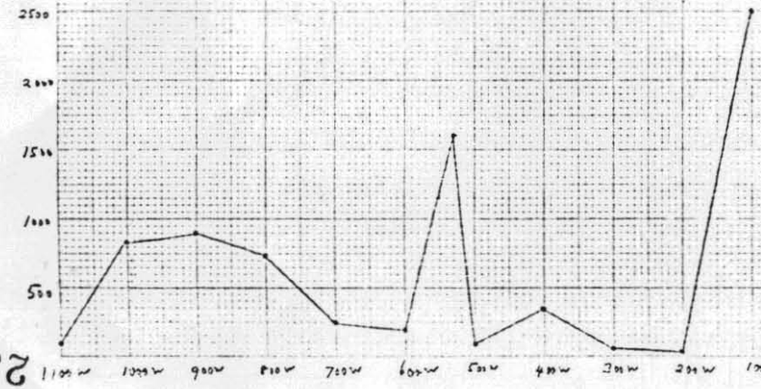


FIG 10 e

Mn IN ROCK.

5 cm

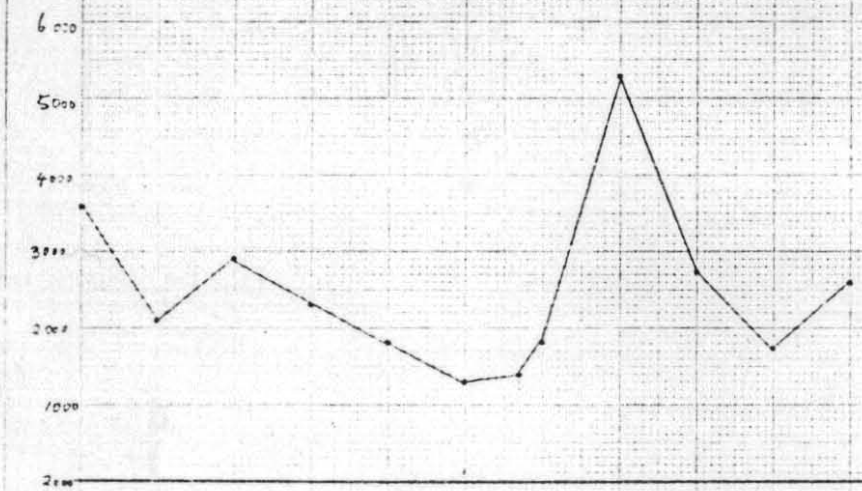
231

1202228

W. HERCULES LINE 800 N

FIG 10 SERIES (continued)

ROCK RESULTS



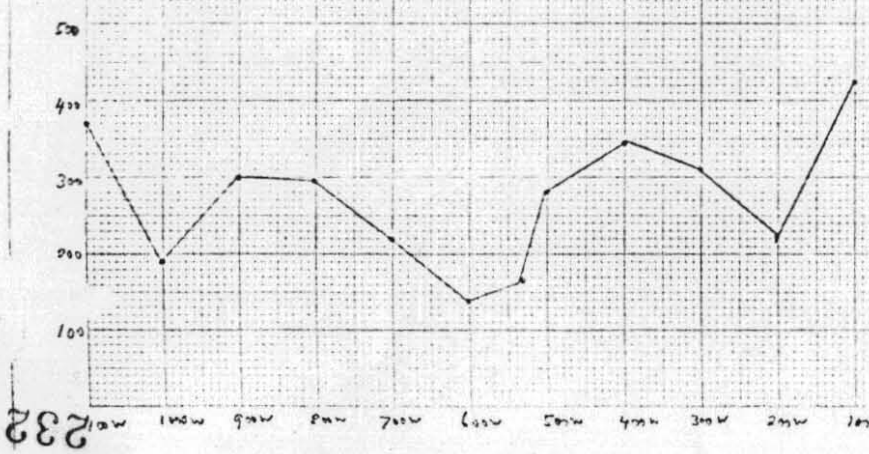
Ba IN ROCKS

FIG. 10 h.



F IN ROCKS

FIG 10 i



Rb IN ROCKS

FIG. 10 j

5 cm

232

120229

W. HERCULES, LINE 800 N

FIG 10 SERIES (continued)

FIG 10 k

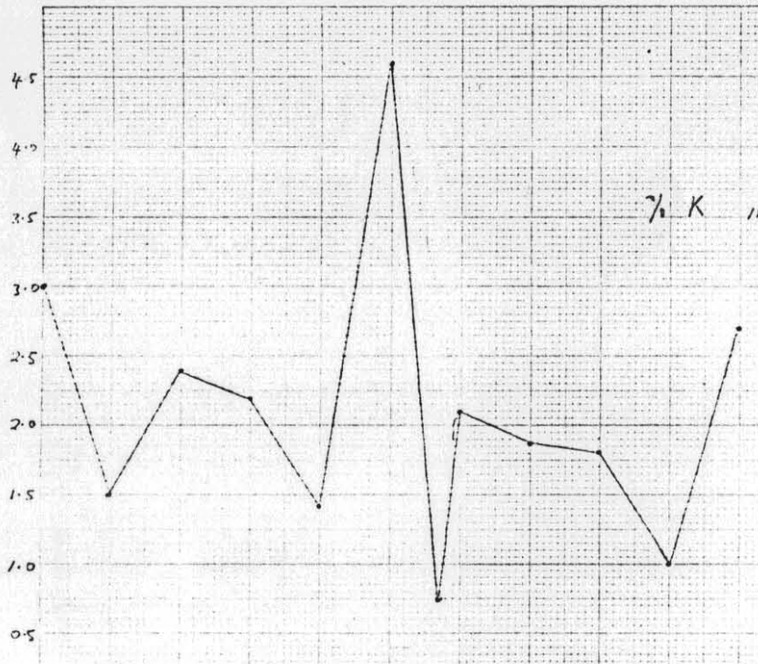
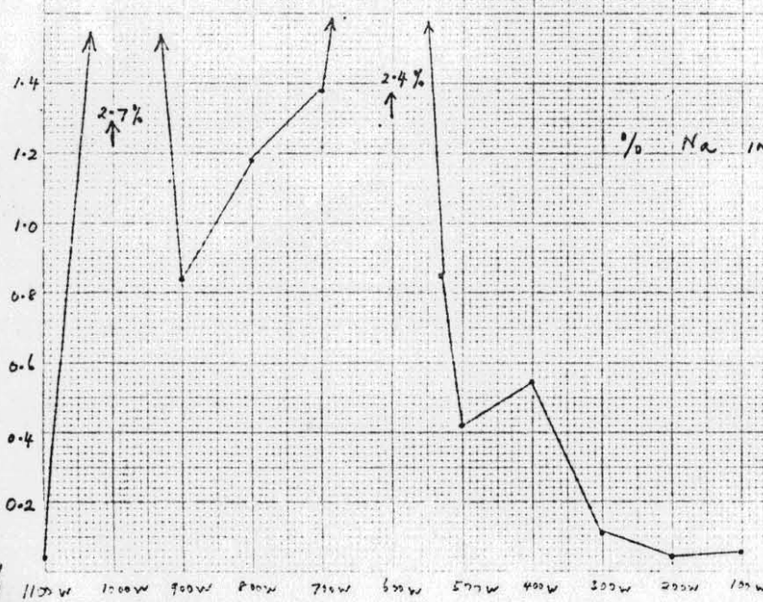


FIG. 10 l



5 cm

120230

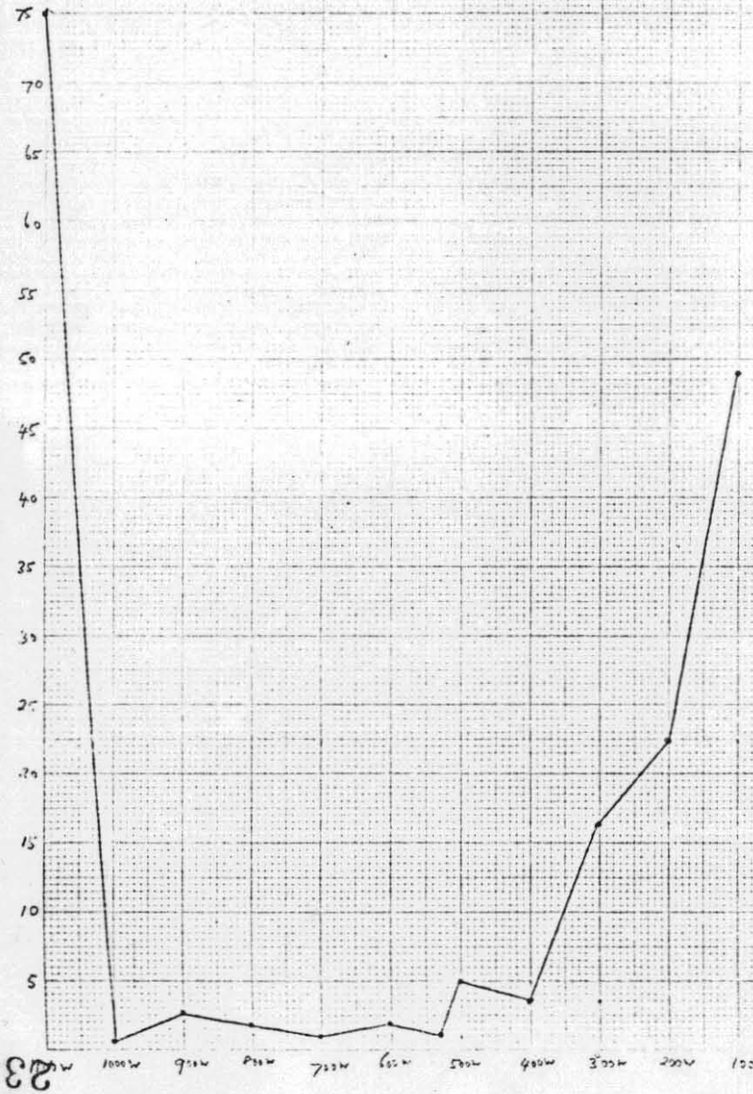
N. HERCULES, LINE 800 N.

FIG 10 SERIES (continued)

ROCK RESULTS

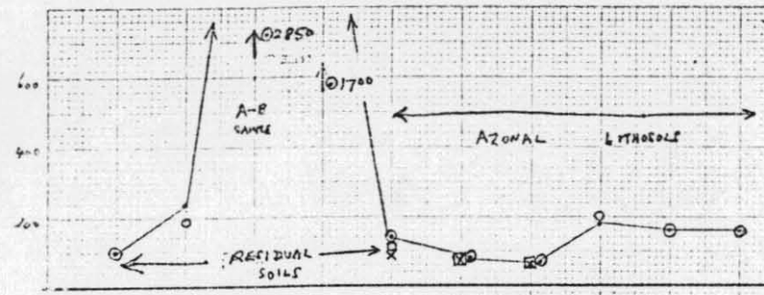
FIG 10 m

K/Na RATIO



5 cm

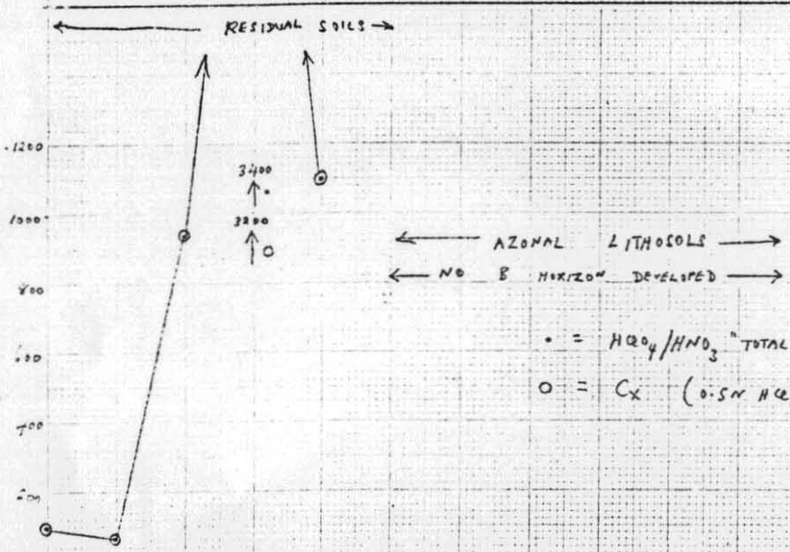
W HERCULES LINE 800 N



• = A_1 SOIL, TOTAL
o = A_1 SOIL, Cx
x = A_2 SOILS, TOTAL
□ = A_2 SOIL, Cx

FIG 11

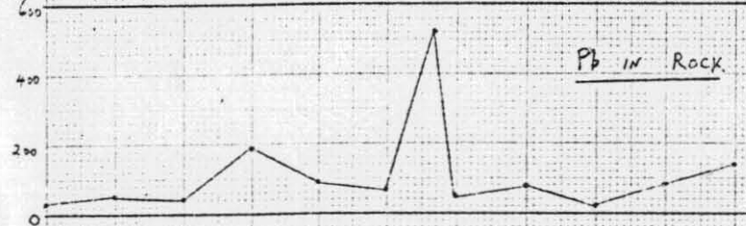
Pb IN A_1 or A_2 SOILS



• = $HClO_4/HNO_3$ "TOTAL"
o = Cx (0.5N HCl, 4 hr.)

FIG 12.

Pb IN B HORIZON SOILS



Pb IN ROCK

FIG 10 SERIES (Continued).
ROCK RESULTS

FIG. 10 c

5 cm

236

APPENDIX II

Orientation Drainage Basin Reconnaissance,
Mt. Black E L and environs.
(See sample nos. plotted on maps)
Sampled with R. Williams and J. Mill. 22.2.79

site 1.

30 M upstream from HEC road bridge over Boco Ck.

Contamination from EBR railway (concentrate trains) Heavy mineral sample panned but not collected showed tourmaline + few specks chalcopyrite (or tarnished pyrite). No galena or sphalerite seen.
Stream 30 m wide, with acid volcanic pebbles and Owen conglomerate boulders.

23051

Mn coated pebbles for leaching surface coatings - analyze for Cu Pb Zn Co Mn Fe (As)

23052

Composite stream sediment sample. To be treated as A fraction: -80#, total and Cx Cn Pb Zn Co Mn Fe As
B fraction: -80+10#, for Mn leach (Mt. Lyell Lab) elements Cu Pb Zn Co Mn Fe (As)

site 2.

Chester Rivulet, 20 m upstream from HEC road.

4 m stream with cobbles and boulders of acid ash flow ("unmixed source"). Abundant humic acids, peat and Mn stains in creek. Possible contamination from rubbish. Drains Chester Pyrite Deposit ½ mile upstream. Heavy mineral panning shows abundant f.g pyrite + occassional tourmaline (?)

23053

Mn coated pebbles - for Mn leach (Mt. Lyell Lab).

23054

Composite bulk stream sediment sample. To be split and treated as A and B fractions with analyses as before.

site 3

Marionoak River, 100 m upstream from bridge.

8 m stream, cobbles of 70% Rosebery Gp. sediments (shales, siltstones, argillites) + 30% acid-intermediate volcanics; some Owen conglomerate boulders.
Heavy mineral panning shows abundant rounded tourmaline with rounded (2nd generation?) quartz.

23055

Mn coated pebbles - treat as above

23056

bulk stream sediment - treat as above

237

site 4.

Chester pyrite mine.

23057

Sample of transported gossan with tarnished, botryoidal pyrite/marcasite and large prismatic striated limonite casts (after amphibole ??)
From mullock heap near adit.
Run for base metals + As, Ba.

23058

Dump sample of f-g massive pyrite bands in a cherty silica matrix, from "Chester rock slide".
Run base metals + As, Ba.

site 5.

N of Chester Mine (no drainage influence)
On access road 50 m N of Comstaff Chester campsite.

23059

1-2 m stream in outcrop of acid vitric crystal tuffs with cobbles of same ("unmixed lithology")
(Some Owen conglomerate cobbles ex glacials).
bulk stream sediment for treatment as above.
No Mn coatings available.

site 6.

N of Chester Mine (no drainage influence)
50 m upstream of Chester Mine/Burns Peak access road ("Photogenic Ck").
Boulders of acid tuff, pink albitized volcanics, pyritic grey siltstone and pyritic quartz-feldspar tuffs.

23060

Mn coated pebbles - treat as above

23061

Rock sample of Mn wad formed in seepage in bank of creek - local origin from thick cover of talus scree and soil in acid tuffs on hillside above.

23062

Bulk stream sediment - treat as above.

site 7.

Marionoak R, access track W of Burns Peak.
2 m stream, 10 m upstream of road crossing.
Drainage entirely in feldspar porphyry and ash flow tuffs ("unmixed"). Heavy mineral panning shows presence of tourmaline.

23063

Mn coated pebbles - treat as above.

23064

Bulk stream sediment - treat as above.

site 8.

Burns Peak Creek.
Drains mostly acid volcanics (and 5% quartz - feldspar porphyry). No known mineralization drained. ½ m stream 50 m upstream from road draining sheared, bleached acid volcanics (rock alteration in probable rhyolite). Panning shows presence of tourmaline.

23065

Mn coated pebbles - treat as above.

23066 Bulk stream sediment - treat as above.

site 9.

Access road E of Burns Peak.
"Log Culvert Ck" 50 m upstream from road.
½ m stream in rhyolitic volcanics.
Panning shows presence of tourmaline.

23067

Mn coated pebbles - treat as above.

23068

Bulk stream sediment - treat as above.

site 10.

Boco Ck. 100 m upstream from EBR Railway.
10 m stream width, with boulders of Owen conglomerate, volcanics and minor shale.
Heavy mineral panning shows abundant tourmaline + chlorite.

23069

Mn coated pebbles (rare) - treat as above.

23070

Bulk stream sediment - treat as above.

site 11.

Tributary of Sock Ck.
3 m stream 50 m upstream of DD access track.
Draining dacitic volcanics.

23071

Fe and Mn coated pebbles - treat as above.

23072

Bulk stream sediment - treat as above.

site 12.

Sock Ck.
At headwater, 40m upstream from access track, S of mineralized fault zone (ie upstream background) Altered, bleached, sericitized and silicified quartzo-feldspathic volcanic.
Drainage is actually a flat, swampy zone with no defined channel. No Mn stained pebbles available.

23073

Bulk stream sediment sample.

site 13.

Sock Ck., half-way downstream from Comstaff costean. Width 5 m where undisturbed, but stream width largely disturbed by logging and access operations, with contamination from costeans.
Cobbles consist of (intrusive) quartz-feldspar porphyry, acid volcanics, and minor black shale.

23074

Fe and Mn coated pebbles (Fe Mn) - treat as above.

23075

Bulk stream sediment - treat as above.

site 14.

Sock Ck, at access road crossing 300 m downstream from site 13. Lithology is reworked tuffs and Q F porphyries.

23076

Fe/Mn coated pebbles (Fe Mn) - treat as above.

23077

Bulk stream sediment. - treat as before.

site 15.

Bulggobac River, 200 m upstream from Sock Ck. junction (ie background).
15 m wide stream draining mainly felsic volcanics and some black shales.

23078

Fe/Mn pebbles (Fe Mn) - treat as before.

23079

Bulk stream sediment - treat as before.

23080

Heavy mineral fraction collected - contained some magnetite or ilmenite, possibly from weathering of Tertiary basalt cap.
Spectrographic analysis scan required.
Cu Pb Zn Fe Mn Ba B W Sn Ti

site 16.

Bulgobac R, 100 m downstream from Sock Ck. junction (ie mineralized, diluted drainage)
Stream 15 m wide, lithology as at site 15.

23081

Fe/Mn coated pebbles (Fe Mn) - treat as before.

23082

Bulk stream sediment - treat as before.

23083

Heavy mineral fraction panned - treat as above.

site 17.

Sock Ck. 50 m above junction with Bulgobac R (ie mineralized, undiluted drainage) 1½ m wide stream channel, well developed, lithology as before.

23084

Fe/Mn coated pebbles -(Fe Mn) - treat as before.

23085

Bulk stream sediment - treat as before.

23086

Panned heavy mineral fraction - treat as above.

N.B. To ensure relative relationships in analytical results, constant volumes of bulk stream sediment were panned to a constant volume of concentrate.



II.1. Sample site 6
Note brown, humic acid rich water, and black Mn coated boulders - sample 23061

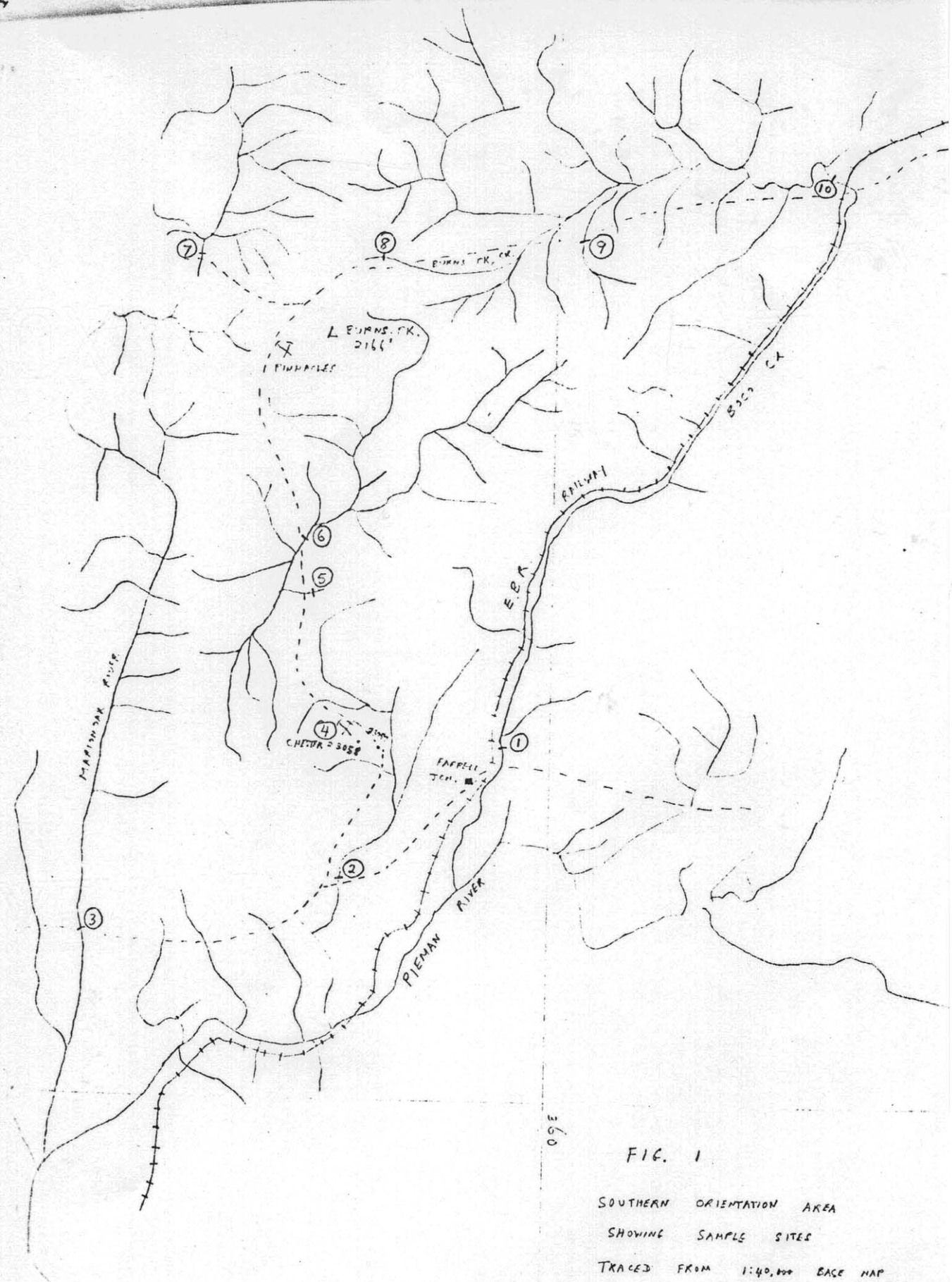


FIG. 1

SOUTHERN ORIENTATION AREA
SHOWING SAMPLE SITES
TRACED FROM 1:40,000 BASE MAP
(AERIAL PHOTOGRAPHY 1956)

① SAMPLE SITE

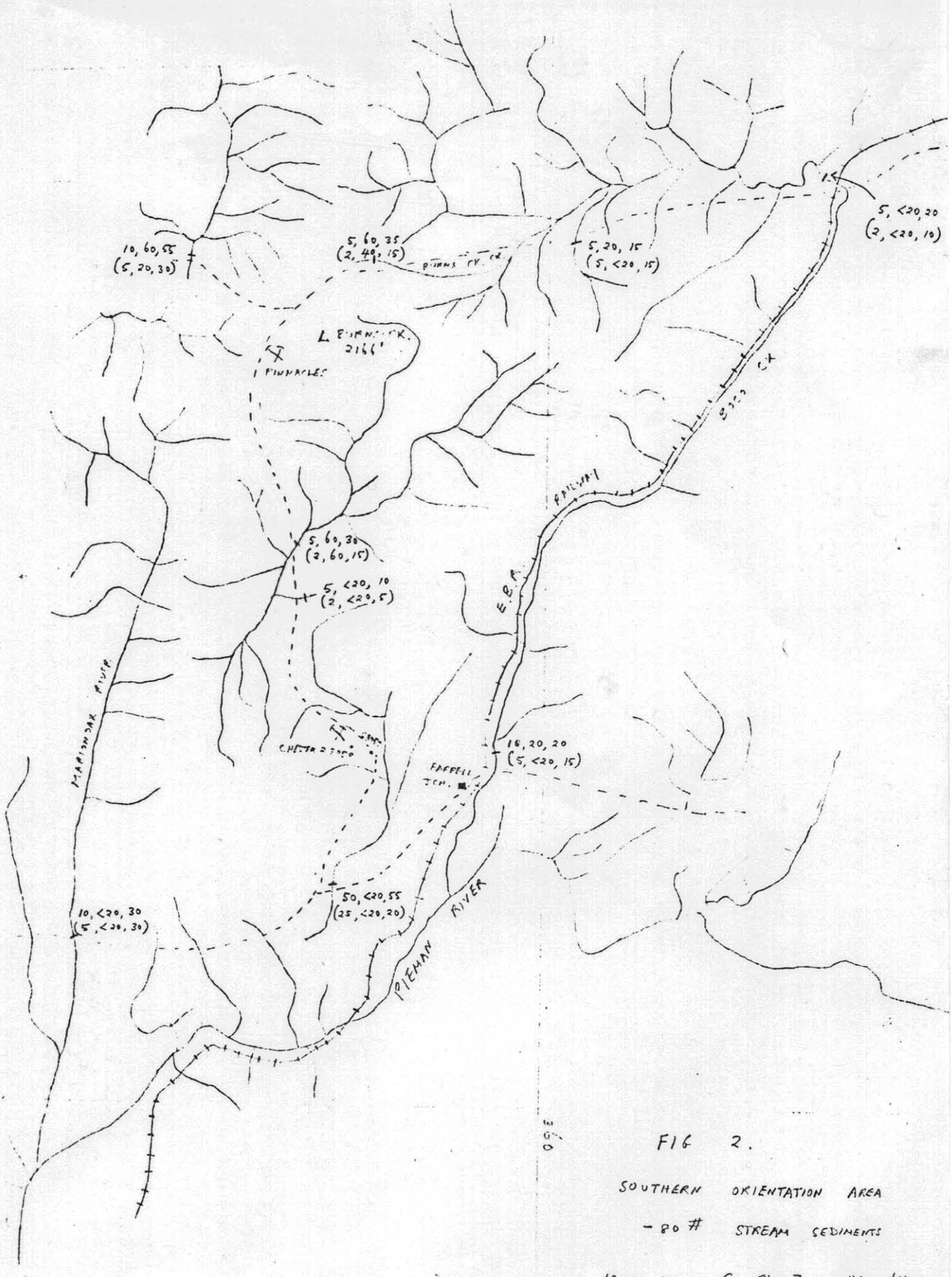


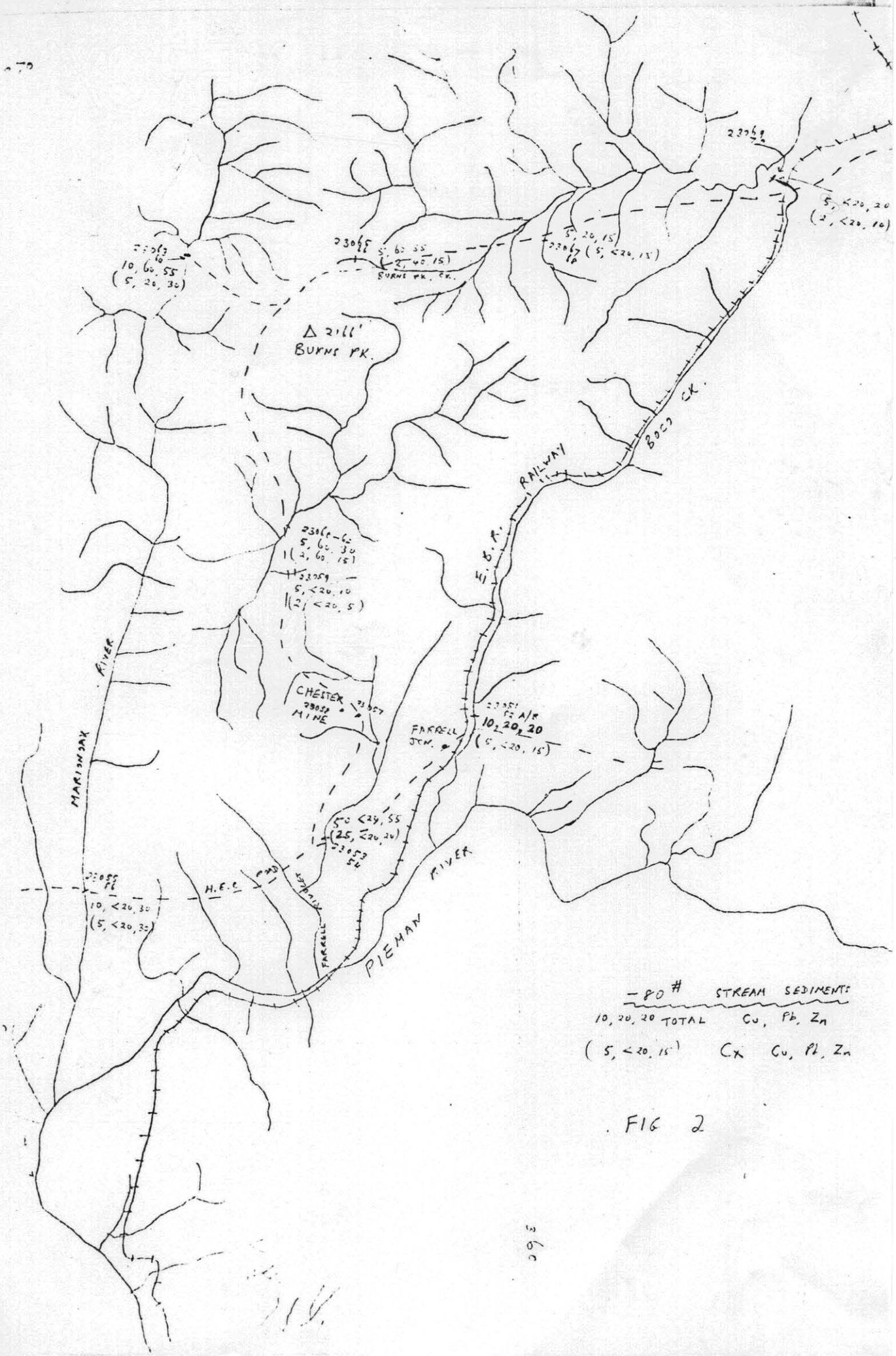
FIG 2.

SOUTHERN ORIENTATION AREA

- 80 # STREAM SEDIMENTS

10, 20, 20 Cu, Pb, Zn $HClO_4/HNO_3$

(5, <20, 15) Cu Pb Zn COLD EXTRACTABLE (IN HCl)



10, 60, 55
(5, 20, 30)
5, 60, 55
(2, 40, 15)
BURNS PK. CK.
5, 20, 15
(5, <20, 15)
5, <20, 20
(2, <20, 10)
Δ 2166'
BURNS PK.
BOCO CK.
RAILWAY
E.B.R.
5, 60, 30
(2, 60, 15)
5, <20, 10
(2, <20, 5)
CHESTER
MINE
FARRELL
JCN.
10, 20, 20
(5, <20, 15)
MARIONOAK
RIVER
50 <24, 55
(25, <20, 20)
H.E.C.
10, <20, 30
(5, <20, 30)
FARRELL
PIEMAN
RIVER
-80 # STREAM SEDIMENTS
10, 20, 20 TOTAL Cu, Pb, Zn
(5, <20, 15) Cx Cu, Pb, Zn

FIG 2

245

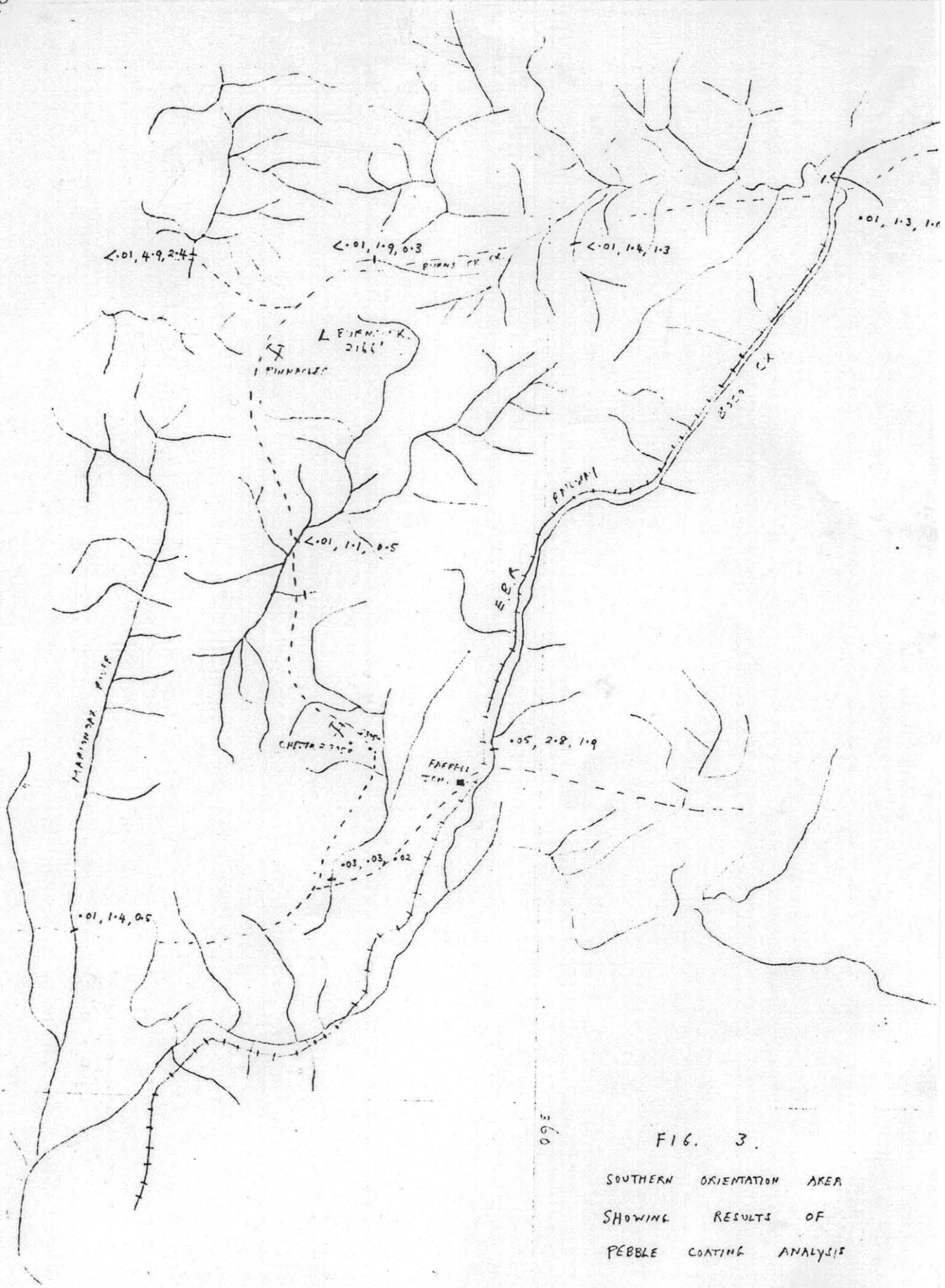


FIG. 3.

SOUTHERN ORIENTATION AREA SHOWING RESULTS OF PEBBLE COATING ANALYSIS

<.01, 1.4, 1.3, Cu, Pb, Zn IN HYDROXYLAMINE LEACH SOLN.

246

120242

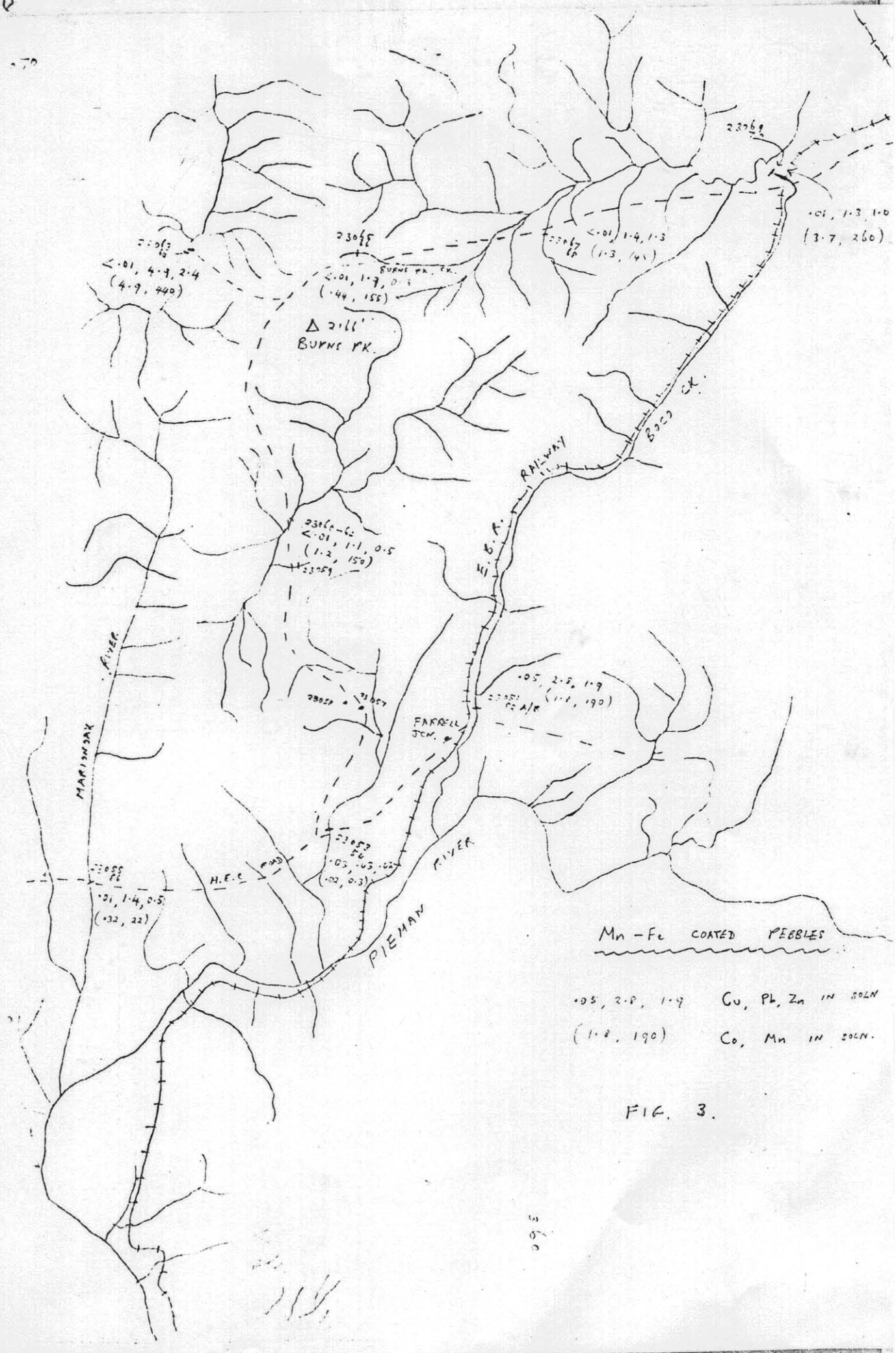


FIG. 3.

247

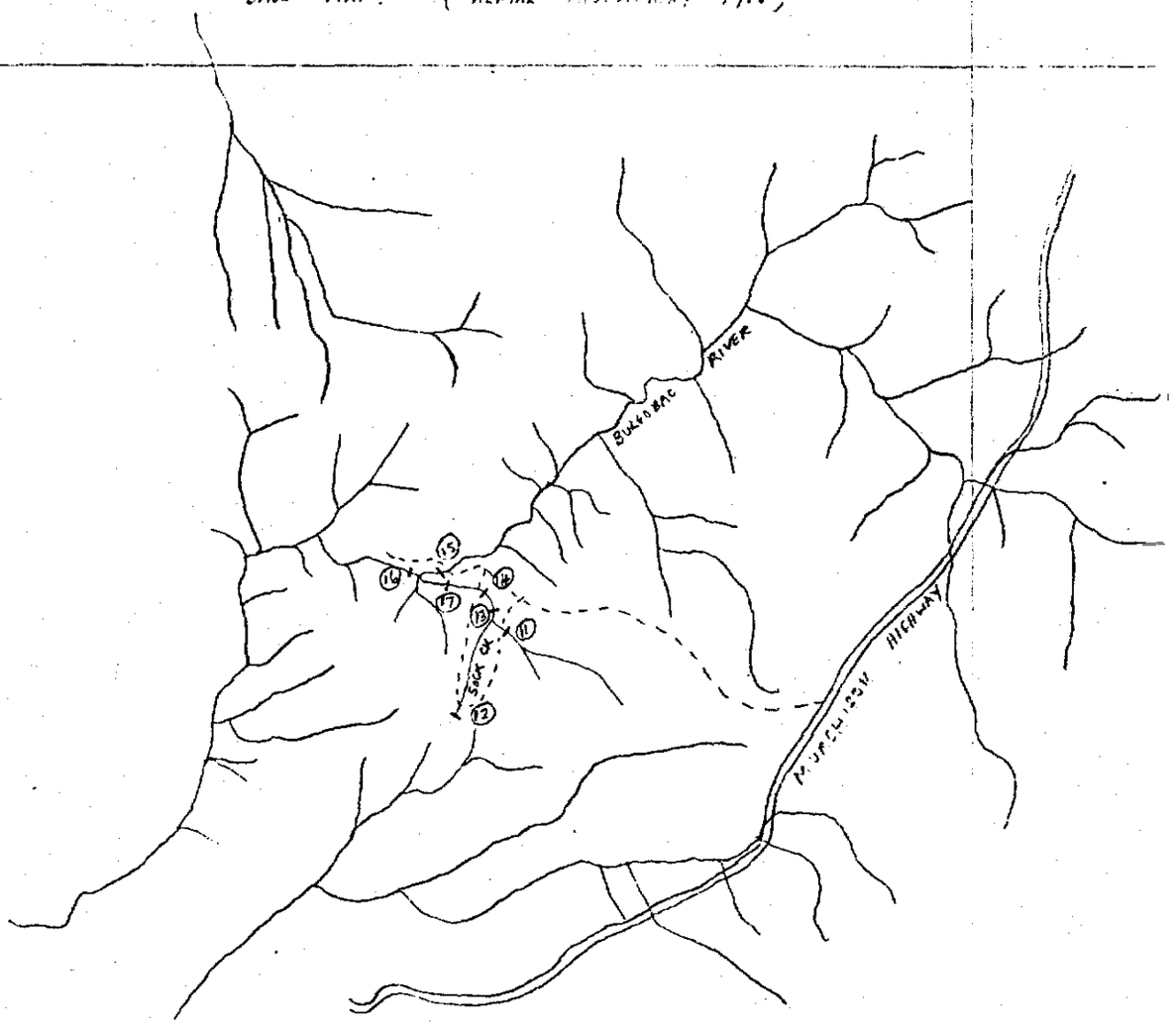
120243

FIG. 4.

SOCK CK ORIENTATION AREA SHOWING SAMPLE SITES. TRACED FROM 1:40 000 BASE MAP. (AERIAL PHOTOGRAPHY 1956)

370

280



SCALE 1 : 40,000

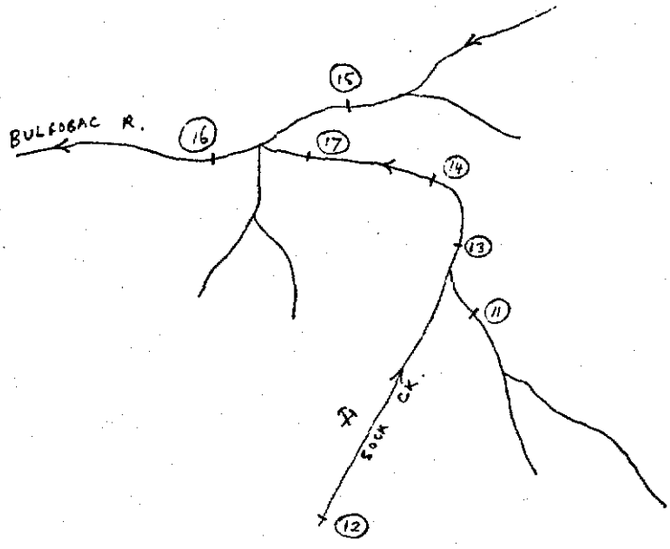
14 SAMPLE SITE

TRACK

5 cm

FIG. 5.

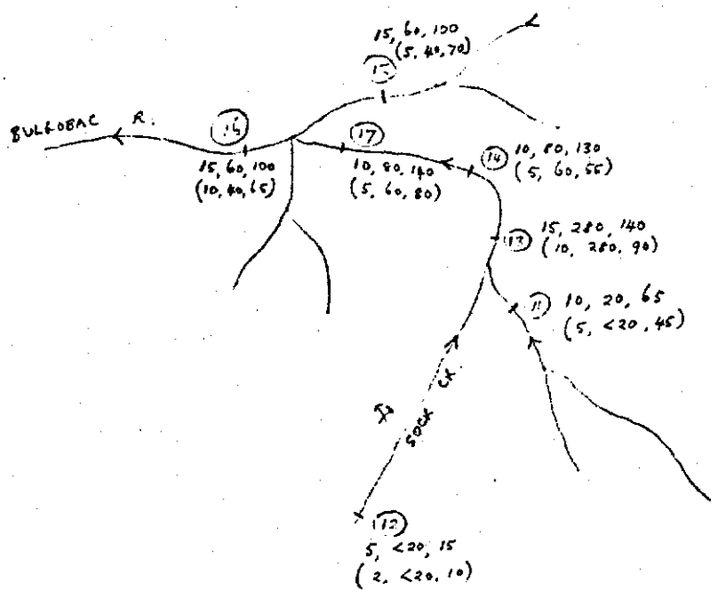
SKETCH MAP OF SOCK CK.
ORIENTATION AREA SHOWING
DRAINAGE RELATIONSHIPS AT
SAMPLE SITES



(12) SAMPLE SITE (SEE APPENDIX II)

FIG. 6

SKETCH MAP OF SOCK CK ORIENTATION AREA SHOWING RESULTS OF −80 # STREAM SEDIMENT SAMPLES



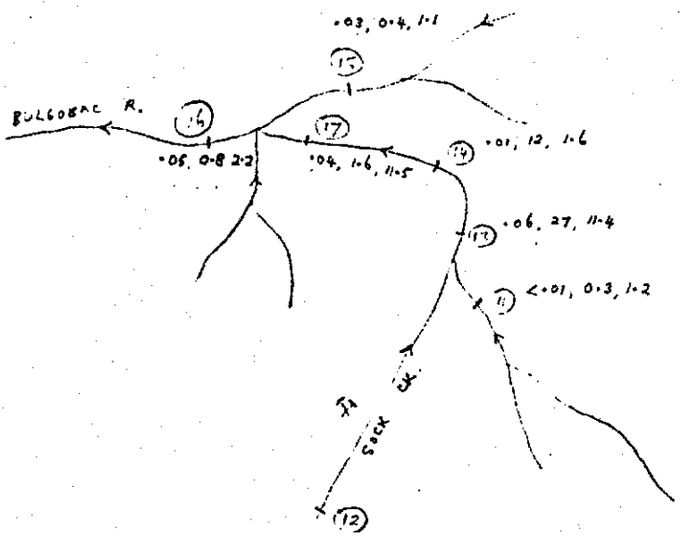
(12) SAMPLE SITE (SEE APPENDIX II)

15, 280, 140 Cu, Pb, Zn BY $HClO_4/HNO_3$ DIGEST

(10, 280, 90) Cu, Pb, Zn BY COLD EXTRACTION (1 N HCl)

FIG 7.

SKETCH MAP OF SOCK CK.
ORIENTATION AREA SHOWING
RESULTS OF PEBBLE COATING ANALYSIS



(13) SAMPLE SITE NO. (SEE APPENDIX II)

.06, 27, 11.4 Cu, Pb, Zn AS PPM IN HYDROXYLAMINE LEACH SOLUTION

251

120247

... RAILWAY CO. LTD.

GEOCHEMICAL SAMPLE DESPATCH

AREA: E.Z. Samples

PAGE.:

DATE:

METHOD: (Mn) Hydroxylamine Hydrochloride

LINE NO: Stream Sed

FRACTION: -20+80#

Assay/Analyse

SAMPLE NO.	CU	Pb	Zn	Co	Fe	Mn
1 23001	0.15	0.71	0.55	0.50	20	24
2 23052A	0.03	0.51	0.17	0.07	14	5.7
3 23052B	0.02	1.28	0.28	0.11	15	12
4 23054	0.22	0.16	0.44	0.02	200	0.9
5 23056	0.04	0.43	0.32	0.05	14	4.4
6 23059	0.03	0.06	0.16	0.01	6.6	0.2
7 23062	0.02	1.10	0.18	0.02	26	7.1
8 23064	0.02	0.36	0.21	0.03	6.3	2.4
9 23066	0.04	0.27	0.12	0.05	6.5	3.5
10 23068	0.01	0.43	0.21	0.17	15	20
11 23070A	0.00	0.21	0.12	0.05	11	4.4
12 23071B	0.00	0.17	0.20	0.05	8.5	4.0
13 23072	0.01	0.22	1.31	0.50	26	58
14 23073A	0.00	0.06	0.23	0.02	5.4	0.4
15 23073B	0.00	0.05	0.16	0.00	5.5	0.3
16 23075A	0.02	6.08	1.32	0.15	18	38
17 23075B	0.01	8.20	1.80	0.26	22	50
18 23077	0.00	2.28	1.05	0.10	22	16
19 23079	0.01	0.26	0.89	0.33	18	22
20 23082A	0.01	0.37	0.71	0.18	16	13
1 23082B	0.02	0.33	0.66	0.18	17	12
14 23085	0.01	0.73	0.91	0.23	22	23

* NO. OF SAMPLES: ..... 22 .....

Results Are P.P.M.
In Solution

252

120248

GEOCHEMICAL SAMPLE DESPATCH

2 3 gm/pkt and 1

AREA:

PAGE: 1

E.Z. SAMPLES

DATE: 2/3/79

METHOD:

Mn Coat. Pebs.

LINE NO: 3 Mn. Scrapings

Hydroxylamine Hydrochloride Assay/Analyse

FRACTION:

SAMPLE NO.	CU	Pb	Zn	Co	Fe	Mn
1 23048	2.45	74	69	0.05	60	360
2 23049	0.37	9.9	1.3	0.10	52	23
3 23050	0.34	58	2.1	0.01	40	3.4
4 23051	0.05	2.8	1.9	1.80	42	190
5 23053	0.03	0.03	0.02	0.02	200	0.3
6 23055	0.01	1.4	0.5	0.37	35	22
7 23060	0.00	1.1	0.5	1.18	65	150
8 23063	0.00	4.9	2.4	4.9	96	440
9 23065	0.00	1.9	0.3	0.44	92	155
10 23067	0.00	1.4	1.3	1.28	48	145
11 23069	0.01	1.3	1.0	3.7	60	260
12 23071	0.00	0.3	1.2	0.70	32	85
13 23074	0.06	27	11.4	0.80	80	135
14 23076	0.01	12	1.6	3.6	45	400
15 23078	0.03	0.4	1.1	0.50	23	35
16 23081	0.05	0.8	2.2	0.86	39	78
17 23084	0.04	1.6	11.5	2.2	65	365
18 23002	0.00	0.04	0.6	5.5	0.3	3,000
19 23061	0.00	0.03	0.3	3.5	0.6	2620

NO. OF SAMPLES: (19)

* Results are P.P.M. In Solution

253

GEOCHEMICAL RESULTS

SEMI-QUANTITATIVE EMISSION SPECTROSCOPY

All Values in ppm

A.C.S. Laboratories Pty. Ltd.
P.O. BOX
UNLEY. S.A. 500
PHONE: 272 57

Samples from: Electrolytic Zinc Co. of A'asia Ltd, 120249

Area:

Samples of: Heavy minerals.

Sheet No.: 1.

Batch No.: A2837

Date: 14/3/79

GROUP		SAMPLE IDENTIFICATION								
		23080	23083	23087						
ES 1	Be (1)									
	Co (5)	<5	<5	<5						
	Cr (20)									
	Ir (2)									
	Mn (5)	300	100	1000						
	Mo (3)									
	Nb (20)									
	Ni (3)									
	Os (10)									
	Pd (10)									
	Pt (10)									
	Re (10)									
	V (10)									
	W (50)	<50	<50	<50						
	Te (100)									
	Th (100)									
ES 2	Ag (0.1)									
	As (50)									
	Au (3)									
	Bi (1)									
	Cd (3)									
	Cu (0.5)	3	10	30						
	Ge (1)									
	In (5)									
	Pb (1)	<1	<1	3						
	Sb (30)									
	Sn (1)	<1	<1	3						
	Tl (1)									
	Zn (20)	<20	<20	<20						
ES 3	Ba (30)	1000	300	300						
	Ce (20)									
	Ce (300)									
	La (100)									
	Sc (50)									
	Sr (30)									
	Ti (100)									
	Y (10)									
	Zr (100)									
	Fe	3%	3%	10%						
ES 4	Hg (30)									
	P (100)									
	Te (20)									
ES 6	K (5)									
	Li (1)									
	Na (50)									
	Cs (30)									
	Rb (10)									
ES 6	B (10)	10	<10	10						

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

NATA

Preparation:

Distribution: Electrolytic Zinc Co. of A'asia Ltd.
Rosebery, Tas.
Burstville, New

Signed: .....

ADELAIDE
Tel: 272 5733

SYDNEY
Tel.: 977 6495

A.M.D.S. LABORATORIES PTY. LTD.
63 ALEXANDER STREET
MANLY, N.S.W. 2095

ANALYTICAL RESULTS

50 Mary Street,
(P.O. Box 3),
UNLEY. 5061.

Samples from: Electrolytic Zinc Co. of A'asia Ltd.

120250

Area:

Samples of: Stream sediments.

Preparation: $HClO_4/HNO_3$

Sheet No.: 1.

Batch No.: SA2851

Date: 21/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ppm	Pb ppm	Zn ppm	Co ppm	Mn ppm	Fe %
23001	25	100	80	40	2700	1.08
52A	10	20	20	<5	90	0.43
52B	10	<20	25	<5	140	0.55
54	50	<20	55	<5	50	3.20
56	10	<20	30	<5	160	0.72
59	5	<20	10	<5	20	0.095
62	5	60	30	<5	250	1.03
64	10	60	55	<5	630	1.33
66	5	60	35	<5	880	0.62
68	5	20	15	<5	60	0.088
70A	5	<20	20	<5	120	0.45
70B	10	20	30	<5	220	0.67
72	10	20	65	10	950	1.53
73A	5	<20	15	<5	20	0.060
73B	5	<20	15	<5	20	0.058
75A	15	280	140	10	790	2.90
75B	15	400	160	15	1000	3.10
77	10	80	130	<5	330	0.88
79	15	60	100	20	1700	2.30
82A	15	60	100	10	540	2.10
82B	15	60	100	10	580	2.00
85	10	80	140	10	1550	1.72
Repeat and check -						
23062	5	60	20	<5	250	1.02
23079	15	40	100	20	1600	2.30

ANALYTICAL METHODS: Cu, Pb, Zn, Co, Mn, Fe, by AAS.

DISTRIBUTION: E.Z.Co. of A'asia Ltd., Rosebery, Tas

Hurstville, Signed

ADELAIDE
Tel: 272 5733

SYDNEY
Tel.: 977 6495

63 ALEXANDER STREET
MANLY, N.S.W. 2095

25

ANALYTICAL RESULTS

50 Mary Street,
(P.O. Box 3),
UNLEY. 5061.

120251

Samples from: Electrolytic Zinc Co. of A'asia Ltd.

Area:

Samples of: Stream sediment

Preparation: N HCl

Batch No.: S A2851

Sheet No.: 2.

Date: 21/3/79

SAMPLES WILL BE DISPOSED OF AFTER TWO MONTHS UNLESS WE ARE OTHERWISE ADVISED

Sample Description	Cu ppm	Pb ppm	Zn ppm	Co ppm	Mn ppm	Fe %
23001	20	120	45	50	2700	0.92
52A	5	<20	15	<5	80	0.24
52B	5	<20	15	<5	120	0.55
54	25	<20	20	<5	40	2.50
56	5	<20	30	<5	130	0.56
59	2	<20	5	<5	10	0.048
62	2	60	15	<5	190	0.72
64	5	20	30	<5	530	0.58
66	2	40	15	5	770	0.50
68	5	<20	15	<5	60	0.055
70A	2	<20	10	<5	90	0.17
70B	5	<20	20	<5	170	0.42
72	5	<20	45	5	820	0.90
73A	2	<20	10	<5	20	0.041
73B	2	<20	10	<5	20	0.040
75A	10	280	90	5	630	1.36
75B	10	380	110	5	800	1.52
77	5	60	55	<5	280	0.54
79	5	40	70	15	1530	1.22
82A	10	40	65	5	460	1.16
82B	10	40	60	5	500	1.07
85	5	60	80	10	1430	1.03
Repeat and check -						
23062	5	40	15	<5	200	0.72
23079	10	40	70	15	1550	1.24

ANALYTICAL METHODS: Cu, Pb, Zn, Co, Mn, Fe, by AAS.

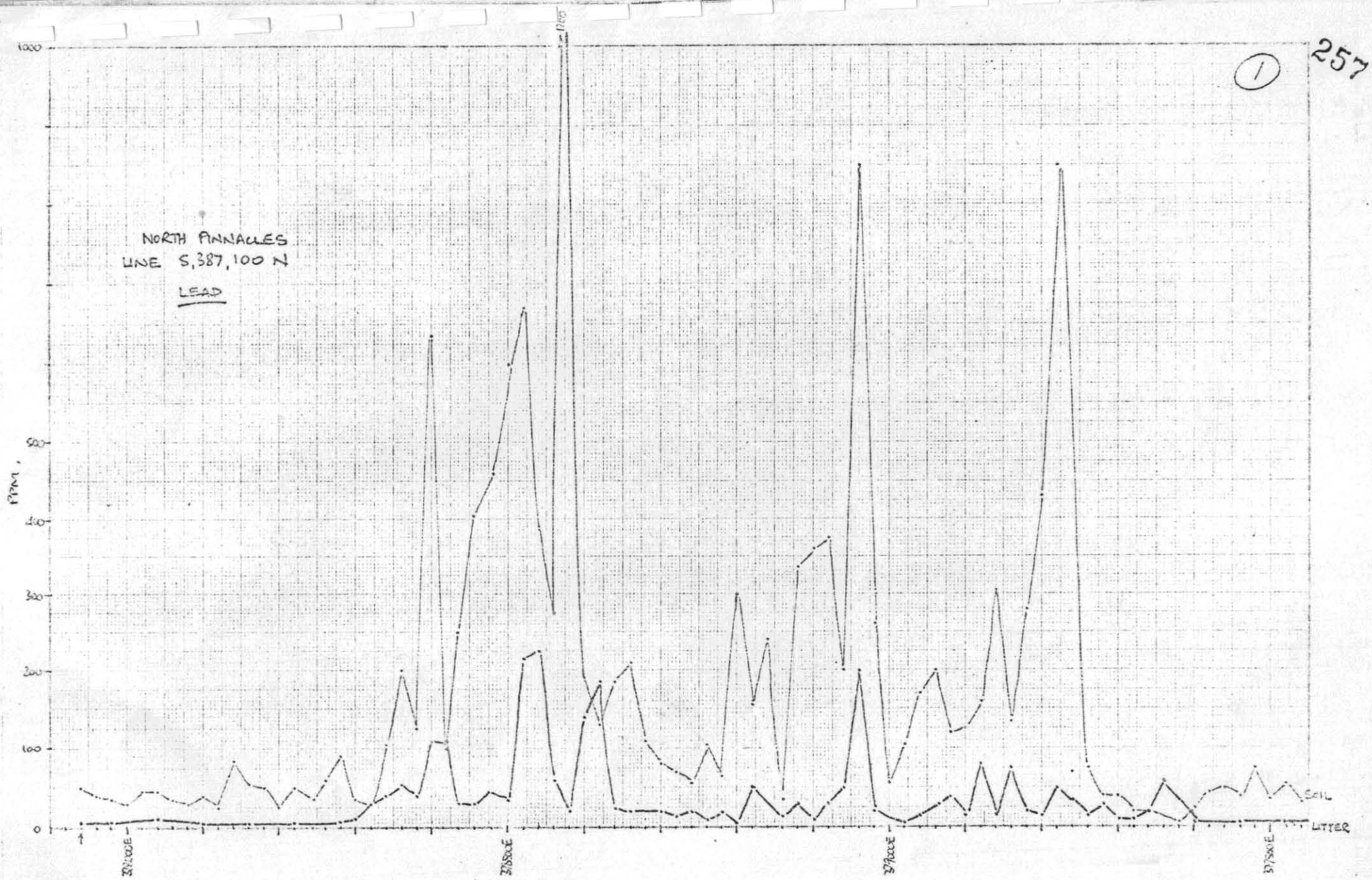
DISTRIBUTION: E.Z.Co. of A'asia Ltd. Rosebery, Tas.
Hurstville,

APPENDIX 5

Cumulative Frequency Plots.

North Pinnacles Pb & Zn
Silver Falls Extension Pb & Zn

Scatter Diagrams of Soil & Litter Samples.
Profiles of Soil & Litter Samples.

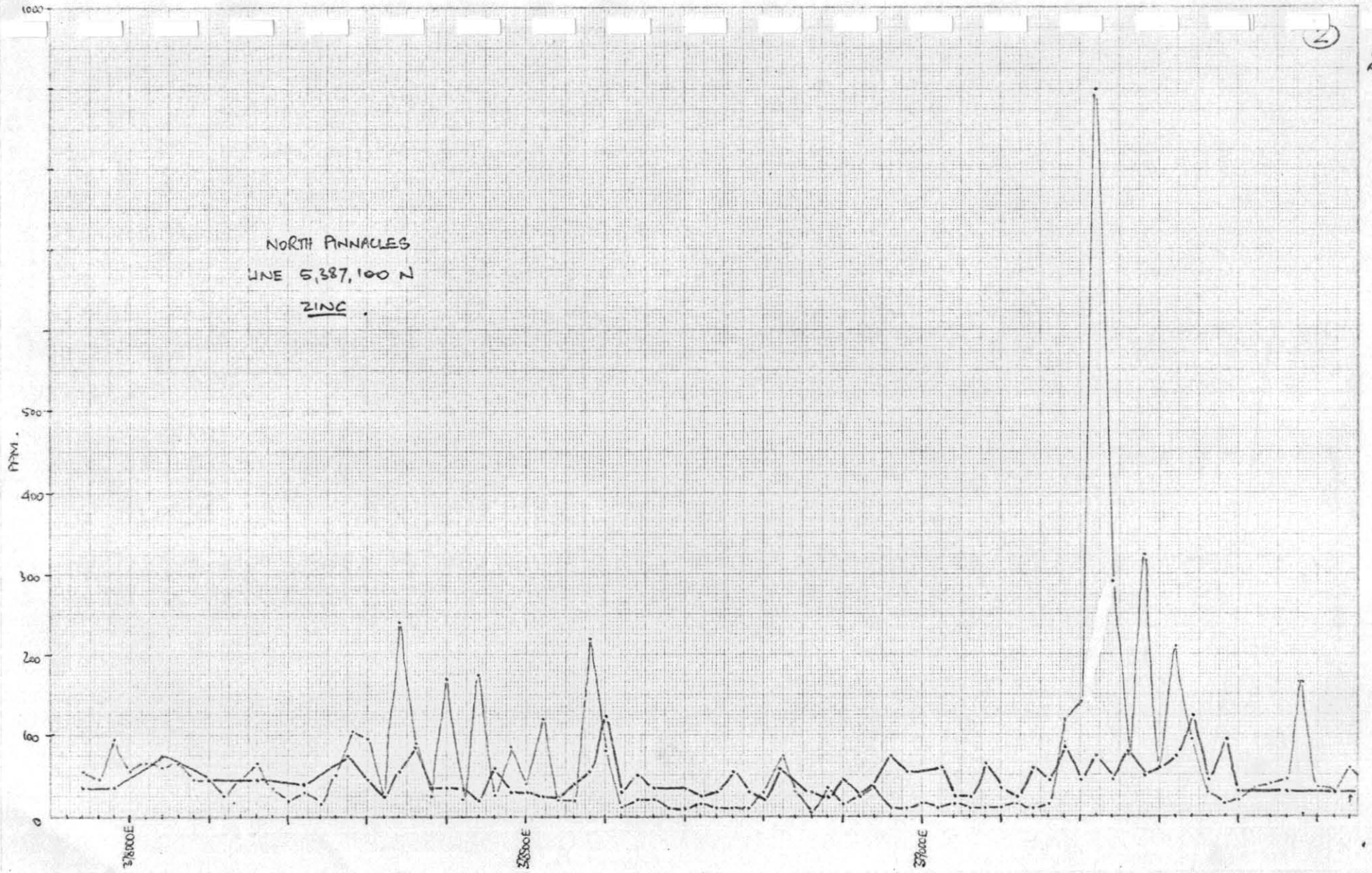


1
257
NORTH PINNACLES
LINE 5,387,100 N
LEAD
PPM
1000
500
400
300
200
100
0
SOIL
LITTER

5 cm

120253

NORTH PINNACLES
LINE 5,387,100 N
ZINC .



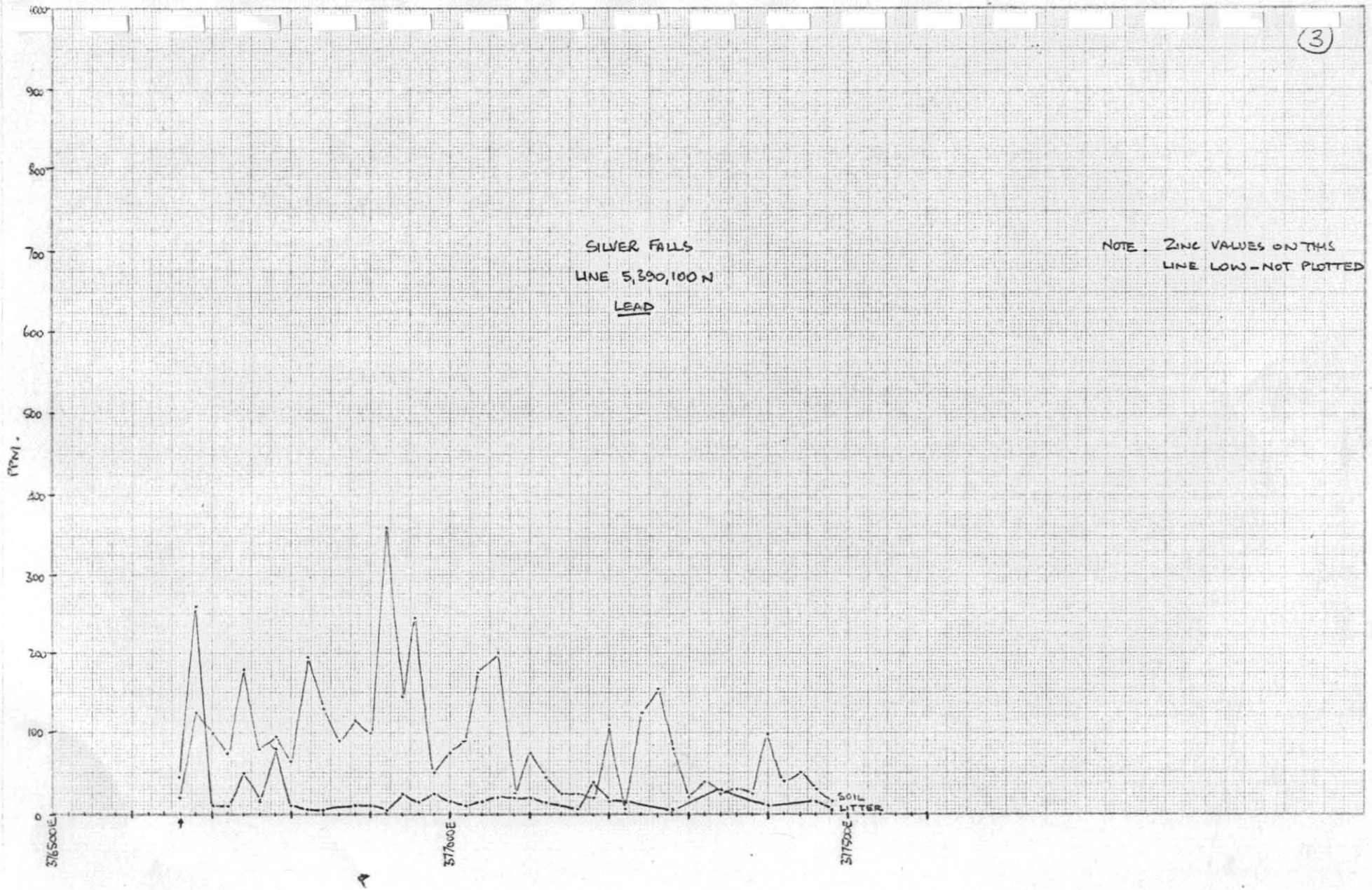
5 cm

SILVER FALLS

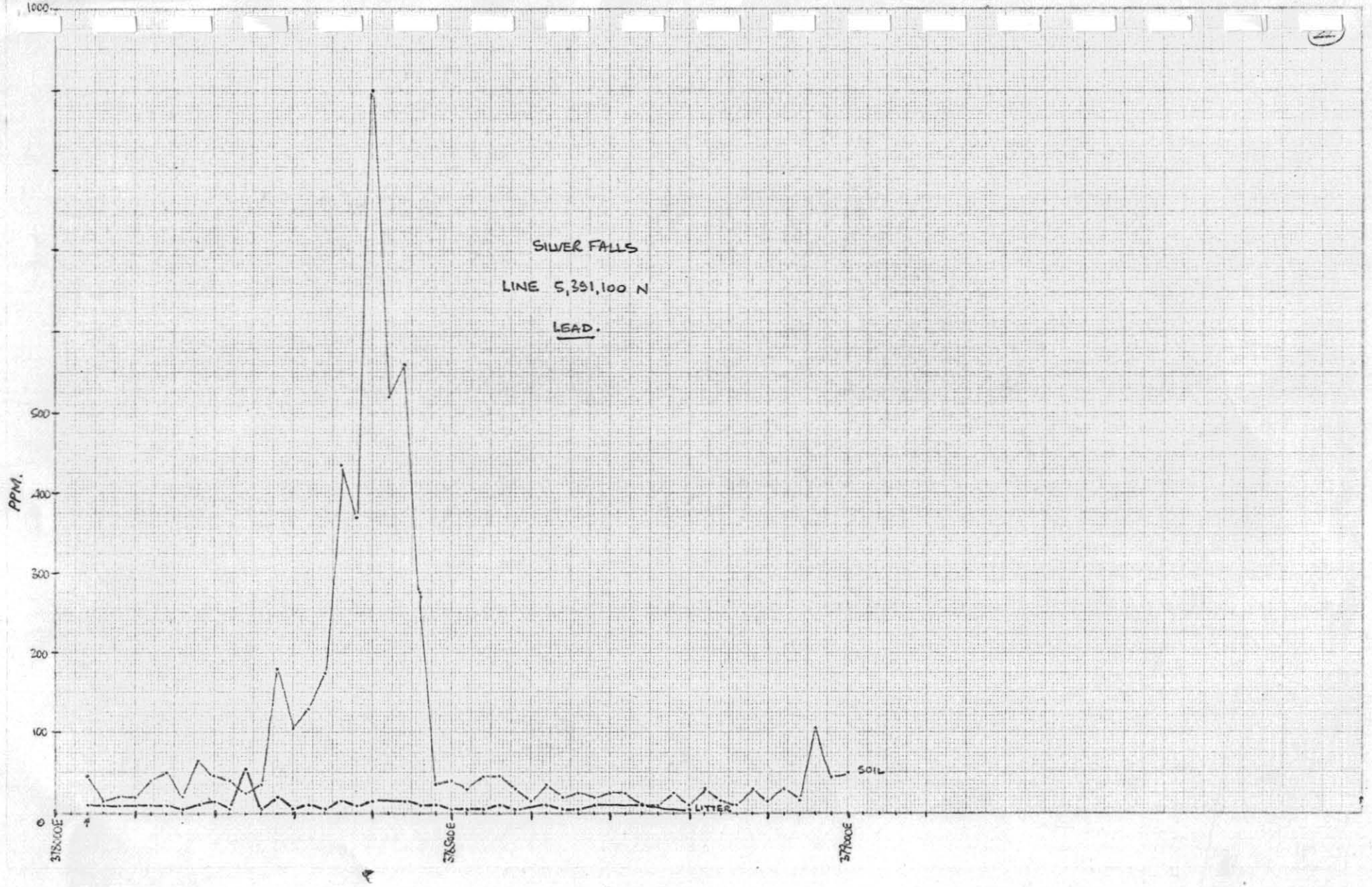
LINE 5,390,100 N

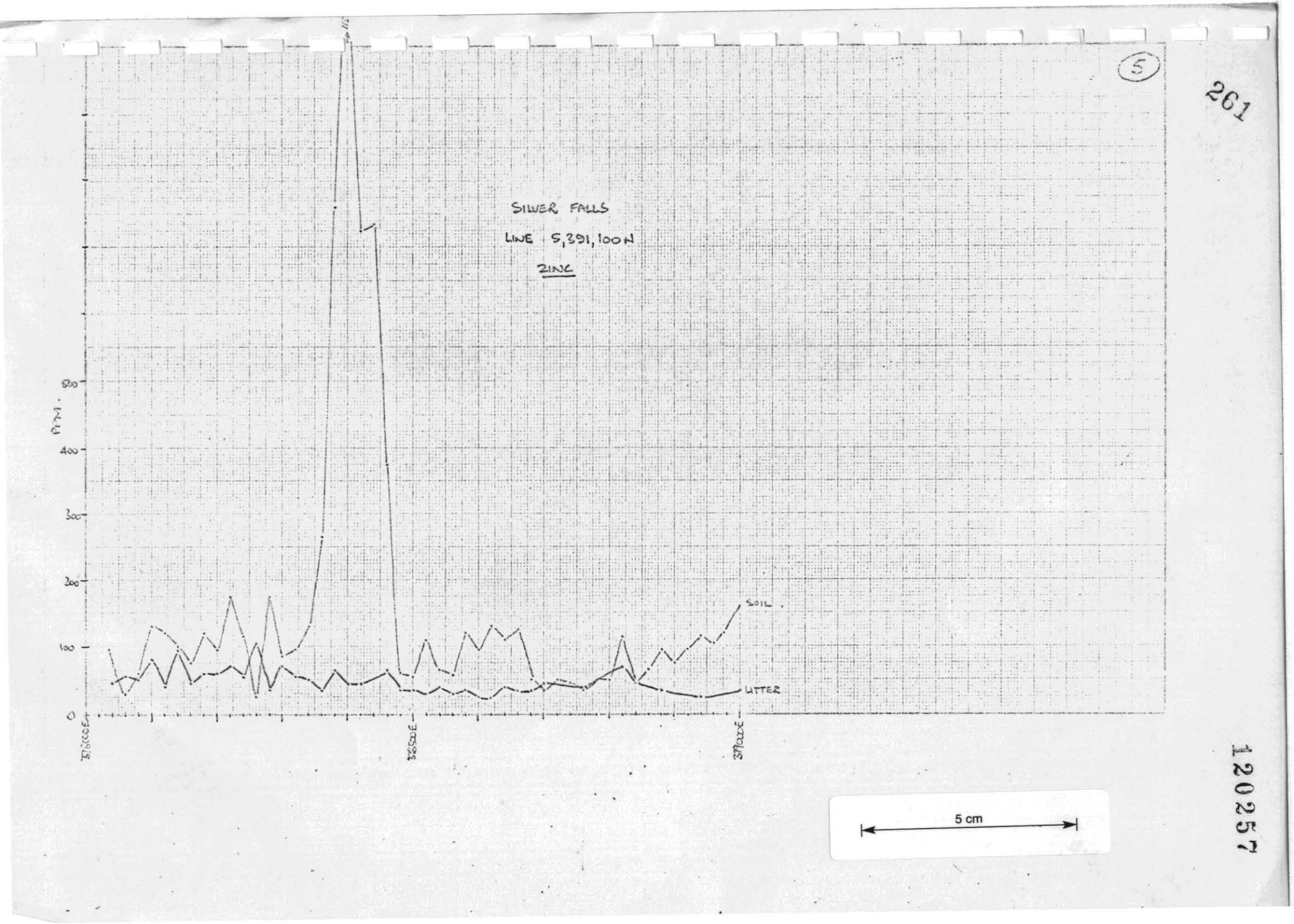
LEAD

NOTE. ZINC VALUES ON THIS LINE LOW - NOT PLOTTED

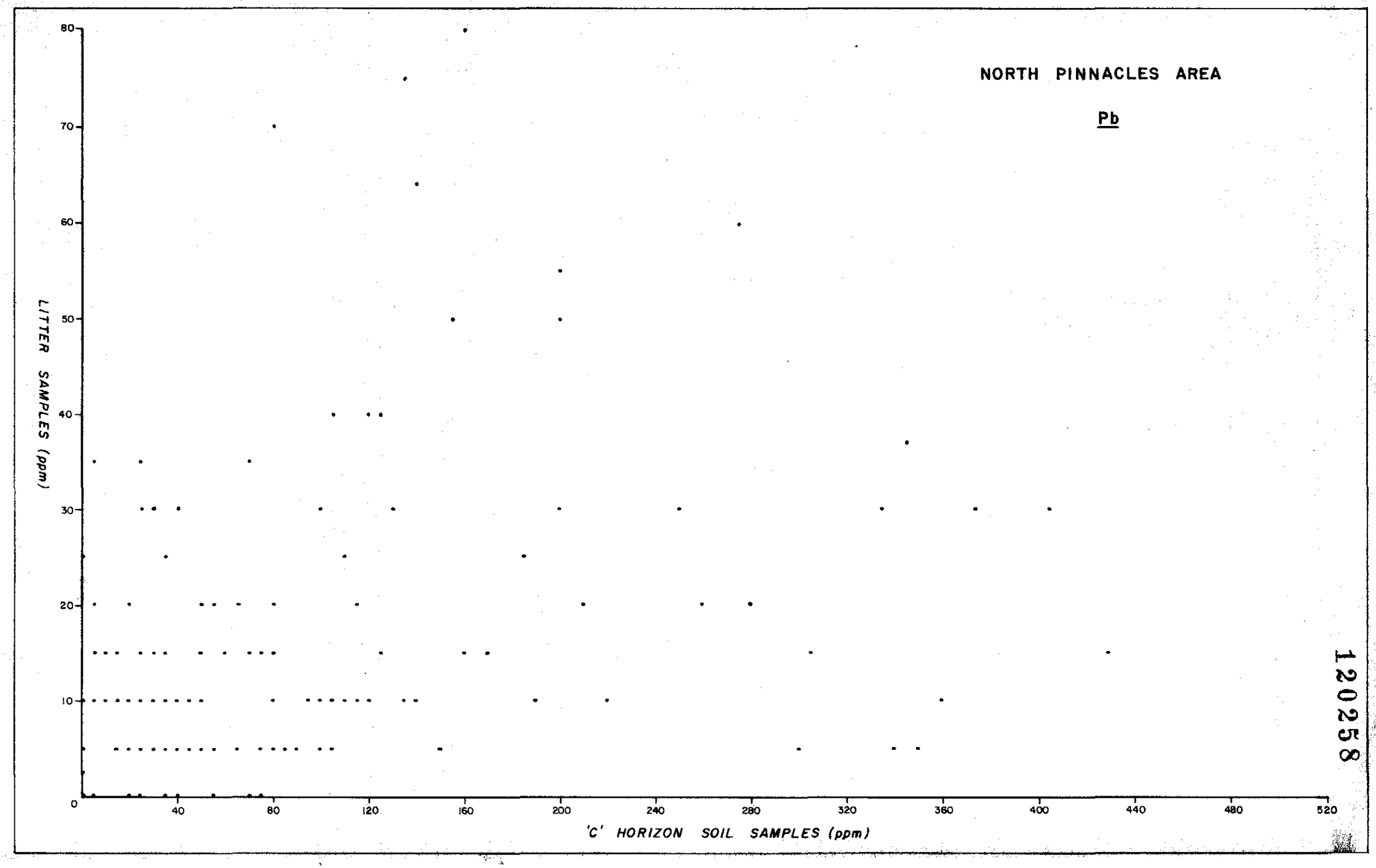


5 cm

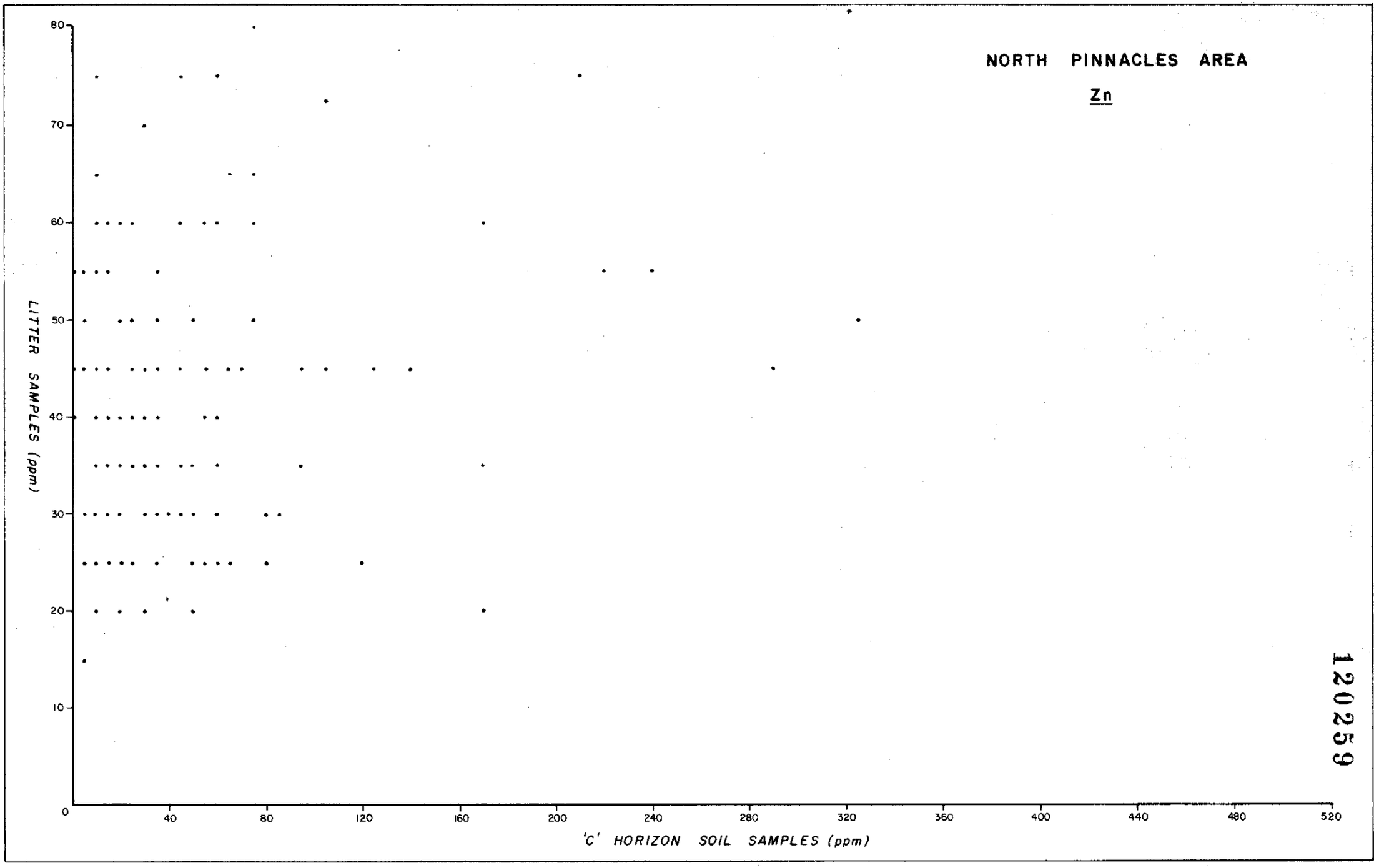

SILVER FALLS
LINE 5,391,100 N
LEAD.
PPM.
1000
500
400
300
200
100
0
378000E
378500E
379000E
SOIL
LITTER
5 cm


SILVER FALLS
LINE 5,391,100N
ZINC
PPM.
500
400
300
200
100
0
SOIL.
LITTER
5 cm

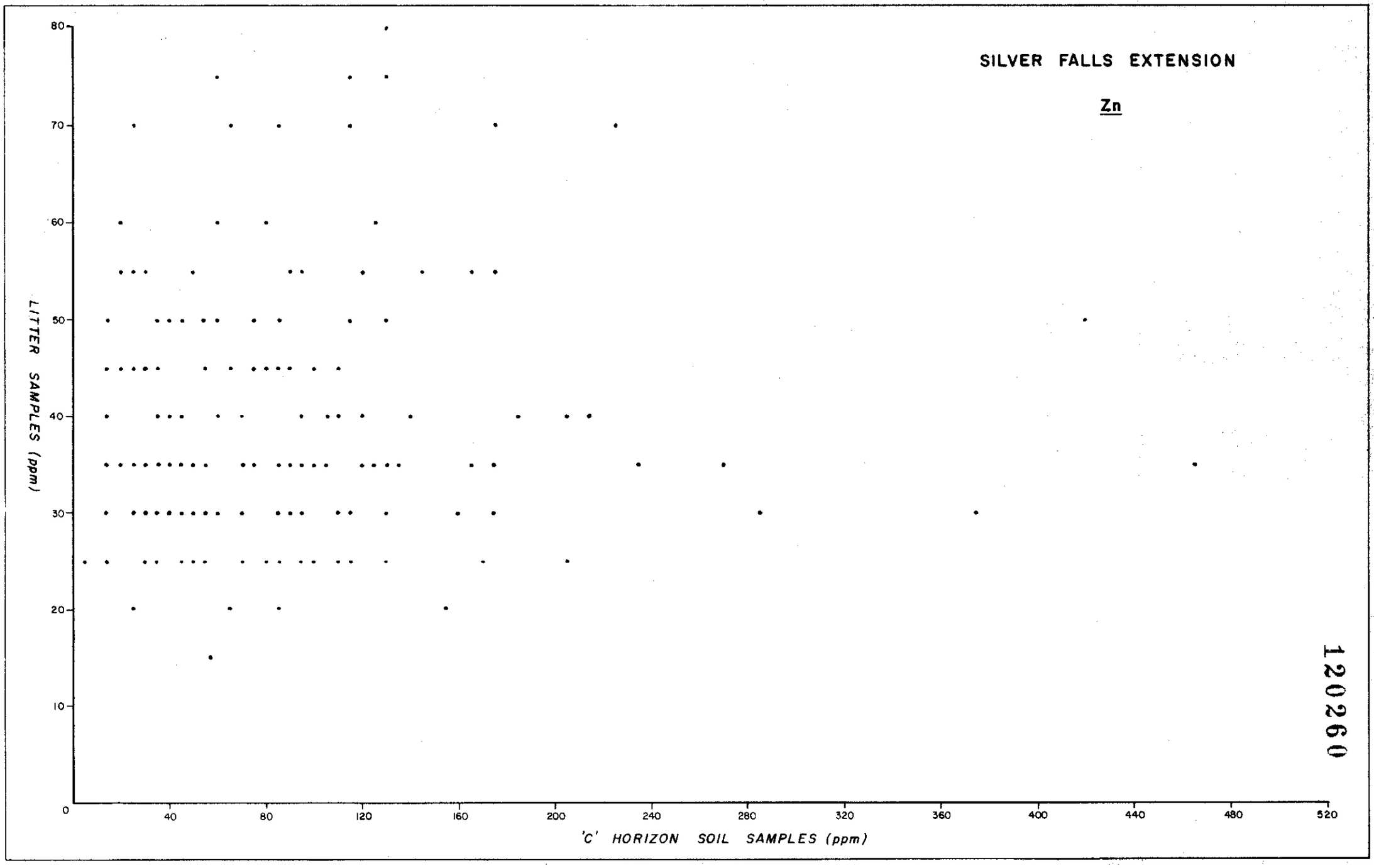
261
120257


NORTH PINNACLES AREA
Pb
LITTER SAMPLES (ppm)
'C' HORIZON SOIL SAMPLES (ppm)
0
10
20
30
40
50
60
70
80
40
80
120
160
200
240
280
320
360
400
440
480
520

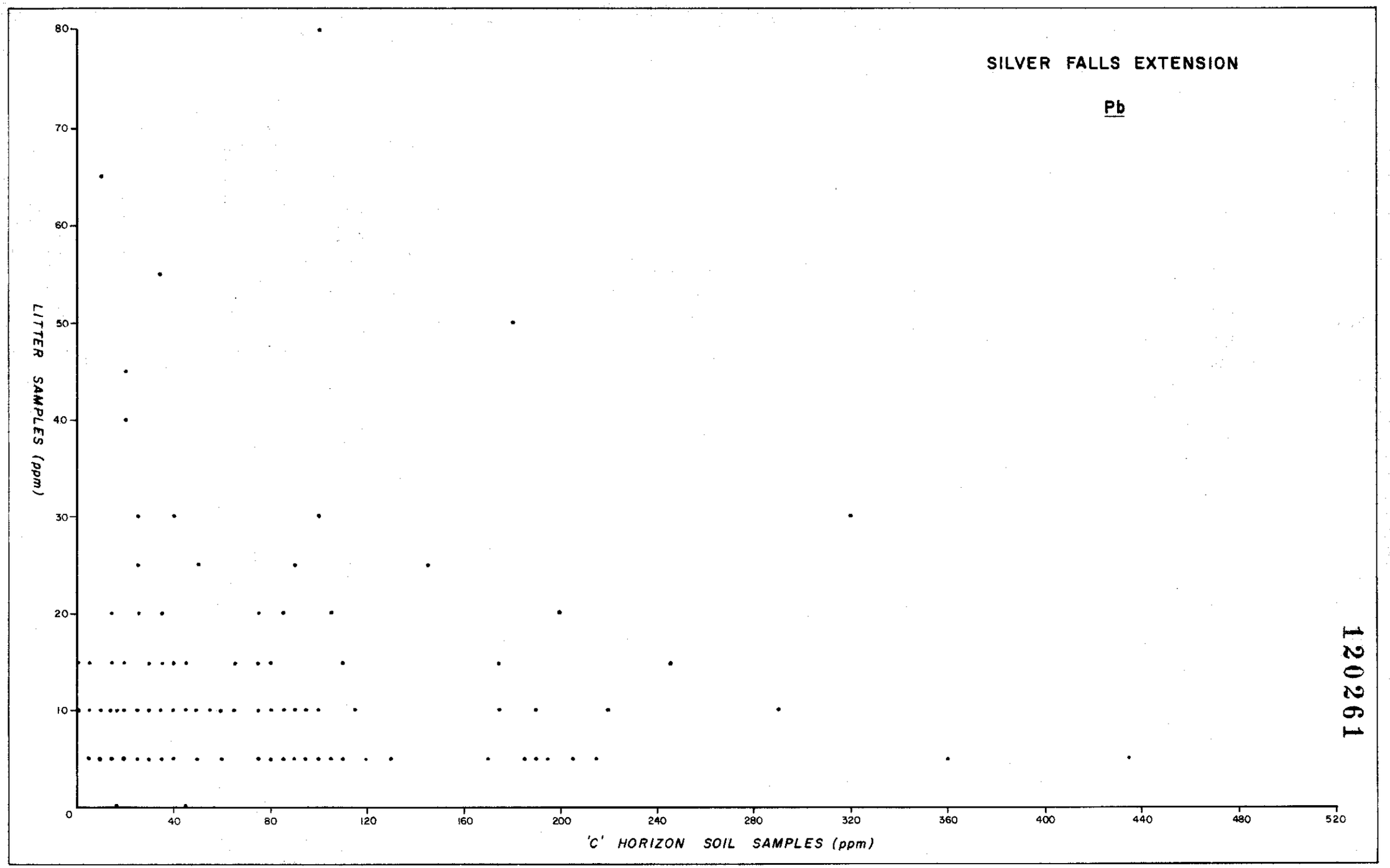
120258


NORTH PINNACLES AREA
Zn
LITTER SAMPLES (ppm)
'C' HORIZON SOIL SAMPLES (ppm)
0
10
20
30
40
50
60
70
80
40
80
120
160
200
240
280
320
360
400
440
480
520

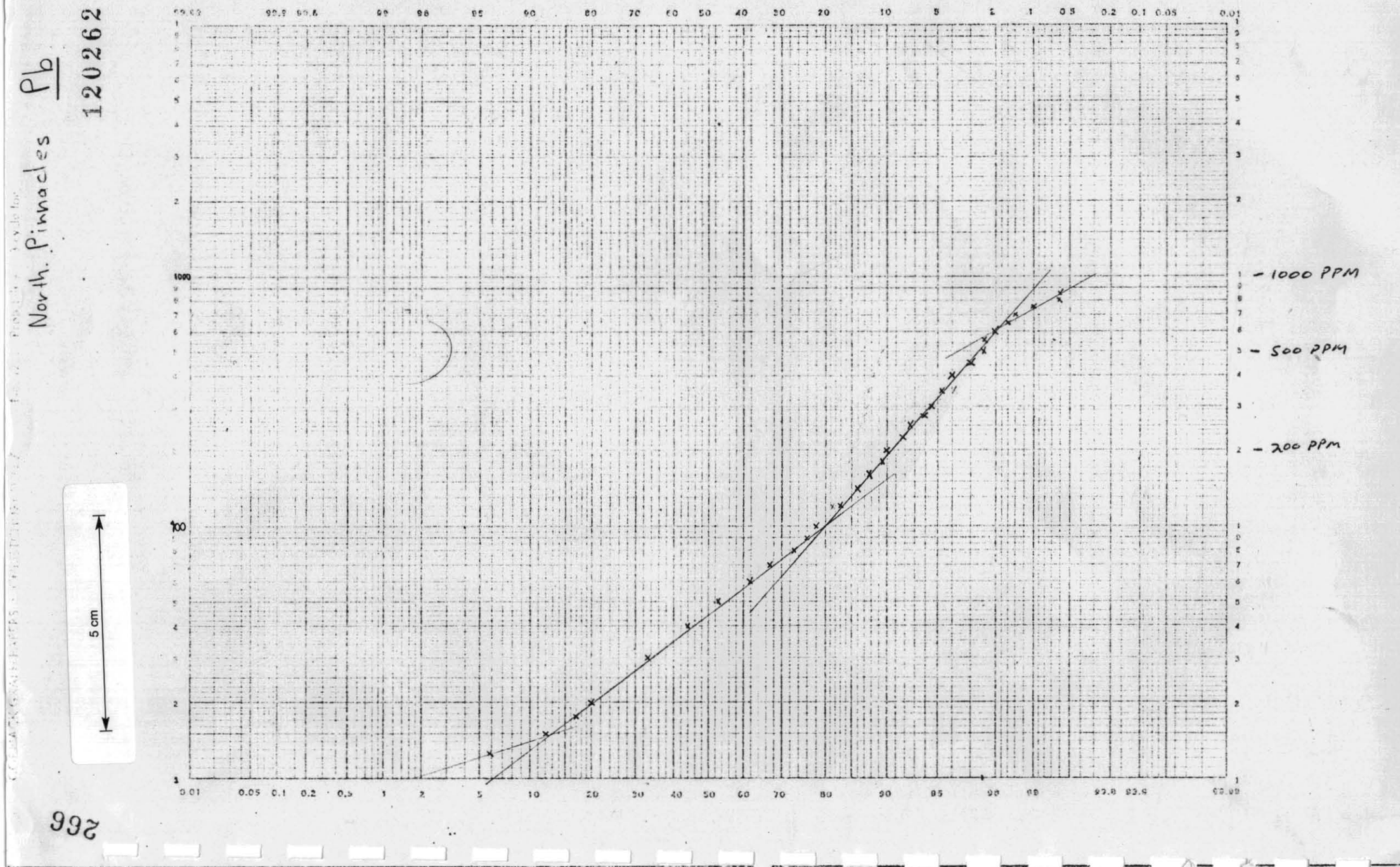
120259


SILVER FALLS EXTENSION
Zn
LITTER SAMPLES (ppm)
'C' HORIZON SOIL SAMPLES (ppm)
0
10
20
30
40
50
60
70
80
40
80
120
160
200
240
280
320
360
400
440
480
520

120260

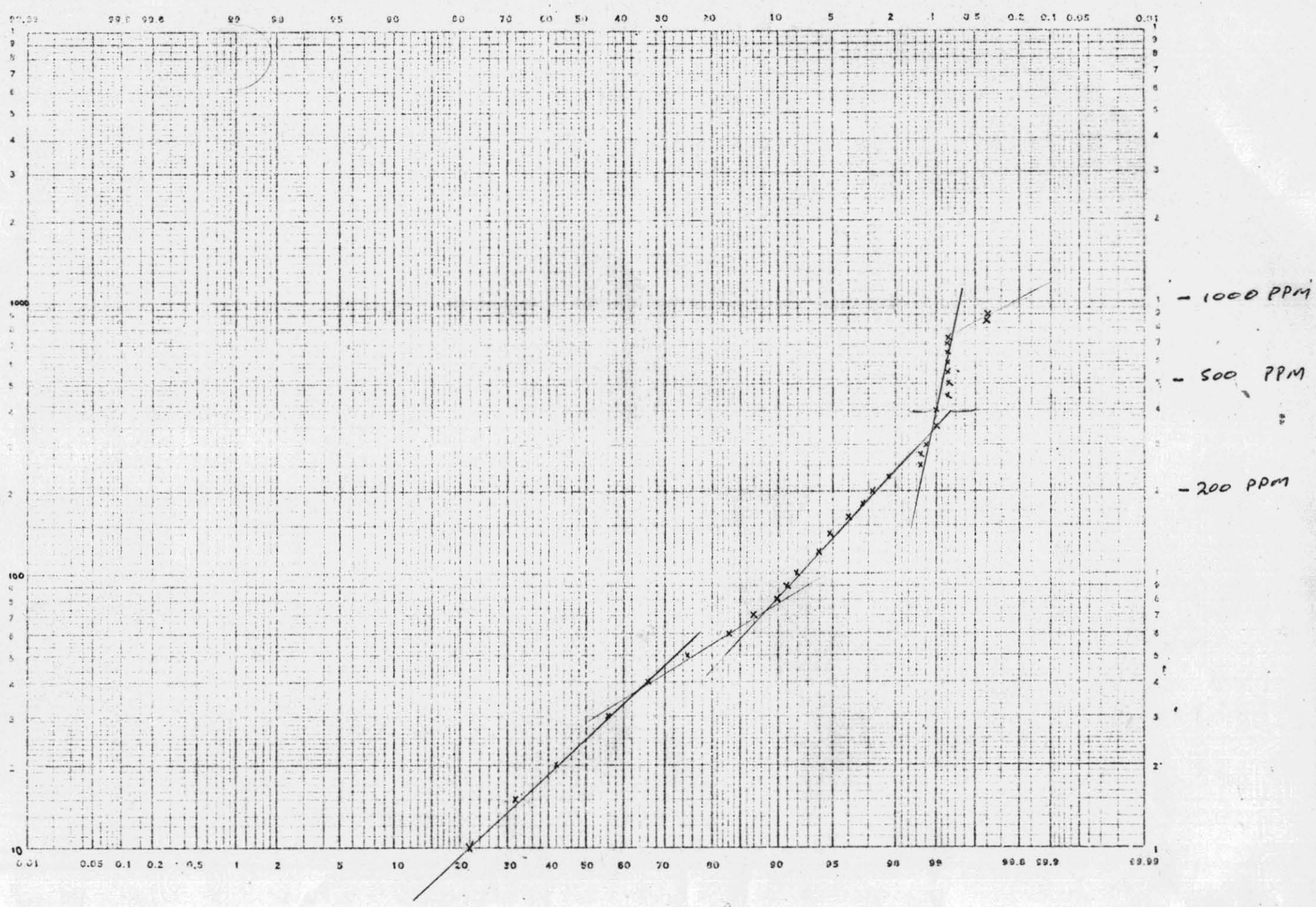

SILVER FALLS EXTENSION
Pb
LITTER SAMPLES (ppm)
'C' HORIZON SOIL SAMPLES (ppm)
0
10
20
30
40
50
60
70
80
40
80
120
160
200
240
280
320
360
400
440
480
520

120261


North. Pinnacles Pb
120262
- 1000 PPM
- 500 PPM
- 200 PPM
5 cm
266

North Pinnacles Zn

120263

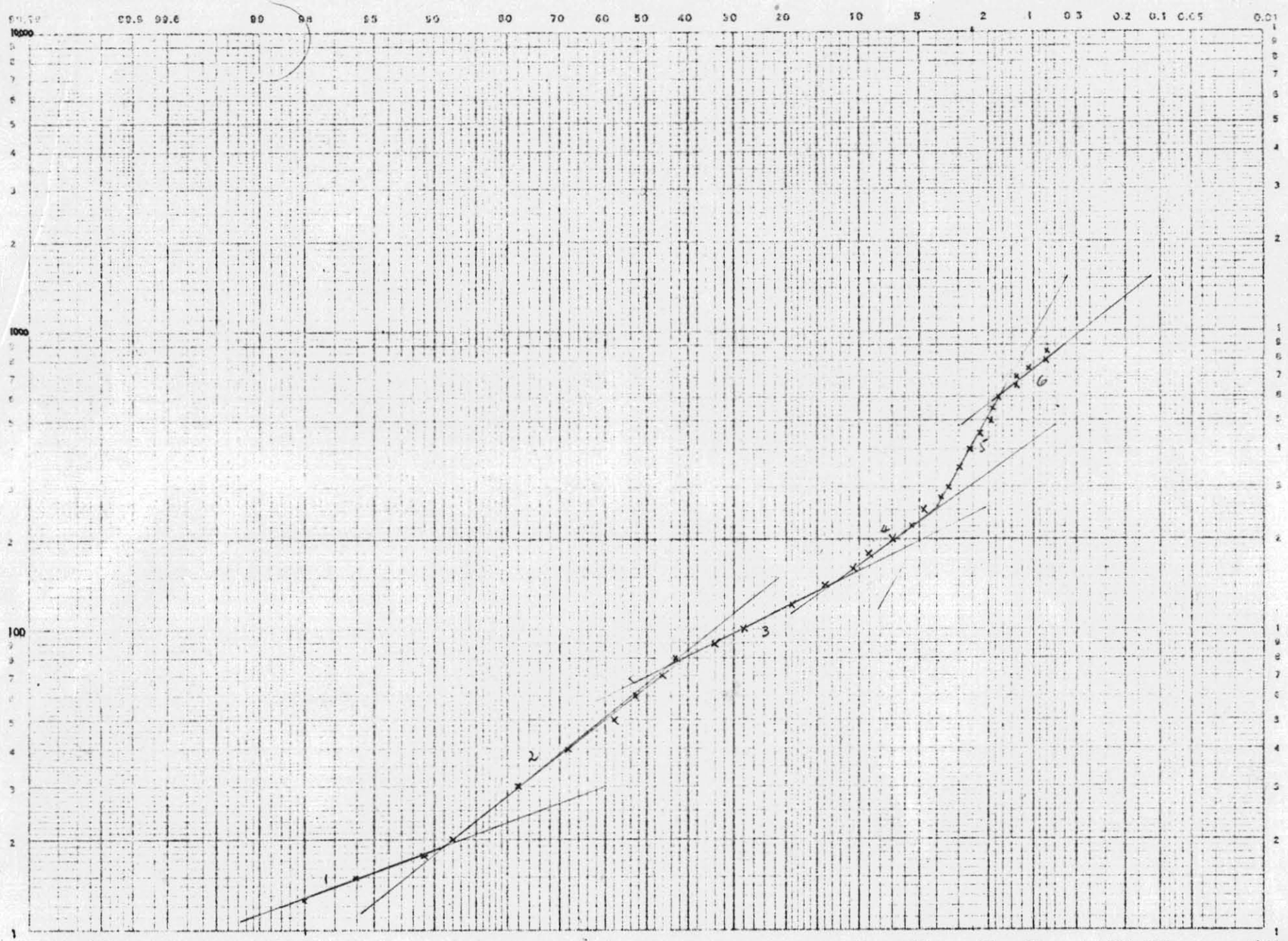


5 cm

267

12064

SILVER FALLS EXTENSION ZN



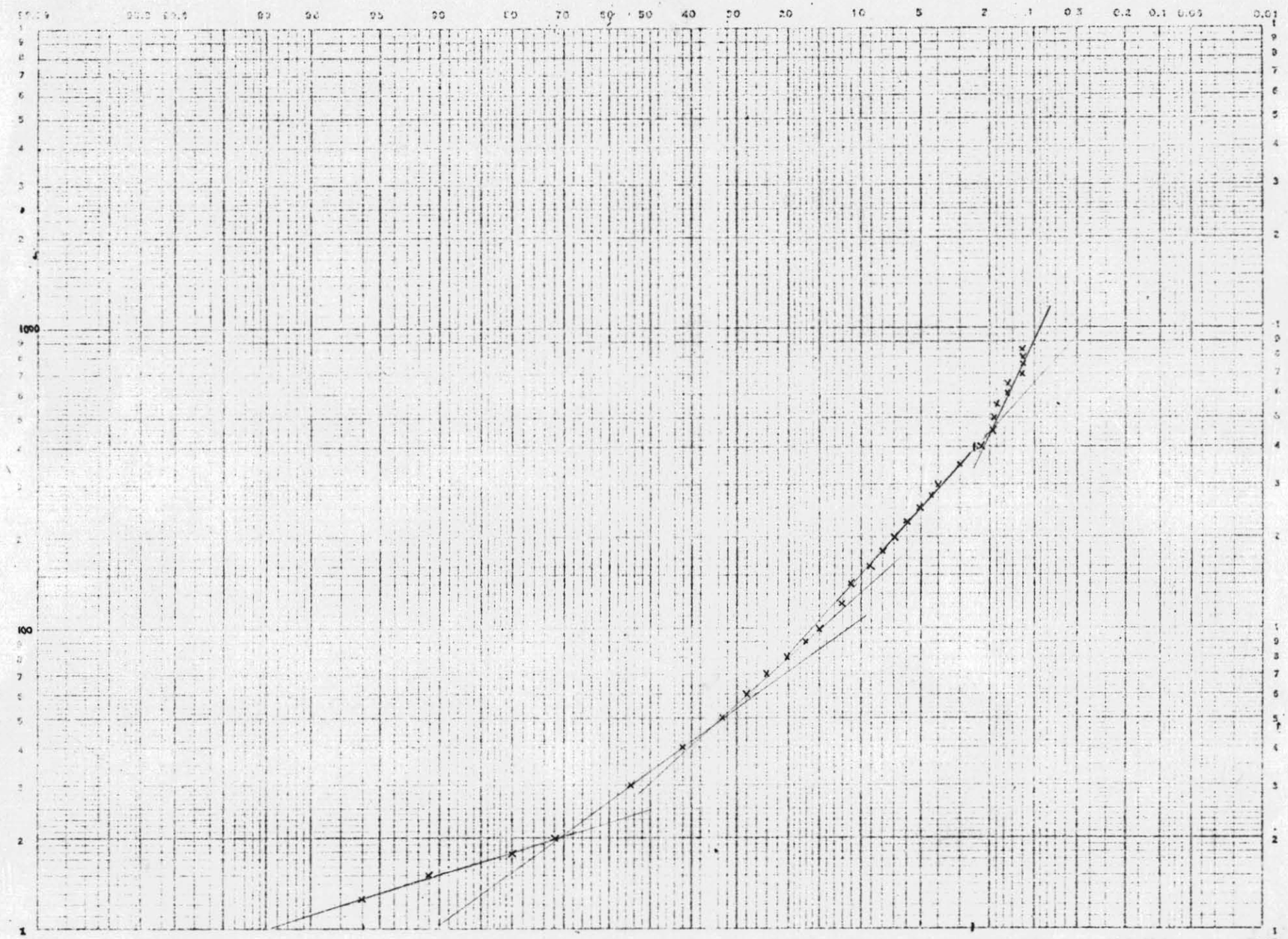
- 1000 PPM
- 500 PPM
- 200 PPM

5 cm

892

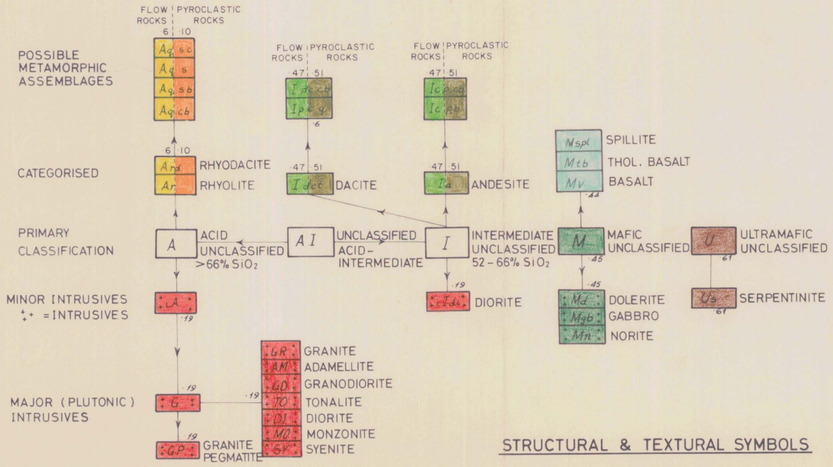
120265

SILVER FALLS EXTENSION Pb

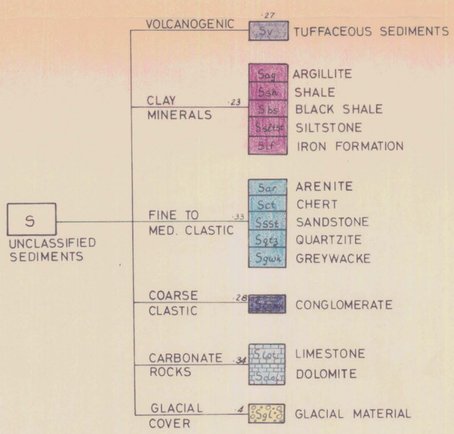


692

IGNEOUS ROCKS



SEDIMENTARY ROCKS



STRUCTURAL SYMBOLS

- FAULT
- DEFINITE CONTACT OR OUTCROP LIMIT
- APPROXIMATE CONTACT OR RUBBLE BOUNDARY
- INTERPRETED CONTACT OR FLOAT BOUNDARY
- SCHISTOSE ZONE
- UNCONFORMITY
- BEDDING
- OVERTURNED BEDDING
- CLEAVAGE
- PRIMARY FOLIATION
- JOINTING
- PLUNGE
- FOLD AXIS PLUNGE
- FACING

STRUCTURAL & TEXTURAL SYMBOLS

t	UNDIFERENTIATED TUFF
lt	LITHIC TUFF
xt	CRYSTAL TUFF
vt	VITRIC TUFF
lpt	LAPILLI TUFF 4-32mm.
b	BRECCIA >32mm.
ag	AGGLOMERATE >32mm.
bm	BOMBS
fm (3)	FIAMME (LENGTH IN cms.)
pm	PUMICE
af	ASH FLOW
qe qtz	QUARTZ EYES/AUGEN TEXTURE
pil	PILLOWS
fb	FLOW BANDING
fa	FLOW BRECCIA
	LAVA
a	AMYGDALOIDAL
s	SPHERULITIC
p	PORPHYRITIC
cl	CLOTS
ac	ACICULAR
oph	OPHITIC
chm	CHILLED MARGIN
pg	PEGMATIC
vns	VEINS
m	MASSIVE
clvd	CLEAVED
sch	SCHIST
ox	OXIDISED
	LATERITE
bd	BEDDED
x bd	CROSS BEDDED
THbd	THICK BEDDED
thbd	THIN BEDDED
lam	LAMINATED
gd	GRADED OR DIRECTION OF DECREASING GRAIN SIZE
	LODE CAST
sf	SCOUR & FILL
ves	VESICULAR
jtd	JOINTED
stain	STAINING
afl	ASH FALL

IGNEOUS GRAIN SIZE

vcg	VERY COURSE GRAINED >5 cm
cg	COARSE GRAINED 5cm-5mm
mg	MEDIUM GRAINED 5mm-1mm
fg	FINE GRAINED <1mm

SILICATE MINERALOGY

q	QUARTZ
k	K-FELSPAR
ab	ALBITE
p	PLAGIOCLASE
a	AMPHIBOLE
px	PYROXENE
b	BIOTITE
c	CHLORITE
cb	CARBONATE
s	SERICITE
e	EPIDOTE
t	TALC
ba	BARITE (STAEDTLER 104-10)
f	FELSPAR
hb	HORNBLENDE
sd	SIDERITE
a'b	ALBITISED
cb'd	CARBONATED
c'd	CHLORITISED
s'd	SERICITISED
si	SILICIFIED

SULPHIDE & OXIDE MINERALOGY

bx	BOXWORK
Sul	SULPHIDES
gos	GOSSAN (KEP INA)
pn	PENTLANDITE
hm	HEMATITE
cc	CHALCOCITE
cv	COVELLITE
bn	BORNITE
cp	CHALCOPYRITE
sp	SPHALERITE
gn	GALENA
po	PYRRHOTITE
py	PYRITE
il	ILLMENITE
lx	LEUCOXENE
mag	MAGNETITE

MINERALISATION

DISS	10% DISSEMINATED (STAEDTLER 104-2)
DISS	10-20% "
DISS	~25% "
STR	STRINGER
MAS	MASSIVE

COLOURS

ple	PALE
d/k	DARK
pk	PINK
rd	RED
org	ORANGE
yel	YELLOW
ol	OLIVE
grn	GREEN
bl	BLUE
gry	GREY
blk	BLACK
brn	BROWN
wht	WHITE
crm	CREAM
purp	PURPLE

TOPOGRAPHICAL SYMBOLS

- WATER RACE
- FENCE
- FORMED ROAD
- TRACK
- RAILWAY
- RAILWAY (ABANDONDED)
- RIVER
- STREAM
- LAKE
- SWAMP
- BUILDING
- POWERLINE
- TRIG. STATION
- HILL (BALD HILL)
- SHAFTS
- ADIT
- TRENCH
- MINE OR QUARRY
- DRILL HOLE - BARREN
- DRILL HOLE - COLOUR FOR MINERALISATION
- (ℓ) DRILL HOLE - SIGNIFICANT OR POSSIBLE ORE GRADE AND WIDTH (STAEDTLER 104-2)
- (ℓℓ) DRILL HOLE - MINOR OR POSSIBLE SUB-ORE GRADE MINERALISATION (STAEDTLER 104-10)
- DRILL HOLE - FAILED TO REACH TARGET

OPERATION OF LEGEND

DESCRIBING ROCK UNITS

1. CAPITAL LETTER - INDICATES PRIMARY CLASSIFICATION eg A - ACID IGNEOUS ROCKS; S - SEDIMENTARY ROCKS
2. LOWER CASE LETTERS - INDICATES THE FOLLOWING:

2a AS PREFIXES IN PROGRESSIVE ORDER

(a) COLOURS eg (i) grn M = GREEN MAFIC IGNEOUS ROCK

(ii) pk/grn A = PINK FRAGMENTS OR PHENOCRYSTS IN AN ACID IGNEOUS ROCK WITH A GREEN MATRIX

(b) STRUCTURAL OR TEXTURAL FEATURES

eg x t A. = CRYSTAL TUFF OF ACID COMPOSITION

(ii) x b d S = CROSS BEDDED SEDIMENTARY ROCK

2b AS SUFFIXES IN PROGRESSIVE ORDER

(a) CATEGORISED eg (i) Ar = RHYOLITE; (ii) SSh = SHALE

(b) MINERALOGY eg (i) pArf - RHYOLITE WITH FELSPAR PHENOCRYSTS

(ii) Aqs = QUARTZ SERICITE ROCK OF ACID IGNEOUS ORIGIN

(iii) Arab = ALBITISED RHYOLITE

EXAMPLE - pk/grn clvd x v t A rd ab c'd

pk/grn (COLOURS) - PINK CRYSTALS IN A GREEN MATRIX; clvd (STRUCTURAL FEATURE) - CLEAVED, x v t (TEXTURE) - CRYSTAL VITRIC TUFF, A (PRIMARY SUBDIVISION) - ACID IGNEOUS ROCK, rd (CATEGORISED) - RHYODACITE, ab (PRIMARY MINERALOGY) - ALBITE PHENOCRYSTS, c'd (ALTERATION MINERALOGY) - CHLORITISED.

120266

10 - COLOUR OF CUMBERLAND "DERWENT" N° 19 PENCIL

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.

PROJECT: MT. BLACK | TAS.

GEOLOGICAL LEGEND (Vol 2/3) 19-1401

FOR EXPLORATION MAPPING

DATE: 10/75 | REVISED: 12/'75 | REF. NO. PLATE 17

2866

380 000 mE

390 000 mE

5 400 000 mN

5 390 000 mN

5 380 000 mN

BULGOBAC E.L. 12/72

NORTHERN AREA

to Burnie

Que River

EMU BAY RAILWAY

Hatfield River

QUE RIVER GRID

20160 N

Camp

QUE RIVER
Pb, Zn, Cu

Que River

Access

SOCK CREEK
Pb, Zn

Northern Track

HIGHWAY

MURCHISON

MT. CHARTER
Ba

SILVER FALLS EXTENSION GRID

Bulgobac River

MAGNETIC ANOMALY

SILVER FALLS
Pb, Zn

WESTERN AREA

NORTH PINNACLES GRID

800

750

700

BOCO SIDING

BOCO EXTENSION GRID

XIII

BP 209

XII

BP 207

BP 208

V

13880 N

13720 N

BOCO AREA

BURNS PEAK
Pb, Zn

to Chester Mine, H.E.C. Road

PINNACLES
Pb, Zn

MT. BLACK
E.L. 1/62

to Tullah 6 km

GEOLOGICAL LEGEND

TERTIARY
- Basalt

CAMBRIAN
- Tuffaceous Sandstone
- Sandstone, Siltstone, Shale and Black Slate
- Acid Lavas
- Intermediate Lavas and Pyroclastics
- Acid Pyroclastics
- Acid and Intermediate Lavas and Pyroclastics

INTRUSIVES

CAMBRIAN ?
- Quartz Feldspar Porphyry

BOCO AREA — Extent of Locality

EXPLORATION COMPLETED - LEGEND

- Line Cut, Pegged, Soil Sampled and Mapped
- Line I. P.
- Access Geologically Mapped

120267

ELECTROLYTIC ZINC CO. OF A'ASIA LTD.

PROJECT: BULGOBAC E.L. 12/72 | TAS.

79-1401
(Vol 2/3).

EXPLORATION COMPLETED : 1978/79

TO OCT. 1979

5 cm

SCALE: 1 : 50,000	Survey: J.M.	Revised:
Reference:	Date: 31.5.79	REF. No. 1
Drawn: R P T.	Checked:	

2867

380 000mE

390 000mE

5 400 000mN

5 390 000mN

5 380 000mN

BULGOBAC E.L.12/72

to Burnie

Que River

EMU BAY RAILWAY

Hatfield River

Bulgobac River

Northern Access Track

HIGHWAY

MURCHISON

Tg

Tmv

Essh-sst

Esbs

EtAr

EAr

EIdct-a and EtIdct-a

Esbo

Jmd

QUE RIVER
Pb, Zn, Cu

SOCK CREEK
Pb, Zn

MT. CHARTER
Ba

SILVER FALLS
Pb, Zn

BOCO SIDING

BURNS PEAK
Pb, Zn

to Chester Mine, H.E.C. Road

PINNACLES
Pb, Zn

MT. BLACK
E.L.1/62

to Tullah 6km

GEOLOGICAL LEGEND

TERTIARY	Tmv		Basalt
	Tg		Gravel
CAMBRIAN	Esbo		Black Slate, Sandstone, Siltstone and ash
	Essh-sst		Grey Shales, Tuffaceous Sandstone and Siltstone and minor Conglomerate
	EAr		Acid Lavas (Rhyolitic)
	EtAr		Acid Pyroclastics (Rhyolitic)
	EIdct-a		Intermediate Lavas (Dacitic - Andecitic)
	EtIdct-a		Intermediate Pyroclastics
INTRUSIVES			
JURASSIC	Jmd		Dolerite
CAMBRIAN?	EtAr		Quartz Feldspar Porphyry

- Inferred Contact
- Faulted Contact
- Unconformity
- Strike / Dip
- Strike of Primary Foliation in Volcanics
- Facing

ELECTROLYTIC ZINC CO. OF A'ASIA LTD.

PROJECT: BULGOBAC E.L. 12/72 | TAS.

120268

79-1401
(Vol 2/3)

BEDROCK GEOLOGICAL PLAN

5 cm

SCALE: 1:50,000	Survey: J.M.	Revised:
Reference:	Date: 27. 6. 79	REF. No. 2
Drawn: R.P.T.	Checked:	

12868

E.L. 12/72

E.L. 12/72

E.L. 12/72

LEGEND

REFER TO SHEET 2

1	2
3	4
5	6
7	8

5 cm

ELECTROLYTIC ZINC CO. OF A'ASIA LTD.

PROJECT: BULGOBAC E.L. 12/72 | TAS

GEOLOGY

COMPILATION OF MAPPING TO

120269

SCALE 1:10,000 | REF. NO.

REFERENCE: | A0 - 525 - 0010

DATE: 29/1/76 | DRAWN: | SHEET 1

379/1401

5397000 N

5396000 N

5395000 N

5394000 N

375 000 E

376 000 E

377 000 E

378 000 E

379 000 E

380 000 E

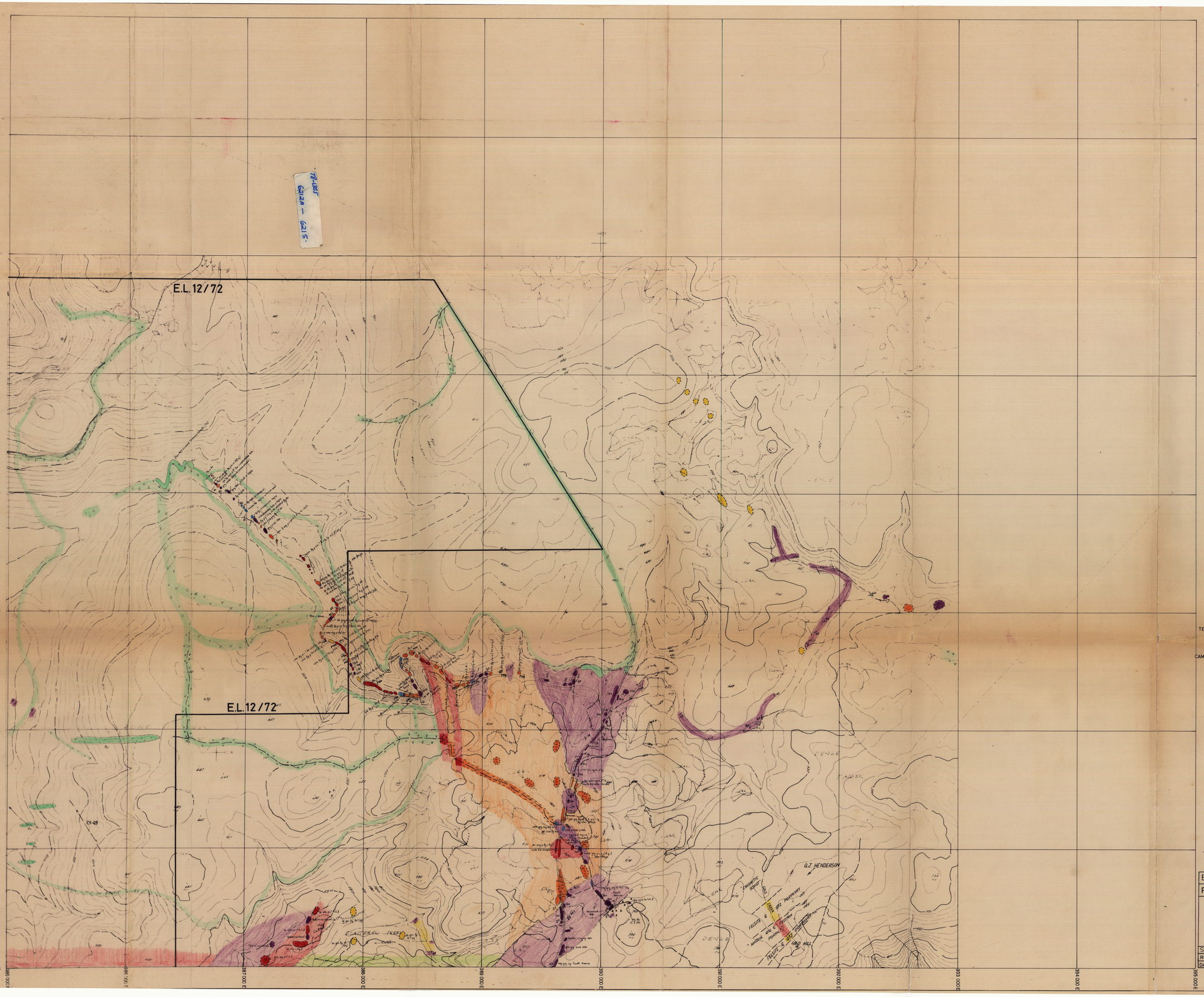
381 000 E

382 000 E

383 000 E

384 000 E

385 000 E



LEGEND

TERTIARY — BASALT

CAMBRIAN
- QUARTZ & QUARTZ FELSPAR PORPHYRY
- SEDIMENTS - SANDSTONES, SILTSTONES, GREYWACKES
- " - SHALES, SILTSTONES, REWORKED TUFFS
- LAVAS - DOMINANTLY RHYOLITIC
- PYROCLASTICS " "
- Ash Flows

1	2
3	4
5	6
7	8

120270

5 cm

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.

PROJECT: BULGOBAC E.L. 12/72 TAS

79-1401 (Vol 2/3)

GEOLOGY

COMPILATION OF MAPPING TO OCT. 1979

SCALE 1:10,000

REFERENCE:

DATE: 29/1/76 DRAWN: SHEET 2

REF. NO. AO - 525 - 0011

2869

E.L.12/72

CRIMSON CREEK SEDIMENTS

E.L.12/72

E.L.12/72

LEGEND

REFER TO SHEET 2

1	2
3	4
5	6
7	8

5 cm

120271

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.

PROJECT: BULGOBAC E.L.12/72 | TAS

79-1401
CVol 215

GEOLOGY

COMPILATION OF MAPPING TO OCT. 1979

SCALE 1:10,000 | REF. NO.

REFERENCE (amended 1979) | AO - 525 - 0012

DATE: 28/1/76 | DRAWN: [illegible] | SHEET 3

2670

2670

E.L. 12/72

ORE LENSES

QUE RIVER PROSPECT

LOCK CREEK

DENSE TIMBER

LEGEND - REFER TO SHEET 2

1	2
3	4
5	6
7	8

120272

5 cm

ELECTROLYTIC ZINC CO. OF A'ASIA LTD.

PROJECT : BULGOBAC EL 12/72 | TAS

71-1141 Vol 2/3

GEOLOGY

COMPILATION OF MAPPING TO OCT. 1979

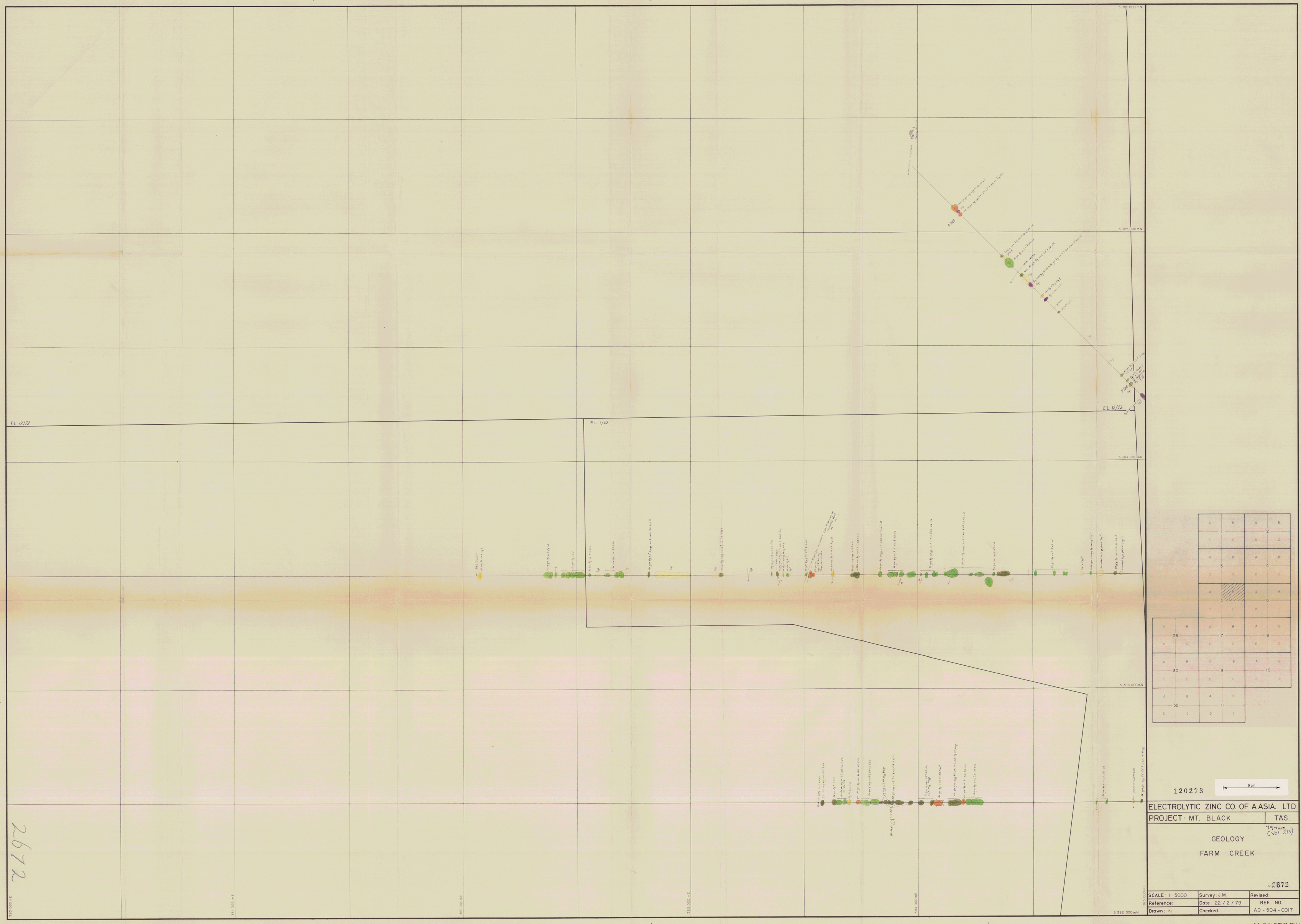
SCALE 1:10,000	SURVEY: J.M.	REF. No.
REFERENCE:		AO - 525 - 0007
DATE: 19/3/79	DRAWN: R.P.T.	

2671

2671

5389000 N
5388000 N
5387000 N
5386000 N

385000 E
386000 E
387000 E
388000 E
389000 E
390000 E
391000 E
392000 E
393000 E
394000 E
395000 E



120273

5 cm

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: MT. BLACK | TAS.

79-1401 (Vol 2/3)

GEOLOGY

FARM CREEK

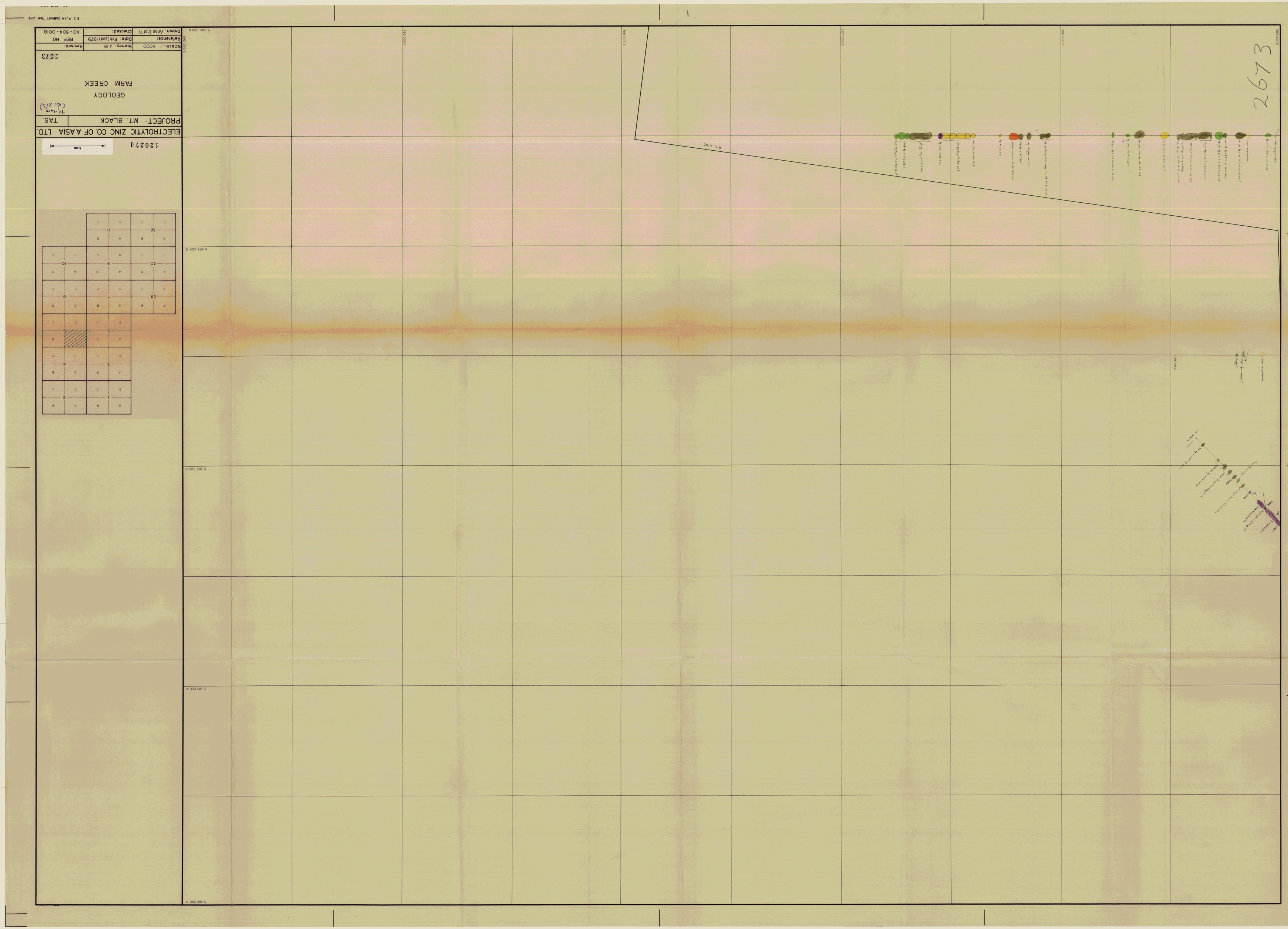
2672

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: 22/2/79	REF. NO.
Drawn:	Checked:	AO-504-0017

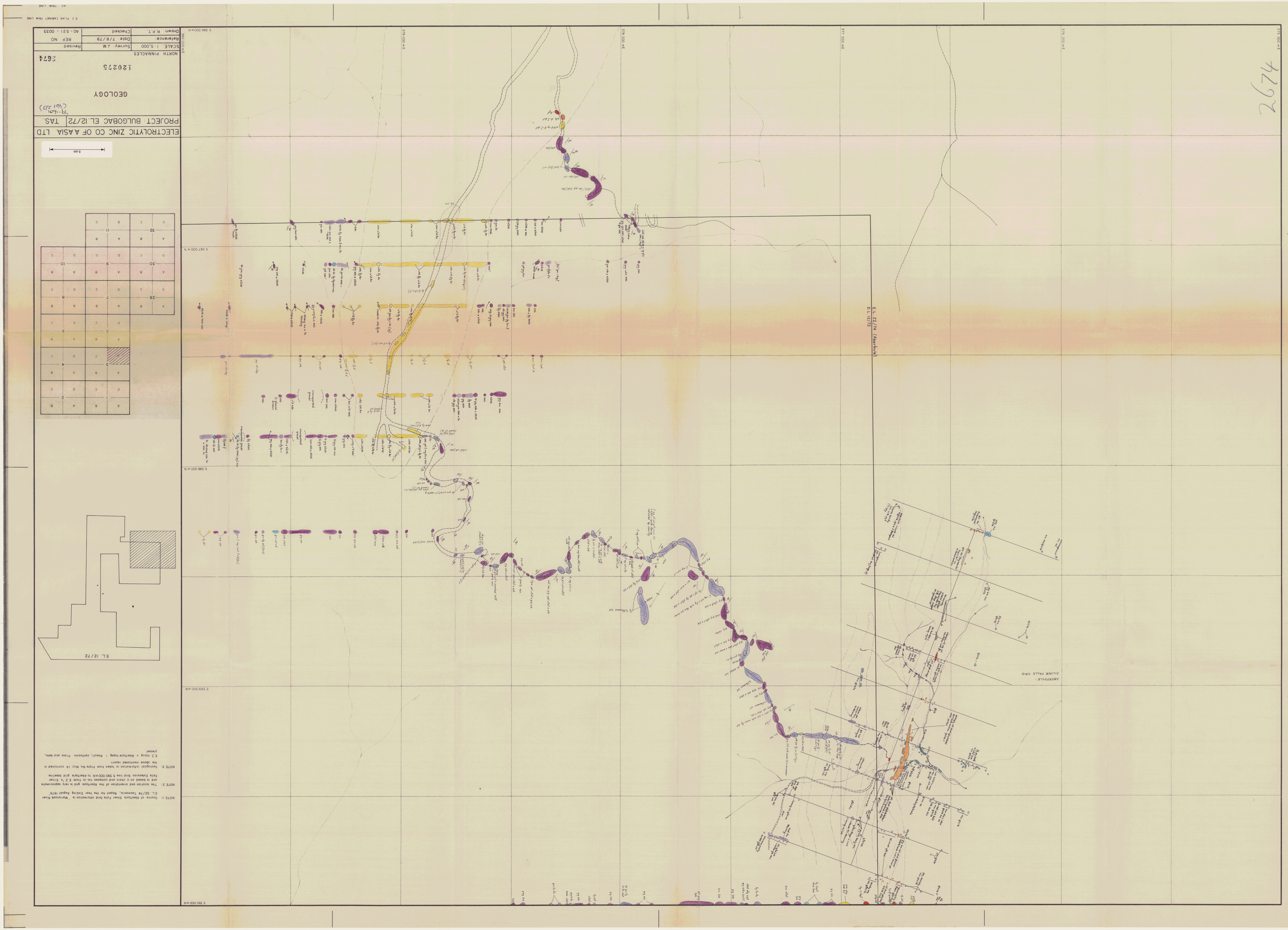
E.Z. PLAN CABINET TRIM LINE

AO TRIM LINE

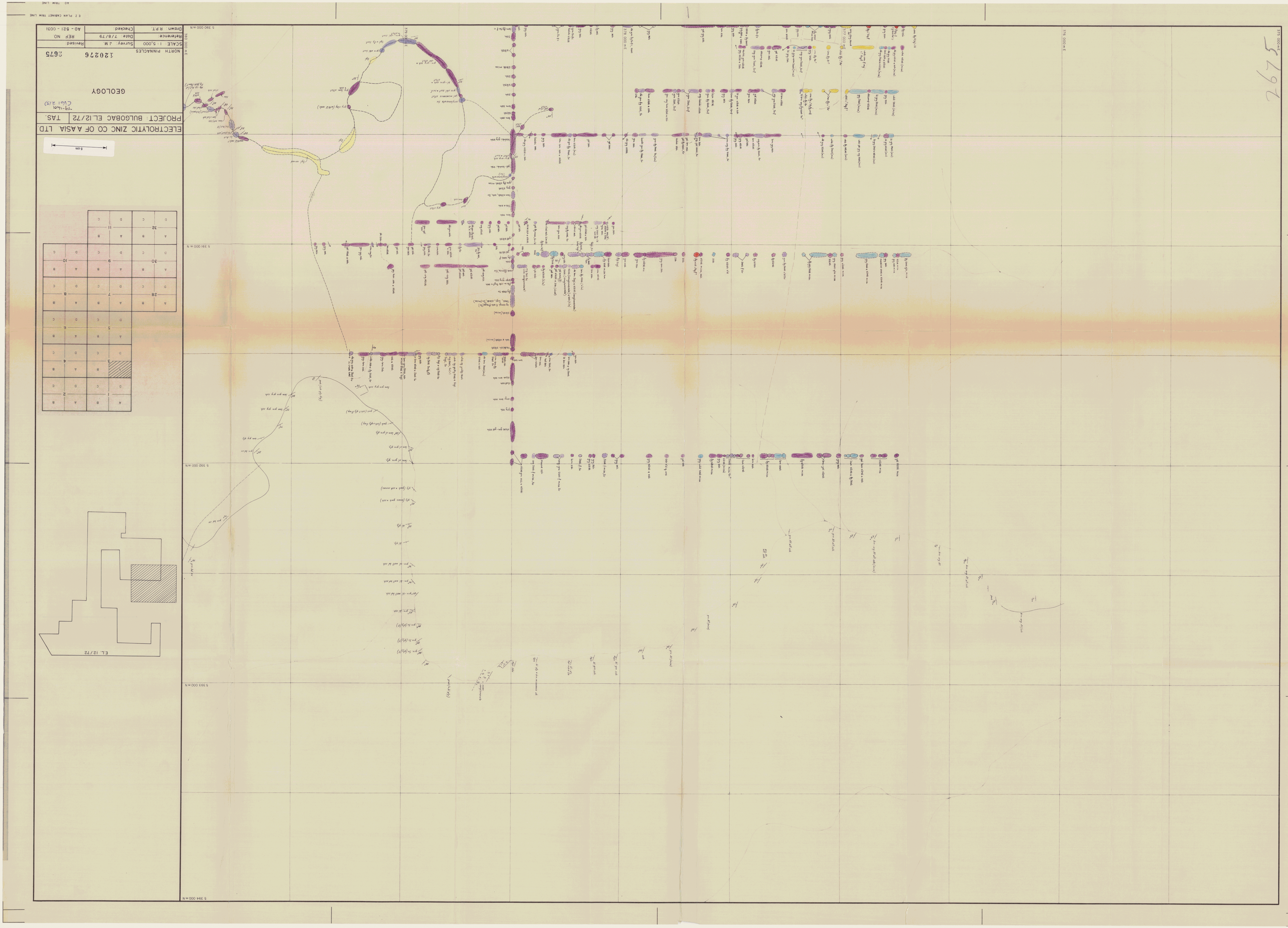
2672

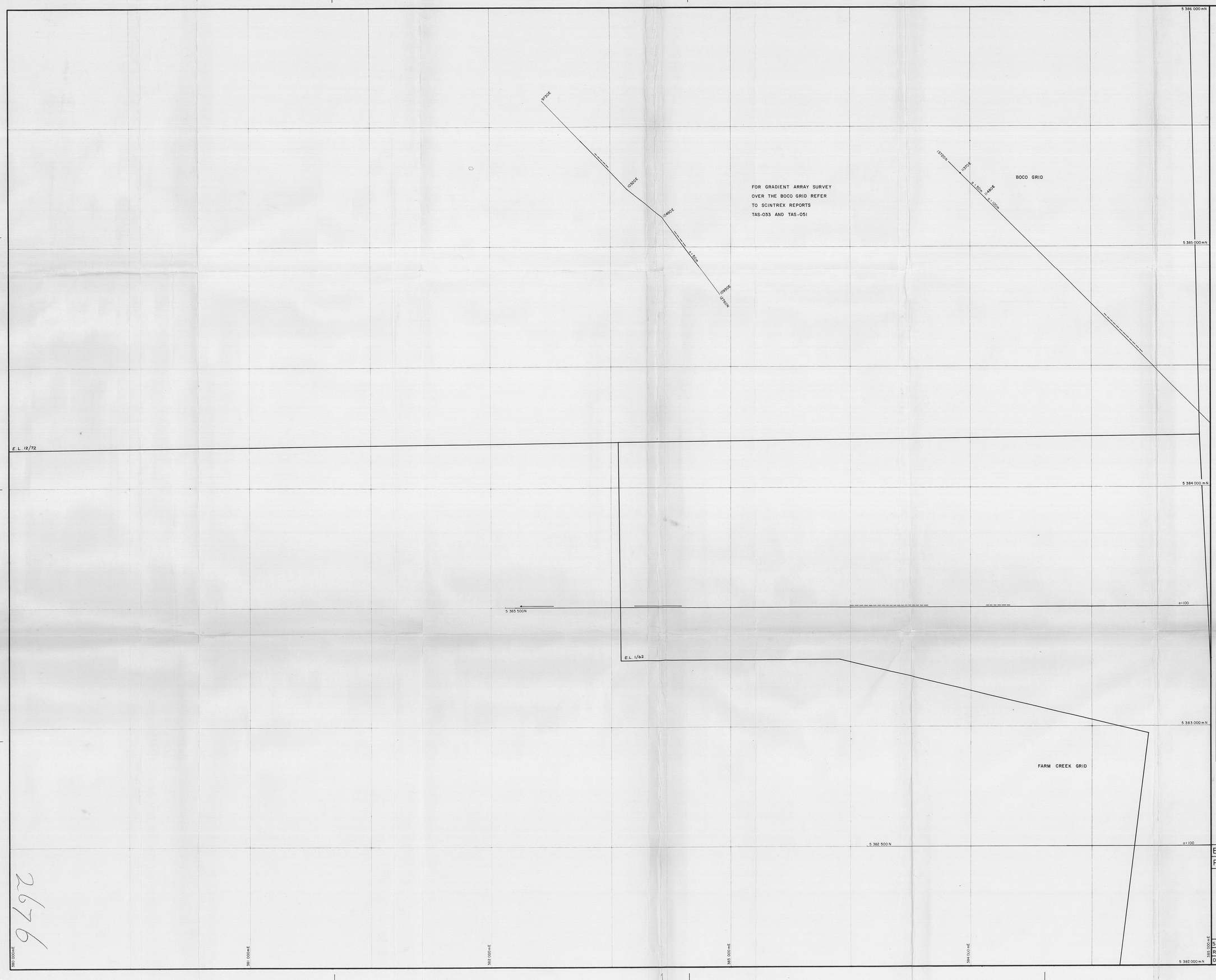


ELECTROLYTIC ZINC CO. OF AASIA. LTD.
PROJECT: MT. BLACK
TAS.
GEOLOGY
FARM CREEK
2673
SCALE: 1:5000
Survey: J.M.
Revised:
Reference:
Date: Feb(just) 1979
REF. NO.
Drawn: Anon (rpt?)
Checked:
AO-504-0018
120274
5 cm
2673



ELECTROLYTIC ZINC CO OF AASIA LTD
PROJECT: BULGOBAC EL.12/72 TAS.
GEOLOGY
120275
2674
NORTH PINNACLES
SCALE: 1:5,000
Surveyed: J.M.
Revised:
Reference:
Date: 7/8/79
REF NO
Drawn: R.P.T.
Checked:
AO-521-0033
E.L. 12/72
E.L. 22/74 (Aberfoyle)
ABERFOYLE: SILVER FALLS GRID
NOTE 1: Source of Aberfoyle Silver Falls Grid information is 'Marionoak River E.L. 22/74 Tasmania, Report for the Year Ending August 1979.'
NOTE 2: The location and orientation of the Aberfoyle grid is very approximate and is based on a chain and compass tie-in from E.Z.'s Silver Falls Extension Grid line 5 390 000mN to Aberfoyle grid baseline.
NOTE 3: Geological information is taken from Plate No. Mac. 14 contained in the above mentioned report.
E.Z. topog. v Aberfoyle topog. = Result, confusion. Place your bets, please!


ELECTROLYTIC ZINC CO OF AASIA LTD
PROJECT: BULGOBAC EL.12/72 TAS.
GEOLOGY
120276 2675
NORTH PINNACLES
SCALE: 1:5,000
Survey: J.M.
Revised:
Reference:
Date: 7/8/79
REF NO
Drawn: R.P.T.
Checked:
AO - 521 - 0031
5 cm
EL. 12/72
2675



NOTES:

1. All dipole-dipole anomalies defined on basis of chargeability or frequency effect values.

2. Dipole-dipole spreads compiled from the following surveys:
   Boco Grid: Scintrex 1978, 1979 (Time domain)
   Reports: TAS 051 May 1978
   TAS 065 August 1979
   Geoex Profile of Anomaly 16 Line 13880N
   E.Z. Report No.129 1978

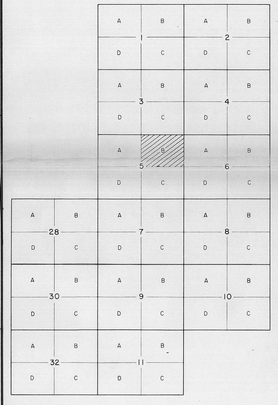
3. Chargeability contours (millivolts/volt) compiled from the following surveys:
   Boco Grid: Scintrex 1976, Report TAS 033 Oct-Nov 1976
   Extended Scintrex 1978, Report TAS 051 May 1978

LEGEND

a=100m — Dipole-Dipole Spread Showing Electrode Interval

Location of Definate Anomalies (Primary and/or Secondary Anomalies)

Location of Possible Anomalies (Tertiary Anomalies)



120277

5 cm

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: MT. BLACK E.L. 1/62 | TAS.

Y9-(4)
(Vol 2/3)

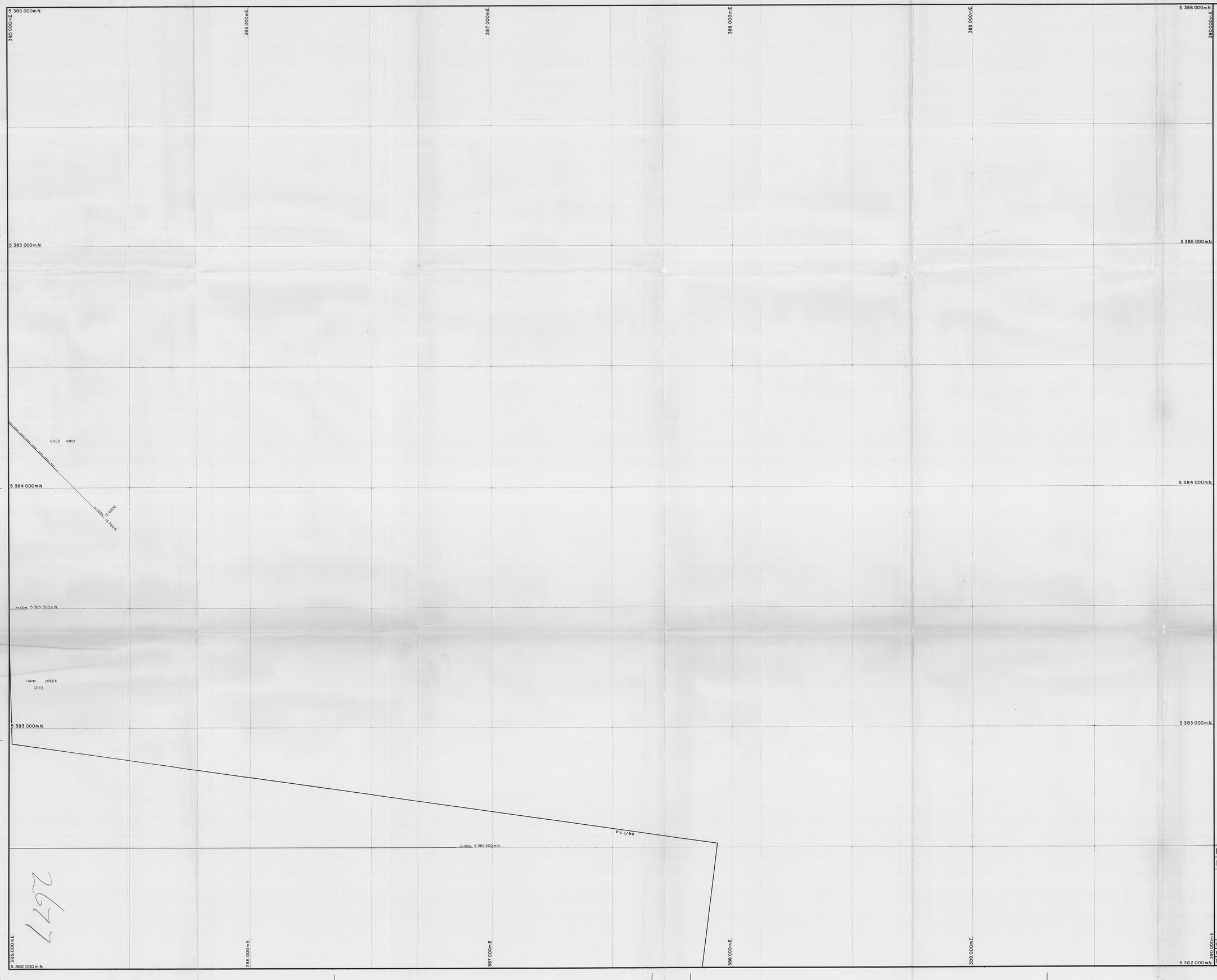
INDUCED POLARIZATION

2676

SCALE: 1:5 000	Survey: J.M.	Revised:
Reference:	Date: NOV. 6th 1979	REF. NO.
Drawn: R.P.T.	Checked:	AO-504-0085

E.Z. PLAN CABINET TRIM LINE

2676

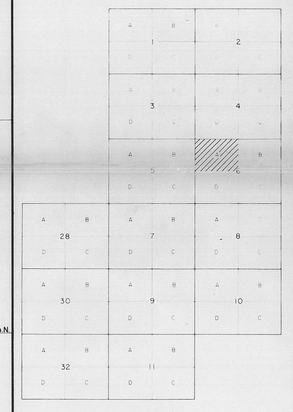


NOTE 1: All Dipole-Dipole anomalies defined on basis of Chargeability or Frequency Effect values.

NOTE 2: Dipole-Dipole spreads compiled from the following surveys:-
(a) Boco grid: Scintrex Report TAS.065 August 1979.
(b) Farm Creek grid: As above.

LEGEND

- Dipole-Dipole Spread Showing Electrode Interval
- Location of Definate Anomalies (Primary and/or Secondary Anomalies)
- Location of Possible Anomalies (Tertiary Anomalies)



120278

5 cm

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: MT. BLACK EL. 1/62 | TAS.

79-1401 (Vol 213)

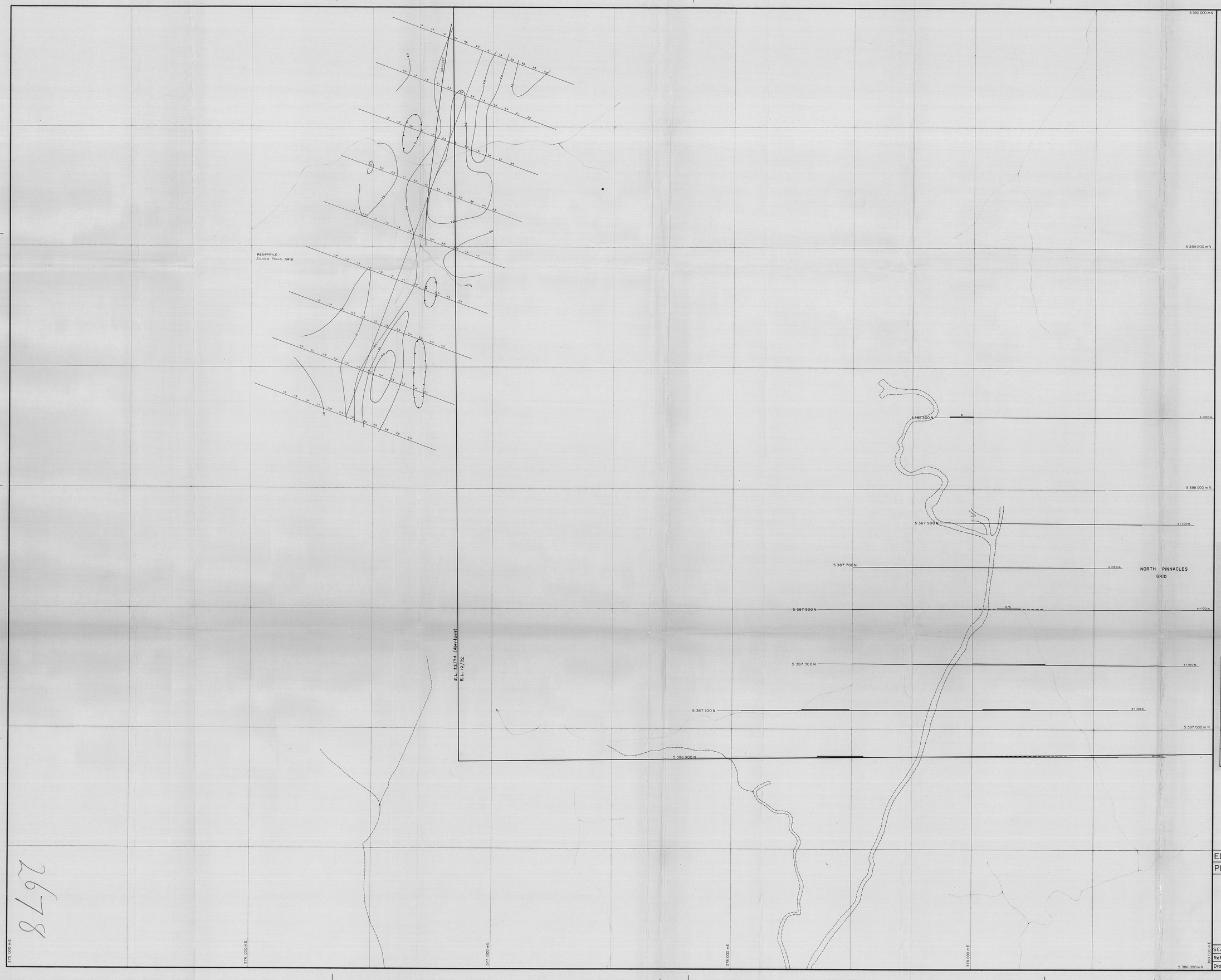
INDUCED POLARIZATION

2677

SCALE: 1:5 000	Survey:	Revised:
Reference:	Date: NOV. 1st 1979	REF. NO.
Drawn: R.A.H.	Checked:	AO-504-0084

E.Z. PLAN CABINET TRIM LINE

AO TRIM LINE



NOTE 1: Source of Aberfoyle Silver Falls Grid information is "Marionoak River E.L. 22/74 Tasmania, Report for the Year Ending August 1979"

NOTE 2: The location and orientation of the Aberfoyle grid is very approximate and is based on a chain and compass tie-in from E.Z.'s Silver Falls Extension Grid line 5 390 000 mN to Aberfoyle grid baseline.

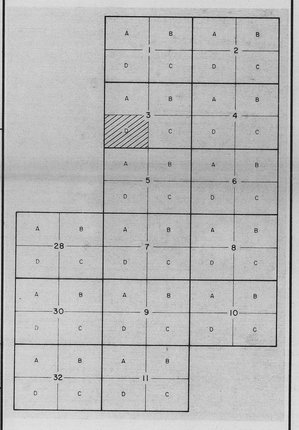
NOTE 3: Percent Frequency Effect is a Xerox reduction of Plate No. Mac. 17 contained in the above mentioned report.

NOTE 4: E.Z.'s North Pinnacles Grid was surveyed by Scintrex using Time Domain Dipole - Dipole I.P. (Electrode spacing 100 m.) See Reports TAS. 065 August 1979; TAS. 065 July 1979.

NOTE 5: All Dipole - Dipole anomalies defined on basis of Chargeability or Frequency Effect values.

LEGEND

- Dipole - Dipole Spread Showing Electrode Interval
- Location of Definate Anomalies (Primary and/or Secondary Anomalies)
- Location of Possible Anomalies (Tertiary Anomalies)



5 cm

120279

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: BULGOBAC EL. 12/72 | TAS.

Y9-1401 (Vol 2/5)

INDUCED POLARIZATION

2678

SCALE: 1:5,000	Survey: Aberfoyle	Revised:
Reference: as note 1	Date: Feb 1979	REF. NO.
Drawn: R.P.T. (25.9.79)	Checked:	AO - 521 - 0040

E.Z. PLAN CABINET TRIM LINE

AO TRIM LINE

2678

5 390 000 m N.

380 000m E

381 000m E

382 000m E

383 000m E

384 000m E

5 390 000 m N

385 000m E

5 389 000m N.

5 389 000m N

x+100m 5 388 300m N

5 388 000m N.

5 388 000m N

NORTH PINNACLES

GRID

x+100m 5 387 500m N

5 387 000m N.

5 387 000m N

5 386 000m N.

380 000m E

381 000m E

382 000m E

383 000m E

384 000m E

385 000m E

5 386 000m N

2679

NOTE 1. EZ's North Pinnacles grid was surveyed by Scintrex using Time Domain Dipole - Dipole I.P (electrode spacing 100m.) See Reports TAS 065 July 1979, TAS 065 August 1979

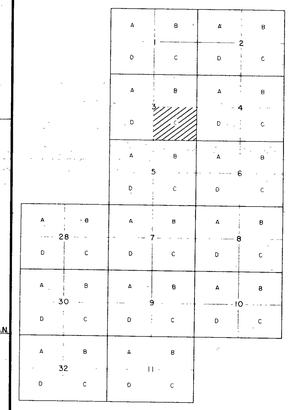
NOTE 2 All Dipole - Dipole anomalies defined on basis of Chargeability or Frequency Effect values

LEGEND

x+100m Dipole - Dipole Spread Showing Electrode Interval

Location of Definate Anomalies (Primary and/or Secondary Anomalies)

Location of Possible Anomalies (Tertiary Anomalies)



5cm

ELECTROLYTIC ZINC CO. OF A'ASIA LTD

PROJECT: BULGOBAC E.L. 12/72 TAS

79-1401 (Vol 2/3)

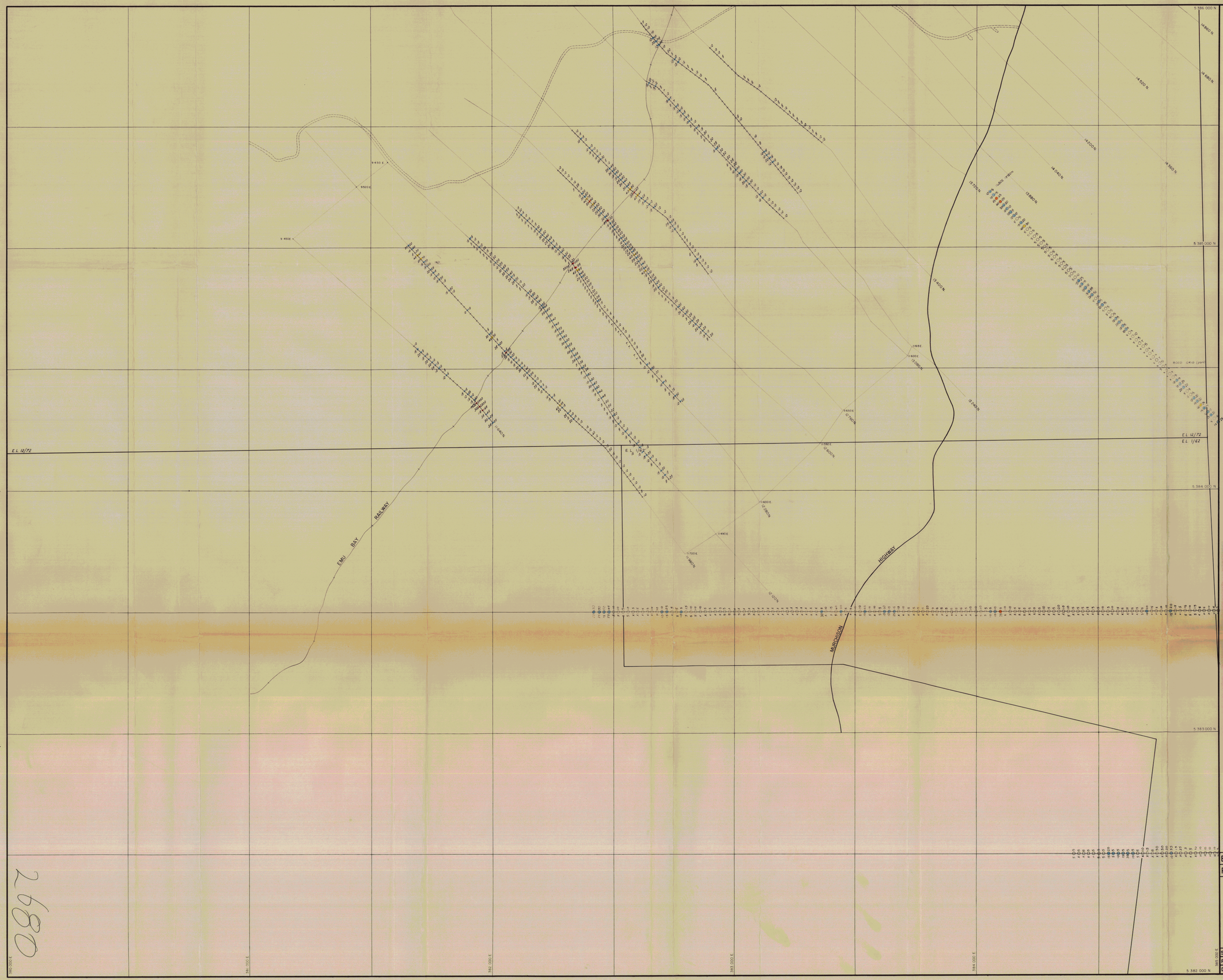
INDUCED POLARIZATION

120280 2679

SCALE 1:5 000	Survey:	Revised
Reference	Date NOV 1st 1979	REF NO
Drawn R.A.H.	Checked	A0 521 0041

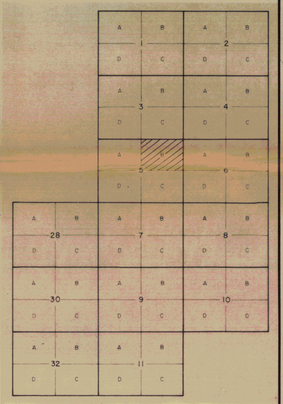
EZ PLAN CABINET TRIM LINE

A0 TRIM LINE



NOTES:

1. Over the Boco Grid, only non glacial soils were sampled.
2. Samples were taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu & Fe — see E.Z. report No. 128 by N.H. Hanson.
3. Results in P.P.M. unless otherwise stated.



Pb.	Zn.
> 80 ppm.	> 135 ppm.
51 - 80 ppm.	81 - 135 ppm.
36 - 50 ppm.	41 - 80 ppm.
8 - 35 ppm.	11 - 40 ppm.
0 - 7 ppm.	0 - 10 ppm.

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: MT. BLACK | TAS.

49-1401 (Vol 2/3)

GEOCHEMISTRY - Pb/Zn

120281

5 cm

FARM CREEK LINES

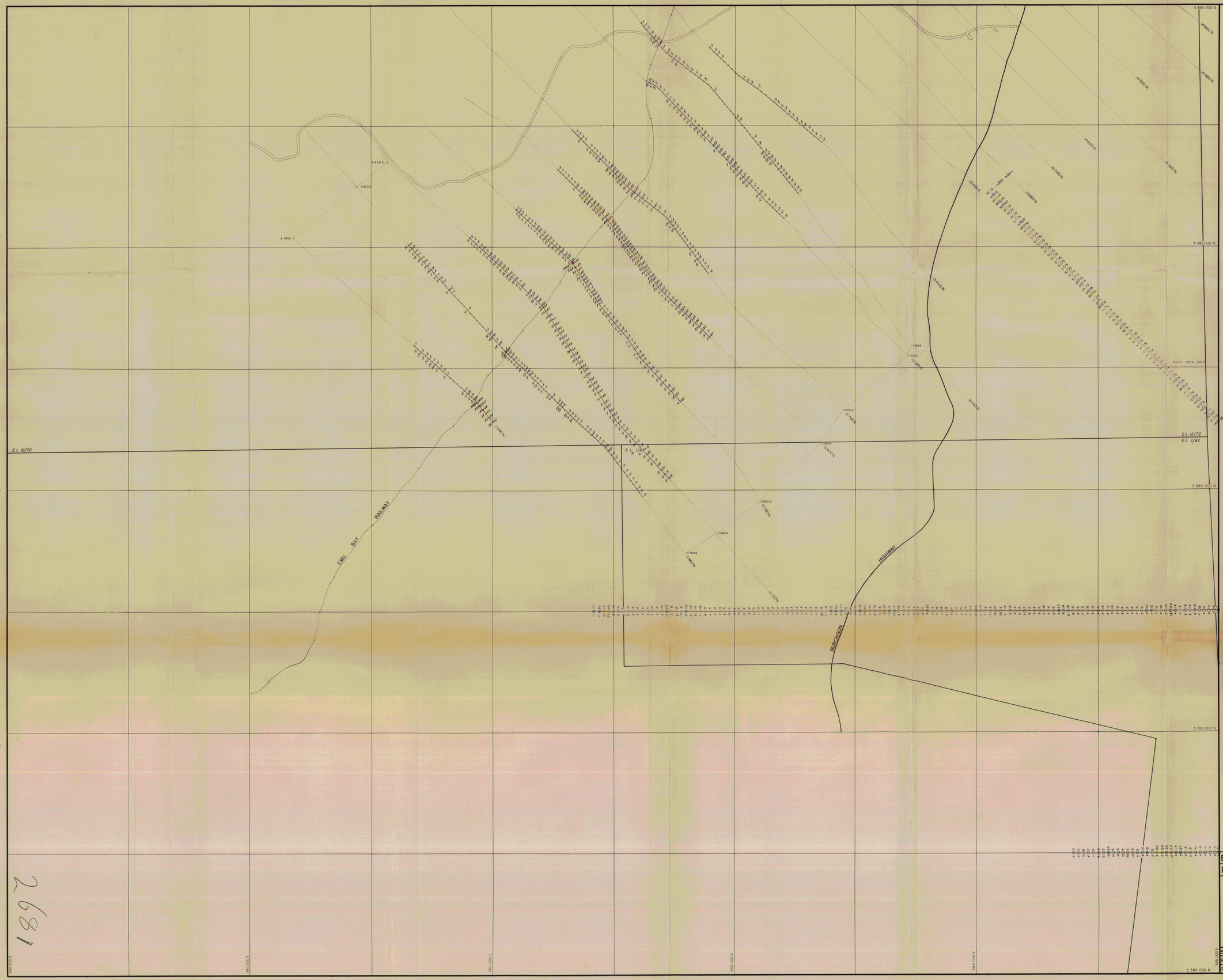
2680

SCALE: 1 : 5000	Survey: J.M.	Revised:
Reference:	Date: Feb 1979	REF. NO.
Drawn: R.P.T.	Checked:	AO-504-0025

E.Z. PLAN CABINET TRIM LINE

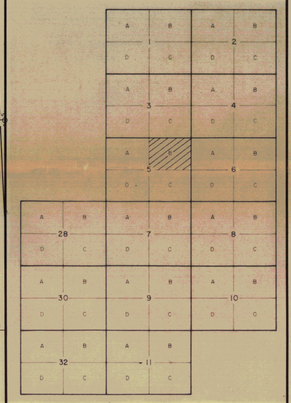
AO TRIM LINE

2680



NOTES:

1. Over the Boco Grid, only non glacial soils were sampled.
2. Samples were taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu & Fe — see E.Z. report No. 128 by N.H. Hanson.
3. Results in P.P.M. unless otherwise stated.



Pb.	Zn.
> 80 ppm.	> 135 ppm.
51 - 80 ppm.	81 - 135 ppm.
36 - 50 ppm.	41 - 80 ppm.
8 - 35 ppm.	11 - 40 ppm.
0 - 7 ppm.	0 - 10 ppm.

ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: MT. BLACK | TAS.

79-1401

GEOCHEMISTRY - Pb/Zn

120282

5 cm

FRAM CREEK LINES

2681

SCALE: 1 : 5000	Survey: J.M.	Revised:
Reference:	Date: Feb 1979	REF. NO.
Drawn: R.P.T. + others	Checked:	A0-504-0025

E.Z. PLAN CABINET TRIM LINE

A0 TRIM LINE

2681

NOTES :

1. Over the Boco Grid only non glacial soils were sampled.
2. Samples were taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb Zn Cu & Fe — see E.Z. report No. 128 by N.H. Hanson.
3. Results in P.P.M. unless otherwise stated.



Cu.
0 - 7 p.p.m.
8 - 30 p.p.m.
31 - 50 p.p.m.
> 50 p.p.m.

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.

PROJECT: MT. BLACK | TAS.

79-1401

GEOCHEMISTRY - Cu/Fe

120283

5 cm

FARM CREEK LINES

2682

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: Feb 1979	REF. NO.
Drawn: R.P.T.	Checked:	A0-504-0026

E Z PLAN CABINET TRIM LINE

A0 TRIM LINE

2682

ELECTROLYTIC ZINC CO. OF A'SIA. LTD.

PROJECT: MT. BLACK | TAS.

TR-1631

GEOCHEMISTRY - Pb / Zn

120284

2683

FARM CREEK LINES

SCALE: 1:5000	Survey: J.M.	Revised:	
Reference:	Date: Feb 1979	REF. NO.	
Drawn: R.P.T.	Checked:	A0-504-0031	

Pb. > 80ppm; 51 - 80ppm; 36 - 50ppm; 8 - 35ppm; 0 - 7ppm

Zn. > 135ppm; 81 - 135ppm; 41 - 80 ppm; 11 - 40ppm; 0 - 10 ppm.

5 cm

E L 1/62

5,386 000 N

5,385 000 N

5,384 000 N

5,383 000 N

5,382 000 N

390 000E

389 000 E

388 000 E

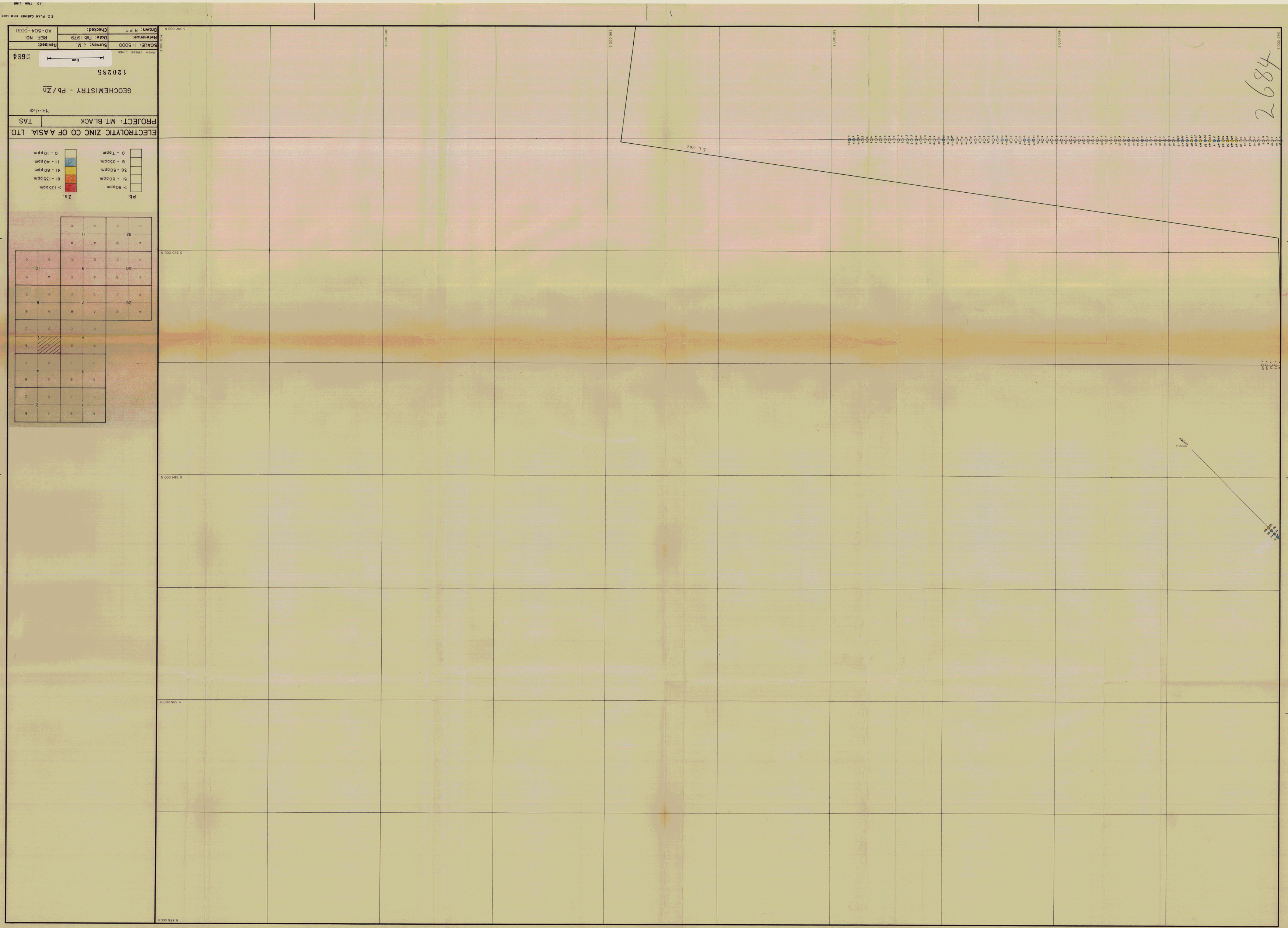
387 000 E

386 000 E

385 000 E

2683

E Z PLAN CABINET TRIM LINE



ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.
PROJECT: MT. BLACK
TAS.
GEOCHEMISTRY - Pb/Zn
120285
2684
SCALE: 1:5000
Survey: J.M.
Reference:
Date: Feb 1979
Drawn: R.P.T.
Checked:
Revised:
REF. NO.
AO-504-0031
Pb.
> 80ppm
51 - 80ppm
36 - 50ppm
8 - 35ppm
0 - 7ppm
Zn.
> 135ppm
81 - 135ppm
41 - 80ppm
11 - 40ppm
0 - 10ppm
E.L. 1/62
2684

ELECTROLYTIC ZINC CO. OF A'SIA. LTD.

PROJECT: MT. BLACK | TAS.

120286

GEOCHEMISTRY - Cu/Fe

FARM CREEK LINES

SCALE: 1:5000 | Survey: J.M. | Revised:

Reference: | Date: Feb 1979 | REF. NO. A0-504-0032

Drawn: R.P.T. | Checked:

2685

Cu.
0 - 7 p.p.m.
8 - 30 p.p.m.
31 - 50 p.p.m.
> 50 p.p.m.

5 cm

E.Z PLAN CABINET TRIM LINE

5 386 000 N
5 385 000 N
5 384 000 N
5 383 000 N
5 382 000 N

389 000 E
388 000 E
387 000 E
386 000 E
385 000 E

E.L. 1/62

BOCO GRID

FARM CREEK GRID

STAKED E. LINE HAGEN

2685

NOTES

1. Relative positions of E.Z.'s Silver Falls Extension Grid and Aberfoyle's Silver Falls Grid have been determined by chain and compass survey.
2. E.Z. soil samples have been taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.
3. E.Z. litter samples (A_0 horizon) were washed & analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric / nitric acid attack.

ABERFOYLE SILVER FALLS GRID

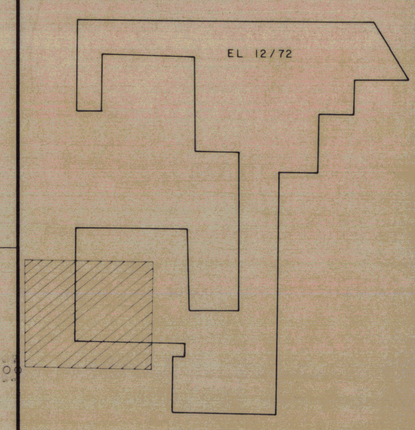
SILVER FALLS EXTENSION GRID

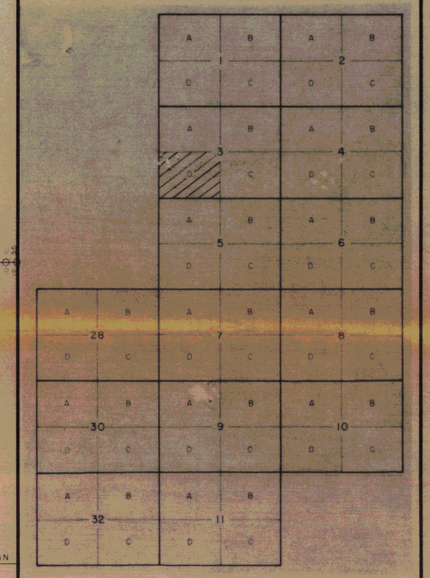
NORTH PINNACLES GRID

E L 12/72

5,390,000 mN
5,389,000 mN
5,388,000 mN
5,387,000 mN
5,386,000 mN

370,000 mE
375,000 mE
377,000 mE
379,000 mE
380,000 mE





LITTER SOIL

1000 p.p.m. Pb.
500
200

5 cm

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD.

PROJECT: BULGOBAC EL. 12/72 TAS.

79-1101

SOIL GEOCHEMISTRY

Pb / Zn

120287

2686

PINNACLES NORTH & SILVER FALLS EXTENSION GRIDS

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: 5/4/79	REF. NO.
Drawn: W.M., R.P.T.	Checked:	AO - 521 - 0024

E.Z. PLAN CABINET TRIM LINE

AO TRIM LINE

2686

NOTES:

1. Relative positions of E.Z.'s Silver Falls Extension Grid and Abertoyle's Silver Falls Grid have been determined by chain and compass survey.

2. E.Z. soil samples have been taken at nominal "C" horizon and analyzed by A.A.S. (Geochem) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.

3. E.Z. litter samples (A_0 horizon) were washed & analyzed by A.A.S. (Geochem) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric / nitric acid attack.

SILVER FALLS EXTENSION GRID

ABERFOYLE SILVER FALLS GRID

NORTH PINNACLES GRID

E.L. 12/72

5,390,000 mN
5,389,000 mN
5,388,000 mN
5,387,000 mN
5,386,000 mN

376,000 mE
376,000 mE
377,000 mE
378,000 mE
379,000 mE
380,000 mE

EL 12/72

1 2 3 4 5 6 7 8 26 9 10 30 11 32

LETTER SOIL

1000 p.p.m. Zn.
500
200

5 cm

ELECTROLYTIC ZINC CO. OF A'SIA. LTD.

PROJECT: BULGOBAC EL. 12/72 | TAS.

120288

SOIL GEOCHEMISTRY

Pb / Zn

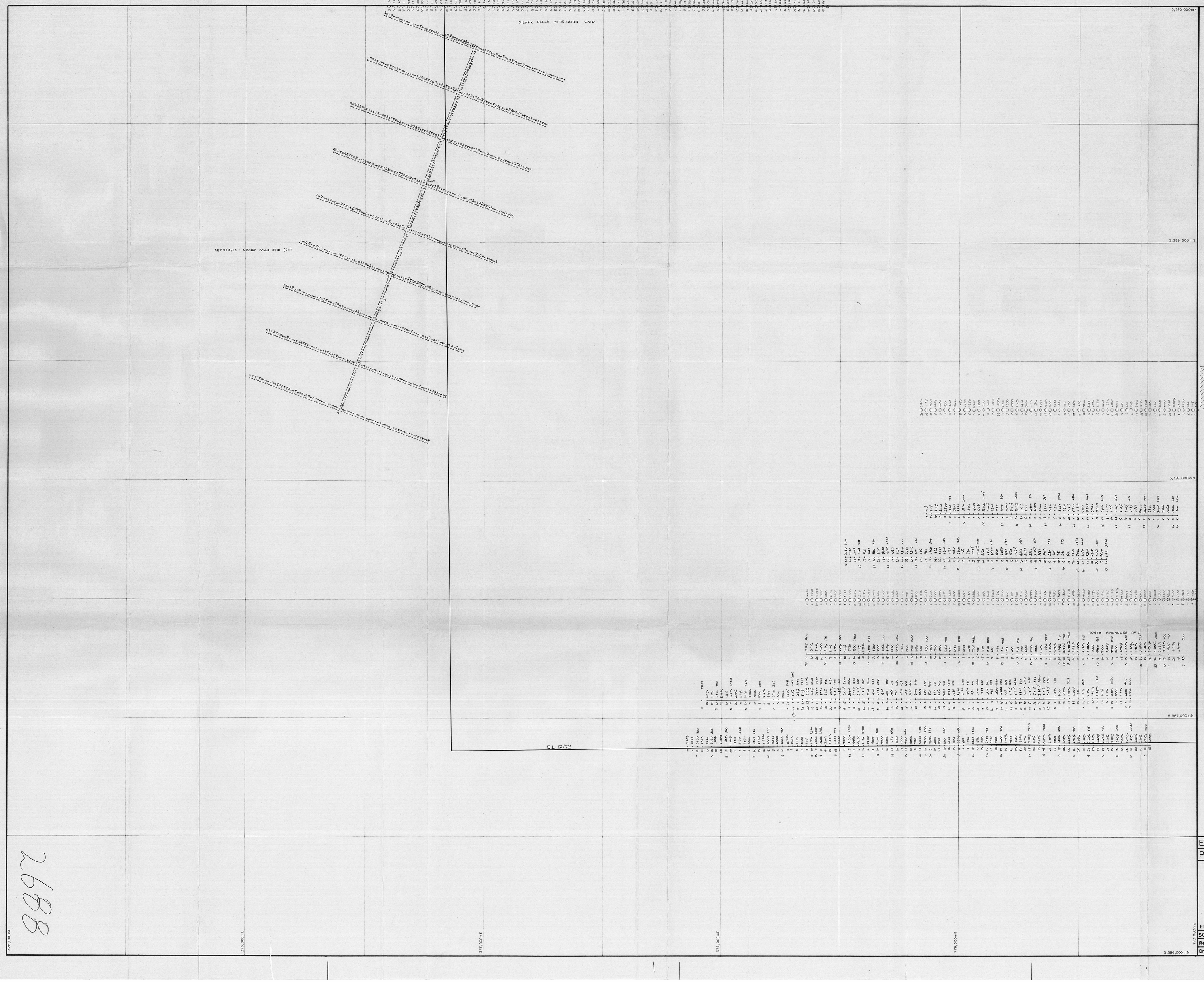
PINNACLES NORTH & SILVER FALLS EXTENSION GRIDS

SCALE: 1 5000	Survey: J.M.	Revised:
Reference:	Date: 5/4/79	REF. NO.
Drawn: W.M., R.P.T.	Checked:	AO - 521 - 0024

2687

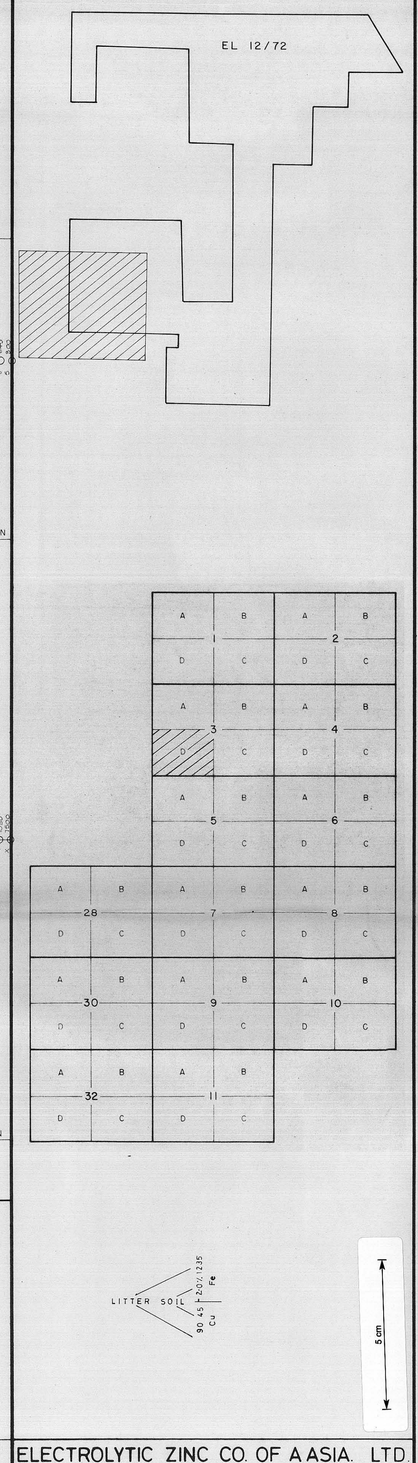
E.Z. PLAN CABINET TRIM LINE

A0 TRIM LINE



NOTES:

1. Relative positions of E.Z.'s Silver Falls Extension Grid and Aberfoyle's Silver Falls Grid have been determined by chain and compass survey.
2. E.Z. soil samples have been taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.
3. E.Z. litter samples (A_0 horizon) were washed & analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric / nitric acid attack.
4. Aberfoyle soil samples have been taken at nominal "C" horizon and were analyzed by A.A.S. (Geochem.) for Pb, Zn & Cu.
5. Results in P.P.M. unless otherwise stated.



ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: BULGOBAC EL. 12/72 | TAS.

120289 79-1401

SOIL GEOCHEMISTRY

Cu/Fe

2688

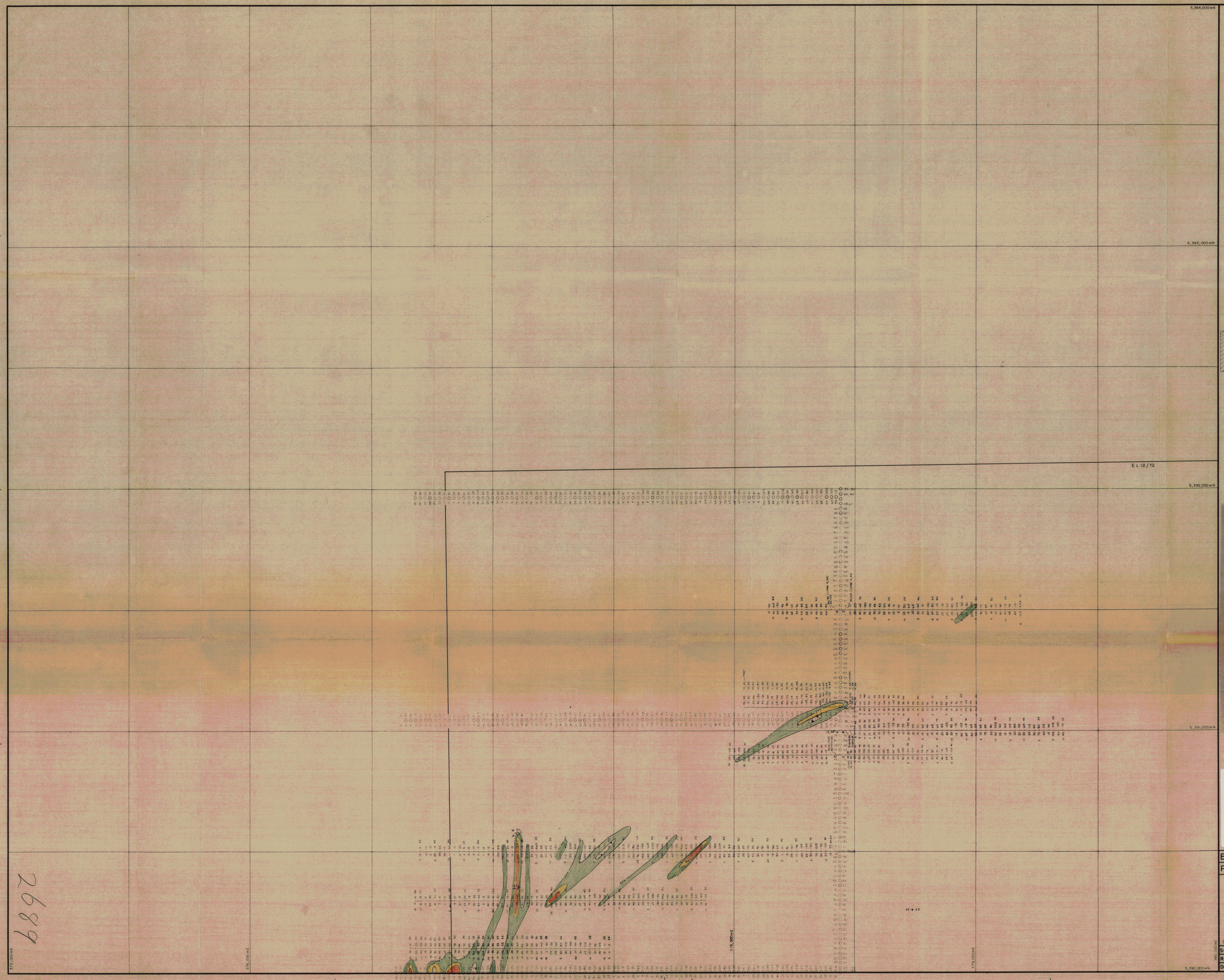
PINNACLES NORTH & SILVER FALLS EXTENSION GRIDS

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: 5/4/79	REF. NO.
Drawn: W.M., R.P.T.	Checked:	AO - 521 - 0025

E Z PLAN CABINET TRIM LINE

AO TRIM LINE

2688

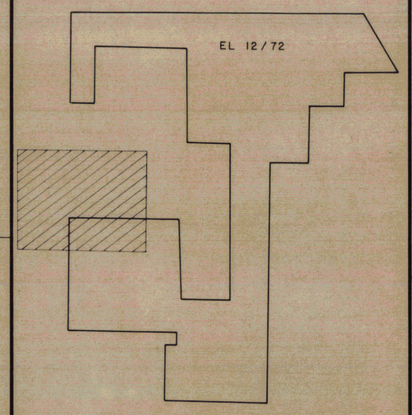


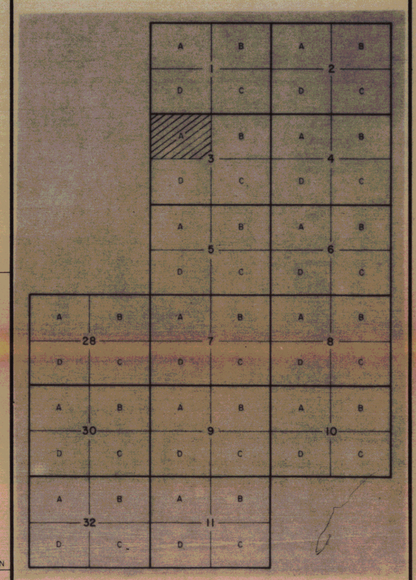
NOTES:

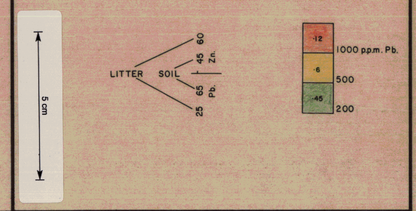
1. E.Z. soil samples have been taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.

2. E.Z. litter samples (A_0 horizon) were washed & analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric/nitric acid attack.

3. Results in P.P.M. unless otherwise stated.







ELECTROLYTIC ZINC CO. OF A ASIA. LTD.

PROJECT: BULGOBAC EL.12/72 | TAS.

120290 79-1401

SOIL GEOCHEMISTRY

Pb / Zn

SILVER FALLS EXTENSION GRID 2689

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: 5/4/79	REF. NO.
Drawn: W.M., R.P.T.	Checked:	AO - 521 - 0026

E.Z. PLAN CABINET TRIM LINE

AO TRIM LINE

2689

NOTES

1. E Z soil samples have been taken at nominal "C" horizon depth analyzed by A A S (Geochem.) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.
2. E Z litter samples (A_0 horizon) were washed & analyzed by A A S (Geochem.) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric/nitric acid attack.
3. Results in P P M unless otherwise stated.

EL 12/72

1000 p.p.m. Zn
500
200

LITTER
SOIL

5 cm

ELECTROLYTIC ZINC CO. OF A'SIA. LTD.

PROJECT: BULGOBAC EL 12/72 TAS.

79-1691

120291

SOIL GEOCHEMISTRY

Pb / Zn

L 2690

SILVER FALLS EXTENSION GRID

SCALE: 1: 5000	Survey: J M
Reference:	Date: 5/4/79
Drawn: W.M. RPT	Checked:

Revised:

REF NO

A0 - 521 - 0026

E Z PLAN CABINET TRIM LINE

A0 TRIM LINE

5,394,000mN
5,393,000mN
5,392,000mN
5,391,000mN
5,390,000mN
E L 12/72
578,000mE
579,000mE
580,000mE
581,000mE

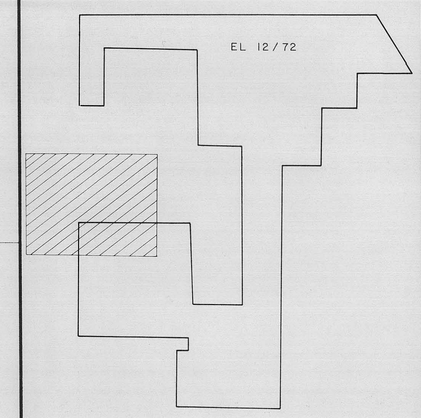
2690

NOTES:

1. E.Z. soil samples have been taken at nominal "C" horizon and analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after perchloric / nitric acid attack.

2. E.Z. litter samples (A_0 horizon) were washed & analyzed by A.A.S. (Geochem.) for Pb, Zn, Cu, Fe & Mn after wet ash perchloric / nitric acid attack.

3. Results in P.P.M. unless otherwise stated.



5,394,000 mN

5,393,000 mN

E.L. 12/72

5,392,000 mN

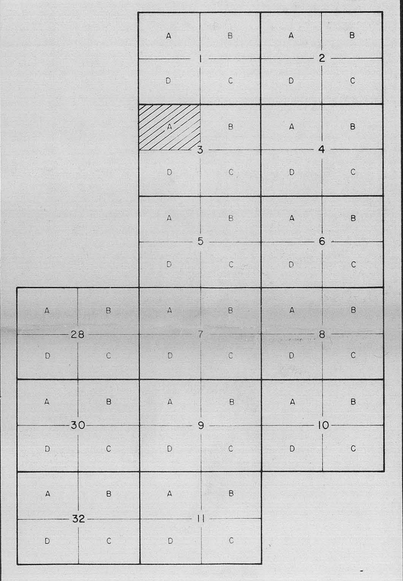
5,391,000 mN

5,390,000 mN

376,000 mE

378,000 mE

380,000 mE



5cm

ELECTROLYTIC ZINC CO. OF A'ASIA. LTD

PROJECT: BULGOBAC EL.12/72 | TAS.

120292

SOIL GEOCHEMISTRY

Cu / Fe

SILVER FALLS EXTENSION GRID 2691

SCALE: 1:5000	Survey: J.M.	Revised:
Reference:	Date: 5/4/79	REF. NO.
Drawn: W.M., R.P.T.	Checked:	AO - 521 - 0027

E.Z. PLAN CABINET TRIM LINE

A0 TRIM LINE