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OUTOKUMPU EXPLORATION AUSTRALIA PTY LIMITED

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ANNUAL REPORT TO JULY 20, 1989
EL 14/85, MT CATTLEY, NW TASMANIA
Summary of Results and Interpretations
1988-89 Exploration Program
VOLUME 1 OF 2

For: Outokumpu Exploration Australia Pty Limited
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Date: 26th June, 1989

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1. INTRODUCTION

This report summarises the results obtained and interpretation derived from the 1988-89 program of TEM geophysical and diamond drilling at Mt Cattley EL 14/85.

EL 14/85 was granted to Pancontinental Mining Limited in August 1985. Since July 1988, Outokumpu Exploration Australia Pty Limited has operated the project on behalf of a Joint Venture between the two companies.

The original objective for the exploration program was for polymetallic base metal/precious metal volcanogenic massive sulphide (VMS) deposits of the Que River, Hellyer type.

The tenement is centred about 12 km NNE and approximately along strike from the Hellyer deposit. It was considered likely that stratigraphic equivalents of the Hellyer - Que River mine sequence could exist within EL 14/85 under a variable thickness of Tertiary basalt cover (Figure 1).

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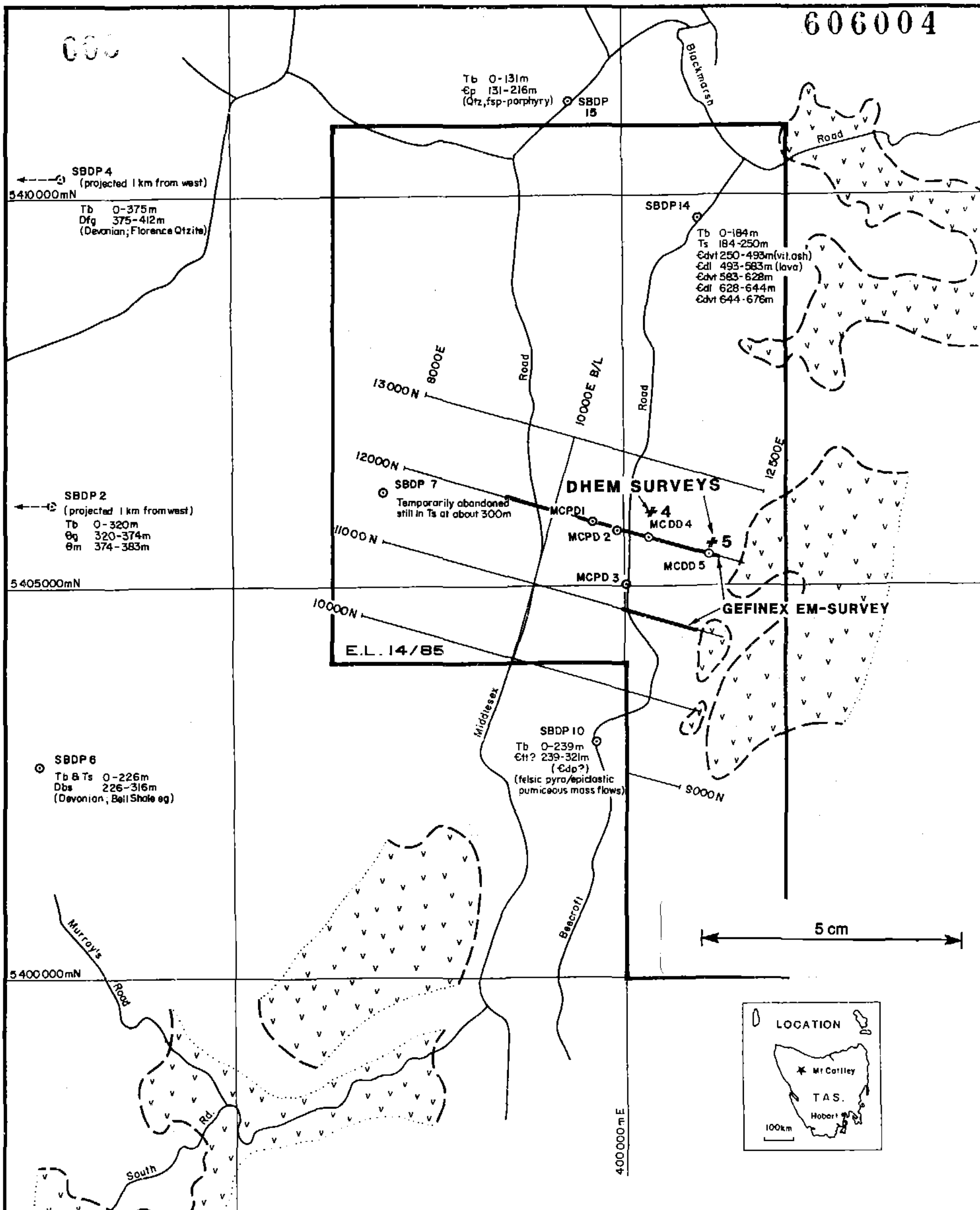

LEGEND

- Sub-Basalt window
- SBDP 4 ⊙ Department of Mines Drill Hole
- MCPD2 ⊙ Pancontinental Drill Hole
- MCDD 4 ⊙ Outokumpu Drill Hole
- GEFINEX EM Survey

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MT. CATTLEY PROJECT
E.L. 14/85 - TASMANIA
LOCATION

0 1000 2000 3000
metres

Compiled: K.O.A.	Date: March, 1989	Dwg. No.: M41-11-1
Report No.: R41-11	Map Ref.: SK 55-3	FIGURE 1

Ref: OUT/MG89/01

2. SUMMARY AND CONCLUSIONS

Diamond drill testing of two Gefinex 400S EM anomalies in EL 14/85 near Mt Cattley has failed to intersect significant mineralization. Subsequent down hole EM37 surveys indicate that both holes passed close to or through formation conductors which probably are the sources for the Gefinex anomalies. In MCDD 4 the conductor is interpreted to be a layer of conductive clays in sediments near the base of the Tertiary cover. In hole MCDD 5 the conductive source is interpreted to be a 30m thick unit of pyritic black siltstone.

A detailed geochemical study of andesitic rocks from previous drill holes MCPD 2 and 3 has shown marked compositional similarities to the footwall andesite - basalt sequence of the Que - Hellyer volcanics and strongly supports a direct time and stratigraphic correlation.

Oriented core observations from MCDD's 4 and 5, however, have contributed to interpretation of a structural model which implies that the Mt Cattley andesites are considerably stratigraphically higher and younger than the Que - Hellyer volcanics.

Further proposals for stratigraphic drilling, to elucidate the structural and stratigraphic setting of these andesites, should be considered in the light of past and anticipated future difficulties with structural interpretation and TEM surveying/ interpretation beneath a substantial cover of Tertiary basalt and associated sediments.

3. PRECIS OF 1988-89 EXPLORATION PROGRAM AND RESULTS ACHIEVED

The 1988-89 exploration program for EL 14/85 included (in chronologial sequence):

* A review of geological interpretation and previous geophysical data with recommendations given for further exploration. (Herrmann and Bishop, July 1988)

* A trial GEFINEX 400 S EM survey of 3.25 line km. (Hattula, 1988)

* Drilling of two diamond drill holes, MCDD's 4 and 5, to test two Gefinex EM anomalies interpreted on line 12000N. (Herrmann, January 1989)

* Downhole EM 37 logging and interpretation of both drill holes. (Bishop, June 1989)

* Petrographic and geochemical studies of core samples from MCPD's 1,2 and 3 and MCDD's 4,5. (Crawford, April 1989)

The results and conclusions derived from these works are briefly stated below but the reader is referred to the references cited above for more comprehensive detail.

The review of July 1988 looked at the exploration potential of EL 14/85 from two slightly different aspects. The geological aspect was based on the unexpected previous intersection of intersecting mafic volcanics, possibly analogous to the Que - Hellyer volcanics, in MCPD's 1, 2, 3 and that these might warrant further "stratigraphic" drilling to assess their structural and stratigraphic setting. In the absence of sufficient structural data, suggestions were provided for a program involving the drilling of several short sub Tertiary basalt holes OR redrilling of MCPD 1 to obtain direction of dip information and, based on that, drilling a single deep stratigraphic hole.

The geophysical aspect was based on the conclusions, independently determined by three geophysicists, that the previous sirotem EM37 surveys over the southern and eastern parts of the licence had been effective but had not been successful in defining conductive anomalies which could be interpreted to represent massive sulphide deposits. Therefore, it was argued those areas already surveyed by surface TEM had been downgraded with respect to VMS mineralization and that future exploration should involve the extension of surface EM37 coverage, especially northwards and elsewhere that the Tertiary cover was considered to be sufficiently thin, on the basis that the location and geological environment was deemed favourable and, as yet, unexplored due to the cover.

Nevertheless, the advent of GEFINEX 400S EM, with potentially greater depth capability than the previous TEM methods, led to its application in a trial survey over the MCPD 1, 2, 3 area as a tertiary check on the validity of the above mentioned geophysical conclusions.

Gefinex EM Survey

The outcome was that (despite some doubts about the reliability of the Gefinex data due to weather related equipment malfunctions and the applicability of horizontally layered earth modelling programs to the folded basement sequence) two Gefinex conductivity anomalies were interpreted on survey line 12000N.

Gefinex Anomaly 1 was interpreted as a sub-horizontal lense shaped body of upto 40m thickness of about 220m lateral width centred at about 180m vertically below 11300E/12000N and having a low conductivity x thickness product.

Gefinex Anomaly 2 was interpreted as a less extensive, moderately west dipping lense of about 20m thickness centred at about 180m below 12100E/12000N.

MCDD 4 was drilled to test Gefinex Anomaly 1. After penetrating the base of Tertiary cover, at about 58m below surface, this hole intersected a steeply south west dipping and facing basement sequence comprising turbiditic micaceous greywacke/siltstone alternating with felsic pyroclastics, epiclastics and mass flow type jumbled breccias combining these lithotypes. The rocks were found to be not significantly hydrothermally altered or mineralized and the source of the Gefinex anomaly was not apparent in the core.

MCDD 5 was drilled to test Gefinex anomaly 2. It penetrated the base of Tertiary cover at about 88m below surface and then intersected a moderately north westerly dipping and facing epiclastic/turbiditic sedimentary basement sequence comprising a thick graded felsic mass flow deposit, underlain by a 30m thick unit of pyritic black siltstone in turn underlain by an at least 50m thick unit of felsic vitric tuffaceous/cherty siltstones. Apart from a few percent of pyrite in the black siltstone unit the sequence was not found to contain significant sulphide mineralisation. The Gefinex 2 anomaly was tentatively attributed to the presence of the black siltstone unit.

Downhole EM Survey

Downhole EM37 logging of both holes was subsequently carried out and the results interpreted by Dr. J.Bishop.

For MCDD 4, DHEM profiles for four of the five transmitting loops used in the survey, indicated the presence of a small, off hole, steeply dipping?, strong conductor with responses recorded at about 65m downhole corresponding approximately to the base of the Tertiary cover. The source, although not precisely located, was attributed to a thin layer of unconsolidated lignitic sands at the base of the Tertiary basalt. Although the indicated depth is much shallower than that interpreted for Gefinex Anomaly 1, Dr Bishop concluded that the two anomalies have the same source (at the base of the Tertiary cover) and that the depth discrepancy might be due to geometrical considerations and (inappropriate) modelling methods.

An apparent weak off hole response at about 170m downhole in profiles from transmitting loop 2 was not confirmed by subsequent loop configurations and was attributed to a spurious "self response" from the loop.

DHEM profiles for MCDD 5 indicate a weak anomaly approximating to the down hole position of the pyritic black siltstone unit confirming that the hole passed through a conductor at that depth. Although larger amplitude responses would have been expected in such a (presumably) extensive conductor, the interpretation is reasonably conclusive that Gefinex Anomaly 2 is attributable to the black siltstone unit and that there are no additional nearby off hole conductors.

Petrographic & Geochemical Study

The comprehensive petrographic and geochemical investigations undertaken by Dr. A.Crawford proceeded with the objective of elucidating relationships between volcanic rocks in the Mt Cattley drill holes and identifying possible correlations with other volcanic suites in the Mt Read Volcanics; particularly the Que - Hellyer volcanics.

The following conclusions were drawn;

* The pervasive sericite + carbonate alteration evident in the aphyric vesicular andesites from MCPD 2 is of considerably greater intensity than is "normal" for the low grade burial metamorphism typical of the Mount Read Volcanics and resembles

the alteration seen around the Que River massive sulphide deposit.

* Volcanic rocks from the other holes (MCPD 3, MCDD's 4, 5) display a more typical degree of low grade burial metamorphism.

* The porphyritic andesites and rhyodacite from MCPD 3 are clearly comagmatic. The prescence of FeTi oxides and apatite micro phenocrysts in pumiceous tuffs of MCDD 4 also suggests a magmatic link with extrusives of MCPD 3. However, markedly different immobile element ratios and REE levels indicate that the MCPD 2 andesites are not comagmatic with those of MCPD 3.

* There is a strong geochemical correlation between the Mt Cattley volcanics in MCPD's 2 and 3 and the Que - Hellyer <u>footwall</u> andesites.

* There is strong evidence for a progressive enrichment in LREE and P_2O_5 in the Mount Read Volcanic lavas with time such that the stratigraphically uppermost are the most enriched. The Mt Cattley extrusives do not show this high level of enrichment and are therefore interpreted to pre-date the Hellyer (hanging wall) basalts and are time correlates of the Que - Hellyer footwall andesites.

* The turbiditic sediments of MCPD1 and MCDD's 4, 5 are composed largely of quartz, mica and lithic grains of quartzite and pelitic schist of a pelitic metasedimentary, presumably Pre Cambrian, provenance. Some of the felsic epiclastics in MCDD's 4 and 5 contain a minor proportion of similar materials. The cleaner quartz rich greywackes of MCPD 1 and MCDD 4 are similar in character and, in turn, are virtually identical to the Animal Creek Creywacke which is the basal unit of the Dundas Group near Mt Charter.

Dr Crawford's over all conclusions were that the Mt Cattley andesites are geochemical, statigraphic and time correlates of the <u>footwall</u> andesite sequence of the Que - Hellyer Volcanics and do not represent a younger stratigraphically higher development of mafic volcanism in the Southwell Sub Group of the (upper) Dundas Group.

4. DISCUSSION OF RESULTS

The application of Gefinex 400S EM, albeit on a trial basis, has not been an outstanding success. The two conductivity anomalies interpreted and tested by drilling have both been attributed to formational sources. The low degree of agreement between interpreted models and intersected geology/DHEM and the apparant inability of Gefinex to discriminate between these formation sources and possible massive sulphide bodies does not suggest that this method provides a solution to the problem of sub basalt exploration in the Mt Cattley area.

Indeed, the general "fuzziness" of the relationships between the Gefinex interpretation, known geology and DHEM results highlights the fundamental difficulty of the task. Although the exploration concept seems sound and some encouraging results have been fortuitously achieved, the "findability" is very low because of the lack of a method of providing precise drilling targets beneath a significant thickness of Tertiary cover in basement rocks of which the geology and structure is virtually unpredictable.

At this, post Gefinex, stage Dr. Bishop's geophysical conclusions of July 1988 are as valid as ever and if anything Gefinex has put another small nail in the coffin of prospectivity for the area already covered by EM 37, including the environs of MCPD 2 and 3.

The combined geophysical evidence suggests that it's time to extend the TEM coverage northwards and elsewhere in areas of thin Tertiary cover on the basis that the Mt Cattley area seems to be a fairly good geological "address" but remains largely unexplored.

However, this course would take us into relatively unknown or relatively uninspiring geological territory. Northwards, the exposures at North Cobbers Road, in basement windows of the Leven and Medway Rivers and in SBPD 14, the basement sequence seems to comprise fairly unpromising Southwell Sub Group type felsic vitric tuffs and greywackes.

On the basis of a possible lithostratigraphic correlation, now strongly supported by Dr. Crawford's findings, between the Mt Cattley andesites and the Que - Hellyer volcanics the geological indications are that the former require follow up.

Given the Tertiary cover, this proposal has a wildcattish character and would probably require a considerable persistance and drilling budget for success.

Results from core orientation measurements in MCDD's 4 and 5 allow a further improvement in the gross structural interpretation. The moderate NW dips in MCDD 5, though slightly more northerly than expected, support the previous interpretation that there is an anticlinal axis just east of the Leven River (at the latitude of 12000 N) such that dips and facing west of the river are generally westward; the sequence intersected in MCDD 5 is also broadly similar to that observed along the Leven River, effectively eliminating the possibility that there is a major structural break between the hole and the river exposures.

The basement sequence in MCDD 4 dips and faces to the southwest at around 55 - 60 degrees and the westerly facing tends to suggest that this location is still on the west limb of the Leven River anticline. This southwesterly dip was, nevertheless, something of a surprise and is contrary to most of my previous structural speculation, excepting the low ranking cross-section 3 of Herrmann 1986. It seems to imply that MCDD 4 might be close to the hinge of a SSW trending synclinal axis which is fairly confidently interpreted from numerous structural observation in the sub basalt windows north of Cobbers Road and near Black Marsh Road. If so, this syncline at line 12000N appears to have a substantial southerly plunge.

The simplest interpretation is that the andesites of MCPD 2 and 3 lie up sequence from MCDD 4. If we pursue this simplest interpretation a little further it becomes apparent that MCDD 1 holds the structural key to predicting the distribution of the andesitic unit(s).

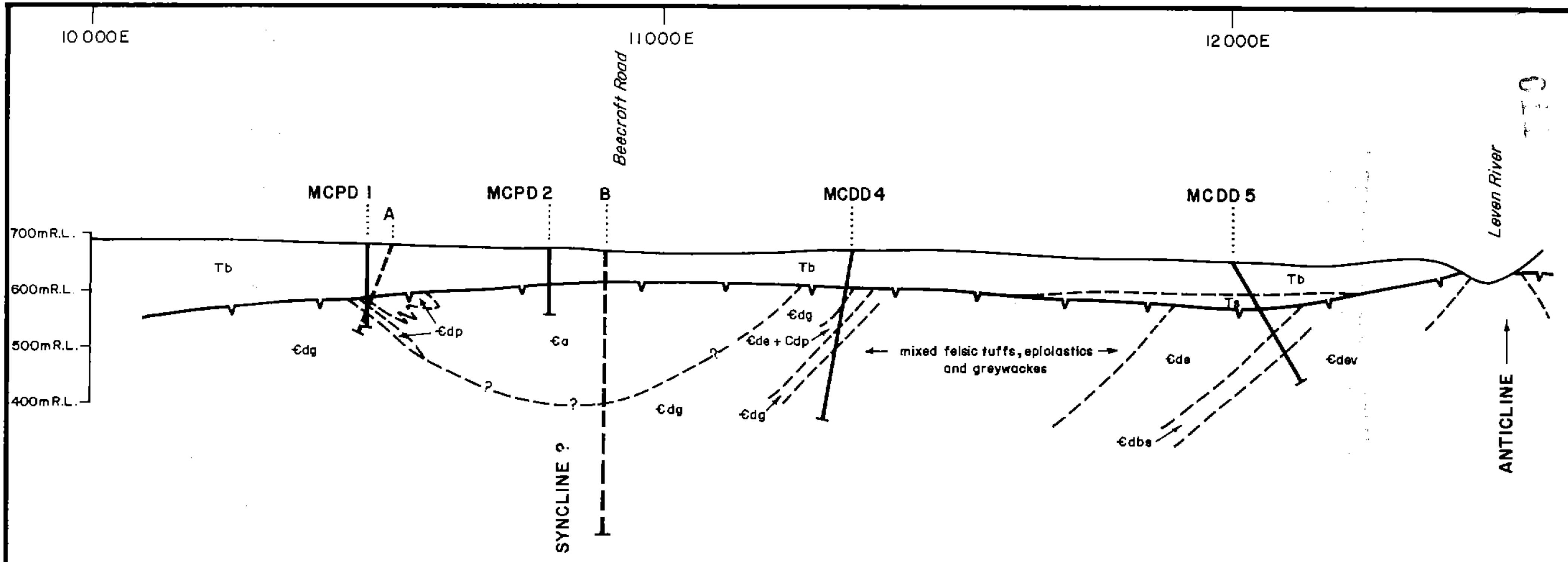
MCPD 1 provides three important points of evidence:

(i) Turbiditic greywackes at the bottom of the hole dip at about 45 and face up the hole.

(ii) These greywackes are petrographically similar to several units intersected in MCDD 4 and, like the latter, are associated with felsic pumiceous/lithic tuffs.

(iii) Weathered vesicular andesite apparently similar to those of MCPD 2 overlie the greywacke in MCPD 1. Assuming the simplest (NE) strike trend the sediments in MCPD 1 can dip either to south east as in Fig 2 or to the north west as in Fig 3.

On the basis that the sequence on the Cradle Mt Link Road near Murrays Plain Road faces generally eastwards and the presence of a synclinal axis near North Cobbers Road, I favour the speculation presented in Figure 2.



GEOLOGICAL REFERENCE

€a	Andesite
€dg	Turbiditic greywacke and siltstone
€dp	Pumiceous felsic tuffs
€de	Felsic epiclastics and mass flow breccias
€dbs	Black siltstone/shale
€dev	Fine grained cherty felsic tuffs (?)

5 cm

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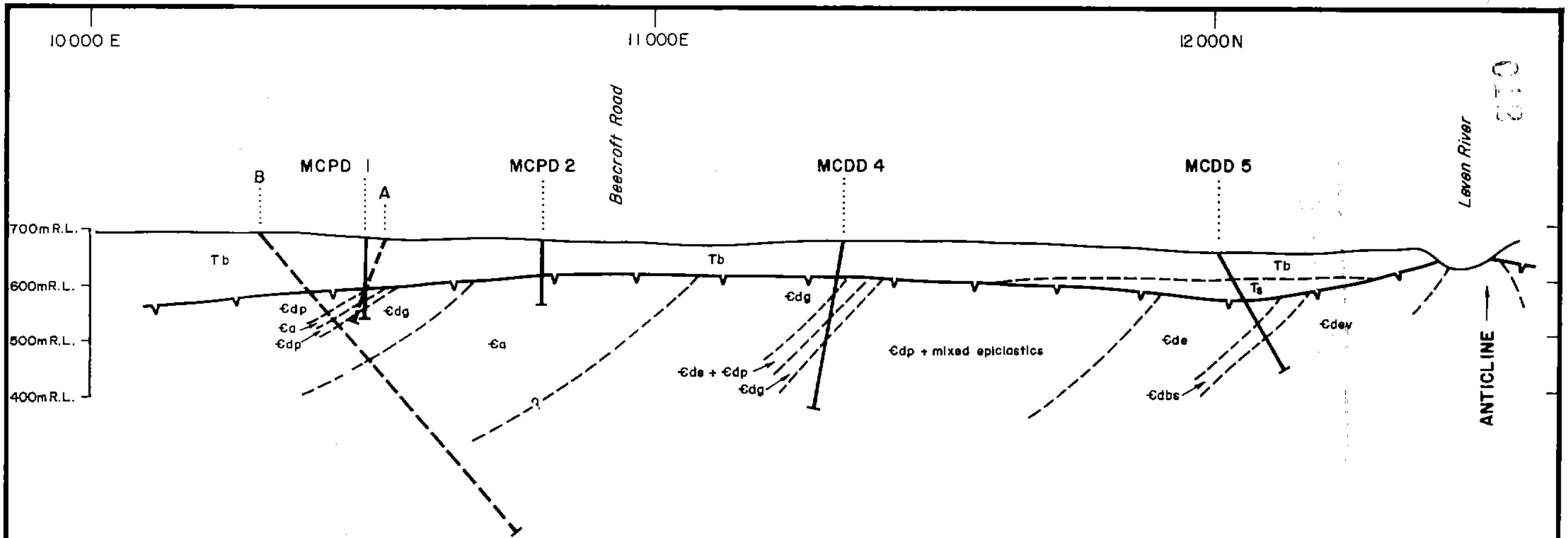
MT.CATTLEY PROJECT
E.L. 14/85 – TASMANIA
SPECULATIVE CROSS SECTION A
12000 N

SCALE 1:10 000
0 100 200 300 400 500
metres

Compiled: W.H.	Date: June, 1989	Dwg. No.: M41·11·2
Drawn: R.J.V.	Report No.: R41·11	FIGURE 2

606012



GEOLOGICAL REFERENCE

Єa	Andesite
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Єde	Felsic epiclastics and mass flow breccias
Єdbs	Black siltstone/shale
Єdev	Fine grained cherty felsic tuffs (?)

5 cm

outokumpu
EXPLORATION AUSTRALIA PTY. LIMITED

MT.CATTLEY PROJECT
E.L. 14/85 – TASMANIA
SPECULATIVE CROSS SECTION B
12000 N

SCALE 1:10 000
0 100 200 300 400 500
metres

Compiled.: W.H.	Date: June, 1989	Dwg.No.: M41·11·3
Drawn: R.J.V.	Report No.: R41·11	**FIGURE 3**

606013

C13

If this is so, then the andesitic volcanics in MCPD's 1, 2, 3 may have fairly restricted synclinal extent in EL 14/85 and plunge fairly steeply to the south west.

In this interpretation, if Dr Crawford's correlations are correct, then the VMS hosting "mixed sequence" of the Que - Hellyer volcanics has a very restricted extent in EL 14/85 close to the southern boundary of the licence.

The alternative, as in Figure 3, allows a little more hope that the ore hosting "mixed sequence" lies up sequence to the west under an increasing depth of Tertiary basalt cover, near Middlesex Road.

However, this simplest interpretation (that MCPD andesites are up sequence from MCDD 4) conflicts with Dr. Crawford's correlation with the Que - Hellyer volcanics. The basis for the structural interpretation is that rocks overlying the Que - Hellyer volcanics and Que River Shale in the Cradle Mountain Link Road area 2 km north east of Hellyer comprise a sequence of pumiceous felsic tuffs, felsic epiclastic mass flows and greywackes known as the Southwell Sub Group. These generally dip and face eastwards and are semi-conformably overlain to the east by Tyndall Group and Denison Group correlates.

The sequence exposed in the Mount Cattley and Leven River sub basalt windows is lithologically similar to the Southwell Subgroup and (east of the Leven River anticline) are overlain by east dipping Tyndall and Denison correlates. These lithological correlates west of the Leven River anticline between the river and MCDD 4, dip and face westerly. If the MCPD andesites are up sequence from MCDD 4 then they must be substantially stratigraphically higher than the Que - Hellyer volcanics. My estimate, based on interpretation of the structural information, is that they are about 1500 - 2000 metres stratigraphically above the Que - Hellyer volcanics.

In order to accomodate the fairly convincing geochemical correlation between Mt Cattley and Que - Hellyer footwall andesites we are forced to consider the possibility of a major structural break between the Southwell Sub Group correlates of MCDD 4 and SBPD 10 and the andesites of MCPD's 2 and 3. This is a possibility but there is no other evidence for it. The hypothetical structure is also spatially quite constrained. Only 530m separates the collars of MCPD 2 and MCDD 4 and the "corridor" between MCPD's 2 and 3 (on the west) and MCDD 4 and SBPD 10 (on the east) is only 200m wide.

To summarize the above discussion it may be stated that the andesitic rocks in MCPD's 1, 2, 3 have some exploration potential based on alternative interpretations. One interpretation is based on a fairly simple structural model and implies that the Mt Cattley andesites are considerably younger and stratigraphically higher than the VMS hosting Que - Hellyer volcanics. Without this time-stratigraphic correlation the prospectivity is somewhat reduced but not entirely eliminated since there appears to be a close petrological similarity and perhaps ore formation was controlled by the petrogenetic/tectonic environment and was not time specific.

The alternative interpretation suggests that the Mt Cattley andesites are time-stratigraphic correlates of the Que - Hellyer footwall sequence and that the local structure is complex and still largely unknown.

Further stratigraphic drilling would (one hopes) elucidate the real situation.

A short 160m stratigraphic diamond drill hole collared at about 40m east of MCPD 1 and inclined at 70 degrees to the west should intersect the well bedded greywacke unit in the lower part of MCPD 1.

Core orientation observations from this unit would allow estimation of the local dip and from that a reasonable prediction of the extent and orientation of the andesitic rocks. From that information a single stratigraphic drillhole of 500-700m depth could be designed to intersect the andesitic sequence. The likely possibilities for location of these stratigraphic holes are shown on Figures 2 and 3 labelled MCDD "A" and "B".

From recent informal discussions with Mr Andrew McNeill of Aberfoyle Exploration, I learned that Aberfoyle has drilled two sub basalt holes on Middlesex Road immediately at and about 1 km south of the boundary of EL 14/85 respectively (figure 4).

These holes, entitled Mac 22 and Mac 20 respectively, both intersected felsic pumiceous tuffs and epiclastics with subordinate interbedded micaceous wackes considered to be typical of the Southwell Sub Group. Some of the fragmental felsic rocks bear considerable resemblance to those of Mines Department hole SBPD 10 on Beecroft Road to the east. Apparently some of the fragmental rocks carry a considerable proportion of basaltic lava fragments. Oriented cores from Mac 20 indicate a dip of 40-50 degrees to the southwest which is consistent with the NW strike trends of tight D2?

folds observed in Denison Group rocks a few kilometres to the south west.

It is also consistent with the dip in MCDD 4 and leads me to speculate that the structure in this area is dominated by these NW complications and not by straightforward D1? NE trends as previously implied by structures in sub basalt windows along the eastern boundary of EL 14/85. This really puts the cat among the structural pigeons and the true situation may be quite different and more complex than I've speculated in Figures 2 and 3.

Oriented core from a future hole intersecting the bedded wackes at the bottom of MCPD 1 would go some way to clarifying the local structure. However the indications from Mac 20, 22, and SBPD 10 suggest that there is not much room left for a major occurrence of andesitic volcanics between Beecroft and Middlesex Road immediately south of EL 14/85.

020

REFERENCES

Bishop J.R., June 1989	Interpretation of Downhole EM Surveys at Mt Cattley EL 14/85 For: Outokumpu Exploration Australia P/L
Crawford A.J., April 1989	Geochemistry and correlation of Lavas in Mt Cattley Drill Holes MCDD 2 and 3, EL 14/85 For: Outokumpu Exploration Australia P/L
Hattula A., December 1988	Multifrequency EM soundings in the Mt Cattley (Tas) and Berserker (Qld) Areas For: Outokumpu Exploration Australia P/L
Herrmann W., 1986	Report on Sub Basalt Drilling Program at Mt Cattley EL 14/85. For:Pancontinental Mining Ltd
Herrmann W. and Bishop J.R., July 1988	Memo: Mt Cattley EL 14/85 Proposed Stratigraphic Drilling. (Memo to Outokumpu Exploration Australia P/L)
Herrmann W., January 1989	Report on Drill testing of two Gefinex EM Anomalies at Mt Cattley EL 14/85. For: Outokumpu Exploration Australia P/L.

LEGEND
MT CATTLEY - TWO HUMMOCKS AREA
CORRELATIONS OF DUNDAS GROUP AND TYNDALL GROUP
€tcst
Volcaniclastic sandstone and conglomerate with intercalated siltstone and minor crystal tuff. Correlate of Tyndall Group.
€dlt
Upper unit of flow banded felsic lava intercalated with vitric tuff and pumice-clast tuff.
€dp
Dominantly pumice-clast-bearing tuff and breccia (€dp). Some units of mass-flow tuff (€dmf), felsic lava (€dl) and greywacke-shale (€dg) indicated.
€dts
Mixed sequence of felsic tuff (including mass-flow units), greywacke, siltstone, vitric ash and minor felsic lava. Some units of mass-flow tuff (€dmf) and felsic quartz-phyric lava (€dl) indicated.
€dg
Dominantly micaceous greywacke and siltstone (€dg). Some units of vitric tuff (€dvt), mass flow tuff (€dmf) and a minor occurrence of mafic-intermediate lava (€dgl) indicated.
€dvt
Dominantly fine-grained vitric tuff with intercalated mass-flow tuff, shale and greywacke. Some units of greywacke-shale (€gd) and mass-flow tuff (€dmf) indicated. May be partly equivalent to other units, particularly €dts and €dp.
CAMBRIAN INTRUSIVE ROCKS
€p
Felsic porphyry, generally quartz-feldspar-phyric.
TERTIARY
Tb
Basalt.
DEVONIAN -SILURIAN
S-D
Eldon Group sedimentary sequence undifferentiated.
ORDOVICIAN
Ogl
Gordon Group limestone sequence undifferentiated.
EARLY ORDOVICIAN -LATE CAMBRIAN
€Oo
Siliciclastic conglomerate and minor sandstone of Owen Conglomerate (-Denison Group).
WEST OF HENTY FAULT ZONE
DUNDAS GROUP
€dt
Felsic tuff, generally quartz-feldspar-phyric, often well bedded, with pumice clasts in some cases.
EAST OF HENTY FAULT ZONE
TYNDALL GROUP CORRELATES
€p
Quartz-feldspar porphyry intrusive
€ps
Felsic intrusive, commonly spherulitic, feldspar-quartz-phyric.
€tc
Volcaniclastic conglomerate with minor sandstone and siltstone.
€tt €tl
Felsic tuff and agglomerate generally quartz-feldspar -phyric, with intercalations of felsic lava (€tl).
€ts
Interbedded lithicwacke and siltstone.
€t
Geological boundary - accurate or approximate.
Geological boundary - inferred or concealed.
Fault - accurate or approximate.
Axial surface trace of major anticline, syncline, with plunge where known.
E.L. 14/85
SBDP 15
SBDP 14
SBDP 7
SBDP 6
SBDP 10
MCPD 1
MCPD 2
MCPD 3
MCDD4
MCDD5
MAC 22
MAC 20
WATTLE PARK ROAD
BLACK MARSH ROAD
COBBER'S NORTH ROAD
MIDDLESEX ROAD
BEECROFT
CRADLE MOUNTAIN LINK ROAD
HENTY FAULT ZONE
HELLYER
QUE RIVER
QR-Shale
€Q-H volcs
TASMANIA
Queenstown
HOBART
5 cm
606018
Adapted from : Tasmanian Department of Mines Mount Read Volcanics Project (Maps 1, 7 and 8)
outokumpu
EXPLORATION AUSTRALIA PTY. LIMITED
HELLYER - MT.CATTLEY AREA
TASMANIA
GEOLOGICAL COMPILATION
SCALE 1:25000
0 500 1000 1500 2000
METRES
Compiled : W.Herrmann
Date: June, 1989
Dwg. No.: M41·11·4
Drawn: R.J.Voss
Report No.: R41·11
FIGURE 4

APPENDIX I

INTERPRETATION OF DOWNHOLE ELECTROMAGNETIC SURVEYS, MT CATTLEY (EL 14/85)

606020

MITRE GEOPHYSICS PTY LTD

MINERAL EXPLORATION AND ENGINEERING CONSULTANTS

BUGGS LANE ELLIOTT TASMANIA 7325 PHONE 004-363143

INTERPRETATION OF DOWNHOLE ELECTROMAGNETIC SURVEYS, MT CATTLEY (E.L. 14/85).

for

Outokumpu Exploration Australia Pty Ltd

by

Dr J.R. Bishop

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OUT/MG89/01
June, 1989

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SUMMMARY

Electromagnetic surveys have been carried out down two holes on E.L. 14/85 which were drilled to test two anomalies defined by a 'Gefinex-400s' EM survey. The results of the down-hole surveys have shown the source of the anomaly tested by MCDD4 to be a conductive layer in unconsolidated sediments at the base of the Tertiary basalt and the source of the anomaly tested by MCDD5 to be a pyritic black (graphitic?) siltstone.

INTRODUCTION

The Mt Cattley licence, E.L. 14/85 is held under a joint venture agreement between Pancontinental Mining and Outokumpu Exploration with the latter now operating as manager. The licence lies immediately along strike and to the north of Aberfoyle's 'Macintosh' licence which covers the Que River and Hellyer deposits.

This report presents the results. and an interpretation, of down-hole electromagnetic (DHEM) surveys down holes MCDD4 and MCDD5 which were both drilled, in December 1988, on 'Gefinex' EM anomalies.

EXPLORATION TARGETS AND GEOLOGICAL SETTING

The Mt Cattley region is predominantly covered by Tertiary basalt and until the discovery of the Hellyer deposit, had received little attention. In fact prior to pegging of the licence by Pancontinental in 1985, the area had not been subject to any significant exploration program. Mapping (in 1986) of a number of windows in the basalt, which were not indicated on the Mines Dept's regional maps, confirmed the presence of the Mt Read Volcanics host rocks. A recent interpretation of the geology using the logs from the five holes drilled by the JV partners plus data from the Mines Dept's Sub-basalt Drilling Project, is summarised in Herrmann (1989).

The prime target is for a similar deposit to Hellyer, which is a 15+ million tonne polymetallic massive sulphide deposit. Like Rosebery further to the south, Hellyer is dense, chargeable and a good, but not excellent, conductor with no magnetic response (see Bishop and Lewis, 1988).

EXPLORATION HISTORY

Following the initial mapping and stream sediment sampling (Herrmann, 1986), Sirotem soundings were conducted over five 1km - spaced lines to try and determine the thickness of basalt. The results were interpreted and an isopach map of basalt thickness produced (Wilson, 1986). Three holes, drilled to test the effectiveness of the survey, gave good agreement with the interpretation. Beneath the basalt, these holes intersected volcanics with similar assemblages to the andesitic and dacitic sequences around Que River - Hellyer.

In May, 1987 a fixed-loop EM37 survey was carried out over the area of thinner cover defined by the Sirotem survey. This data was interpreted by Lakanen (1987) who concluded that no sub-basalt conductors had been detected. However, a plan of weak responses, interpreted to be basalt edge effects or changes in basalt conductivity (Wilson, 1987), was drawn up and several zones indicated (Pancontinental drawing 36/E/4, which also shows the EM37 coverage.)

In October, 1988 the eastern ends of lines 11000N and 12000N were surved by Outokumpu's 'Gefinex 400s'. This is a multi frequency depth sounding EM system designed and built by Outokumpu. (It is similar in concept to Geoprobe's EMR-16 'Maxi-probe' and was specifically brought out from Finland for this and other areas held by Outokumpu.) The operation of the survey at Mt Cattley is well described by Herrmann (1989).

Hattula (1988) interpreted a highly conductive body at the eastern extremity of line 12000N; ie, beneath 12100E. A depth of 150m to 180m was indicated. Hattula also suggested that a "weak conductor may be located at a depth of 180m at 11300E". This response, since designated Anomaly 1, is not indicated on Hattula's interpretive cross-section and presumably had a low priority (the report does not present the data). The response at 12100E/12000N has been designated Anomaly 2 and diamond drill holes MCDD4 and* MCDD5 were designed to test anomalies 1 & 2 respectively. Figure 1 gives the location of the holes. Figure 2, by Herrmann, shows the two drill holes in section and plan with a summary of the geology superimposed on the interpreted Gefinex anomalies.

SURVEY DETAILS

The surveys were carried out in two stages. In early March 1989, hole MCDD4 was surveyed with two loops and hole MCDD5 with one loop. A possible deep-seated response was indicated in MCDD4 from loop 2 and this hole was re-surveyed with three different loop positions in late April 1989. The loops for both MCDD4 and MCDD5 were positioned parallel to strike (the two directions were orthogonal to each other) to aid the interpretation (see Figure 3). Geoterrex carried out all surveys using an EM37, with a nominal size of 150m x 150m for all loops. MCDD4 was read down to 290m (EOH at 301m) and MCDD5 to 238m (EOH at 245m). Steel casing was left down MCDD5 to about 112m: Figure 9a is the standard Geoterrex plot and Figure 9b shows the below casing data plotted on a logarithmic scale to detail the intermediate and late-time responses. Geoterrex plotted the first set of surveys at 1:1000 scale and the later ones at 1:2500. On the plots and in the text below, a particular profile is identified by the hole number followed by the loop number. Thus profile 4/3 is

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* Anomaly 1 was covered by the earlier EM37 survey which recorded a 'response' (as distinct from interpreting a possible anomaly) at ~11400E on 12000N. The survey finished at 11700E on this line and thus the second Gefinex anomaly was not covered by the EM37.

the survey down MCDD4 using loop 3. Reductions of the profiles are presented in Figures 4 to 9.

INTERPRETATION

In profile 4/1 (Figure 4), the profile is essentially flat, with positive values at early times, decaying through zero to larger negative values, then back towards zero. These negative values, for a hole totally 'within' the transmitting loop, are not readily explained and are further discussed in the Appendix. In Figure 5, profile 4/2, an initially positive, then negative-going response can be seen at 60-70m. This coincides with a narrow (0.4m) intersection of unconsolidated sands at the base of the basalt. On the same profile, the broad negative response in channels 16 to 20, centred at about 170m, was interpreted as possibly being due to an off-hole conductor and further surveys with different loop positions were recommended to better define this response. These follow up surveys confirmed the shallow response at ~65m, producing strong and contrasting anomalies with loops 3 and 5 (Figures 6 and 8), but gave no responses at all at the more interesting deeper levels. Although there were some minor problems with the probe during the later surveys (eg, the late time offsets -see the Appendix), I believe that the data is valid and that the response interpreted at 170m in profile 4/2, rather than being due to an off-hole conductor is caused by the loop - drill hole geometry (see Appendix). The source of the strong anomalies at 165m in profiles 4/3 and 4/5 is interpreted to be clays or unconsolidated sands at the base of the basalt.

MCDD5 was drilled to intersect the better of the Gefinex anomalies, which was interpreted to lie between 150 and 200m down hole. From the geological log, it appeared likely that the pyritic black siltstones, intersected between 146 and 158m and described as "probably graphitic" (Herrmann, 1989), were the source of the response. The DHEM survey down MCDD5 was recorded through steel casing to 112m, giving the predicted large responses (the change at 50m perhaps being caused by a break or insulated join in the casing). The casing caused only a local effect and did not influence the readings below 120m. A slight positive 'bump' can be seen in the very early time data at around 160m and this could tentatively be ascribed to an in-hole response. The response persists with time (see Figure 9b) indicating a good conductor. There are some unexpected features in this profile, which are discussed in the Appendix, but the results indicate that a 'conductor' was intersected by MCDD5 in the vicinity of 160m.

CONCLUSIONS AND RECOMMENDATIONS

MCDD4 was drilled to intersect a weak conductor interpreted from the Gefinex survey to lie at ~180m below the surface. A tentative response from survey 4/2 at 170m was not confirmed by later surveys (using different loops) and the 4/2 response can be explained by a so-called 'self response' whereby* the probe sees the transmitting loop itself as a source. The surveys down MCDD4 did show the presence of a strongly conductive layer at the base of the basalt which may be the source of the Gefinex anomaly. Although this conductor has not been quantitatively interpreted, it seems likely that it is steeply dipping and possibly of small size. Such conductors are not well approximated by the horizontally layered-earth modelling program used to interpret the Gefinex data and this might be the reason for the discrepancy between the observed and predicted depths.

MCDD5 was drilled to intersect a Gefinex anomaly which was interpreted as being caused by a highly conductive body lying at 150m to 180m below the surface. This area was not covered by the fixed loop surface EM37 survey, but did give a Sirotem response interpreted as a 'contact zone' (ie, the edge of the basalt). The hole intersected a pyritic black siltstone between 146m and 158m and a small positive response was recorded by the DHEM survey over this interval. Although one would have expected a conductor good enough to produce a response at the surface to have produced a much larger response from a receiver passing through it, it can be reasonably inferred that this unit is the source of the Gefinex anomaly.

Thus the source of the first Gefinex anomaly is a conductive layer within unconsolidated Tertiary sediments at a much shallower depth than was indicated by the (restricted) interpretation technique. And the source of the second anomaly has been interpreted as a conductive rock unit at the predicted depth.

With regard to future exploration, geophysical recommendations would include determining the thickness of the basalt over the rest of the licence and surveying areas of thin cover with EM.

J.R. Bishop
June, 1989

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* In retrospect, the 4/2 survey should have been repeated during the second visit to the site, especially in view of the -later learnt -instrumental problems.

REFERENCES

Asten, M. W., King, A. and Peacock, J., 1987. Sign changes in DHEM surveys for cindered coal in the Sydney Basin. Explor. Geophysics 18, 319-324.

Bishop, J.R. and Lewis, R.J.G., 1988. Geophysical signatures of western Tasmanian mineralisation. Tas. Mines Dept report.

Hattula, A., 1988. Multifrequency EM soundings in the Mt Cattley area, Tasmania and the Berserker area, Queensland, October to November, 1988. Outokumpu company report.

Herrmann, W., 1986. Notes on the geology of the Mt Cattley Area. Report to Pancontinental Mining.

Herrmann, W., 1989. Preliminary report on drill testing of two Gefinex-EM anomalies at Mt Cattley, E.L. 14/85. Report to Outokumpu.

Lakanen, E., 1987. Sirotem and EM37 surveys in Mt Cattley, Tasmania. Outokumpu company report.

Macnae, J. and Staltari, G., 1987. Classification of sign changes in borehole TEM decays. Explor. Geophysics 18, 331-340.

Smith, R.S. and West, G.F., 1988. An explanation of abnormal TEM responses: coincident loop negatives, and the loop effect. Explor. Geophysics 19, 435-446.

Wilson, D.R., 1986. Interpretation of Mt Cattley Sirotem Data. Pancontinental memorandum.

Wilson, D.R., 1987. Mt Cattley EM37 survey, May 1987. Pancontinental memorandum.

APPENDIX

Further Explanation of Mt Cattley DHEM Results

Late-time negatives: profile 4/1.

For a hole such as MCDD4 whose plan projection is entirely within the #1 transmitting loop, one would normally expect only positive values to be recorded.* Negative values should only occur from an off-hole response . (And there is indeed a slight concavity to this data consistent with the response from a very distant conductor -but this has little credence.) It is known from other surveys conducted by Geoterrex during this season that there have been some instrumental problems; the most common of which has been a D.C. offset (ie, the data decays away to some non-zero value: see Figures 6, 7 & 8). This does not appear to have occurred here, and the data, with the possible exception of the early time data at the end of the hole, appears 'reasonable'.

One possible explanation for the late-time negatives has been provided by Smith and West (1988) who have modelled late-time in-loop negatives by placing a thin polarisable overburden directly beneath the transmitter. The polarisation (or IP effect) can be quite weak and could be produced by clays within the Tertiary sediments. This effect could conceivably be recorded at depth (ie, down-hole) in a resistive environment such as should pertain here. (Similar results to 4/1 were recorded by Geoterrex this season from a survey with a similar geometry in the Zeehan area, where there is, again, often a conductive, polarisable surface layer.)

Apparent response: profile 4/2.

The survey down MCDD4 using loop 2 shows an apparent negative response centred at 170m (ie, coincident with a fault

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* Temporal changes of sign (as distinct from spatial sign changes) are usually due to one of two causes. One is the migration of current past the drill hole and the second is for a sign change as the 'smoke-ring' of energy passes by the drill-hole. Neither explanation occurs here. The first occurs when a conductor has been intersected and the induced current ring contracts with increasing delay time past the drill hole. The second alternative cannot occur within the transmitting loop, since the source, the energising field, expands out into the earth away from the loop (in a manner very reminiscent of smoke rings). Macnae and Staltari (1987) note that a conductive host or overburden beneath a transmitter may produce a sign change but show, in their example, a change from negative to positive with increasing time (ie, the opposite to that observed here).

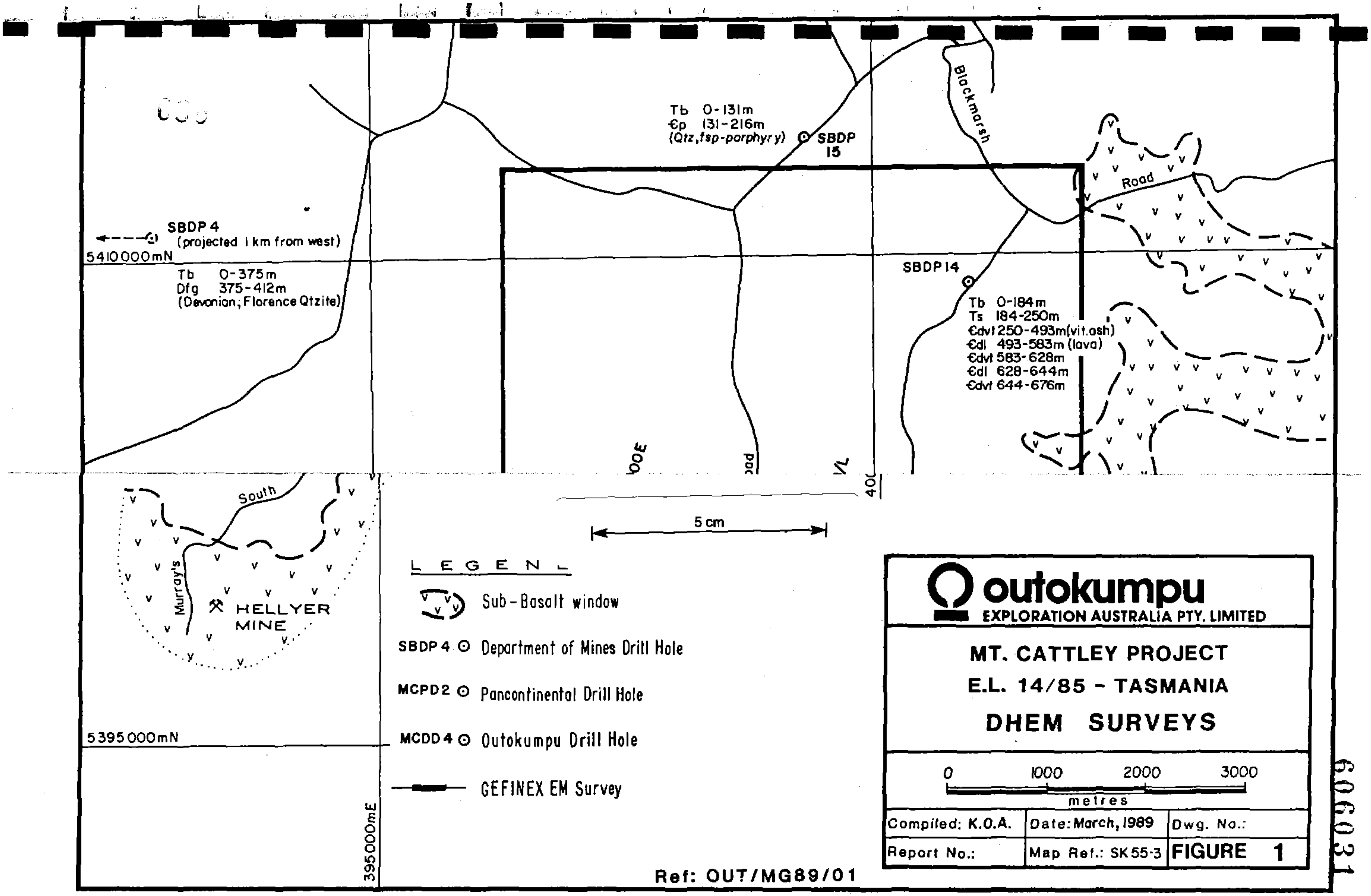
zone). This suggests an off-hole conductor and was the impetus for the second set of surveys. Since these failed to confirm its existence, other causes must be sought. Superposition of the loop's primary magnetic field upon the drill hole (Figure 10) shows a change in direction at around 100m which would produce this observed positive-to-negative sign change down the hole (this usually occurs in all channels). The lower values at the end of the hole produce the concave shape to the profile, thus giving it the appearance of a prospective anomaly. The positive response at 65m is due to an off-hole conductor with the later-time negative-going response not due to current migration in the body, but probably to the overlying conductive basalt (eg, Asten et al, 1987). This shallow response was tentatively attributed to the unconsolidated sands at the base of the basalt.

Shallow response: MCDD4 profiles.

Loops 3, 4 & 5 set up to better define the interpreted response at 170m in 4/2, only responded to the shallow source at the base of the Tertiary basalt. Despite the strong responses, especially in loops 3 and 5, the source is not readily located: it has to be dipping so that it causes a positive response from loop 5, a negative from loop 3 and a very weak negative from loop 4. This could be solved by modelling, but there is little economic incentive to do so, since the source is confidently interpreted as lying within the unconsolidated sediments at the base of the basalt.

Deep response: MCDD5/1.

The logarithmic plot of the survey down MCDD5 (Figure 9b) shows that the response is positive at early times, tends negative at intermediate times before going positive again at late times. Such a persistent response indicates a much better conductor than is suggested by "pyritic black siltstone". One would also expect such a large scale lithological feature, if conductive, to produce a much higher amplitude response than that shown in profile 5/1. The IP effects invoked for the negative responses in MCDD4 could perhaps also be used here to explain the change in sign direction and possibly also the subdued amplitudes. To thoroughly pursue this interpretation, inductive measurements should be made of several pieces of the core. But whatever the reasons for the observed features, no off-hole responses have been recorded down MCDD5.



outokumpu
EXPLORATION AUSTRALIA PTY. LIMITED

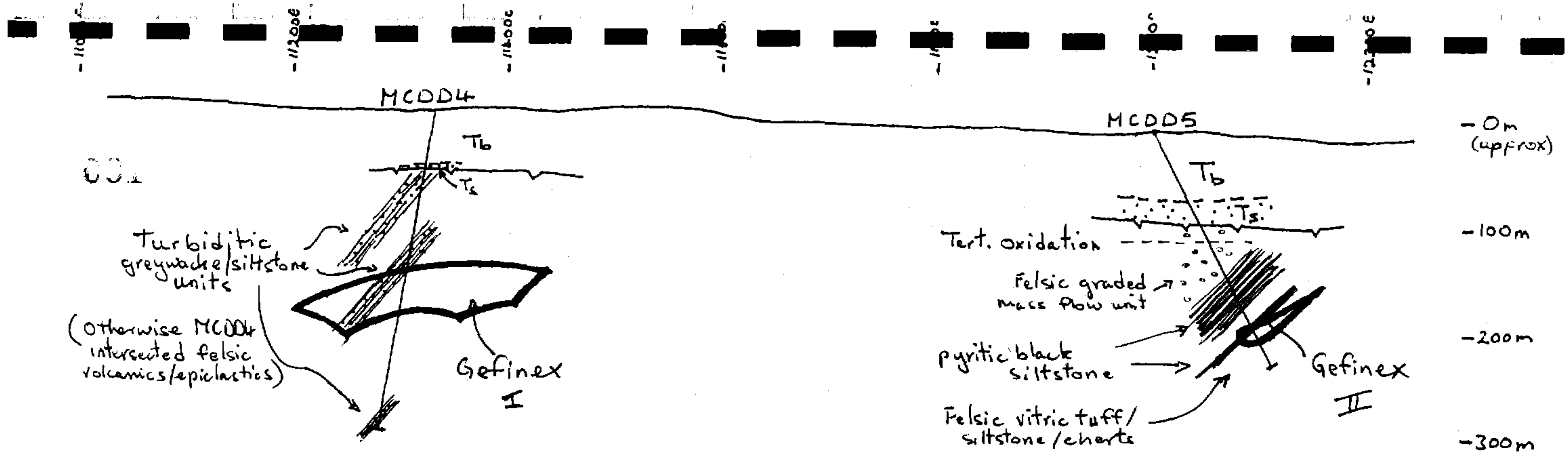
MT. CATTLEY PROJECT
E.L. 14/85 - TASMANIA
DHEM SURVEYS

0 1000 2000 3000 metres

Compiled: K.O.A.	Date: March, 1989	Dwg. No.:
Report No.:	Map Ref.: SK 55-3	FIGURE 1

Ref: OUT/MG89/01

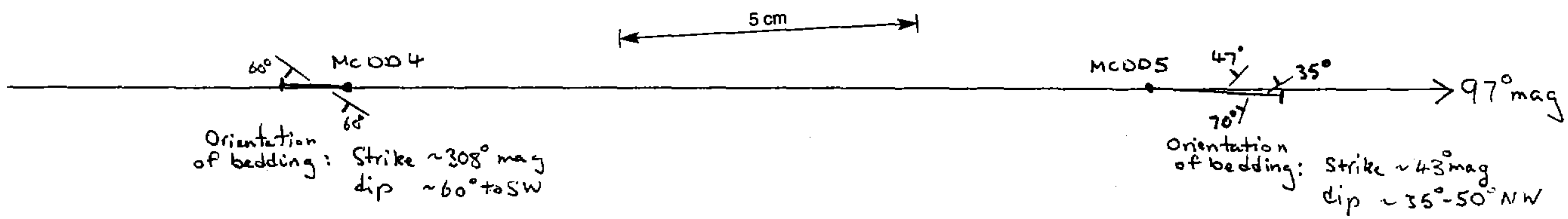
60603 1



SECTION

PLAN

LINE 12000N
Scale 1:5000



Mt Cattley, E.L. 14/85

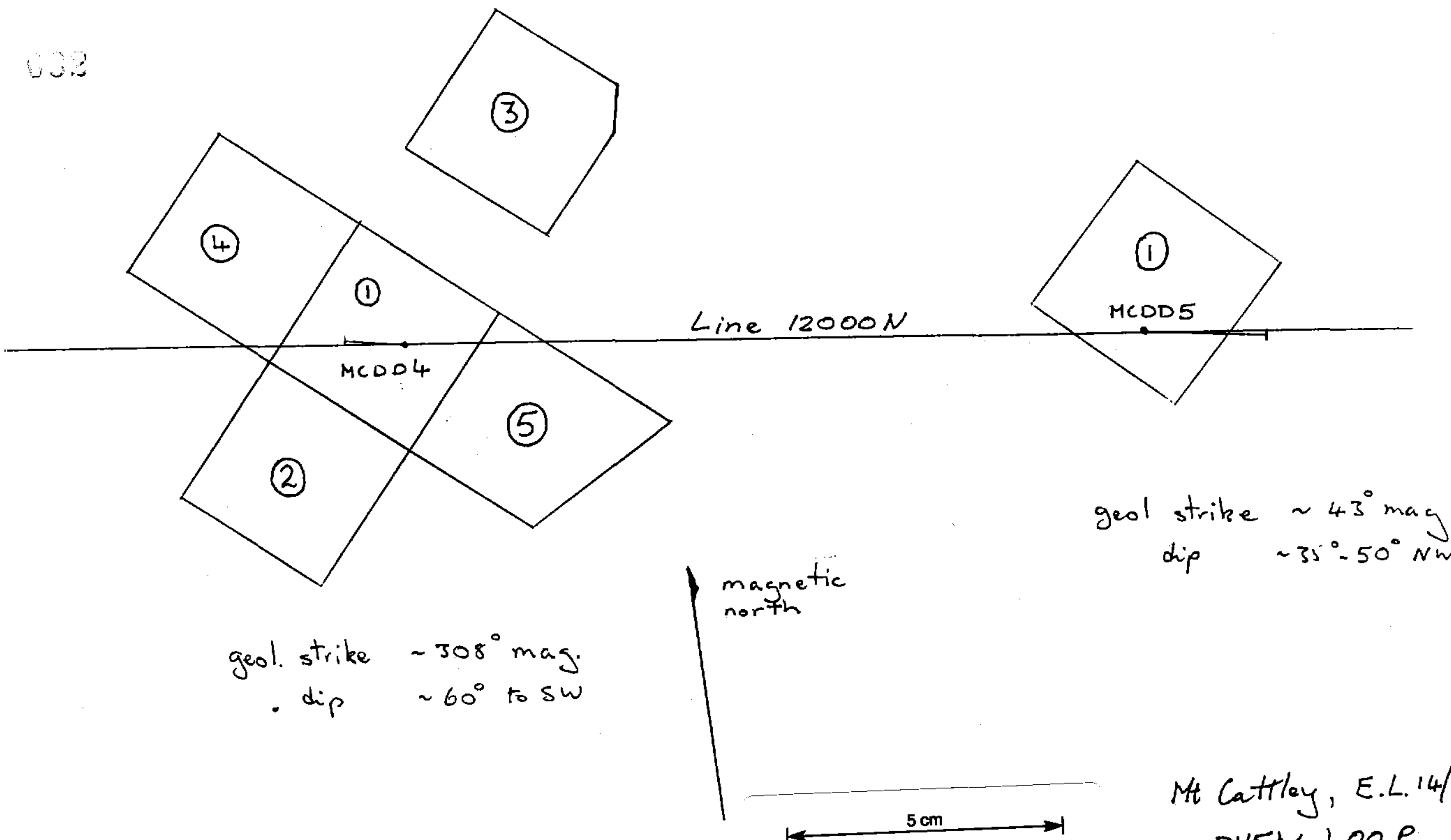
MCDD4 & MCDD5
CROSS-SECTION & PLAN

(Herrmann, 1989)

606032

ref: Out/MF89/01

Fig. 2.



Mt Cattley, E.L. 14/85
DHEM LOOP POSITIONS

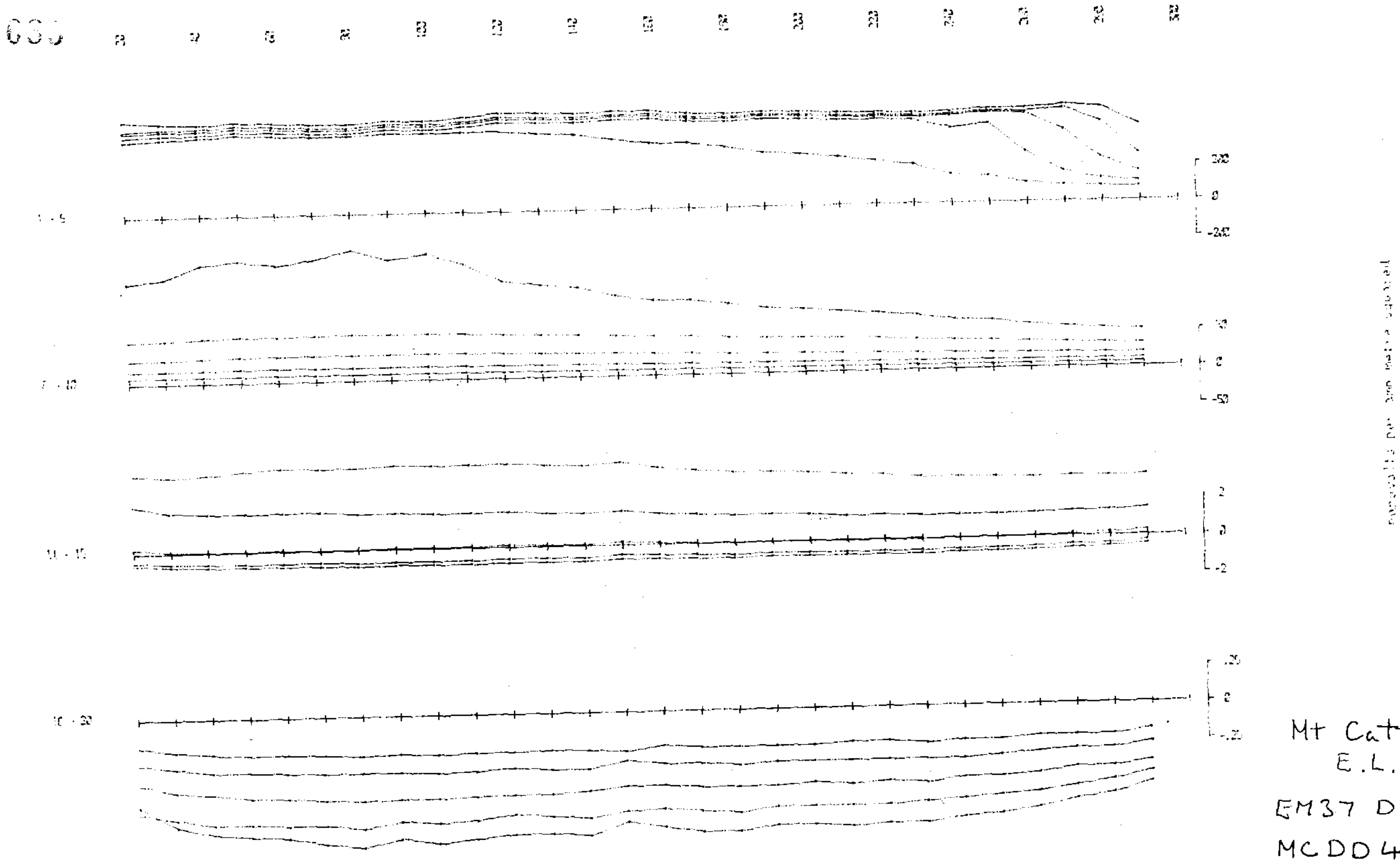
nominal loop size: 150m
scale 1:5000

ref: Out/M689/01
June, 1989.

Fig. 3.

606033

AXIAL COMPONENT B (Z)



Mt Cattley
E.L. 14/85

EM37 DHEM

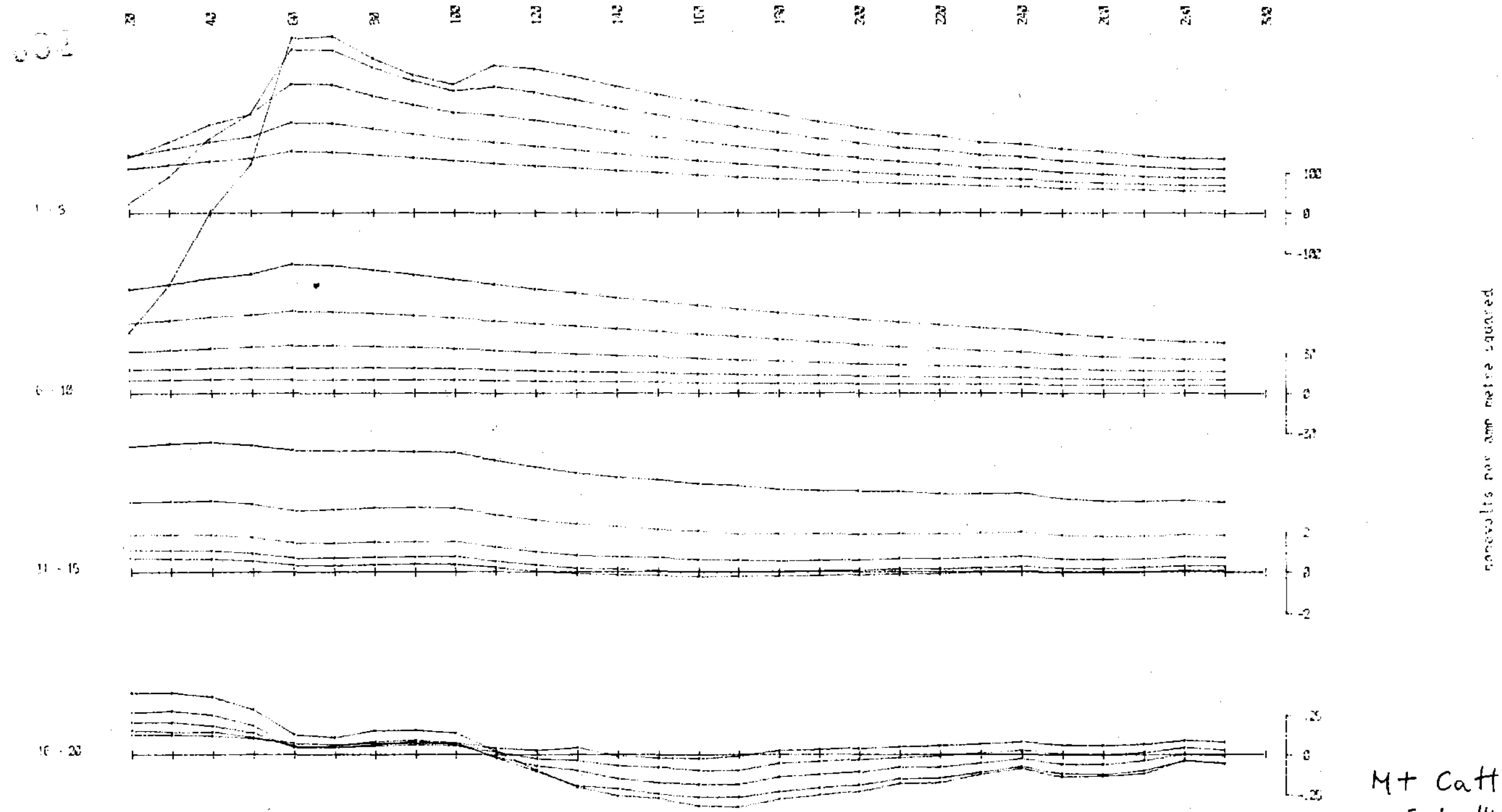
MCDD4/1

FIG. 4

ref:
Out/MG89/01

606034

AXIAL COMPONENT B (Z)



Mt Cattley
E.L. 14/85

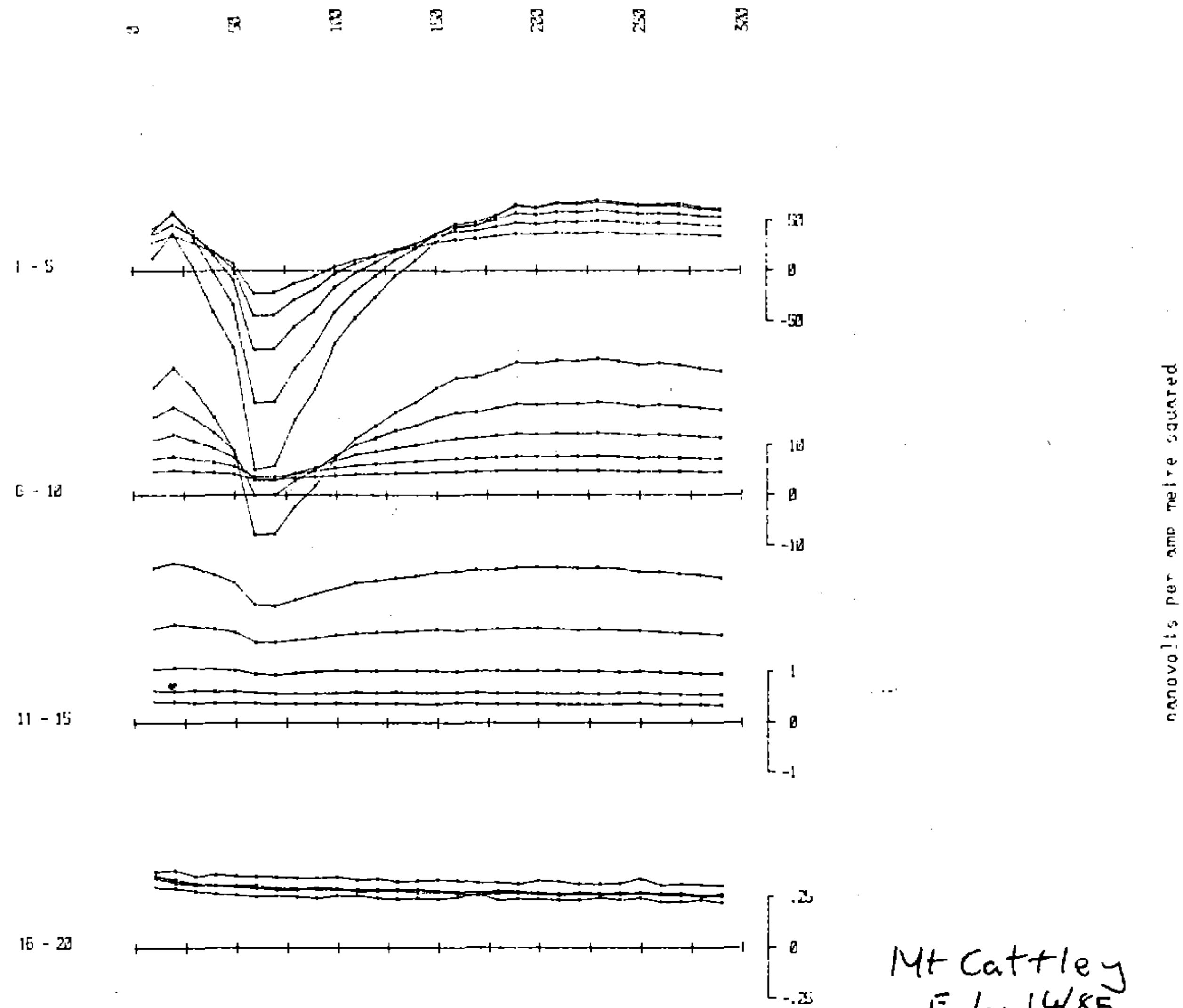
EM37 DHEM

MCDD4/2

ref: FIG. 5
Out/M689/01

606035

AXIAL COMPONENT B (Z)



EM-37

BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY SECONDARY FIELD

TIME DERIVATIVE OF FLUX DENSITY (B)

5 cm

TX LOOP SIDES	:	00390N	00150W
	:	00530N	00030E
TX LOOP SIZE	:	150 m X 150 m	
TX TURN OFF TIME	:	120 microsecs.	
FIRST GATE TIME	:	00.5 microsecs.	
CURRENT	:	21.4 amps	
FREQUENCY	:	25 Hz.	
INTEGRATION TIME	:	1024 cycles	
SYNC MODE	:	CRYSTAL	
HORIZONTAL SCALE	:	1 2500	
SURVEYED BY	:	DMA	
DATE	:	29/04/1989	

SURVEYED AND COMPILED BY GEOTERREX PTY. LTD.	PROJECT NO. 4-102

CLIENT	.	OUTOKUMPU	
PROJECT	:	EL 14/85	
AREA	.	MT CATTLEY TASMANIA	
BOREHOLE	:	DD4	A
TX LOOP	.	3	

Mt Cattley
E.L. 14/85

EM37 DHEM

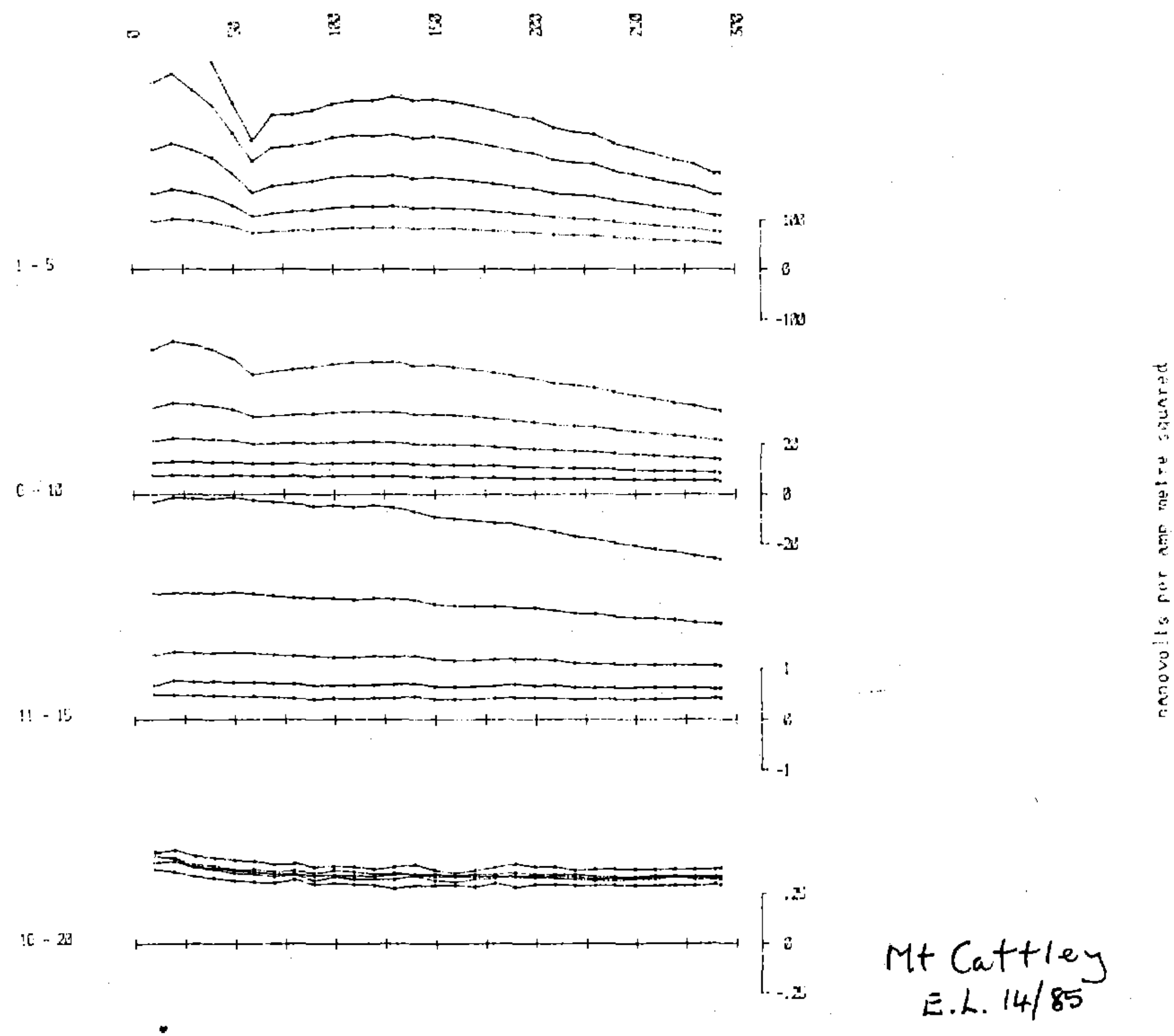
MCDD4/3

ref: out/MG89/01

FIG. 6.

606036

AXIAL COMPONENT B (Z)



EM-37

BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY SECONDARY FIELD

TIME DERIVATIVE OF FLUX DENSITY (B)

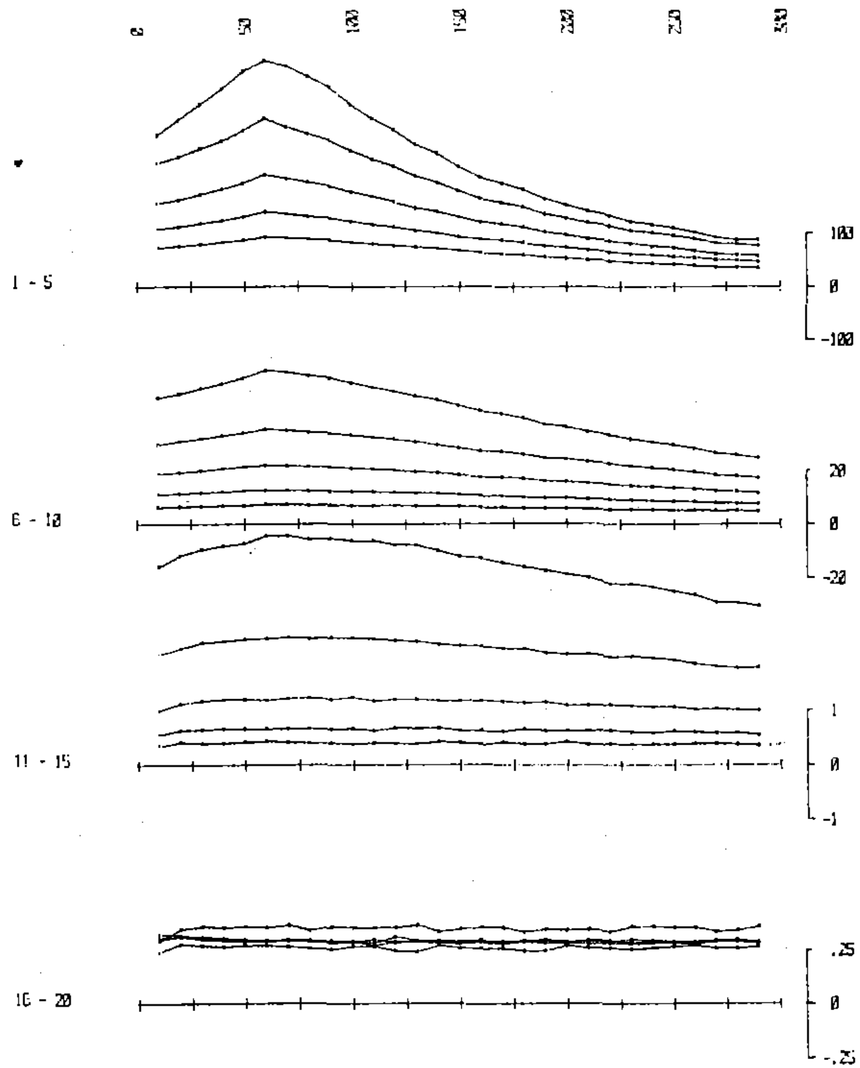
5 cm

TX LOOP SIDES	: 00150N 00300W	
	: 00300N 00150W	
TX LOOP SIZE	: 150 m X 150 m	
TX TURN OFF TIME	: 90 microsecs.	
FIRST GATE TIME	: 99.5 microsecs.	
CURRENT	: 15.5 amps	
FREQUENCY	: 25 Hz.	
INTEGRATION TIME	: 1024 cycles	
SYNC MODE	:	
HORIZONTAL SCALE	: 1:2500	
SURVEYED BY	: DMA	
DATE	: 27/04/1989	
SURVEYED AND COMPILED BY GEOTERREX PTY. LTD.		PROJECT NO. 4-102
CLIENT	: OUTOKUMPU	
PROJECT	: EL 14/85	
AREA	: MT CATTLEY TASMANIA	
BOREHOLE	: DDH4 A	
TX LOOP	: 4	

Mt Cattley
E.L. 14/85
EM37 DHEM
MCDD4/4
FIG. 7.
ref: Out/MG89/01

606037

AXIAL COMPONENT B (Z)



EM-37

BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY SECONDARY FIELD

TIME DERIVATIVE OF FLUX DENSITY (B)

5 cm

TX LOOP SIDES	: 00150N 00000E
	: 00300N 00150E
TX LOOP SIZE	: 150 m X 150 m
TX TURN OFF TIME	: 102 microsecs.
FIRST GATE TIME	: 88.5 microsecs.
CURRENT	: 16.2 amps
FREQUENCY	: 25 Hz.
INTEGRATION TIME	: 1024 cycles
SYNC MODE	: CRYSTAL
HORIZONTAL SCALE	: 1:2500
SURVEYED BY	: DMA
DATE	: 29/04/1989

SURVEYED AND COMPILED BY GEOTERREX PTY. LTD.	PROJECT NO. 4-102

CLIENT	: OUTOKUMPU
PROJECT	: EL 14/85
AREA	: MT CATTLEY TASMANIA
BOREHOLE	: DD4A
TX LOOP	: 5

Mt Cattley
E.L. 14/85

EM37 DHEM

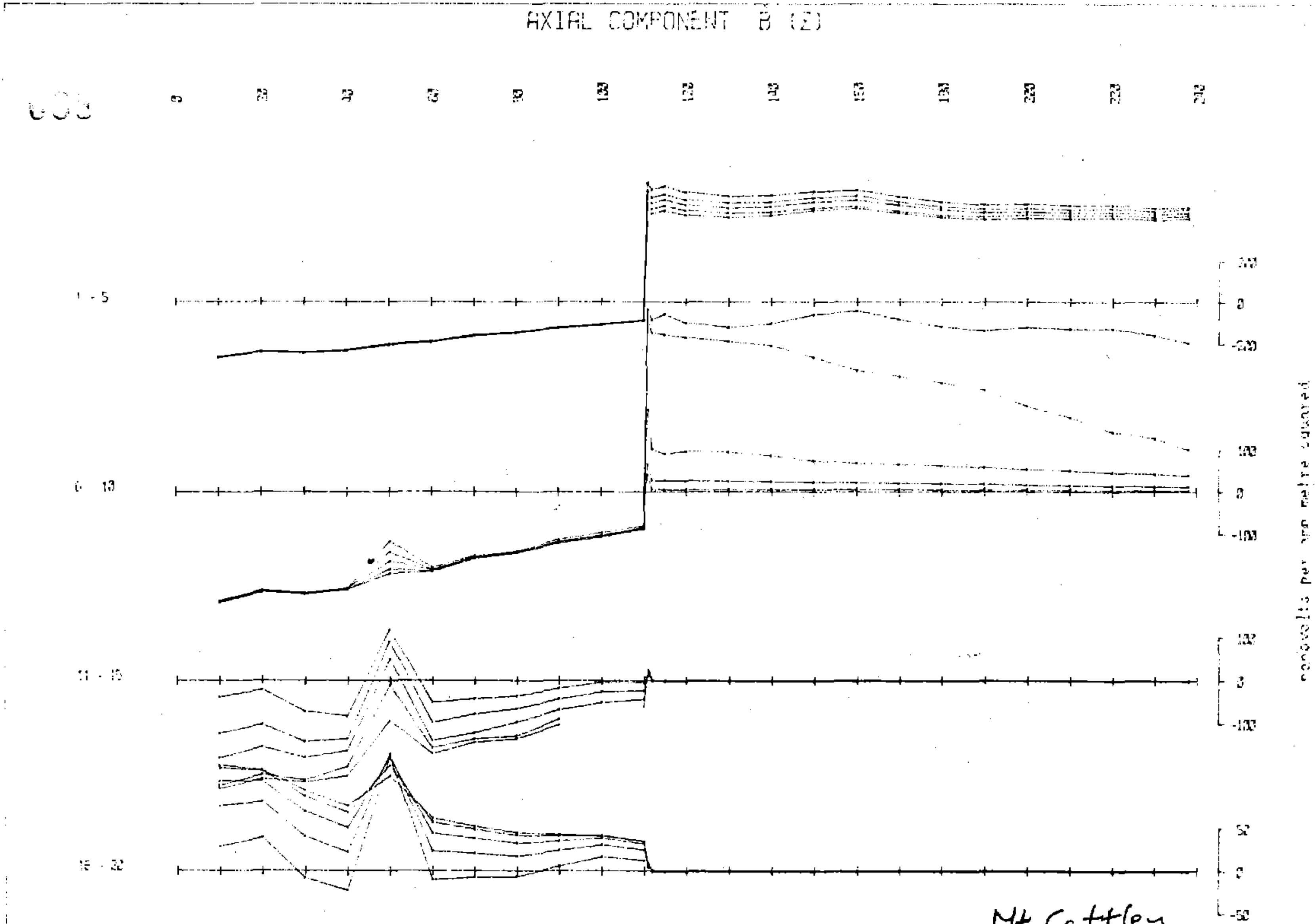
MCDD4/5

FIG. 8.

ref: Out/MG89/01

606038

AXIAL COMPONENT B (Z)



EM-37

BOREHOLE SURVEY

ELECTROMOTIVE FORCE INDUCED BY SECONDARY FIELD

TIME DERIVATIVE OF FLUX DENSITY (B)

5 cm

TX LOOP SIDES	[illegible]N [illegible]E
	[illegible]N [illegible]W
TX LOOP SIZE	: 100 m X 100 m
TX TURN OFF TIME	: 100 microsecs.
FIRST GATE TIME	: [illegible] microsecs.
CURRENT	: [illegible] amps
FREQUENCY	: 25 Hz.
INTEGRATION TIME	: 1024 cycles
SYNC MODE	:
HORIZONTAL SCALE	: 1:1000
SURVEYED BY	: [illegible]
DATE	: [illegible]/1989

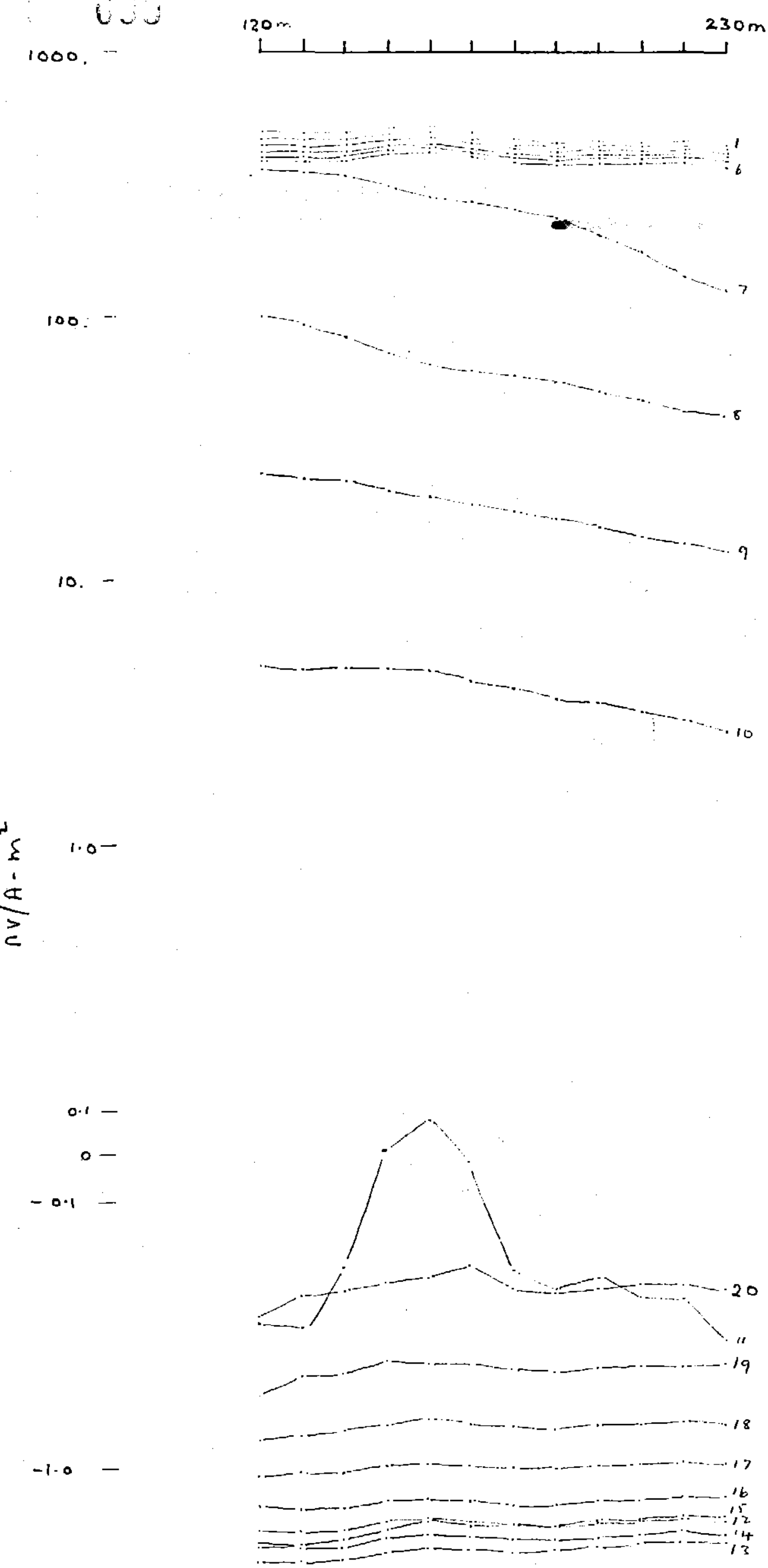
SURVEYED AND COMPILED BY GEOTERREX PTY. LTD. | PROJECT NO. [illegible]

CLIENT	: OUTOKUMPU
PROJECT	: MT CATTLEY
AREA	: MT CATTLEY TASMANIA
BOREHOLE	: MCDD5 [illegible]
TX LOOP	: [illegible]

Mt Cattley
E.L. 14/85
EM37 DHEM
MCDD5/1
Fig. 9a.
ref: Out/MG89/01

606039

030



5 cm

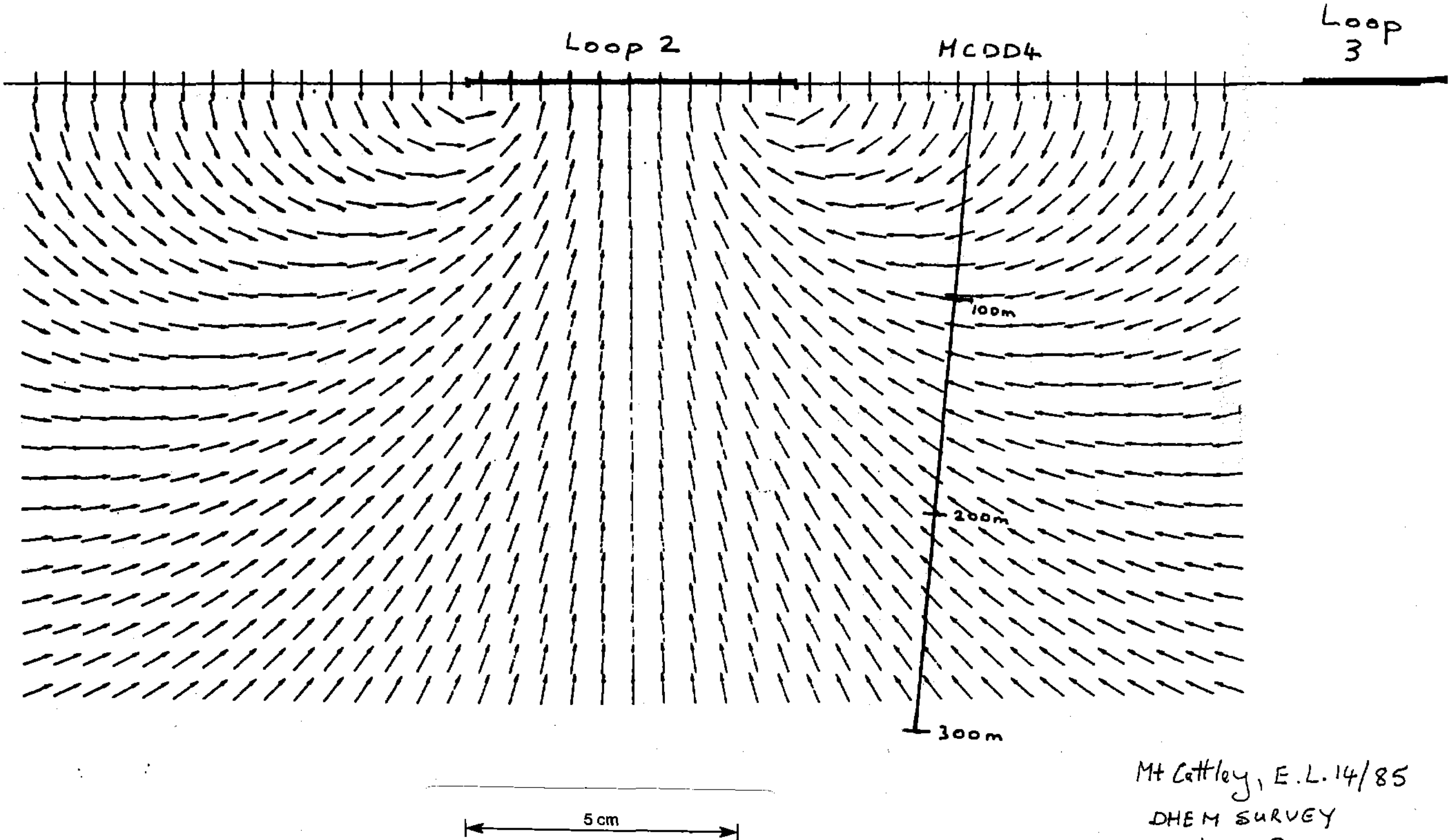
606040

Mt Cattley
E.L. 14/85

EM37 DHEM
MCDD 5/1

ref:
Fig 9b.

620



scale 1:2500

Mt Cattley, E.L. 14/85
DHEM SURVEY
Loop 2
CROSS SECTION

Fig. 10.

ref: OUT/MG89/01

606041

606042

APPENDIX II

GEOCHEMISTRY AND CORRELATION OF LAVAS
IN MT CATTLEY DRILLHOLES MCDD 2 AND 3,
EL 14/85 TASMANIA

GEOCHEMISTRY AND CORRELATION OF LAVAS IN MOUNT CATTLEY DRILLHOLES MCDD 2 AND 3, EL 14/85 TASMANIA

A Report for Outokumpu Exploration (Australia)

Anthony J. Crawford
Geology Department
University of Tasmania

25/4/89

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INTRODUCTION

EL 14/85, originally pegged by Pancontinental Mining Ltd. in mid-1985 for volcanogenic massive sulphide exploration, is located about 12km NNE and approximately along strike from the Hellyer deposit. The area of the lease is covered by Tertiary basalt, but five diamond drillholes MCDD 1 to 5, have been put down through the Tertiary basalt into Mount Read Volcanics correlates. Significant thicknesses of basic and intermediate lavas within the Mount Read Volcanics (herein MRV) correlates were only encountered in MCDD 2 and 3. Drillhole 2 intersected amygdaloidal Cambrian basalt from 60m to the end of the hole at 117.5m, and MCDD 3 intersected feldspar-phyric andesites from 83m to 109.4m and from 125.1m to the end of the hole at 129.5m. A feldspar-quartz-chlorite porphyry present between 109.4m and 125.1m has been interpreted as an 'intrusive(?)' by Green (1987) and as a flow-banded rhyodacite by Herrmann (1986).

A major problem blocking a better understanding of the geology and exploration potential of the Mount Cattley drillhole sequences is the absence of any firm evidence which can tie them into the stratigraphy of the Mount Read Volcanics, as established by Corbett and the MRV Project team. The main conclusions resulting from the drilling of the first three holes (MCDD1-3) are that:

1. the mixed lava-pyroclastic sequence encountered in holes 2 and 3 apparently overlies a thick micaceous greywacke-siltstone unit, and
2. the significant thickness of basic and intermediate lavas suggests some broad correlation with the Que-Hellyer sequence.

The Mount Cattley sequence has been correlated with the Southwell Subgroup, which forms the upper part of the Dundas Group in the area NE of Hellyer and *overlies* the Que River Shale and the Que-Hellyer Volcanics (Corbett et al. 1988). Herrmann (1989) suggests that the westerly dip direction and facing of the sequences in MCDD 4 and 5 might indicate that the mafic and intermediate volcanics encountered in MCDD 2 and 3 lie stratigraphically above the holes 4 and 5 sequence, in the upper part of (or above) the Southwell Subgroup. This, of course, implies that the Cattley lavas are not correlates of the Que-Hellyer lava sequence. Herrmann (1989) considered as valid, but very unlikely, the possibility that major fault displacements had upthrown the Que-Hellyer Volcanics, so that it could possibly be these Que-Hellyer lavas encountered in holes 2 and 3. Herrmann (1989) also suggested that the greywackes in holes 1 and 4 may be stratigraphically equivalent (a correlation my petrographic examination supports), and if so, the volcanics in holes 2 and 3 would occur in the hinge area of a probably southward-plunging syncline.

In my assessment of the data available, two possibilities exist as to the stratigraphic position and correlation of the Cattley lavas in holes 2 and 3.

Possibility 1: The greywackes in holes 1 and 4 are equivalent, and correlate with the Animal Creek Greywacke further southwest. This implies that the Cattley lavas are correlates of the Que-Hellyer footwall lava sequence, and that the Hellyer basalt and Que River Shale are 'above' the drilled sequence and remain unlocated in the Mt. Cattley area.

Possibility 2: The entire drilled sequence in the Mount Cattley EL is within the Southwell Subgroup and stratigraphically above the Que River Shale and Hellyer basalts. In this case, the lavas in holes 2 and 3 represent a newly-discovered episode of mafic-intermediate magmatism within the Dundas Group, which elsewhere in the Mount Read Volcanics and Dundas Trough is represented by felsic pyroclastics, epiclastics and volcanogenic greywackes.

AIMS OF THIS STUDY

Based on the foregoing background information, it is apparent that information capable of better locating the Cattley lavas in the regional stratigraphic setting would be particularly valuable. To this end, it was proposed that I carry out a detailed petrological and geochemical study of the lavas in holes 2 and 3 for comparison with the regional MRV data base, which I have compiled over the last four years. This data base includes around 200 wholerock major and trace element analyses of the best-preserved lavas from across the compositional and geographic range covered by the MRV. Some 70 of these lavas have also been analyzed for rare earth elements (REE), which have been proved to be of particular value in correlation between lava units, both on a local and a regional scale. Detailed compositional data for the Cattley lavas should enable correlation with the Que-Hellyer lavas, or with other lava units represented in the MRV; alternatively, it could show that possibility 2 above is valid, and that the Cattley lavas have no known compositional correlates in the MRV.

METHODS

Background information for this study was provided by Wally Herrmann, and included previous Pancontinental Mining Ltd. reports and a hand-wriiten February 1989 Report Wally Herrmann was preparing at that thime for Outokumpu. An evening was spent in Zeehan discussing many aspects of the proposed project with Wally Herrmann in February. Subsequently, a trip was made to Devonport to sample core from drillholes 4 and 5. As only a single lava flow (rhyolite; see thin section description for Hole 5, 159.6m) was encountered in these holes, sampling concentrated on least altered units covering the apparent lithologic range represented, so that the sequence drilled could be thoroughly documented petrographically by thin section studies. Eight samples were selected from MCDD 4, and 11 from MCDD 5.

Cores from MCDD 1, 2 and 3 are presently stored at the Tasmanian Department of Mines coreshed at Mornington. Most of one day was spent locating, checking logging and sampling these cores. Three samples were selected from MCDD 1, two from the pyroclastic unit between 114 and 129m and one from the basal hole greywackes. Six representative samples were selected from MCPD 2 to cover the range of lavas drilled between 60m and EOH at 117.5m. Similarly, seven samples were taken from the Cambrian lavas cored by MCDD 3 between 102m and EOH at 129.5m. Thin section descriptions of all samples are appended to this report.

In addition to the samples detailed above, a sample of Cambrian basalt core from MCDD 2 at 111m was given to Dr. Ross Large by Bob Close in mid-1988, and this was also analyzed, although apparently no material was left for thin section description.

C 3

TABLE 1:SUMMARY OF SAMPLES FROM MT CATTLEY DRILLHOLES 1-5

DRILLHOLE DEPTH (m)	THIN SECTION	ROCKTYPE	WHOLEROCK ANALYSIS	REE ANALYSIS
MCDD 1				
127.7	YES	Rhyolitic tuff	No	No
128.9	YES	Rhyolitic tuff	No	No
135.5	YES	Qtz-rich greywacke	No	No
MCDD 2				
85.1	YES	Vesic. aphyric andesite	Yes	Yes
93.9	YES	Vesic. aphyric andesite	Yes	No
98.4	YES	Vesic. aphyric andesite	No	No
104.4	YES	Vesic. aphyric andesite	Yes	Yes
106.7	YES	Vesic. aphyric andesite	No	No
111	NO	Vesicular bas. andesite	Yes	Yes
117.1	YES	Vesic. aphyric andesite	Yes	Yes
MCDD 3				
103.0	YES	Plag+augite-phyric dacite	Yes	No
104.3	YES	Plag+augite-phyric andesite	Yes	Yes
118.2	YES	Rhyodacite	No	No
121.5	YES	Rhyodacite	No	No
122.4	YES	Rhyodacite	Yes	Yes
126.0	YES	Plag+augite-phyric dacite	Yes	No
128.7	YES	Plag+augite-phyric dacite	Yes	Yes
MCDD 4				
63.2	YES	Qtz-rich greywacke	No	No
96.2	YES	Micaceous siltstone	No	No
105.3	YES	Qtz-rich greywacke	No	No
121.6	YES	Vitric xl tuff	No	No
212.4	YES	Vitric xl tuff	No	No
240.3	YES	Siltstone/tuff contact	No	No
294.6	YES	Volcanoclastic sandstone	No	No
301.0	YES	Pumiceous vitric xl tuff	No	No
MCDD 5				
129.6	YES	Coarse epiclastic sandstone	No	No
144.0	YES	Coarse epiclastic sandstone	No	No
159.6	YES	Aphyric rhyolitic intrusive	No	No
183.2	YES	Chert	No	No
196.6	YES	Black shale	No	No
231.0	YES	Chert	No	No
239.9	YES	Chert	No	No

Each analyzed sample was crushed in a WC mill and analyzed for major and trace elements using the standard XRF technique employed in the Geology Department, University of Tasmania. After assessment of the wholerock analytical data, six samples were selected for rare earth element (REE) analysis using the ion exchange - XRF technique developed in this Department. For REE concentrations greater than four times chondritic levels, REE data determined by this technique have been found to be very reliable in terms of both accuracy and precision, based on repeated analyses of international and in-house standards.

Since all analyzed samples are metalavas with loss on ignition values greater than 4% for most, analyses (see later) have been recalculated to 100% (volatile-free) to eliminate compositional differences due to dilution by water in hydrous secondary minerals. In addition to the ten samples analyzed for this study, Pancontinental Report Spt-Oct 1986 on the Mount Cattley EL contained 3 analyses from MCDD 2 lavas and 3 analyses from MCDD 3; these analyses were done by AMDEL Laboratories, and are also given further on in the section dealing with the compositional features of the Cattley lavas. Comparisons of samples analyzed in the Dept of Geology at the University of Tasmania and those analyzed by AMDEL from similar units show a systematically lower P_2O_5 and V values and higher Y levels in samples analyzed by AMDEL. The three MCDD 2 samples analyzed by AMDEL were exceptionally altered (7.4-10.8% loss on ignition) and would not have been chosen by me for this study. However, their MCDD 3 samples appear to be similarly altered to those chosen for the present study, and as such should be useful in interpretation of the suite. However, almost all the discussion of compositional variation in the Cattley lavas is based on the data obtained in this Department.

In the following pages, a review of the regional distribution, stratigraphic subdivision, geochemical characteristics, compositional range through time and tectonic significance of the MRV is given, and is followed by an attempt to correlate, on compositional grounds, the Mount Cattley lavas with other lava sequences in the MRV.

THE MOUNT READ VOLCANICS: A REVIEW

Perhaps the most important part of this study, and certainly the msot time-consuming, is to compare and contrast the compositions of the analyzed lavas from the Mt. Cattley drillholes with those from elsewhere within the MRV belt, to learn more about the stratigraphic position of these lavas relative to, for instance, the Hellyer basalts and Central Volcanic Complex lavas. To put this discussion into proper perspective requires a detailed review of the geochemical variation of, and correlations within, the MRV.

Five years ago I initiated a study to determine the tectonic affinities of the MRV, using very carefully selected least-altered lavas taken from existing University, Mines Department and company collections (see AMIRA Report 84/P210 April 1986 for background). An initial batch of analyses of around 100 well-preserved lavas was presented in the aforementioned AMIRA Report, but the stratigraphic positions of these rocks was not discussed. Subsequent work, documented in the August 1987 AMIRA Report, increased the data base (mainly with samples collected either by myself, Dr. Keith Corbett (Dept. of Mines) or several company geologists), and attempted to assign compositional classification/characteristics to well-defined stratigraphic units such as the Hellyer basalts and the Central Volcanic Complex andesite-dacite-rhyolite sequence. About 30 wholerock analyses plotted on the diagrams in the following pages, mainly from the Que- Hellyer area, are not listed in the Tables, since they are proprietary information of Aberfoyle Exploration. Further additions to the data base have been made mainly from samples collected by Dr. Joe Stolz, as part of the Mount Read gold study reported in the August 1988 AMIRA Report, and samples from the E-W striking section of the MRV from east of Hellyer to Beulah. The latter samples were mainly collected by Doug Jack (Abefoyle Exploration Ltd.) or myself, and analyses of the Aberfoyle samples are not proprietary information. The data for these Hellyer to Beulah samples became available in the same analytical run that produced the Mt. Cattley data, so this is the first attempt to fit these northern MRV into any regional correlation scheme.

To achieve that end, the following pages provide a detailed and necessary review of my current understanding of the compositional range, distribution and affinities of the various diverse rock suites that constitute the MRV. All the data used in this compilation is appended as Tables 1 to 10 in the Appendix, and a Macintosh double-sided disk containing all the data in an EXCEL file (for use on a Macintosh MacPlus or SE microcomputer has been included in this package.

Although no detailed study of the petrology, geochemistry and tectonic significance of the MRV (herein MRV) has been attempted prior to the present (ongoing) study, previous reconnaissance studies of the MRV have reached concensus that they are a typical calc-alkaline orogenic basalt-andesite-dacite-rhyolite suite, dominated by dacites and rhyolites.

The Noddy Creek Volcanics, a belt of Cambrian calc-alkaline andesites on the Sorell Peninsula south of Macquarie Harbour and east of the MRV proper, are considered by previous authors to be a separate entity to the MRV, and have not been effectively incorporated in any tectonic model for the development of western Tasmania.

THE MOUNT READ VOLCANICS: GEOLOGICAL CONSIDERATIONS

The MRV are a basalt-andesite-dacite-rhyolite suite with abundant interbedded pyroclastics, epiclastics and shale horizons. Rapid facies changes, complex internal stratigraphy and structure, paucity of fossils, variable alteration and poor exposure have frustrated a detailed understanding of their regional geological and tectonic significance, although major advances have been made in the last three years following a detailed mapping programme funded by the State Government's MRV Project. Radiometric dating has provided little clarification of age relationships within the MRV, due to pervasive alteration. Probably, the most reliable date is a zircon age of 511 m.y. for the Darwin Granite, which intrudes Tyndall Group, whereas K-Ar dates range from 407 to 528 m.y. Late Middle- and Upper Cambrian fossils are recorded from several localities within the MRV (Corbett and Lees 1987), and a presently undated trilobite locality has recently been discovered by the author in the area just west of Paradise. A detailed review of the stratigraphy of the MRV is given in Corbett and Solomon (1989) in the new Geology and Mineral Resources of Tasmania volume.

Recent systematic detailed mapping by the MRV Project geologists from the Tasmanian Department of Mines has clarified important geological relationships within the belt (Figures 1 and 2), although several major problems remain. Whereas the Tyndall and Dundas Groups both clearly overlie Central Belt Volcanics, some uncertainty

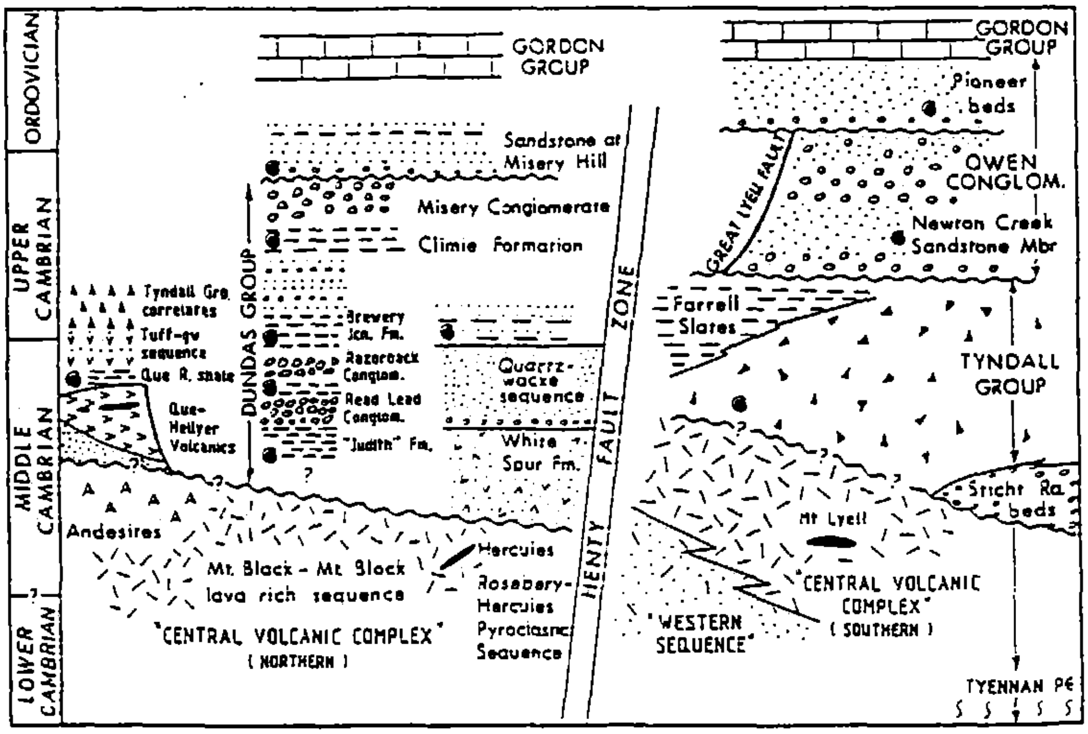

FIGURE 1: Stratigraphy of the Mount Read Volcanics (from Geology and Mineral Deposits of Tasmania, 1989).

STRATIGRAPHIC DIAGRAM FOR DUNDAS GROUP
IN QUE - HELLYER AREA

TASMANIA DEPARTMENT OF MINES REPORT 1, MT READ VOLCANICS PROJECT
AUTHORS K.D. CORBETT & P. KOMYSHAN

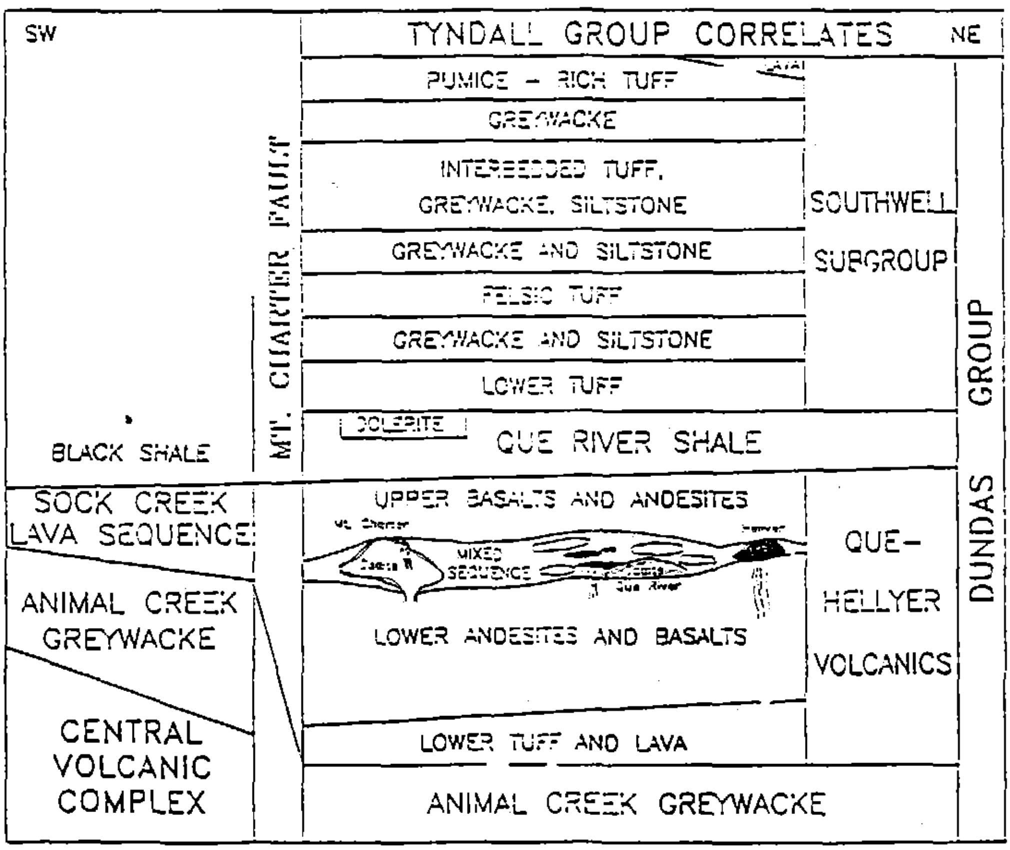

FIGURE 2:

remains regarding the stratigraphic relationships and geological significance of Corbett's (1979) Western Sequence. Corbett (1979) argued that, since the Western Sequence south of Queenstown apparently dips beneath the Central Volcanic Complex, it is likely to be older than the latter. However, my detailed geochemical studies of Western Sequence lavas indicate that they are almost certainly equivalent to the Hellyer basalts, time-correlated with the basal Dundas Group (see Figs. 1 and 2), which are agreed to be post-Central Volcanic Complex. This suggests that the Central Volcanic Complex in the area south of Queestown may have been thrust westward over flanking younger Western Sequence rocks. This postulated fault would be a southern analogue of the east-dipping Rosebery Fault, which juxtaposes Dundas Group rocks with overthrust but older Central Volcanic Complex in the Rosebery area; main movement on this fault was Tabberabberan (Corbett & Lees 1987). I prefer to incorporate all lava-dominated sequences along the western side of the MRV in the Western Volcanic Sequence; this includes Corbett's (1979) Western Sequence in the area south of Queenstown, and basal Dundas Group lavas in the Que-Hellyer area further north.

Several significant findings of geological mapping of the MRV by Corbett and others have been:

1. recognition of the Henty Fault System, which transects the MRV east of Rosebery, bifurcating south of Red Hills; it separates regions of the Central Volcanic Complex which have different dominant lithologies, structure and ore deposits: and,
2. the discovery of tholeiitic lavas and dykes outcropping in the core of an anticline within the Western Volcanic Sequence at Miners Ridge (SW of Queenstown; Corbett 1979), also in the western part of the block sandwiched between the north and south Henty Faults (known as the Henty Fault Wedge), and as a basaltic dyke swarm (the Henty Dyke Swarm) through the Central Volcanic Complex north of the Henty Fault, between Mount Dundas and the Pinnacles. These lavas and dykes are compositionally unlike the high-K calc-alkaline MRV, and their nature and existence must be taken into account in any comprehensive attempt to model the tectonic development of western Tasmania.

Central Volcanic Complex

The Central Volcanic Complex shows significant differences on either side of the Henty Fault System. Southeast of the fault, volumetrically dominant plagioclase-phyric dacitic and rhyolitic lavas are intruded by domes and plugs of hornblende+plagioclase-phyric andesites, well-exposed on Crown Hill and Leach Hill. Subvolcanic granitoids intrude the Central Volcanic Complex both north (Murchison Granite) and south (Darwin Granite) of Queenstown, and are thought to be responsible for the extensive, pink-weathering potassic alteration which affects felsic lavas throughout this area. Ignimbrite-like flows with flattened pumice shards are common, but shale interbeds are sparse. North and west of the Henty Fault the Central Volcanic Complex contains more andesites than further south, no granites are recorded, and pink, potassic alteration is rare. Andesites appear to be mainly extrusive, and as for further south, ignimbritic flows are abundant and shale intervals are rare. Basaltic dykes of the Henty Dyke Swarm, unrelated to MRV magmatism, intrude the Central Volcanic Complex north of the Henty Fault. No basaltic lavas are known from either the northern or southern segments of the Central Volcanic Complex.

Western Volcanic Sequence

The Western Volcanic Sequence extends along the western side of the Central Volcanic Complex from Hellyer to south of Queenstown. Unlike the Central Volcanic Complex, it includes abundant basalts, and shows a compositional spectrum from basaltic through to rhyolitic lavas, although basalts are dominant. Extensive, sheet-like bodies of dacitic to rhyolitic porphyries may be of shallow, intrusive origin. Basalt- and andesite-dominated sequences occur in the Que-Hellyer and Lynch Creek areas, and may represent individual volcanic edifices.

Tyndall Group

The Tyndall Group is presently known only on the southeastern side of the Henty Fault System. In the Queenstown area, and further south, the Tyndall Group apparently overlies both the Western Volcanic Sequence and the Central Volcanic Complex. Correlates of the Tyndall Group occupy several near-meridional grabens extending north from Queenstown, one along the Tyndall Range to near Red Hills and the other along the eastern margin of the MRV in the Lake Dora - Lake Selina area. A significant difference between the rhyolitic lithologies of the Tyndall Group and those in the Central Volcanic Complex is the relative abundance of quartz phenocrysts in the Tyndall rocks, and their general paucity in the latter. Late Middle Cambrian fossils are known from near the base of the Tyndall Group at several localities. Tuffs, laharic breccias and epiclastics dominate the Tyndall Group, although lavas are present in the belt along the eastern side of the MRV. The most distinctive unit within the Tyndall Group is the Comstock Tuff, a banded pink and grey tuff well exposed on the Anthony Road. Corbett (1979) recorded a strikingly similar unit, the Lynchford Tuff, overlying Western Volcanic Sequence rocks south of Queenstown. The dominant lithology in the Tyndall Group is quartz+ feldspar-phyric rhyolitic tuff and subordinate lavas, although dacites are present in the Lake Dora - Lake Selina area. Siliciclastic sediments of the Owen Conglomerate unconformably overlie the Tyndall Group.

The Noddy Creek Volcanics

The Queenstown 1: 250,000 sheet, and also a small less detailed map from the new Geology and Mineral Resources of Tasmania (Fig. 3) shows a probably fault-bounded block of Mount Read Volcanics-type volcanics, informally named the Noddy Creek Volcanics, extending from Asbestos Point on the southern shore of Macquarie Harbour southward past the Timbertops area to the headwaters of the Hibbs River and beyond. As this area is largely inaccessible, details of the stratigraphy and structure are presently unavailable. Most analyzed samples in my database were collected by AMOCO/Cyprus geologists during traverses across the area in summer 1985-86. The volcanic belt is overlain, probably unconformably, by correlatives of the Owen Conglomerate and Gordon Limestone; these form a syncline which trends northwest, at a high angle to the regional strike of the Cambrian lavas and associated rocks. A second, complex belt of mafic and ultramafic rocks, with slivers of Owen Conglomerate and fossiliferous Late Cambrian Dundas Group rocks, crops out sub-parallel to the Noddy Creek belt only a few kilometers further west. On the Queenstown sheet, this belt appears to be pinched out by faulting before it reaches the southern shore of Macquarie Harbour.

MRV nd M. Sandiford along the southern shore of Macquarie Harbour around Asbestos Point, where the Noddy Creek belt is inferred to outcrop, has shown that lavas are absent from the

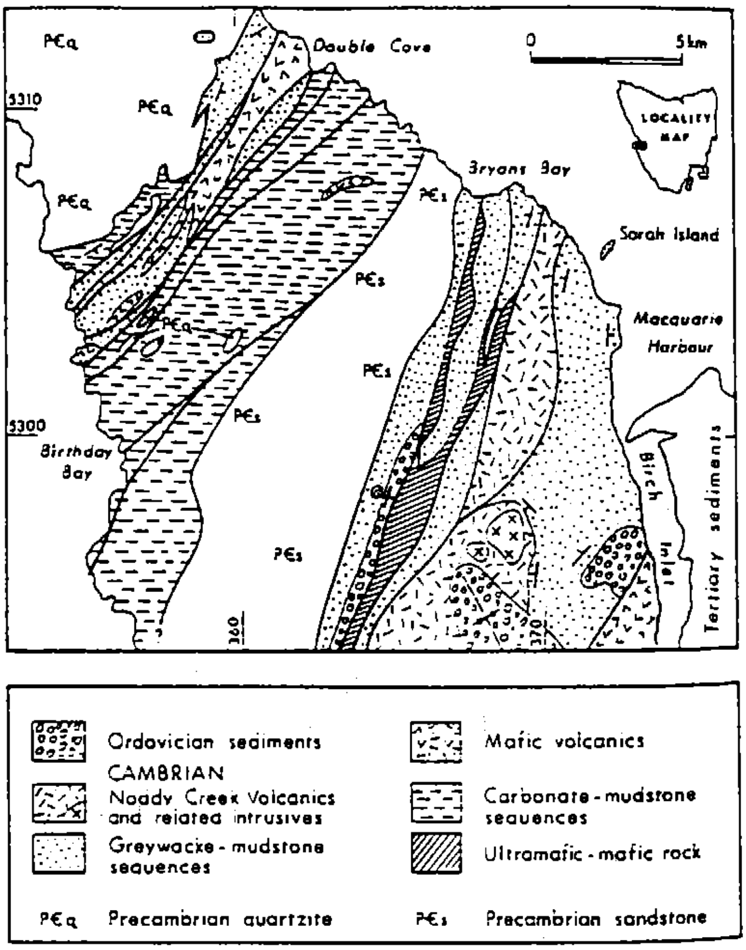

FIGURE 3: Geology of Sorell Peninsula, showing location of the Noddy Creek Volcanics ((from Geology and Mineral Deposits of Tasmania, 1989).

highly-sheared sequence here. Cataclasized, serpentinized formerly orthopyroxene-rich ultramafics contain low-Ti dolerite boudins and dolerite dykes up to 10m thick outcrop immediately east of Asbestos Point. No MRV lithologies have been found along this coast; I suggest that it is the western mafic-ultramafic belt which reaches Macquarie Harbour near Asbestos Point, not the Noddy Creek belt. Further inland the former belt contains orthopyroxene- rich ultramafic cumulates and gabbros, and also boninitic lavas. It is interpreted to be a considerably more tectonized equivalent of the mafic-ultramafic complexes exposed further north in the Dundas Trough at Heazlewood River, Serpentine Hill and McIvor Hill (Berry and Crawford 1988). The extent of the Noddy Creek belt north of Timbertops is unknown, but it does not intersect the Macquarie Harbour shoreline .

Mount Read Volcanics collected in the Noddy Creek belt include representatives of a basalt- andesite-dacite-rhyolite suite, and a range of hornblende- bearing dioritic to granodioritic shallow intrusives. A small hornblende- bearing granodiorite intrusion at Timbertops (Fig. 3), and a newly-discovered larger pluton of diorite-granodiorite in the headwaters of the Hibbs River further south (boundaries presently unknown) are undoubtedly part of the MRV (ie. Cambrian, and not related to the Upper Devonian granites elsewhere in W Tasmania) sequence in this area, and may be related to the Murchison and Darwin granitoids which intrude the MRV north of Macquarie Harbour.

Granitoid Intrusives

The sub-volcanic Murchison Granite intrudes Tyndall Group lavas and pyroclastics, and at least two plutons intrude Noddy Creek Volcanics on Sorell Peninsula. However relative age relationships of the Darwin Granite are less clear cut. The Darwin Granite intrudes Central Volcanic Complex lavas, but pebbles of Darwin Granite occur in sediments which unconformably overlie the granite, and were assigned to the Tyndall Group by Corbett (1979). On this basis, the Darwin Granite must be pre-Tyndall Group and cannot be related to the Murchison Granite intrusive event; implied are two discrete episodes of granitoid magmatism within the Cambrian in western Tasmania. This problem is simply resolved if the sediments containing the granite pebbles near Mount Darwin are not Tyndall Group, but Jukes Breccia; pebbles of Murchison Granite occur in the

Dora Conglomerate, a Jukes Breccia correlate, which disconformably overlies Tyndall Group lavas near Mount Murchison.

The Miners Ridge Sequence

Mapping by Corbett (1979) delineated an occurrence of *tholeiitic* basalts and dolerites in the core of an anticline within the Western Volcanic Sequence in the Miners Ridge area, southwest of Queenstown. They are separated from overlying Western Volcanic Sequence MRV lavas by a sequence of greywacke, shale and tuff, followed upward by a distinctive quartzwacke marker horizon, the Miners Ridge Sandstone, then an overlying sequence of tuff, shale and greywacke which becomes more greywacke-rich up-sequence. Several voluminous basalt-andesite units (Lynch Creek Basalts) within the greywacke sequence, which forms part of my Western Volcanic Sequnce, are interpreted as a major volcanic edifice (Corbett 1979). A white quartz-rich tuff separates the greywacke sequence from the overlying Lynchford Tuff, which bears remarkable similarity in outcrop and thin section to the type formation of the Tyndall Group, the Comstock Tuff.

The Henty Fault Wedge and Henty Dyke Swarm

Between the northern and southern extensions of the Henty Fault System, Corbett & Lees (1987) recorded a complex sequence of lavas and sediments. Near the junction of the two branches of the Henty Fault and in the central part of the wedge, the sequence is sediment- dominated, but some felsic tuffs and andesitic lavas are also present. However in the western part of the wedge, a belt of pillowed and massive tholeiitic basalts and intrusive gabbros occurs. The western boundary of this mafic sequence is a fault; relationships between the basalts, and sediments and andesites occurring a short distance further east, remain unknown.

Abundant dykes of basalt and dolerite of the Henty Dyke Swarm intrude the Central Volcanic Complex along, and northwest of the northern branch of the Henty Fault, at least as far north as Tullah. Preliminary geochemical studies (McClenaghan & Corbett 1985) showed these dykes to be tholeiitic, and Corbett & Lees (1987) suggested that they may be related to the basalt sequence within the Henty Fault Wedge.

GEOCHEMISTRY OF THE MOUNT READ VOLCANICS

For the purposes of this review, I have distinguished nine igneous suites within the MRV. These are:-

1-3. the Central Volcanic Complex
4. the Western Volcanic Sequence
5. the Tyndall Group
6. the Noddy Creek Volcanics
7. the Miners Ridge basalts, and
8. Henty Fault Wedge basalts and the Henty Dyke Swarm, all tholeiitic, and
9. the Darwin, Murchison and Timbertop-Hibbs Rv. sub-volcanic granitoids.

In the following section, I present and discuss mainly new analytical data for each of these suites. As stated earlier, two aims of this study are to determine the tectonic setting of eruption of the MRV, and to use geochemical data for carefully selected, least-altered lavas to aid in within-belt stratigraphical correlation, especially to attempt correlation of the Mt. Cattley lavas with other MRV suites. For both purposes, data for the basalt-andesite part of the compositional spectrum are more useful than data for rhyolites and dacites. I therefore concentrate discussion on data for basalts and andesites, but present dacite-rhyolite analyses in the interest of completeness and to provide best estimates of primary MRV felsic lava compositions for use in alteration studies and comparison with the Mt. Cattley felsic lavas.

However, all rocks studied have clearly undergone some degree (albeit generally minor) of mineralogical readjustment during burial metamorphism; therefore some comment on the strategy employed in interpreting the 'primary' chemistry of these altered rocks is warranted, prior to drawing petrogenetic or tectonic conclusions from the data presented.

Element Mobility

Here, I concentrate on elements considered to be essentially immobile during the style of alteration which has affected all rocks selected for this study; these include Ti, Zr, Y, Nb, Sc and particularly, the rare earth elements (REE). However, as noted earlier in this report, careful sample selection and preparation considerably reduces compositional scatter, for example, by the scatter of points on the K_2O versus SiO_2 variation diagram (Fig. 4), and by the range of K_2O contents in

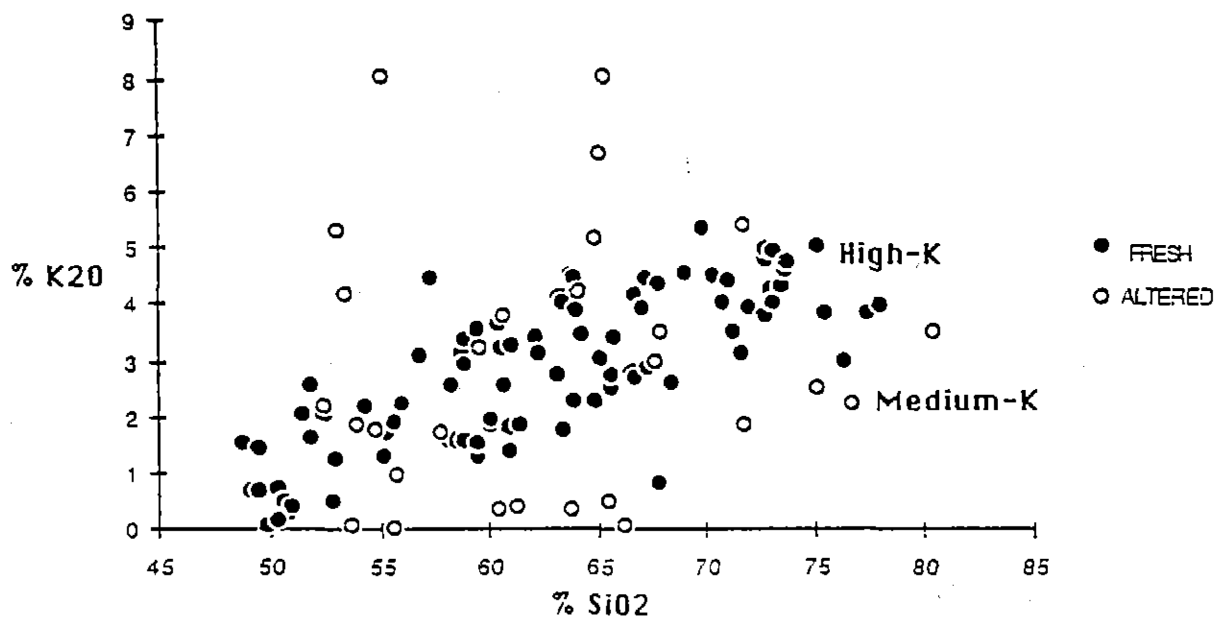

FIGURE 4: K_2O-SiO_2 diagram for relatively fresh and altered Mount Read Volcanics, showing more coherent 'magmatic-type' trend of the least altered lavas.

Mt. Cattley lavas from MCDD 2 (Table 9) selected by me after careful core and petrographic examination (1.9-2.6%), with the three less carefully selected samples from the same hole analyzed by AMDEL (0.5-2.7%)

Significant emphasis is placed on interpretation of REE patterns. Essential immobility of REE has been suggested by numerous studies of natural examples of alteration of basalts and andesites and by experimental studies of basalt-water interaction at temperatures above 150^{o} . In contrast, other studies have reported limited REE mobilty during relatively intense alteration of volcanic rocks (Hellman and Henderson 1977; Whitford et al. 1988). The meta-andesites studied by Hellman and Henderson (1977) and Whitford et al. (1988) were considerably more altered than samples selected for the present study, including those more-than-typically altered Mt. Cattley MCDD 2 andesites. Altered lavas studied by Hellman and Henderson (1977) showed extensive development of patchy, almost monomineralic epidote (Ca-rich) and albite (Na-rich) domains, whereas in the study by Whitford et al. (1988) of hydrothermally altered andesites around the Que Rv. massive sulphide deposit, many lavas were extensively silicified or showed intense sericite- carbonate alteration. Despite this intense alteration, REE behaved remarkably coherently; REE patterns show either no change of slope, but only vertical translations due to dilution-residual enrichment processes, or very slight LREE depletion (flattening of patterns).

Whitford et al. (1988) argued that weakly-altered lavas (such as those selected for this study) have retained primary REE patterns, with only Eu showing some evidence for post-magmatic mobility in the form of larger-than-expected negative Eu anomalies in some samples. Similar examples of selective Eu depletion have been documented in altered lavas from around other massive sulphide deposits, and have been attributed to the ability of normally trivalent Eu to change to Eu^{2+} under hydrothermal conditions, and thus be available for leaching with Ca during albitization of calcic plagioclase and alteration of glass. In this respect, the erratic Eu abundances in the three quite altered Mt. Cattley MCDD2 lavas analyzed for REE (see later) takes on some exploration significance. As noted earlier in this report, the style of alteration shown by the MCDD 2 andesites is more typical of hydrothermal alteration than regional metamorphic degradation of similar lavas.

In summary, however, I am confident that for all the lavas studied for this project, the amount of REE mobility is certainly not enough to lead to an incorrect petrogenetic interpretation of the suites involved, and that for the least-altered MRV selected for this study, the REE patterns are representative of the primary magmatic REE patterns for these rocks, with the proviso that Eu abundances may have been slightly modified. In addition, abundances of Ti, Zr, Y, Nb, Sc, V and probably Ni, Cr, Fe and Mg in these lavas are little removed from their primary abundances in these rocks. While the K-group (K, Rb, Ba) elements and Ca, Na and Sr were undoubtedly more mobile, careful interpretation of their abundances in these least-altered MRV can provide petrogenetically useful information.

Wholerock Chemistry

Representative analyses of andesites, dacites and rhyolites from the Central Volcanic Complex are given in Appendix Tables 1 and 2; analyses of Western Volcanic Sequence lavas are given in Tables 3 and 4; analyses of the Que-Hellyer Footwall andesites are listed in Table 5, and analyses of the Mount Read lavas from Hellyer to Beulah are given in Table 6; analyses of lavas and granitoids from the Noddy Creek belt are given in Table 7, and analyses of Miners Ridge and Henty Dyke Swarm mafic lavas are given in Table 8. Finally, the Mt. Cattley lavas analyzed for this study, and also the six analyzed by AMDEL, are given in Table 9

Central Volcanic Complex

Within the main body of the Central Volcanic Complex from south of Queenstown to the Mount Charter Fault, the 61 analyzed least-altered lavas fall into two clearly defined compositional groups, clearly shown by the variation diagrams in Figure 5. Note that no lavas more mafic than 58% SiO_2 are known. Group 1 lavas are volumetrically dominant, and contain no amphibole in the andesite-dacite compositional range, whereas the Group 2 rocks almost always contain amphibole, and appear to be intrusive into the Group 1 lavas. The best occurrences of these Group 2 amphibole-bearing shallow intrusive rocks is around Crown Hill, N of Queenstown. Both suites are high-K calc-alkaline andesites.

Representative REE patterns of the Central Volcanic Complex Groups 1 and 2 rocks are given in Figure 6a. The Group 2 rocks are clearly considerably more enriched in REE, and have more pronounced LREE-enrichment than any Group 1 lavas at similar MgO levels, and lack the pronounced Eu anomalies that typify the Group 1 andesites.

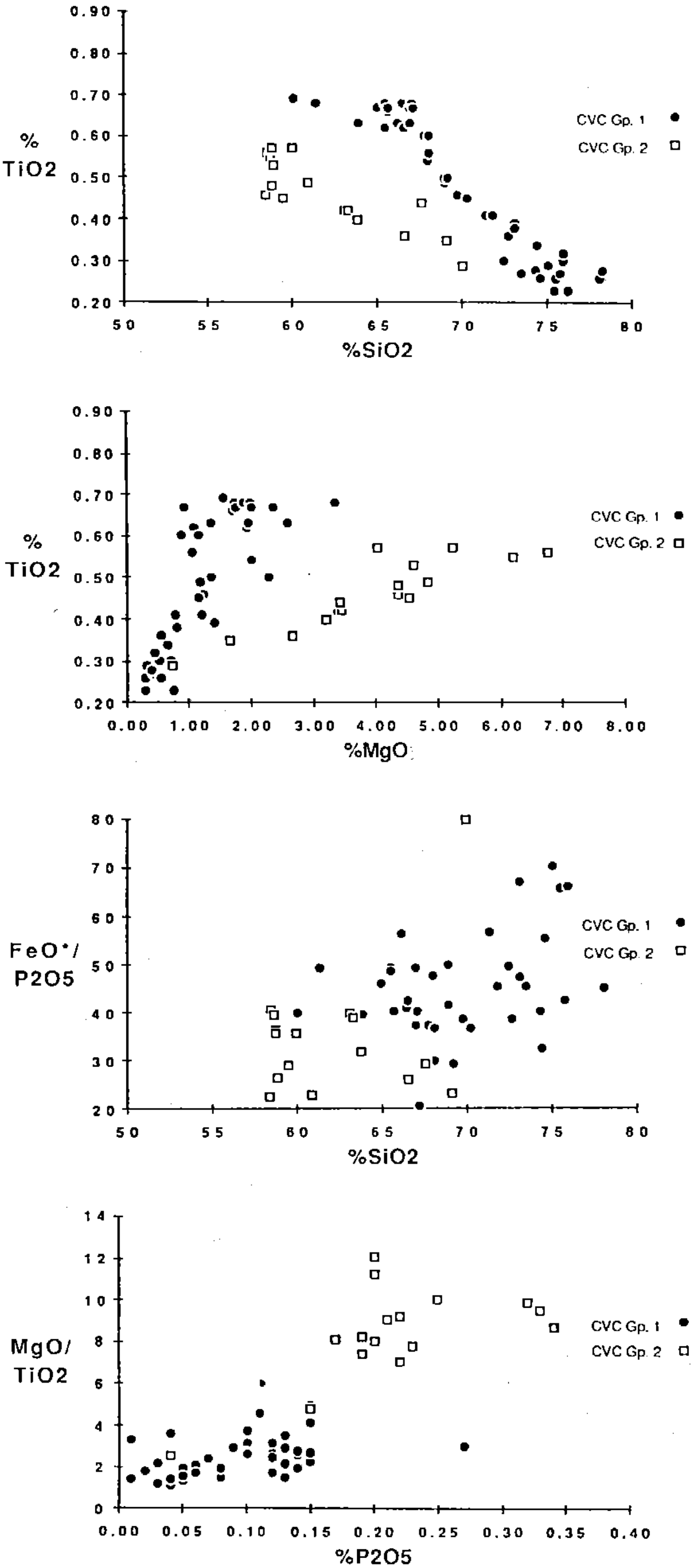

FIGURE 5: Variation diagrams showing distinct compositional fields for Mount Read Volcanics Central Volcanic Complex Group 1 and Group 2 lavas.

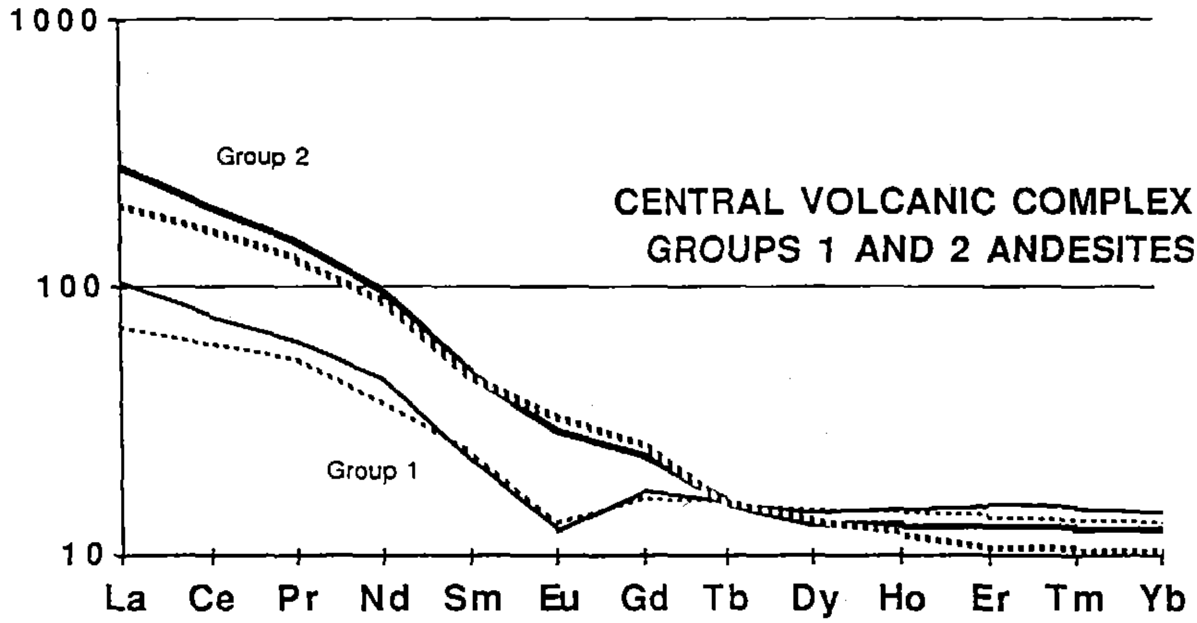

FIGURE 6a: *Chondrite-normalized REE patterns for representative andesites from Central Volcanic Complex Groups 1 and 2.*

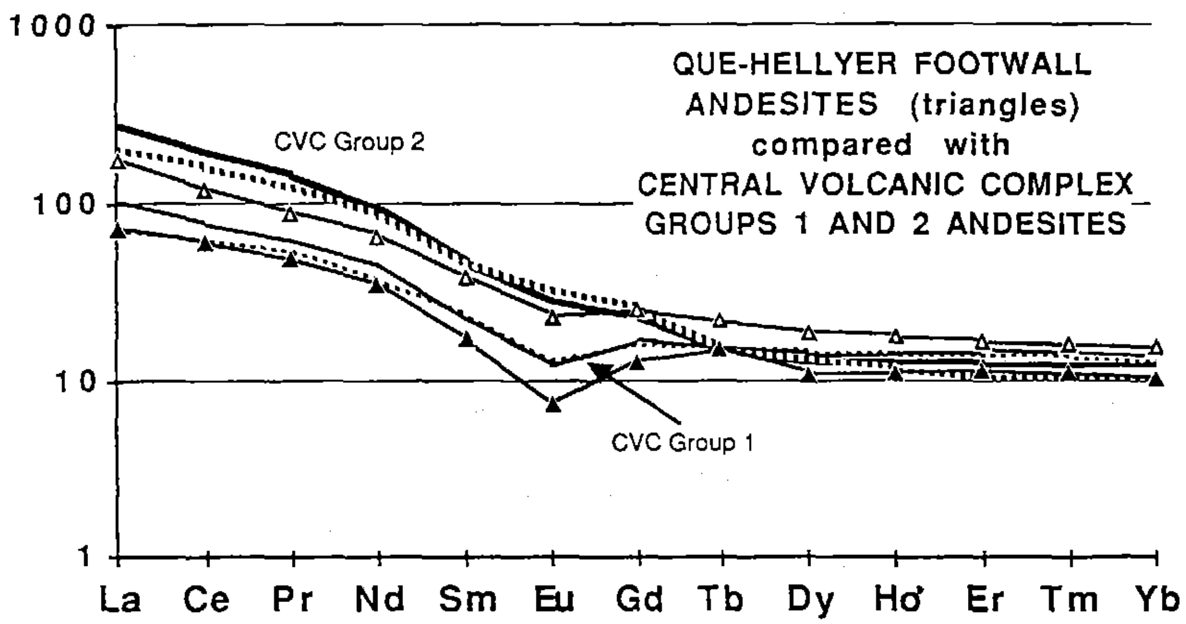

FIGURE 6b: Chondrite-normalized REE patterns for representative andesites from the Que-Hellyer Footwall sequence compared with the Central Volcanic Complex Groups 1 and 2 andesites.

Que-Hellyer Footwall Andesites

Abundant andesites and dacites in the area N of the Mt. Charter Fault, and occurring footwall to the Hellyer and Que Rv. massive sulphide deposits, are high-K calc-alkaline orogenic andesites. They are much less enriched in P_2O_5- and LREE contents than the far more magnesian Hellyer-Lynchford basalts, that are described further on. These footwall andesites, however, bear many compositional similarities to the Central Volcanic Complex Group 1 andesite-dacite- rhyolite lavas, as shown by the element variation diagrams in Figure 7. On most of the major element variation diagrams, the Que-Hellyer Footwall andesites bridge the compositional gap between the Central Volcanic Complex Groups1 and 2 lavas. Trace element ratios plotted against major element abundances or ratios (Figure 7 continued) show that the mafic Central Volcanic Complex Group 1 andesite with 61% SiO_2 tends to plot in the field of the Que-Hellyer Footwall andesites. Note that the great majority of analyzed Central Volcanic Complex Group 1 lavas have more than 65% SiO_2, whereas the Que-Hellyer Footwall lavas range down to 53% SiO_2 and have abundant lavas with less than 65% SiO_2.

It is generally accepted that the Que-Hellyer Footwall andesites are separated from the underlying Central Volcanic Complex lavas by the Precambrian-derived Animal Creek Greywacke. As suggested above, the Central Volcanic Complex Group 2 andesites and related rocks are compositionally transitional to the Western Volcanic Sequence andesites, and are clearly intrusive into the Group 1 CVC lavas. This implies that there may be a gradual temporal compositional change in the Mt. Read Volcanics from Group 1 CVC lavas, through Que-Hellyer Footwall andesites towards the Group 2 CVC intrusive andesites, and related lavas in the Western Volcanic Sequence. The latter grade into the exceptionally P_2O_5- and LREE-enriched shoshonitic basalts of the Western Volcanic Sequence.

Some evidence to support this hypothesis is shown in Figure 6b, where the two analyzed least-altered Que Rv. andesites can be seen to cover the range from CVC Group 1 andesites almost to the LREE levels of the more LREE-rich CVC Group 2 andesites.

Western Volcanic Sequence Lavas

Abundant basalts in the Western Volcanic Sequence both N and S of the Henty Fault System range compositionally from high-K calc-alkaline basalt compositions to exceptionally P_2O_5- and LREE-enriched shoshonites

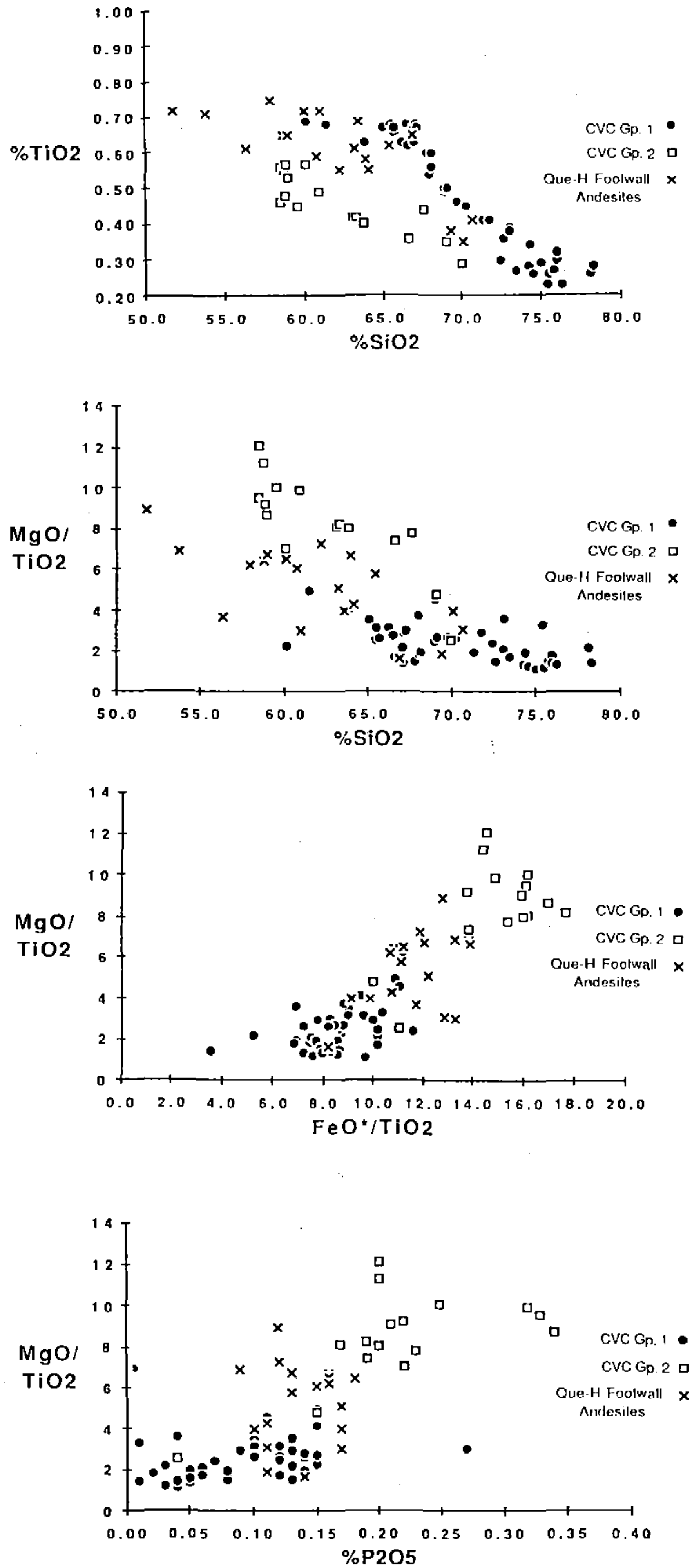

FIGURE 7: Element variation diagrams showing the compositional range for least-altered Que-Hellyer Footwall Andesites and more evolved lavas compared with those from Group 1 and 2 of the Central Volcanic Complex.

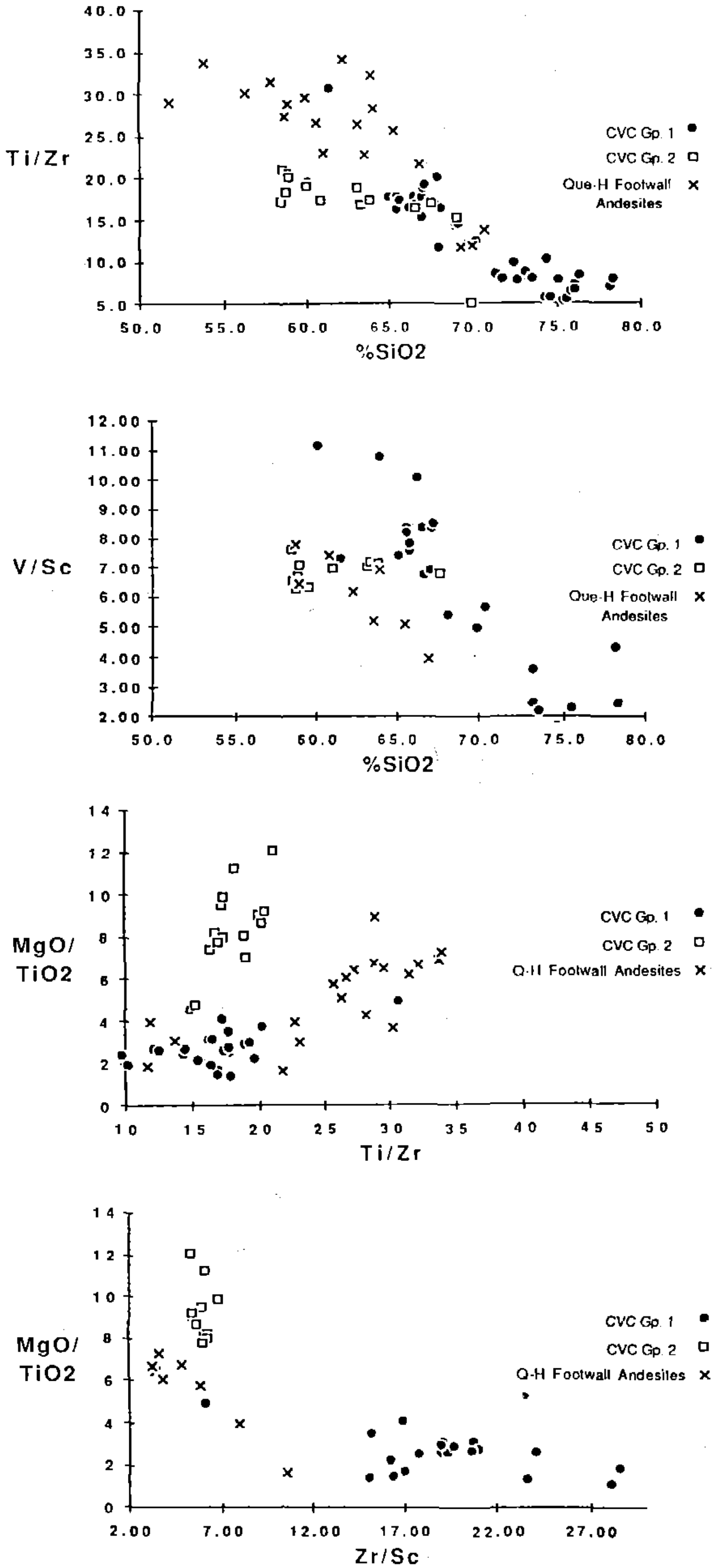

FIGURE 7 (continued): Further element variation diagrams showing the compositional range for least-altered Que-Hellyer Footwall Andesites and more evolved lavas compared with those from Group 1 and 2 of the Central Volcanic Complex.

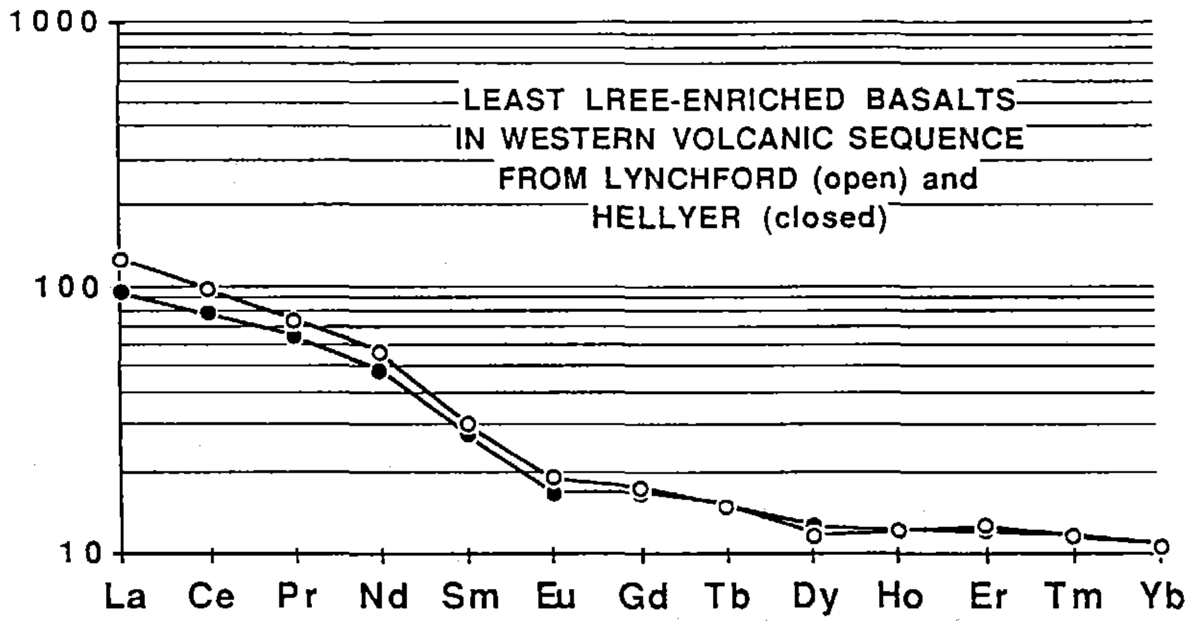

FIGURE 8a: Less LREE- and P-enriched endmembers of the shoshonitic basalt suite in the Western Volcanic Sequence from Hellyer and Lynchford.

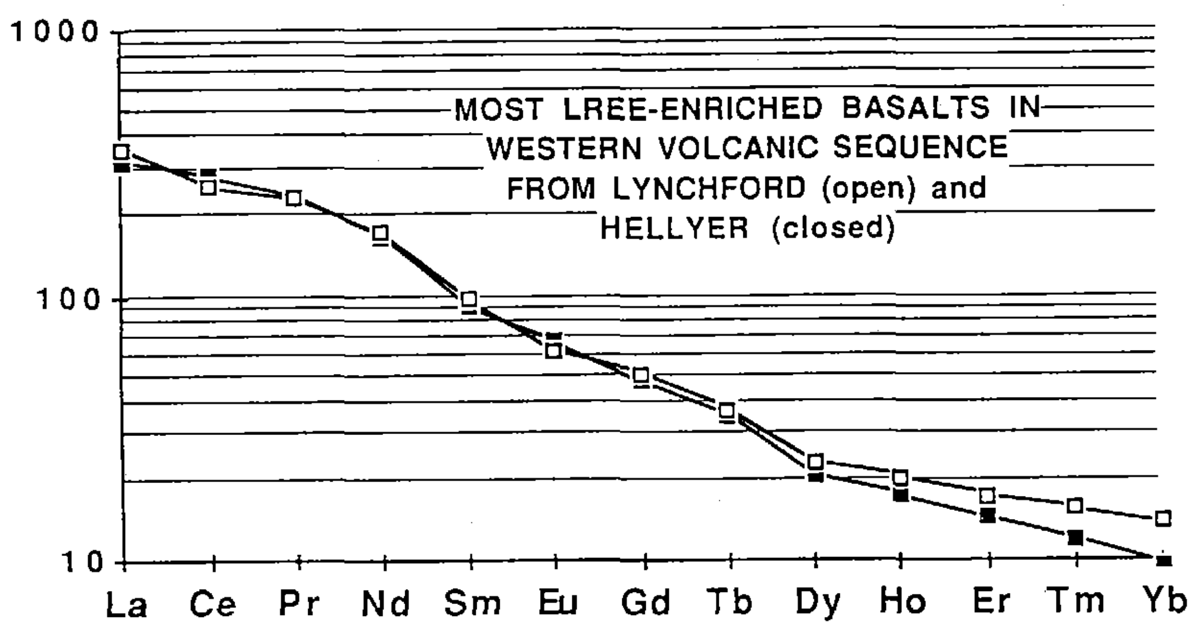

FIGURE 8b: Strongly LREE- and P-enriched endmembers of the shoshonitic basalt suite in the Western Volcanic Sequence from Hellyer and Lynchford.

(Tables 3 and 4). These occur in two main accumulations, at Hellyer, and another further south at Lynchford. Both probably represent volcanic edifices. No basaltic lavas are known from the Central Volcanic Complex, and the Western Volcanic Sequence andesitic lavas, although apparently subordinate volumetrically to basalts, are compositionally distinct from any possible parent magmas of the Central Volcanic Complex Group 1 andesites.

The less enriched end-members of the spectrum of (basalt and) andesite compositions in the Western Volcanic Sequence overlap compositionally with Central Volcanic Complex Group 2 andesites (Figure 8a), and extend to considerably higher LREE and P_2O_5, and lower Ti/Zr contents (Figure 8b and Tables 3 and 4).

The occurrence of strikingly unusual highly P_2O_5- and LREE-enriched (Figure 8b) magnesian basaltic lavas both in the northern part of the Western Volcanic Sequence (Hellyer area) and 50 km further south at Lynchford (west of Queenstown) forms the basis of my claim that Corbett's (1979) Western Sequence in the Queenstown area is likely to be younger than the Central Volcanic Sequence, and a correlate of the Hellyer basalt-andesite sequence.

Noddy Creek Volcanics

Representative analyses of the Noddy Creek Volcanics are given in Table . These are a high-K calc-alkaline suite extending across the basalt to rhyolite compositional range. They are plotted along with the Central Volcanic Complex lavas and the Que-Hellyer Footwall lavas in element variation diagrams in Figure 9. Compositional fields of the Noddy Creek rocks as shown in Figure 9, plus REE patterns (Fig. 10) suggest that both the compositional groups recognized within the Central Volcanic Complex are also present in the Noddy Creek belt. This is further supported by the observation that the group of Noddy Creek rocks with the higher REE levels, close to those of the Central Volcanic Complex Group 2, are hornblende diorites and granodiorites compositionally and mineralogically very close to the CVC Group 2 hornblende-bearing lavas. One difference from the Central Volcanic Complex, however, is that the extrusive basalts within the Noddy Creek Volcanics have no known counterparts in the Central Volcanic Complex.

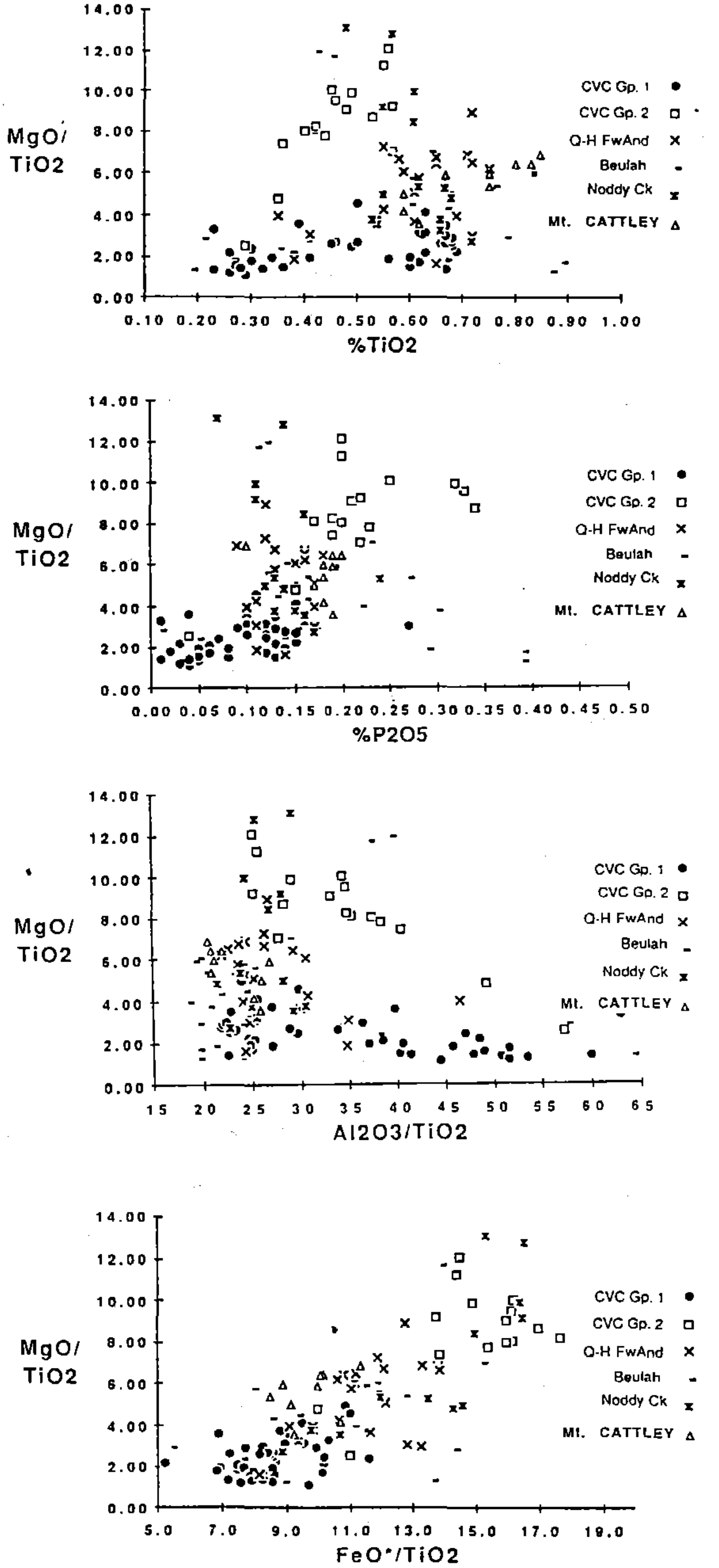

FIGURE 9: Element variation diagrams showing compositional fields for Central Volcanic Complex lavas, Que-Hellyer Footwall Lavas, the Noddy Creek belt lavas and intrusives, the Mount Cattley lavas, and lavas from the region between Hellyer and Beulah.

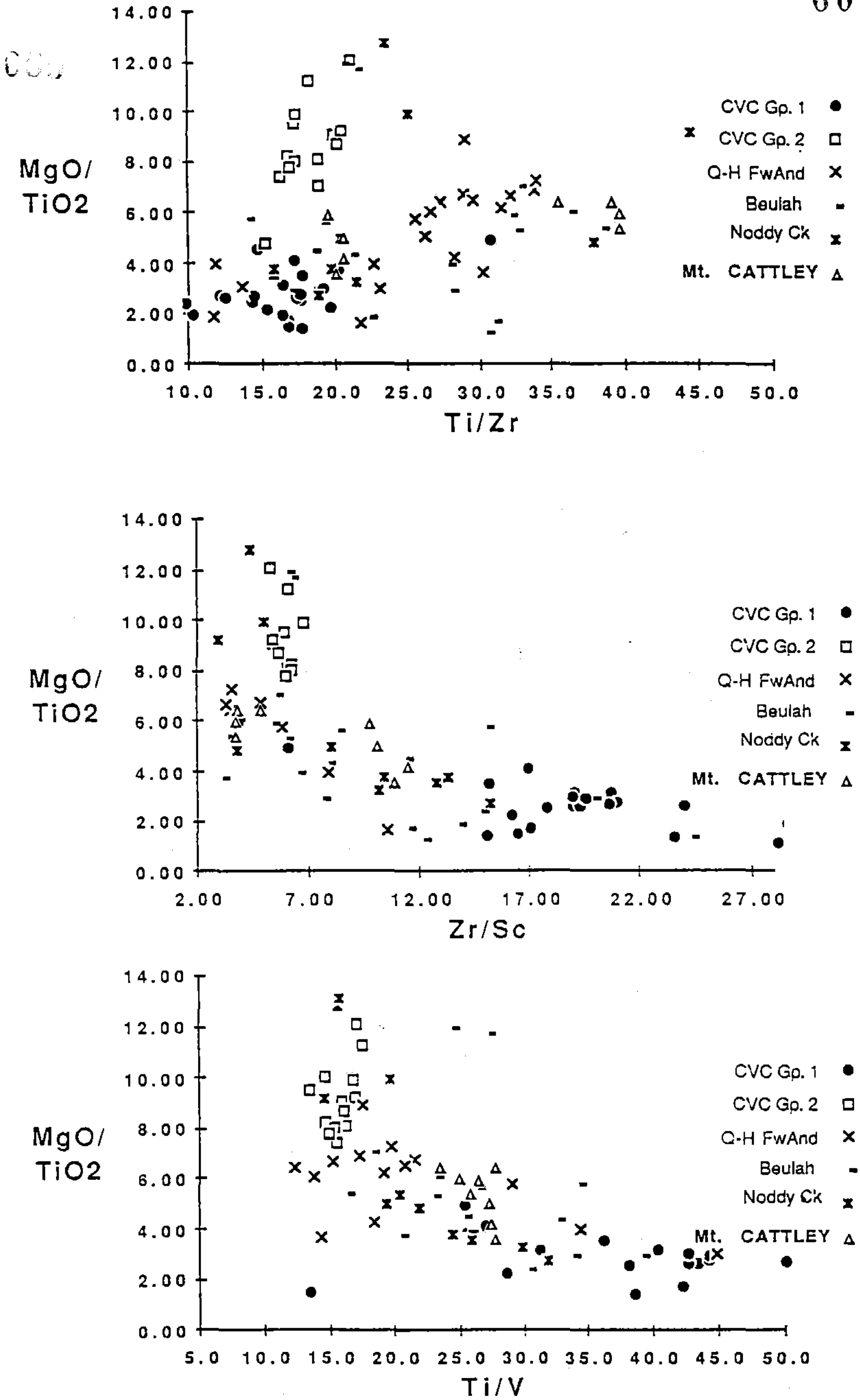

FIGURE 9: Element variation diagrams showing compositional fields for Central Volcanic Complex lavas, Que-Hellyer Footwall Lavas, the Noddy Creek belt lavas and intrusives, the Mount Cattley lavas, and lavas from the region between Hellyer and Beulah.

(continued):

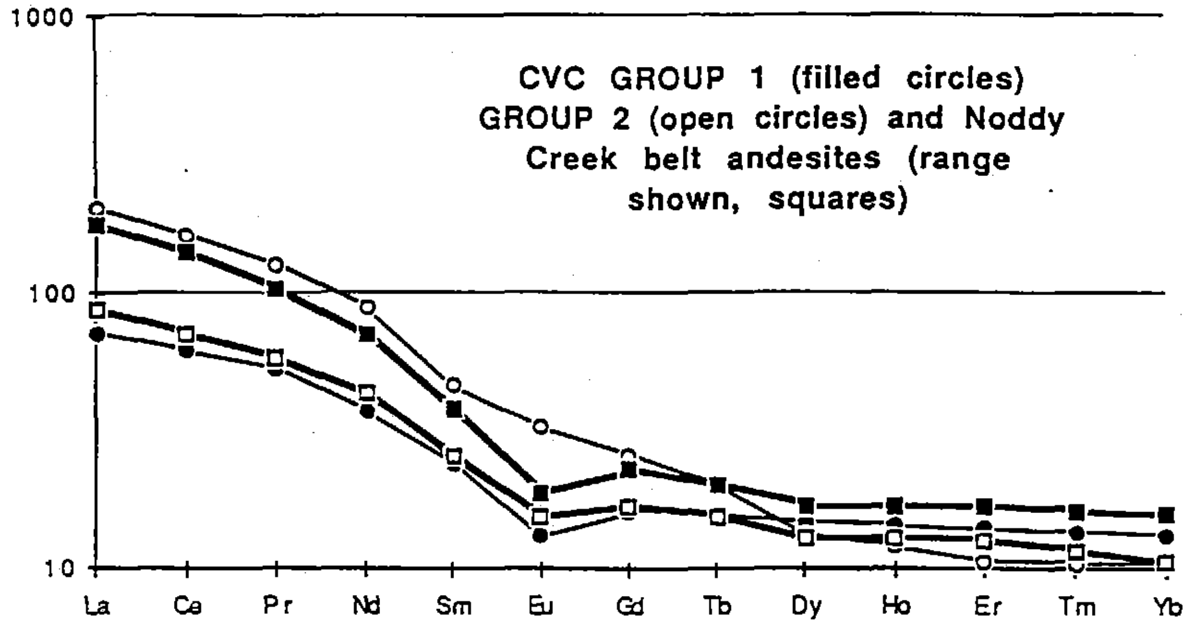

FIGURE 10: REE patterns for representative Noddy Creek balt andesite (open circle) and intrusive hornblende-bearing diorite (filled squares), with two representative patterns for Central Volcanic Complex andesites from Group 1 (filled circles) and Group 2 (open circles).

The Tyndall Group

Geochemical study of the Tyndall Group and the Cambrian granitoids in western Tasmania is only now commencing, so it is premature to draw any firm conclusions about the compositional affinities and correlations of these lavas, which for the available data, always have more than 66 SiO_2. However, it appears that in most respects, the lavas at least are similar to the Group 1 Central Volcanic Complex lavas with similar SiO_2 levels.

The Henty Dyke Swarm and Henty Fault Wedge Sequence.

As for the Tyndall Group, geochemical studies of these rocks have only recently commenced. However, on the basis of available data, it is clear that both the Henty Dyke Swarm and the Henty Fault Wedge are basalt-dominated sequences, and that the lavas are tholeiitic (Table 8), with relatively flat REE patterns (Fig. 11a) and other immobile trace element ratios most similar to incipient backarc basin basalts. The dyke swarm, at least, attests to an episode of tension and rifting of the Central Volcanic Complex that has no known counterpart in the Western Volcanic Sequence. It will be critical to determine if Henty Dyke Swarm correlates are present in the Hellyer to Beulah area.

The Miners Ridge Basalts

Basalts outcropping in the anticlinal core within the Western Volcanic Sequence at Miners Ridge are compositionally (Table 8) unlike the MRV, in that they are strongly tholeiitic, with Ti/Zr values from 90 to 160, very low P_2O_5 contents, and strongly depleted REE patterns (Fig. 11b). All these compositional features are characteristic of island arc tholeiites erupted in an intra-oceanic arc setting, such as those presently erupting in the Tongan and Vanuatu arcs. In this respect, they would seem to be unrelated to the MRV. They probably formed, together with the large ophiolites along the western margin of the Dundas Trough, part of the allochthon of forearc crust that was emplaced on Rocky Cape passive margin crust during the Middle Cambrian arc-continent collision which constructed much of the crust of western Tasmania (see later).

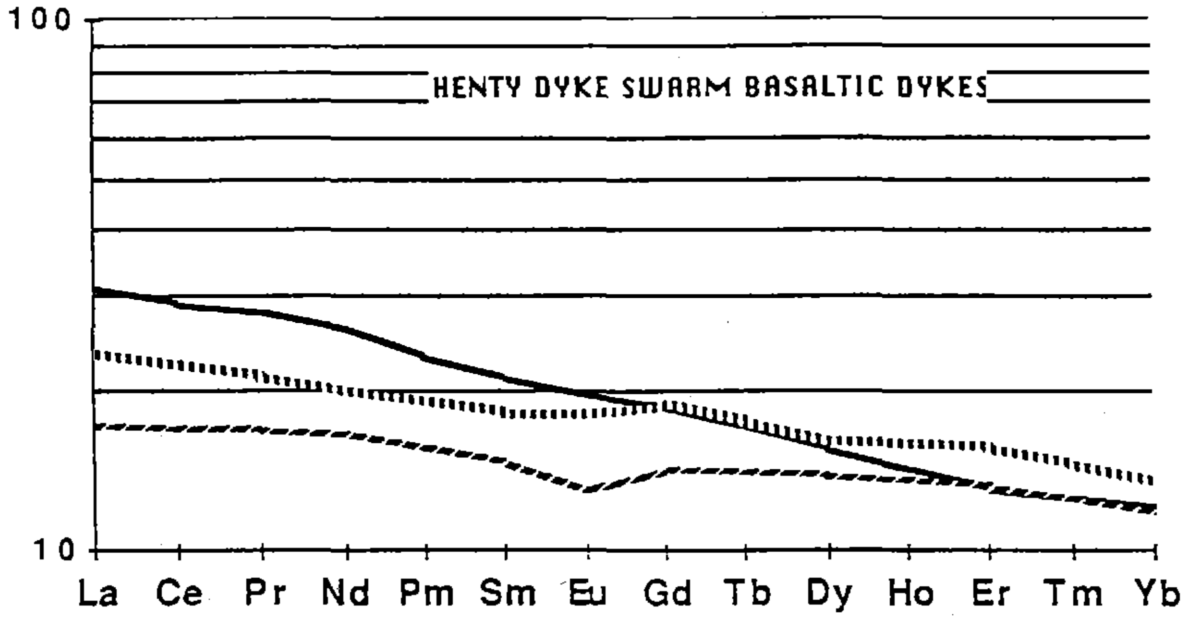

FIGURE 11a: REE patterns for representative Henty Dyke Swarm basalts

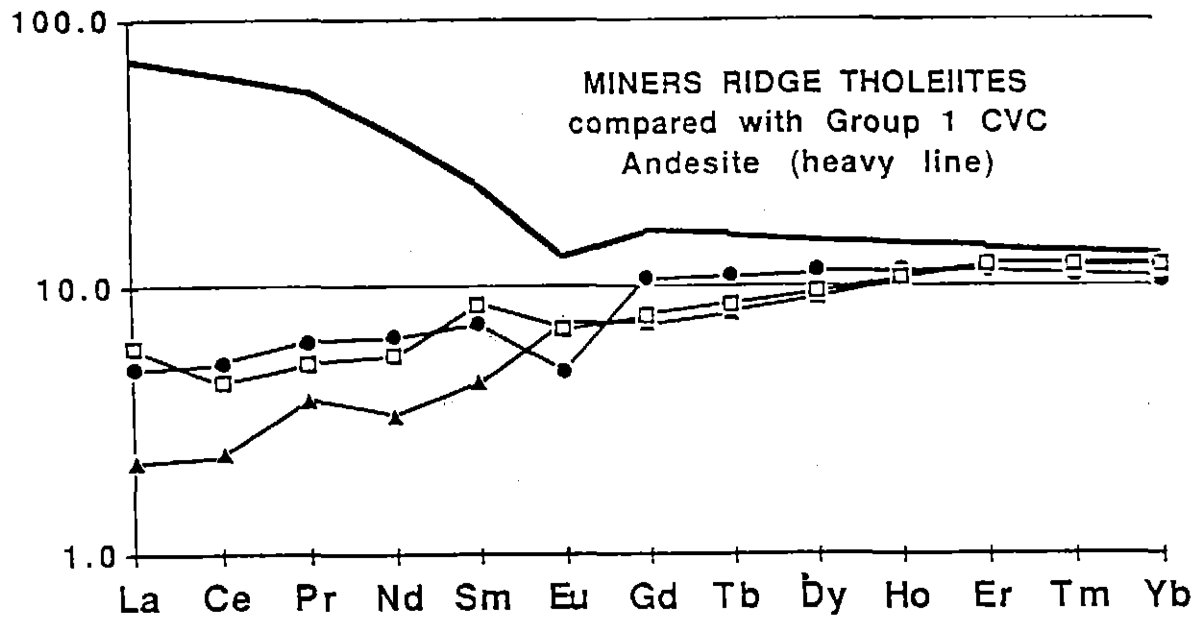

FIGURE 11b: REE patterns for representative Miners Ridge arc tholeiites, with a Group 1 Central Volcanic Complex andesite REE pattern shown for comparison.

CORRELATION OF THE MOUNT CATTLEY LAVAS

PETROGRAPHIC SUMMARY OF THE ANALYZED LAVAS

MCDD 2: Six of the seven samples analyzed from MCDD 2 were examined in thin section. All are very similar slightly vesicular aphyric andesites with rare albitized plagioclase microphenocrysts in a pilotaxitic (trachytic) flow-textured groundmass. No primary minerals are preserved, but original textures are well-preserved. Vesicles are filled by calcite and/or quartz. All the analyzed lavas are pervasively altered to carbonate- sericite assemblages, and the intensity of this alteration is considerably greater than is 'normal' for regionally prehnite-pumpellyite grade metamorphosed MRV. It is more typical of the alteration seen around the Que massive sulphide deposit. Petrographically similar aphyric andesitic lavas are known from the area around the Beulah barite occurrence, presently under investigation by Aberfoyle Exploration Ltd., and from several other locations within the MRV, notably in the Leven Gorge.

MCDD 3: These samples vary from porphyritic andesites to porphyritic rhyodacites. They have been subdivided into two groups. Group 1 includes the more andesitic lavas, which are plagioclase+augite -phyric, and contain a notable amount of apatite and FeTi oxide microphenocrysts in a devitrified and recrystallized formerly glassy groundmass. These Group 1 lavas are often autobrecciated, and both plagioclase and augite are altered, to albite and chlorite respectively.

Group 2 lavas from MCDD 3 are porphyritic rhyodacites and rhyolites from the generally flow-banded body of pinkish-grey felsic lavas logged by Wally Herrmann from 109.4m-125.1m. These are petrographically little different from the Group 1, as reflected in the chemical analyses (Table 9). The pink colour of these rocks relative to those in Group 1 is clearly not due to K feldspar, as the grey coloured more andesitic lavas contain over 1 wt.% more K_2O than the analyzed rhyodacite from the flow-banded body. As indicated by the analyses in Table 9, there is little doubt that all the lavas studied from MCDD 3 are comagmatic and probably were erupted from the same fractionating magma chamber.

The metamorphic assemblage of lavas in MCDD 3 is prehnite-pumpellyite facies, and the extent of alteration is typical of that seen on a regional scale in the MRV, and notably less intense than shown by the MCDD 2 lavas.

COMPOSITIONAL FEATURES OF MT. CATTLEY LAVAS

MCDD 2

Compositions of MCDD 2 lavas are given in Table 9. Volatile-free SiO_2 contents vary from 55.8% to 61.3%, and MgO contents show a serial decrease from 5.9% to 4%. The rocks are therefore andesitic. It is difficult to judge whether or not all five samples come from a single flow, or whether a number of distinct flows were sampled. Neither Wally Herrmann (1986) nor I could determine whether flow margins existed within this section (72.5 - 117.5m) of core. If the samples all come from the same flow, it must be at least 31m thick, and the compositional differences recorded between the five analyzed MCDD 2 lavas must be attributable to variations in phenocryst abundance (eg. local depletion or accumulation of augite). If the samples, instead, represent several different flows, the remarkably similar Ti/Zr and other immobile element ratios of the analyzed MCDD 2 lavas indicate that these lavas are certainly comagmatic.

Although the alkalies (Na, K, Ba, Rb) are undoubtedly mobile to some extent during the style of metamorphic degradation that produced the carbonate+sericite-rich secondary assemblages in these lavas, the range of K_2O contents is only from 1.91 to 2.56%, and averages 2.2%. Similarly, Ba contents range from 1033 to 1410ppm, averaging 1260ppm. These values are probably not far removed from the primary values, as much less altered MRV andesites from Beulah and the Que-Hellyer Footwall andesites generally fall within this range. If this interpretation is correct, these andesites fall on the boundary between medium- and high-K calc-alkaline andesites (see Fig. 4). The FeO^* and TiO_2 contents decrease with fractionation, as is typical of calc-alkaline andesites. CaO contents are highly variable, from 1.3 to 6.1%, reflecting the variable modal abundance of secondary calcite. The remarkably high Ba contents are considered to be primary, as mentioned above, and are a characteristic feature of the MRV. The rare earth element patterns (Fig. 12a) are LREE-enriched, with flat HREE levels, as is typical of most orogenic andesites. The affinities of the Mount Cattley and other MRV andesites are discussed in a later section.

MCDD 3

These lavas are significantly less altered than those in MCDD 2, as indicated by the lower loss on ignition values for the MCDD 3 lavas. They

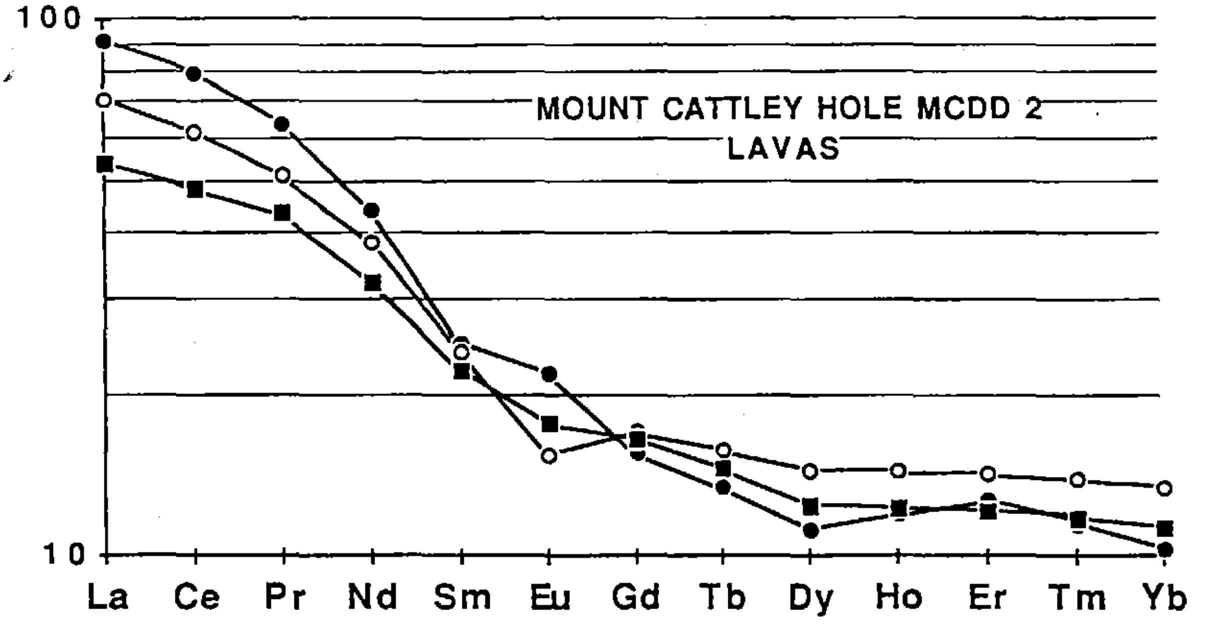

FIGURE 12a: REE patterns for lavas from Mount Cattley drillhole MCDD 2

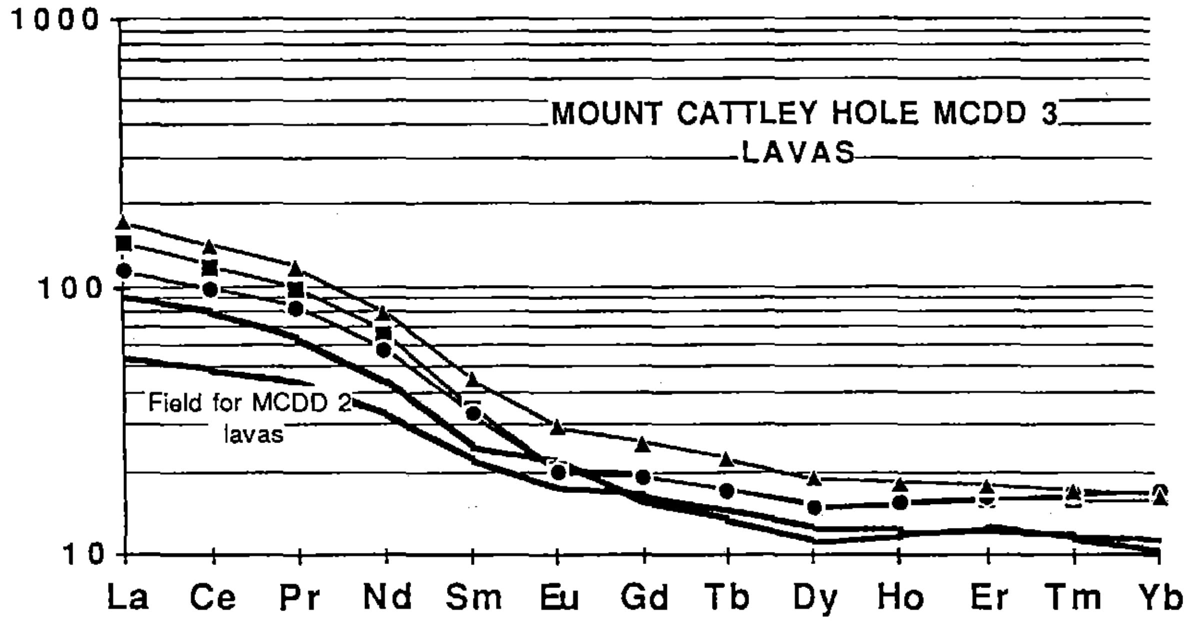

FIGURE 12b: REE patterns for lavas from Mount Cattley drillhole MCDD 3

range in composition from andesites with 62% SiO_2 and 4% MgO (eg. 104.3m) to rhyodacites with 72.5% SiO_2 and 0.75% MgO. Several distinct flows are clearly represented, including the thick banded rhyodacite (eg. 122,4m) between 109.4 to 125.1m, and dacites (eg. 112.7m, 103.3m and 126.0m) above and below the banded rhyodacite. These lava flows are almost certainly comagmatic, as indicated by the immobile element ratios and REE patterns (Fig. 12b).

It is important to attempt to determine whether or not the lavas in MCDD 2 are comagmatic with those in MCDD 3. To do this, it is best to compare immobile element ratios and REE patterns of representative lavas from both holes *at approximately the same stage of fractionation* (ie, at similar SiO_2 and MgO abundances). The closest approach to this ideal condition involves comparing #117.1 from MCDD 2 with #104.3 from MCDD 3 (61.3% versus 62.0% SiO_2 and 4.5% versus 4% MgO). It is immediately evident from Table 9 that the MCDD 2 and 3 samples have dramatically different Ti/Zr, Zr/Sc and Ti/V ratios, and that the LREE contents of the MCDD 3 lava(s) are three times those of the andesite from MCDD 2 at similar P_2O_5 contents. These features together indicate that the lavas in MCDD 2 are clearly not comagmatic with those in MCDD 3, but were derived from a more 'enriched' parent magma (and presumably, enriched source). The CaO contents of the lavas in MCDD 3 have been strongly depleted, and comparison with best-preserved MRV andesites suggests that the original CaO abundances in the andesites and dacites were probably three to five times higher. As for the MCDD 2 lavas, abundances of K_2O and Ba are high, and suggest affinities with high-K orogenic andesites.

The three MCDD 3 lavas analyzed by AMDEL show essentially the same compositional range, and have the same compositional implications, as those analyzed in this Department. However, two of the three AMDEL-analyzed MCDD 2 lavas are considered to be too altered to be useful in interpretation, and the third (107.7m) is very close compositionally to my sample #111m.

In summary, andesitic to rhyodacitic lavas in Mt. Cattley holes 2 and 3 are high-K calc-alkaline orogenic lavas, with strong LREE-enrichment. At similar degrees of fractionation, notably different immobile element ratios and REE levels indicate that the MCDD 2 lavas are not comagmatic with those in MCDD 3.

CORRELATION OF MT. CATTLEY LAVAS WITHIN THE MT. READ VOLCANICS

Element variation diagrams given in Figure 13 show compositional fields of the analyzed Mt. Cattley lavas together with those of the Groups 1 and 2 lavas from the Central Volcanic Complex, and the Que-Hellyer Footwall andesites. The Mt. Cattley lavas, being andesitic or more evolved, are not comparable with any Western Volcanic Sequence lavas, which are thus not shown in Figure 13. Certain positive conclusions can be drawn from the data shown in these element variation diagrams. Firstly, it is quite clear that the Cattley lavas are not compositionally related to the generally intrusive and hornblende-bearing Group 2 andesites from the Central Volcanic Complex. It is evident from Figure 13 that a high degree of overlap exists between the compositional fields for the Que-Hellyer Footwall andesites and the Cattley andesites, and that this similarity extends towards rhyodacitic compositions. Perhaps the only significant difference between these two suites is the slightly higher TiO_2 contents and Ti/Zr of the Cattley andesites with around 60% SiO_2; however, in terms of the overall similarity of these suites, such differences are trivial.

REE patterns of the Cattley lavas are compared with the Que-Hellyer Footwall lavas in Figure 14. As already noted above, the MCDD 3 lavas are more LREE-enriched than those in MCDD 2, and have REE patterns almost identical to the more enriched end-members of the Que-Hellyer Footwall andesites. In contrast, the MCDD 2 lavas show lower REE levels, and overlap the less-enriched Que-Hellyer Footwall lavas. The prominent negative Eu anomaly in Que andesite 502650 may be due to its proximity to footwall alteration beneath the orebody (see earlier discussion of selective Eu mobility).

In summary, the spectrum of Cattley andesite compositions ranges from less-LREE enriched andesites (Hole 2) with relatively high Ti/Zr (~40) to more strongly LREE-enriched andesites (Hole 3) with lower Ti/Zr values. A virtually identical range of compositions is found within the Que-Hellyer Footwall andesites, and a strong case is therefore made that the Cattley lavas are correlates of the Que-Hellyer Footwall andesites.

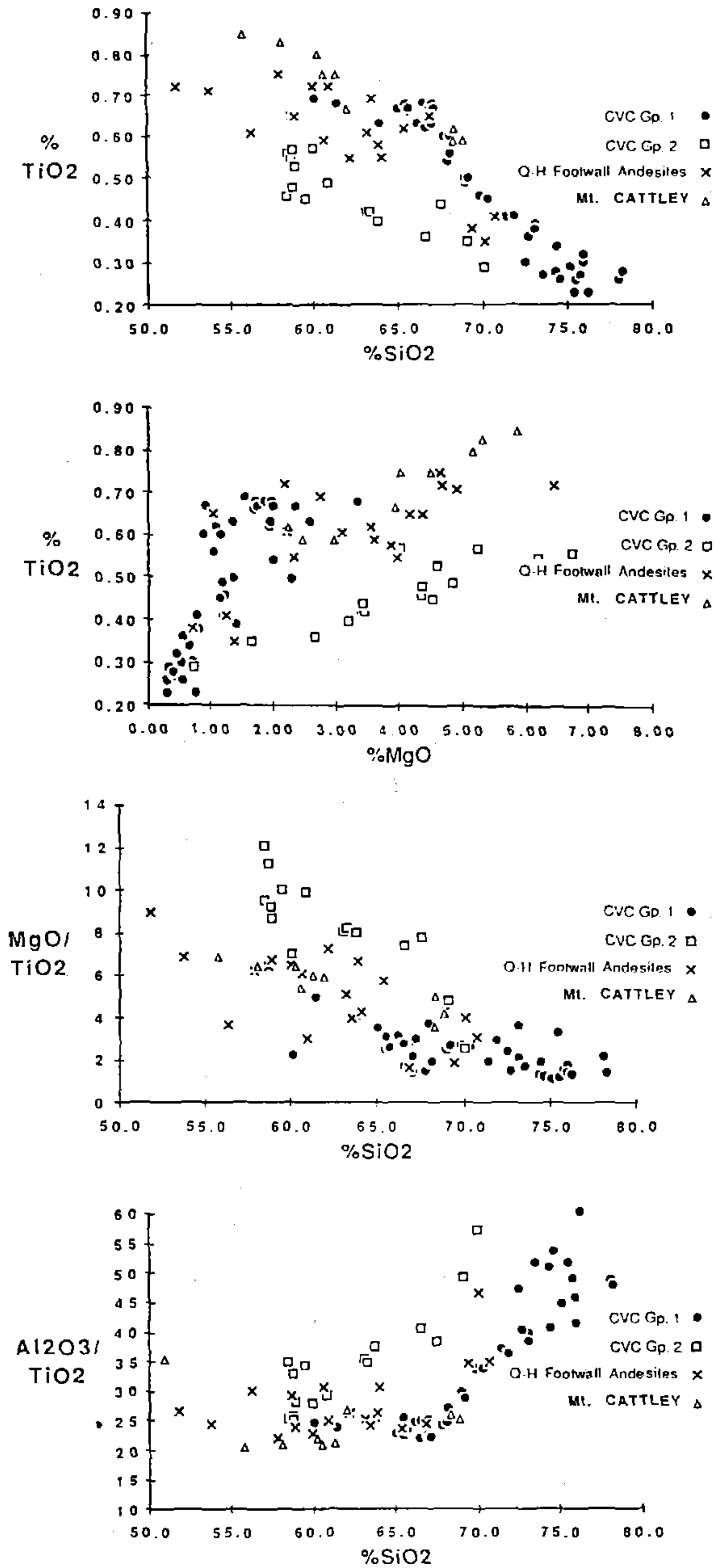

FIGURE 13: Element variation diagrams showing compositional spread of lavas from the Central Volcanic Complex, the Que-Hellyer Footwall andesites and the Mount Cattley lavas.

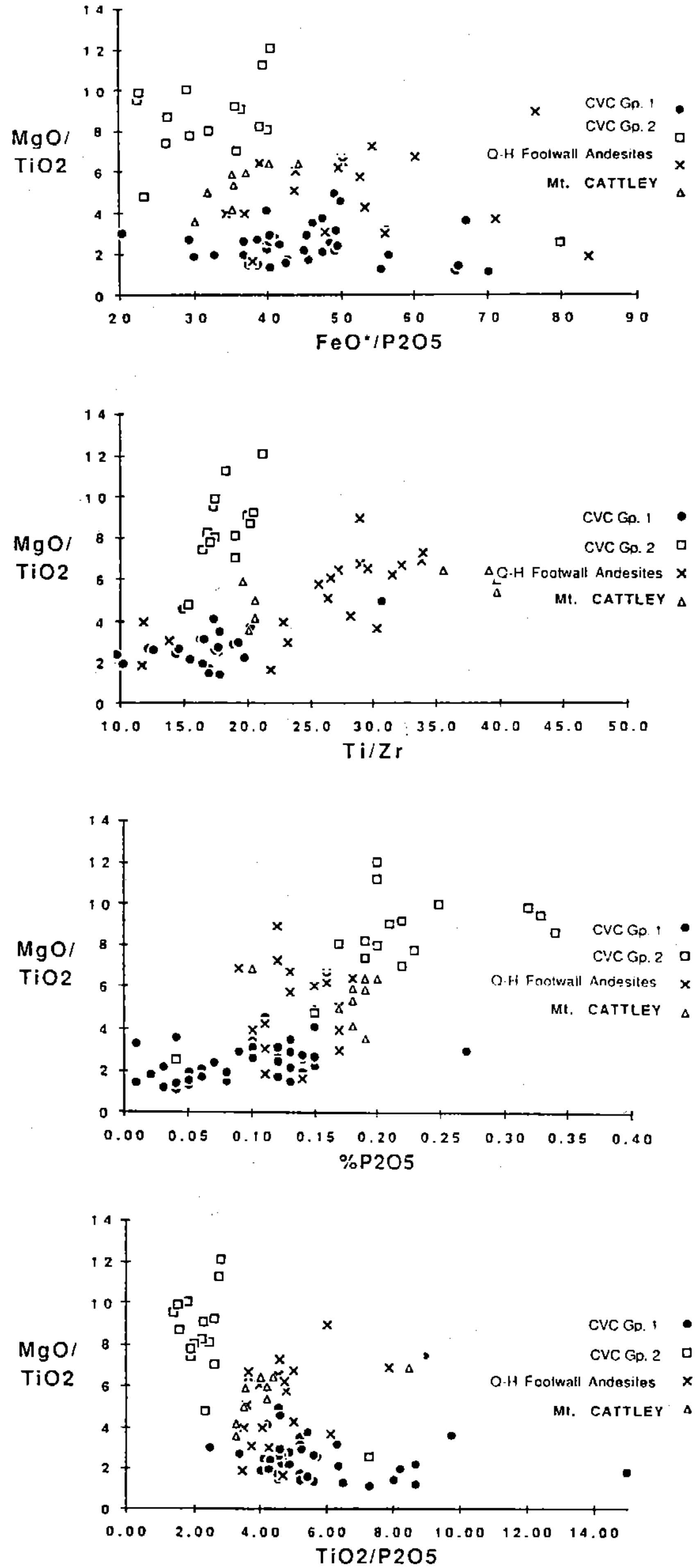

FIGURE 13: (continued): Element variation diagrams showing compositional spread of lavas from the Central Volcanic Complex, the Que-Hellyer Footwall andesites and the Mount Cattley lavas.

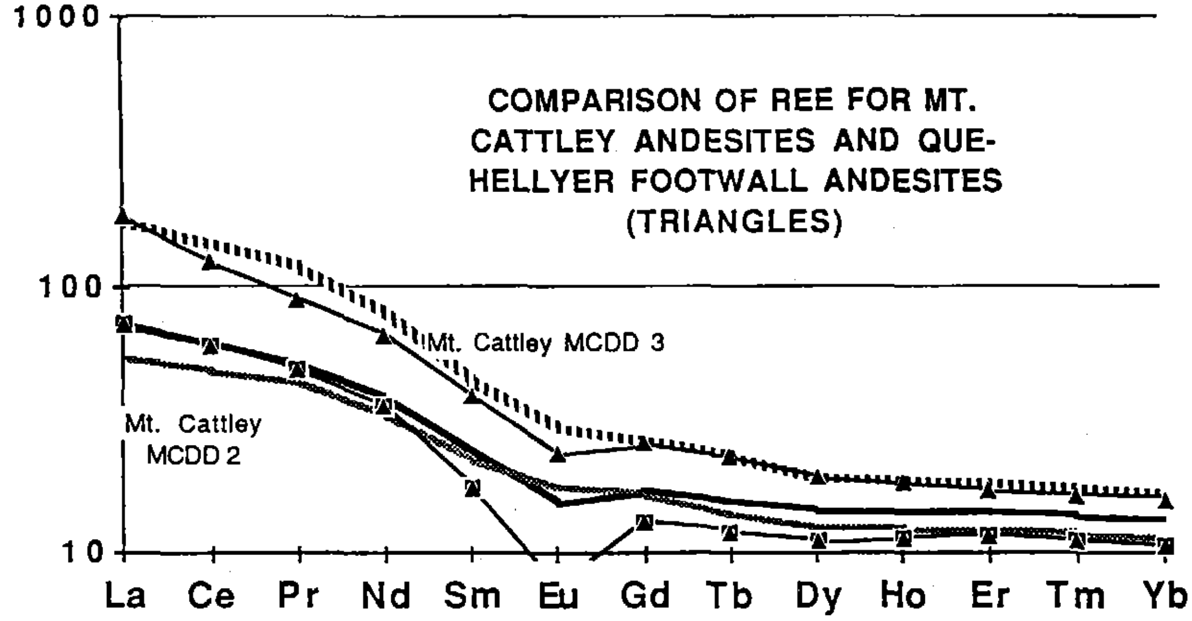

FIGURE 14: REE patterns for lavas from Mount Cattley andesites compared with patterns for the most- and least- LREE-enriched andesites from the Que - Hellyer Footwall andesites.

SUMMARY OF THE GEOCHEMICAL CORRELATIONS WITHIN THE MOUNT READ VOLCANICS

The element variations diagrams presented in all the foregoing discussion, which are combined in Figure 9, suggest to me the following conclusions regarding correlations within the MRV.

1. The primitive, LREE-depleted tholeiites exposed at the base of the Western Volcanic Sequence at Miners Ridge are probably part of the ophiolitic allochthon extending along the western side of the Mt. Read Volcanics belt, and formed in an intra-oceanic island arc. The Western Volcanic Sequence lavas may have been erupted partly or entirely through and onto this ophiolitic sheet.
2. The Western Volcanic Sequence lavas are basalt dominated and occur in two major accumulations, at Hellyer and at Lynchford. These basalts range from high-K basalts to exceptionally LREE-and P_2O_5-enriched shoshonitic compositions. The latter are characteristic of post-collisional magmatism, and their tectonic significance will be discussed further on.
3. Rocks classified as belonging to the Central Volcanic Complex of the MRV in the area from the Mount Charter Fault to south of Queenstown are high-K orogenic andesites and fall into two major compositional groups. The older Group 1 andesite-dacite-rhyolite sequence (minimum SiO_2 content 58%) is intruded by the often hornblende-bearing Group 2 andesitic to dacitic rocks, which are much more strongly REE-enriched, and have lower TiO_2 and higher P_2O_5 contents at any stage of fractionation. It should be examined in the future whether these Group 2 rocks are compositionally transitional into the Western Volcanic Sequence lava spectrum.
4. North of the Mount Charter Fault, the Que-Hellyer Footwall andesite-dacite sequence shows a strong compositional overlap with the Central Volcanic Complex Group 1 lavas, but nevertheless can be discriminated from the latter using appropriate variation diagrams. The Quė-Hellyer Footwall andesites show a range of compositions, from relatively weak LREE-enrichment, to quite pronounced LREE-enrichment, approaching levels shown by the Central Volcanic Complex Group 2 lavas. This sequence of lavas is separated from the overlying Hellyer basalts and shoshonites by the Animal Creek Greywacke (see Figs. 2 and 3.)

5. The sequence of lavas exposed on the Sorell Peninsula, known as the Noddy Creek Volcanics, shows an almost identical range of compositions to the Central Volcanic Complex, except that it contains basaltic flows which remain undiscovered if they exist within the Central Volcanic Complex. Both the less LREE-enriched (Group 1) and more strongly LREE-enriched (Group 2) suites represented in the Central Volcanic Complex are also present in the Noddy Creek Volcanics, with the further similaritiy that the Group 2 correlates are hornblende-bearing intrusives similar to many of the Central Volcanic Complex Group 2 lavas around Crown and Leach Hills, N of Queenstown.
6. The poorly-known lava sequence extending from Hellyer to Beulah further east, and including the Mount Cattley lavas studied, also shows a compositional range overlapping extensively with the Central Volcanic Complex and especially with the Que-Hellyer Footwall lavas. No correlates of the enriched Hellyer and Lynchford basalts of the Western Volcanic Sequence are known to date from this belt.
7. Preliminary geochemical studies of the Tyndall Group are only just commencing, but the small amount of available data suggest that the few Tyndall Group andesites known (from the Lake Selina area) are compositionally identical to the Group 1 Central Volcanic Complex lavas. As it is presently understood, I am not happy with the definition and interpretations of the distribution and significane of the Tyndall Group. It seems to me to be simply the top part of the Central Volcanic Complex, separated from the main underlying lava pile by a weak (or sometimes probably absent) dis- or unconformity.
8. Finally, the Central Volcanic Complex is intruded by abundant basaltic dykes of the Henty Dyke Swarm. These basalts are closest compositionally to young and incipient backarc basin basalts, and are unknown intruding the Western Volcanic Sequence or the belt of Mount Read Volcanics north of the Mount Charter Fault and also east of Hellyer.

GEOLOGICAL IMPLICATIONS OF THE PROPOSED CORRELATION OF THE MT. CATTLEY LAVAS

A main aim of this study was to determine the stratigraphic location of the Mt. Cattley lavas within the MRV. Two alternatives were considered possible.

1. The Cattley lavas are correlates of the Que-Hellyer footwall lava sequence, and that the Hellyer basalt and Que River Shale are 'above' the drilled sequence and remain unlocated in the Mt. Cattley area.
2: The entire drilled sequence in the Mount Cattley EL is within the Southwell Subgroup and stratigraphically above the Que River Shale and Hellyer basalts. In this case, the lavas in holes 2 and 3 represent a newly-discovered episode of mafic-intermediate magmatism within the Dundas Group, which elsewhere in the Mount Read Volcanics and Dundas Trough is represented by felsic pyroclastics, epiclastics and volcanogenic greywackes.

The available data in my opinion strongly supports the first alternative. Geological support for this correlation comes from the presence of Precambrian metamorphic-derived greywacke beneath volcanics in MCDD 1, and also in MCDD 4, which are petrographically identical to the Animal Creek Greywacke, that underlies the Que-Hellyer Footwall lavas further south.

Several arguments against alternative 2 above may also be made. Firstly, there is fairly concrete evidence that within the MRV, magmatism became more K-, LREE- and P2O5-enriched with time, reaching an extreme in the shoshonites of the Western Volcanic sequence, and including the uppermost basalts at Hellyer and Lynchford. Such compositions remain unknown in the long section of MRV east of Hellyer. Secondly, the only known occurrence of lavas within thwhat is unambiguous Dundas Group sequences is at Montezuma Falls near Dundas, where the so-called Curtin-Davis Volcanics outcrop over a limited area. These lavas are strongly altered, but the three available analyses (Foden 1973) of Curtin-Davis andesites have high P_2O_5 contents from 0.46 to 0.75%. These are clearly more P_2O_5- (and almost certainly LREE-) enriched than any Central Volcanic Complex rocks, and invite comparison with Western Volcanic Sequence basalts and andesites. The existence of these 'enriched' lavas well up in the Dundas Group supports my conclusion that magmatism became more P_2O_5 - and LREE-enriched with time in MRV magmatic episode. Tectonically, this is explained by arrival beneath the Central Volcanic Complex of the sub-passive margin enriched subcontinental mantle, and it records arc-continent collision.

MODERN ANALOGUES OF THE MOUNT READ VOLCANICS

High-K calc-alkaline and shoshonitic suites

Most andesites and associated lavas recorded in this study (some Central Volcanic Complex lavas and their correlates east of Hellyer, in the Que-Hellyer Footwall and in the Noddy Creek belt, have REE patterns comparable to modern high-K calc-alkaline arc lavas. The closest chemically analogous modern arc suites to these MRV andesites are those high-K calc-alkaline suites erupted in mature island arcs or continental margin arcs such as the Aeolian and northwestern Hellenic arcs , the Andes, Mexico and Central America and Indonesia .

The closest modern analogues of the high-K and shoshonitic basaltic-andesitic suites in the Western Volcanic Sequence are the high-K mafic-intermediate lava series from eastern Papua and the Papua-Niugini highlands, the lower-K suites of the Roman Province, post-orogenic dykes in the European Alps in northern Italy and post-collisional lavas in eastern Turkey - northern Iran. In each of these areas magmatism is post-collisional, yet the lavas show evidence (eg. low Ti, Nb) of derivation from a subduction-modified upper mantle. Varne (1985) argued that K-rich lavas in the Indonesian and other island arcs may be derived from ancient, enriched subcontinental mantle dragged into the sub-arc subduction zone of magma generation during continent-arc collision.

I am impressed by the similarities in geological setting and composition of the MRV and those from eastern Papua. At the latter location, high-K and shoshonitic lavas overlie allochthonous, depleted 'ophiolitic' basement (that includes boninites; Jenner 1981) of the Papuan Ultramafic Belt, which had been emplaced during Mid-Tertiary arc-continent collision. As shown in the Miners Ridge area, similar LREE- and P_2O_5 -rich, high-K andesites and basalts (shoshonites) overlie LREE-depleted basalts very similar to those in the low-Ti lava carapace of the Serpentine Hill MUC thrust slice . This actualistic tectonic comparison offers further support for the hypothesis that the igneous rock associations in W Tasmania were assembled as a result of a middle Middle Cambrian arc-continent collision (Berry & Crawford 1988).

CONCLUSIONS

The Mount Read Volcanics are a complex Middle and Upper Cambrian orogenic volcanic series in which the major magmatic suites represented are high-K calc-alkaline, differing mainly in the degree of enrichment of LREE (and probably originally, of K-group elements and P). The lavas range from high-K andesites with *relatively* weak LREE-enrichment (yet still significantly greater than for many normal, medium-K arc (orogenic) andesites, to shoshonitic basalts with extreme LREE- and P-enrichment The former extend along the length of the Mount Read Volcanic belt, and must include at least several discrete volcanic centres. Subtle but consistent compositional differences, for example between the Que-Hellyer Footwall andesites and the Central Volcanic Complex Group 1 andesites support this interpretation. Shoshonites are apparently restricted to several major eruptive centres, and occur near the top of the Mount Read lava pile. There is strong evidence for a progressive enrichment in LREE and P_2O_5 in the Mount Read lavas with time, so that the uppermost lavas should be, and apparently are, the most enriched. On this basis, and the strong compositional similarities with the Que-Hellyer Footwall andesites, I conclude that the Mount Cattley lavas are not records of a newly-identified magmatic episode in the Dundas-Southwell Sub-group time, but rather, they pre-date the Hellyer basalts and are time- and compositional correlates of the Que-Hellyer Footwall andesites. This implies the presence of a major fault between the Hellyer area and Mt, Cattley that has upthrown the Footwall basement of the Hellyer basalts. On this basis, further deepening of MCDD 1 should encounter a thick continuation of the EOH greywacke (Animal Creek Greywacke correlate) and then pass into an andesite-dacite pyroclastic-lava sequence very similar to the Mount Read Central Volcanic Complex rocks exposed in the Tullah area.

Modern calc-alkaline magmatic provinces most similar to Suite 1 are those active continental margin arc settings such as occur in the Aeolian arc, the central and northern Andes, and Mexico and Central America. Closest modern analogues to the more LILE-enriched basalts and andesites of Suites 2 and 3 occur in areas of arc-continent (E Papua, Niugini Highlands; Hellenic and Aeolian arcs) and continent-continent (E. Turkey - N. Iran) collision.

LREE-depleted, low-Ti tholeiites outcropping in the core of an anticline at Miners Ridge are tentatively correlated with the uppermost lavas in the allochthonous mafic-ultramafic complexes which extend down the western margin of the Dundas Trough. Since the Miners Ridge sequence forms basement to the Western Volcanic Sequence of the MRV, it is inferred that lavas of the latter sequence were erupted through and onto the recently-emplaced allochthon, and record the progressive change in mantle composition and structure as underthrust sub-continental mantle arrived under the former site of arc magmatism.

The range of magma suites represented in the MRV record continental arc magmatism during and after an arc-continent collision.

REFERENCES

R.F. Berry and A.J. Crawford: 1988. The tectonic significance of Cambrian allochthonous mafic-ultramafic complexes in Tasmania. Austr. J. Earth Sci. 35, 523-533.

K.D. Corbett: 1979. Stratigraphy, correlation and evolution of the Mount Read Volcanics in the Queenstown, Jukes-Darwin and Mount Sedgwick areas. Tasmanian Geological Survey Bulletin 58, 75pp.

K.D. Corbett and T.C. Lees: 1987. Stratigraphic and structural relationships and evidence for Cambrian deformation at the western margin of the Mount Read Volcanics. Austr. J. Earth Sci. 34, 45-67.

K.D. Corbett, J. Pemberton and M. Vicary. 1988. Excursion guide notes for Cooks Tour of Maps 7 and 8. Tasmanian Dept. of Mines Mt. Read Volcanics Project.

G.R. Green: 1987. Petrography of altered and mineralized Cambrian rocks from beneath Tertiary basalt in the Mount Cattley area. Tasmanian Dept. of Mines Unpublished Report.

W. Herrmann: 1986. Report to Pancontinental Mining Ltd. on sub-basalt drilling program at Mount Cattley, EL 14/85, September-October 1986.

W. Herrmann: 1989. Preliminary report to Outukumpu Exploration Australia on drill testing of two GEFINEX-EM anomalies at Mount Cattley, EL 14/85.

TABLE 1: Wholerock XRF analyses of Group 1 lavas from the Central Volcanic Complex																		
SAMPLE	MR396*	MR644	44078	MR654*	36113	40140A	44063	40140	427240	MR650	44041	30039A	44067	PRR/D	LDP11A	44045	30039B	BP269/C
SiO2	60.1	60.7	61.4	63.9	65.0	65.5	65.5	65.7	65.7	66.2	66.5	66.6	67.0	67.0	67.1	67.2	67.8	68.0
TiO2	0.69	0.78	0.68	0.63	0.67	0.62	0.68	0.66	0.67	0.63	0.68	0.62	0.67	0.63	0.68	0.67	0.60	0.54
Al2O3	17.0	16.4	16.3	16.2	15.3	15.8	15.4	15.4	15.7	15.6	14.9	15.5	15.1	15.9	15.0	15.0	14.5	14.6
FeO*	5.97	6.64	7.37	5.96	6.00	5.92	5.83	5.57	4.82	5.63	5.72	5.11	4.84	6.40	5.24	5.52	4.85	4.75
MnO	0.12	0.12	0.13	0.11	0.08	0.10	0.07	0.07	0.08	0.09	0.11	0.09	0.08	0.17	0.10	0.09	0.07	0.26
MgO	1.57	2.97	3.35	2.59	2.37	1.94	1.74	1.71	1.75	1.96	1.88	1.08	0.94	1.35	1.98	2.01	0.88	2.01
CaO	9.58	7.90	4.61	3.86	3.17	3.71	3.36	3.12	4.90	3.49	2.96	2.33	3.29	2.18	2.04	1.91	6.99	3.75
Na2O	3.52	3.90	4.03	4.23	4.25	3.74	4.50	4.20	3.23	3.78	4.31	4.43	4.04	3.60	3.33	4.35	3.34	3.02
K2O	0.85	0.39	1.88	2.24	3.05	2.53	2.78	3.43	3.02	2.57	2.83	4.18	3.97	2.64	4.45	2.92	0.82	2.92
P2O5	0.15	0.15	0.15	0.15	0.13	0.12	0.12	0.14	0.12	0.10	0.14	0.12	0.13	0.13	0.13	0.27	0.13	0.10
LOI	2.06	3.26	2.42	3.42	2.30	2.23	1.67	1.52	1.88	1.76	1.44	0.95	1.89	3.76	1.28	1.49	1.56	4.30
Ni	10	14	22	3	6	4	5	4	6	8	4	5	5		3	4	5	
Cr	145	77	81	60	23	9	23	12	23	96	13	12	23		9	12	15	
V	145	163	161	140	111	92	107	91	94	121	92	88	104		92	94	269	
Sc	13	13	22	13	15	11	13	12	12	12	11	13	15		11	11	13	
Zr	210	146	133	220	227	228	231	228	232	229	231	221	226	246	216	209	213	160
Nb	11	8.7	10	10	13	14	13	13	12.9	12.1	13	12	12	13.4	14	12	12.5	9.4
Y	33	30	31	28	37	40	39	37	38	42	37	39	39	50	34	34	35	34
Sr	390	31	465	200	191	204	264	182	365	247	184	188	218	111	182	172	435	97
Rb	27	10	48	89	75	101	58	88	124	64	119	118	105	105	155	89	25	118
Ba	200	151	664	530	658	696	620	882	835	640	764	927	819		1099	860	218	34
Ti/Zr	19.7	32.0	30.7	17.2	17.7	16.3	17.6	17.4	17.3	16.5	17.6	16.8	17.8	15.4	18.9	19.2	16.9	20.2
Zr/Y	6.4	4.9	4.3	7.9	6.1	5.7	5.9	6.2	6.1	5.5	6.2	5.7	5.8	4.9	6.4	6.1	6.1	4.7
Zr/Nb	19.1	16.8	13.3	22.0	17.5	16.3	17.8	17.5	18.0	18.9	17.8	18.4	18.8	18.4	15.4	17.4	17.0	17.0
Y/Nb	3.0	3.4	3.1	2.8	2.8	2.9	3.0	2.8	2.9	3.5	2.8	3.3	3.3	3.7	2.4	2.8	2.8	3.6
V/Sc	11.2	12.5	7.3	10.8	7.4	8.4	8.2	7.6	7.8	10.1	8.4	6.8	6.9		8.4	8.5	20.7	
Zr/Sc	16.2	11.2	6.0	16.9	15.1	20.7	17.8	19.0	19.3	19.1	21.0	17.0	15.1		19.6	19.0	16.4	
Ti/V	28.5	28.7	25.3	27.0	36.2	40.4	38.1	43.5	42.7	31.2	44.3	42.2	38.6		44.3	42.7	13.4	
La		22.3	32.8							35.6		34			29.8			
Ce		50.1	62.9							77.5		74.1			69.5			
Pr		6	7.01							9.37		8.27			7.86			
Nd		22.1	27							35.3		32.6			31.6			
Sm		4.63	4.34							7.7		6.64			6.86			
Eu		0.94	0.88							1.69		1.37			1.66			
Gd		4.18	4.45							6.91		6.21			5.89			
Dy		4.81	4.67							6.87		5.87			5.56			
Er		2.97	3.27							4.37		4.05			3.7			
Yb		2.71	2.96							4.09		4.04			3.8			

TABLE 1 (continued) : Wholerock XRF analyses of Group 1 lavas from the Central Volcanic Complex

SAMPLE	CI27/7	PRR/C	RED87/1	Hx1/C	80R/B	30050	30051A	H955A	HX1/A	PRR/H	HCL	PRR/G	MRDDH	40136	85R/A	80R/D	CI27/4	36117
SiO2	68.1	68.1	69.0	69.0	69.2	69.8	70.3	71.4	71.8	72.5	73.1	72.7	73.1	73.5	74.3	74.4	74.6	75.1
TiO2	0.56	0.60	0.49	0.50	0.50	0.46	0.45	0.41	0.41	0.30	0.39	0.36	0.38	0.27	0.28	0.34	0.26	0.29
Al2O3	15.2	14.9	14.5	14.9	14.4	15.6	15.2	15.2	14.9	14.1	15.5	14.5	14.6	13.9	14.2	13.8	13.9	12.9
FeO*	4.17	5.13	4.98	5.49	4.39	3.86	3.67	2.83	4.07	3.47	2.68	3.09	2.84	2.73	2.01	2.61	2.22	2.80
MnO	0.08	0.09	0.07	0.12	0.12	0.04	0.07	0.08	0.06	0.09	0.04	0.07	0.07	0.04	0.05	0.07	0.05	0.05
MgO	1.06	1.15	1.19	2.28	1.36	1.23	1.16	0.79	1.20	0.71	1.40	0.54	0.80	0.46	0.37	0.65	0.32	0.32
CaO	3.71	3.62	2.71	1.38	3.39	0.69	1.54	1.67	0.43	3.19	0.64	1.70	1.28	1.39	1.08	2.78	0.52	0.64
Na2O	3.59	3.73	3.56	3.49	3.60	2.87	2.93	3.75	3.67	2.12	4.20	3.56	2.40	3.29	3.46	3.15	4.09	2.82
K2O	3.40	2.52	3.39	2.75	2.87	5.36	4.52	3.85	3.47	3.45	2.09	3.44	4.55	4.34	4.20	2.08	4.03	5.05
P2O5	0.14	0.14	0.12	0.11	0.15	0.10	0.10	0.05	0.09	0.07	0.04	0.08	0.06	0.06	0.05	0.08	0.04	0.04
LOI	4.39	4.20	3.33	3.43	4.07	1.44	1.22	1.16	1.97	4.03	1.99	2.68	2.50	1.66	2.17	2.87	0.97	0.83
Ni	3					3	3							2			1	2
Cr	6					7	9							5			3	4
V	54					55	51				10		18	11			5	12
Sc	10					11	9				4		5	5			3	8
Zr	286	219	205	203	207	227	216	285	308	184	280	275	259	205	292	199	274	225
Nb	14.7	12.6	11.3	12.2	10.4	15	15	14.2	13.3	10.5	16	17.4	15	15	18.6	10.3	16.4	13
Y	37	34.5	31	28	27	30	36	40	41	23	40	47	40	40	42.3	30	37	45
Sr	174	118	188	116	215	156	238	360	93	120	248	116	98	153	135	302	131	134
Rb	131	102	119	110	112	218	169	179	113	154	104	136	216	134	156	80	131	133
Ba	757		4	8	7	1463	1033	4	14	2	840	2	839	1093	6	6	985	987
Ti/Zr	11.7	16.4	14.3	14.8	14.5	12.1	12.5	8.6	8.0	9.8	8.4	7.8	8.8	7.9	5.7	10.2	5.7	7.7
Zr/Y	7.7	6.3	6.6	7.3	7.7	7.6	6.0	7.1	7.5	8.0	7.0	5.9	6.5	5.1	6.9	6.6	7.4	5.0
Zr/Nb	19.5	17.4	18.1	16.6	19.9	15.1	14.4	20.1	23.2	17.5	17.5	15.8	17.3	13.7	15.7	19.3	16.7	17.3
Y/Nb	2.5	2.7	2.7	2.3	2.6	2.0	2.4	2.8	3.1	2.2	2.5	2.7	2.7	2.7	2.3	2.9	2.3	3.5
V/Sc	5.4					5.0	5.7				2.5		3.6	2.2			1.7	1.5
Zr/Sc	28.6					20.6	24.0				70.0		51.8	41.0			91.3	28.1
Ti/V	62.2					50.1	52.9				233.8		126.6	147.2			311.7	144.9
La											51.8		46.6					
Ce											111		108.4					
Pr											12		12.1					
Nd											45.8		43.9					
Sm											7.53		7.63					
Eu											0.92		1.5					
Gd											5.98		6.41					
Dy											6.03		6.43					
Er											4.11		4.52					
Yb											4.03		4.2					

TABLE 1 (continued) : Wholerock XRF analyses of Group 1 lavas from the Central Volcanic Compl

SAMPLE	LPD6	CI27/2	427244	RED87/1(	JD2001A	42610	PD1	427230
SiO2	75.4	75.5	75.8	76.0	76.0	76.3	78.1	78.3
TiO2	0.23	0.26	0.27	0.30	0.32	0.23	0.26	0.28
Al2O3	14.5	13.4	13.2	13.7	13.2	13.8	12.6	13.4
FeO*	2.37	1.97	2.12	2.04	2.64	1.82	1.35	0.99
MnO	0.02	0.03	0.07	0.07	0.07	0.04	0.07	0.01
MgO	0.76	0.31	0.42	0.53	0.45	0.30	0.56	0.40
CaO	0.03	0.23	0.14	1.39	1.33	0.10	1.34	0.03
Na2O	2.81	3.86	4.02	2.20	2.89	4.32	2.09	2.57
K2O	3.87	4.34	3.89	3.74	3.02	2.99	3.19	4.01
P2O5	0.01	0.03	0.05	0.02	0.04	0.01	0.03	0.01
LOI	1.74	0.84	1.11	2.49	2.71	1.35	2.83	1.96
Ni	2	1	1					1
Cr	6	3	4			3		2
V	6	7	6			10	13	10
Sc	7	3	1			7	3	4
Zr	256	279	252	252	288	165	223	209
Nb	17	16.6	14.8	15.5	15.5	11	13	15.01
Y	35	30	38	34	42	27	29	24
Sr	52	118	91	104	93	120	61	55
Rb	114	150	116	148	120	76	140	126
Ba	808	1008	915	16	3	1189	750	1171
Ti/Zr	5.4	5.6	6.4	7.1	6.7	8.4	7.0	8.0
Zr/Y	7.3	9.3	6.6	7.4	6.9	6.1	7.7	8.7
Zr/Nb	15.1	16.8	17.0	16.3	18.6	15.0	17.2	13.9
Y/Nb	2.1	1.8	2.6	2.2	2.7	2.5	2.2	1.6
V/Sc	0.9	2.3	6.0			1.4	4.3	2.5
Zr/Sc	36.6	93.0	252.0			23.6	74.3	52.3
Ti/V	229.8	222.7	269.8			137.9	119.9	167.9
La	20.2					36.5	41.4	
Ce	47					75.8	92.6	
Pr	4.99					7.52	9.3	
Nd	19.4					26.3	34.4	
Sm	4.11					4.39	5.68	
Eu	0.85					0.87	0.93	
Gd	3.87					3.72	4.47	
Dy	5.11					4.07	4.22	
Er	3.8					3.03	2.82	
Yb	4.58					3.46	2.79	

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TABLE 2 : Wholerock XRF analyses of Group 2 lavas from the Central Volcanic Complex

SAMPLE	AR6	39233	W93	M189	39232	32522	3399	AR11	Z632	3402	M235	HR71	HR65	HR70	AR10	PRR/E
SiO2	58.5	58.5	58.7	58.8	58.8	58.9	59.5	60.0	60.9	63.1	63.3	63.8	66.6	67.6	69.1	70.0
TiO2	0.46	0.56	0.55	0.48	0.57	0.53	0.45	0.57	0.49	0.42	0.42	0.40	0.36	0.44	0.35	0.29
Al2O3	16.0	14.2	14.2	15.9	14.4	15.0	15.5	15.9	14.3	14.9	14.7	15.0	14.6	16.9	17.2	16.6
FeO*	7.41	8.11	7.90	7.65	7.83	8.99	7.26	7.87	7.29	6.79	7.42	6.38	4.98	6.76	3.49	3.19
MnO	0.11	0.13	0.12	0.21	0.12	0.14	0.13	0.14	0.13	0.11	0.16	0.07	0.11	0.02	0.04	0.04
MgO	4.37	6.75	6.19	4.37	5.24	4.62	4.53	4.03	4.84	3.39	3.45	3.20	2.66	3.43	1.67	0.73
CaO	6.26	5.18	5.05	6.35	5.62	6.62	5.45	3.19	6.29	5.75	4.51	4.96	2.30	0.10	0.72	1.54
Na2O	6.75	4.76	3.97	4.40	4.24	3.24	5.36	5.20	4.07	2.55	4.05	3.64	5.53	1.44	4.55	3.45
K2O	0.37	1.61	3.15	1.59	2.97	1.57	1.56	2.95	1.39	2.77	1.77	2.32	2.74	3.02	2.78	4.19
P2O5	0.33	0.20	0.20	0.21	0.22	0.34	0.25	0.22	0.32	0.17	0.19	0.20	0.19	0.23	0.15	0.04
LOI	1.65	2.11	1.65	1.81	1.85	1.81	2.03	1.71	1.94	3.62	2.96	1.72	1.26	4.28	2.04	2.87
Ni	40	53	52	15	49	47	38		39	32	25	24	17	24		
Cr	142	224	157	68	160	321	139		130	72	40	59	52	64		
V	206	196	188	181	201	198	184		175	155	172	157	140	177		
Sc	27	30	30	27	31	28	29		25	22	24	22		26		
Zr	160	159	181	144	167	157		180	169	133	150	138	132	155	136	339
Nb	8	8	10	8.4	9	9		9.1	8	7	7.8	7.6	6.8	7.1	6.1	20.7
Y	23	27	28.5	25	35	26		27	24	21	26	21	23	27	36	51
Sr	516	363	354	716	262	682		320	683	620	418	488	1004	94	511	110
Rb	14	53	93	49	85	65		74	42	74	52	70	116	105	112	162
Ba	188	572	1160	1403	1068	1067	1143	14	1184	1148	2720	773		747	12	1
Ti/Zr	17.2	21.1	18.2	20.0	20.5	20.2		19.0	17.4	18.9	16.8	17.4	16.4	17.0	15.2	5.1
Zr/Y	7.0	5.9	6.4	5.8	4.8	6.0		6.7	7.0	6.3	5.8	6.6	5.7	5.7	3.8	6.6
Zr/Nb	20.0	19.9	18.1	17.1	18.6	17.4		19.8	21.1	19.0	19.2	18.2	19.4	21.8	22.6	16.4
Y/Nb	2.9	3.4	2.9	3.0	3.9	2.9		3.0	3.0	3.0	3.3	2.8	3.4	3.8	5.9	2.5
V/Sc	7.6	6.5	6.3	6.7	6.5	7.1	6.3		7.0	7.0	7.2	7.1		6.8		
Zr/Sc	5.9	5.3	6.0	5.3	5.4	5.6			6.8	6.0	6.3	6.3		6.0		
Ti/V	13.4	17.1	17.5	15.9	17.0	16.0	14.7		16.8	16.2	14.6	15.3	15.4	14.9		
La	71.7	40.7		88.8	44.1				63.7				51.7	68.4		
Ce	149	87		162	93.9				131				97.7	124		
Pr	15	10.9		16.5	10.5				14.1				9.96	12.1		
Nd	55	41.1		57.2	40.1				52.5				35.8	42.5		
Sm	8.79	8.26		9.06	6.93				8.87				6.07	6.97		
Eu	1.41	1.97		2.08	1.45				2.34				1.38	1.63		
Gd	6.11	6.32		6.07	5.78				6.67				4.17	5.38		
Dy	4.07	4.49		4.19	4.61				4.32				3.23	4.17		
Er	2.28	2.99		2.71	2.63				2.25				2.05	2.5		
Yb	1.85	2.73		2.56	2.52				2.13				2.19	2.73		

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TABLE 3 : Wholerock XRF analyses of mafic lavas from the Western *Volcanic Sequence S of the Henty Fault*

SAMPLE	Z627	Y408	482080	31767A	482074	482071	RM49	Z102	C11*	Z96	C9*	C8*	B6*
SiO2	49.5	51.8	52.1	52.4	52.6	52.9	53.3	54.2	55.05	56.8	56.9	57.2	61.1
TiO2	0.32	0.41	0.57	0.42	0.81	0.50	0.60	0.38	0.57	0.47	0.55	0.47	0.52
Al2O3	8.9	12.5	17.5	11.9	18.1	19.1	16.6	12.0	18.2	13.7	17.5	15.9	15.0
FeO*	10.50	10.00	12.50	9.44	9.53	9.21	10.10	9.10	8.50	8.82	7.78	7.95	7.23
MnO	0.20	0.18	0.15	0.16	0.11	0.09	0.09	0.14	0.18	0.17	0.16	0.14	0.26
MgO	16.40	11.40	6.16	10.70	4.18	4.97	9.37	9.84	5.09	6.91	5.04	6.26	3.55
CaO	11.90	9.48	4.53	10.30	7.38	6.45	2.92	9.20	5.19	6.55	5.99	5.73	4.49
Na2O	1.35	2.02	4.28	2.46	4.85	3.32	2.50	2.92	4.36	3.23	3.99	3.41	4.70
K2O	0.70	1.66	1.83	2.08	1.36	3.15	4.19	2.21	2.39	3.11	1.68	2.61	2.61
P2O5	0.17	0.48	0.36	0.19	1.00	0.26	0.31	0.28	0.35	0.23	0.24	0.28	0.29
LOI	3.28	4.07	3.41	2.43	3.53	2.82	4.44	2.87	4.06	2.59	4.28	3.87	3
Ni	303	130	70	132	34	73	125	115	39		42	57	19
Cr	819	580	85	601	47	75	295	640	74		85	152	20
V	221	240	294	255	305	264	284	240	300		217	227	256
Sc	49	39	33		36	30	47	42	26		19	21	20
Zr	53	105	168	80	254	103		76	130		114	137	147
Nb	4	4	9.3	4.3	9.8	4.5		1.5	6		9	<5	6
Y	34	32	22	23	35	27		17	25		20	24	23
Sr	182	420	372	252	1025	410		185	516		372	636	696
Rb	155	41	41	44	31	92		45	45		35	34	63
Ba	382	1300	1052	1869	1352	1404	2599	1750	1740		825	1650	1500
Ti/Zr	36.2	23.4	20.3	31.7	19.1	29.1		30.0	26.3		28.9	20.6	21.2
Zr/Y	1.6	3.3	7.6	3.5	7.3	3.8		4.5	5.2		5.7	5.7	6.4
Zr/Nb	13.3	26.3	18.1	18.6	25.9	22.9		50.7	21.7		12.7		24.5
Y/Nb	8.5	8.0	2.4	5.3	3.6	6.0		11.3	4.2		2.2		3.8
V/Sc	4.5	6.2	8.9		8.5	8.8	6.0	5.7	11.5		11.4	10.8	12.8
Zr/Sc	1.1	2.7	5.1		7.1	3.4		1.8	5.0		6.0	6.5	7.4
Ti/V	8.7	10.2	11.6	9.9	15.9	11.4	12.7	9.5	11.4		15.2	12.4	12.2
La		112.5		51.2			94.1	54.3		63.3	40.2	60.1	
Ce		209		96.1			153	99.9		117.1	79.7	124	
Pr		26.2		11.3			21.7	11.4		12.9	8.41	13.5	
Nd		103.4		42.6			78.2	43.6		47.8	33.5	50	
Sm		18.8		7.49			12.9	7.65		8.18	5.81	8.17	
Eu		4.49		1.85			3.41	1.96		1.69	1.37	2.16	
Gd		13.2		6.23			8.63	6.09		6.03	4.57	5.79	
Dy		7.51		4.01			6.36	3.84		4.41	3.81	4.33	
Er		3.67		2.38			3.34	2.15		2.75	2.69	2.67	
Yb		2.87		1.92			2.65	1.78		2.14	2.21	2.16	

TABLE 4: Wholerock XRF analyses of mafic lavas from the Western Volcanic Sequence from N of the Henty Fault to Hellyer											
SAMPLE	MC1B	334161	HL55B	BBP253	HL55A	MAC10A	LPD11c	334162	MR437	Z7251	Z7252
SiO2	48.1	48.3	51.1	51.8	53.6	54	55	55.6	56.2	52.9	56.1
TiO2	0.59	0.82	0.48	0.89	0.65	0.86	0.68	0.77	0.60	0.52	0.49
Al2O3	18.0	13.6	14.2	12.5	12.9	12.8	15.7	18.6	13.1	13.6	12.3
FeO*	11.29	9.45	9.11	9.94	9.06	8.60	11.10	10.50	9.02	8.51	7.28
MnO	0.28	0.16	0.19	0.16	0.15	0.27	0.15	0.23	0.18	0.14	0.14
MgO	8.95	11.20	11.47	8.39	9.87	8.53	10.50	4.60	8.20	15.22	11.50
CaO	8.12	8.54	10.76	10.10	9.04	9.94	4.08	3.08	7.96	6.50	9.11
Na2O	2.80	1.18	1.52	1.12	2.90	2.11	1.34	4.12	3.06	1.53	2.34
K2O	1.39	2.97	0.95	4.07	1.59	2.05	1.33	1.93	1.31	0.99	0.65
P2O5	0.55	0.42	0.17	0.98	0.31	0.80	0.19	0.57	0.41	0.12	0.15
LOI	3.63	3.29	6.28	1.88	3.69	7.3	5.22	3.99	2.64	5.37	4.58
Ni				45			113	17	87	380	337
Cr				181			868	5	370	1133	1084
V				267			303	302	282	223	201
Sc				37				31	32	28	29
Zr	142	195	71	295	160	363	97	187	131	75	74
Nb	10.4	13.1	5.3	14	10.3	13.1	7.4	11	8.3	5.4	5.6
Y	30	32	18	37	26	34	35	32	21	16	18
Sr	796	404	341	881	576	403	209	595	612	183	272
Rb	34	50	22	111	28	56	54	46	24	27	22
Ba				2500			400	3407	1114	1337	1059
Ti/Zr	24.9	25.2	40.5	18.1	24.4	14.2		24.7	27.5	41.6	39.7
Zr/Y	4.7	6.1	3.9	8.0	6.2	10.7		5.8	6.2	4.7	4.1
Zr/Nb	13.7	14.9	13.4	21.1	15.5	27.7		17.0	15.8	13.9	13.2
Y/Nb	2.9	2.4	3.4	2.6	2.5	2.6		2.9	2.5	3.0	3.2
V/Sc				7.2				9.7	8.8	8.0	6.9
Zr/Sc				8.0				6.0	4.1	2.7	2.6
Ti/V				20.0			13.5	15.3	12.8	14.0	14.6
La		58.6					29.9	93.5	50.5	21.3	
Ce		137					64.4	193.8	105	42.1	
Pr		15.6					7.27	21.4	11.7	4.71	
Nd		59.3					28.8	84.1	44.5	18.2	
Sm		10.5					5.3	15.1	7.33	3.49	
Eu		2.59					1.21	3.8	1.06	1.02	
Gd		7.18					4.35	10.7	5.58	3.17	
Dy		5.79					4.1	6.93	3.94	2.77	
Er		3					2.56	3.32	1.97	1.77	
Yb		2.03					2.28	2.93	1.62	1.67	

TABLE 5: Wholerock XRF analyses of lavas from the Que-Hellyer Footwall sequence								
SAMPLE	69717	OR1001A	502650	72504	72506	72507	71917	69866
				CSIRO	CSIRO	CSIRO		
SiO2	61	63.2	63.9	51.8	60	57.9	70.1	70.7
TiO2	0.72	0.61	0.58	0.72	0.72	0.75	0.35	0.41
Al2O3	17.9	15.4	15.3	19.2	16.4	16.6	16.3	14.3
FeO*	9.54	7.41	8.04	9.20	8.05	7.95	3.44	5.26
MnO	0.11	0.12	0.12	0.19	0.16	0.16	0.10	0.16
MgO	2.18	3.09	3.88	6.44	4.70	4.68	1.39	1.27
CaO	2.05	3.53	3.24	6.08	5.00	5.28	2.49	1.78
Na2O	4.19	4.49	3.49	5.20	3.58	1.89	2.97	3.59
K2O	2.23	1.92	1.20	0.23	0.80	3.92	2.59	2.30
P2O5	0.17	0.17	0.16	0.12	0.16	0.16	0.10	0.11
LOI	4.48	3.71	5.25	4.88	4.38	3.85	3.37	5.21
Ni			26					
Cr	57		153	139	124	94	16	
V	96		228	246	207	234	40	33
Sc			33					
Zr	187	139	108	149	146	143	177	179
Nb	9.5	10.4	7.3				10.5	9.6
Y	39	29	24	28	28	29	30	30
Sr	318	308	174	792	557		152	133
Rb	72	57	34	10	21		73	82
Ba	1137		701				1826	1012
Ti/Zr	23.1	26.3	32.2	29.0	29.6	31.4	11.9	13.7
Zr/Y	4.8	4.8	4.5	5.3	5.2	4.9	5.9	6.0
Zr/Nb	19.7	13.4	14.8				16.9	18.6
Y/Nb	4.1	2.8	3.3				2.9	3.1
V/Sc			6.9					
Zr/Sc			3.3					
Ti/V	45.0		15.3	17.5	20.9	19.2	52.5	74.5
La	57		23.1					
Ce	100		49.7					125
Pr	10.6		5.51					
Nd	39.8		21.4					44.8
Sm	7.53		3.39					7.29
Eu	1.7		0.54					1.56
Gd	6.7		3.4					5.58
Dy	6.25		3.59					4.45
Er	3.64		2.49					2.78
Yb	3.27		2.2					2.84

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TABLE 6: Wholerock XRF analyses of lavas from the Mt. Read Volcanics east of Hellyer to Beulah

SAMPLE	Beulah	Beulah	G Eden	Beulah	Beulah	Beulah	Beulah	Leven Gge	Quamby	BeuBarite	Quamby	SmithPlai	Winterbk	BOND RGE	Winterbk	Loyatea P	Leven Gor	Loyatea P
	271750	428035	428031	428048	334717	334716	334718	5010	5008	428025	5009	48378	427279	3.4A	427281	427253	5017	427256
SiO2	52.9	53.1	53.3	55.8	57.2	57.6	58.4	58.9	60	60.2	60.9	64.8	65.6	66.3	66.5	68.1	68.3	69.0
TiO2	0.64	0.87	0.87	0.75	0.83	0.91	0.76	0.83	0.45	0.89	0.42	0.61	0.67	0.6	0.60	0.62	0.78	0.67
Al2O3	18.50	17.90	17.00	17.30	16.40	16.90	15.40	15.90	16.80	17.30	16.60	15.30	14.60	14.4	14.60	14.80	15.20	14.10
FeO*	9.7	9.97	7.74	8.83	9.77	10.1	9.66	9.49	6.25	7.6	6.07	7.21	5.68	4.76	5.61	5.01	4.23	5.25
MnO	0.22	0.16	0.12	0.19	0.18	0.2	0.17	0.17	0.11	0.26	0.1	0.12	0.11	0.09	0.1	0.08	0.17	0.07
MgO	4.51	3.23	1.09	3.97	5.04	3.6	4.09	4.92	5.25	1.53	5.01	3.43	2.9	3.47	2.71	1.79	2.26	1.26
CaO	9.45	7.31	3.08	4.82	5.67	5.52	6.61	3.43	4.19	5.04	4.47	3.04	3.15	3.36	2.29	1.54	1.01	0.99
Na2O	3.12	5.71	3.72	5.79	2.72	2.98	2.68	2.79	4.96	3.96	4.59	2.97	4.65	2.52	4.84	3.42	5.28	3.80
K2O	0.73	1.47	2.74	2.2	2.14	1.96	2.12	3.36	1.87	2.87	1.81	2.31	2.51	4.37	2.61	4.47	2.65	4.64
P2O5	0.23	0.3	0.39	0.27	0.14	0.22	0.16	0.19	0.11	0.39	0.12	0.12	0.16	0.19	0.13	0.15	0.17	0.29
LOI	3.66	2.66	4.87	2.48	3.18	3.57	3.47	3.33	2.81	6.97	2.79	2.79	1.79	2.17	1.65	3.03	1.9	2.15
Ni	47	32	6	31	19	16	18	28	101	4	95	8	7	53	6	8	4	2
Cr	124	68	3	75	109	107	102	128	208	7	198	31	27	158	21	24	1	3
V	210	254	95	196	215	216	278	202	99	79	103	139	123	105	142	95	138	34
Sc	21	29	14	23	36	30	35	29	20	15	20	23	24	17	17	11	22	13
Zr	117	92	171	136	137	196	118	155	125	172	122	191	190	255	194	219	167	179
Nb	11	8.3	15.1	11.6	11.2	16.2	8.7	14	8.2	145	7.7	11	10.5	16.7	10.8	15.6	16	12.3
Y	31	29	29	28	27	36	26	32	18	33	17	35	29	43	31	32	42	36
Sr	535	259	146	289	304	215	256	231	132	165	131	378	470	285	423	150	161	194
Rb	22	38	112	61	133	113	97	91	56	116	54	64	53	197	56	181	38	104
Ba	312	390	705	1059	931	455	612	1105	365	700	353	754	1408	1124	1160	1404	859	1810
Ti/Zr	32.8	56.7	30.5	32.6	36.3	27.8	38.6	32.1	21.6	31.0	20.6	19.1	21.1	14.1	18.5	17.0	28.0	22.4
Zr/Y	3.8	3.2	5.9	4.9	5.1	5.4	4.5	4.8	6.9	5.2	7.2	5.5	6.6	5.9	6.3	6.8	4.0	5.0
Zr/Nb	10.6	11.1	11.3	11.9	12.2	12.1	13.6	11.1	15.2	1.2	15.8	17.4	18.1	15.3	18.0	14.0	10.4	14.6
Y/Nb	2.8	3.5	1.9	2.4	2.4	2.2	3.0	2.3	2.2	0.2	2.2	3.2	2.8	2.6	2.9	2.1	2.6	2.9
V/Sc	10.0	8.8	6.8	8.5	6.0	7.2	7.9	7.0	5.0	5.3	5.2	6.0	5.1	6.2	8.4	8.6	6.3	2.6
Zr/Sc	5.6	3.2	12.2	6.0	3.8	6.5	3.4	5.3	6.3	11.5	6.1	8.3	7.9	15.0	11.4	19.9	7.6	13.8
Ti/V	18.3	20.5	54.9	22.9	23.1	25.3	16.4	24.6	27.3	67.5	24.4	26.3	32.7	34.3	25.3	39.1	33.9	118.1
La										31.5		41.6						
Ce										65.6		85.6						
Pr										7.68		9.81						
Nd										29		37.1						
Sm										5.87		6.32						
Eu										1.21		1.34						
Gd										5.35		5.75						
Dy										5.66		5.72						
Er										3.48		3.87						
Yb										3.43		3.3						

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TABLE 6 (continued):			
SAMPLE	Wbrook	Minnow	Union Trac
	427280	334720	Col 1
SiO2	72.6	77.4	77.4
TiO2	0.35	0.21	0.19
Al2O3	13.30	12.10	12.2
FeO*	2.67	3	2.58
MnO	0.05	0.08	0.07
MgO	0.83	0.59	0.26
CaO	2.59	0.14	0.18
Na2O	4.41	4.37	3.17
K2O	3.2	2.1	3.87
P2O5	0.05	0.01	0.03
LOI	2.85	1.08	1.22
Ni	3	3	
Cr	10	-	
V	69	8	4
Sc	10	6	8
Zr	148	218	195
Nb	12.9	15.5	15
Y	27	39	61
Sr	185	89	347
Rb	94	48	47
Ba	986	612	1881
Ti/Zr	14.2	5.8	5.8
Zr/Y	5.5	5.6	3.2
Zr/Nb	11.5	14.1	13.0
Y/Nb	2.1	2.5	4.1
V/Sc	6.9	1.3	0.5
Zr/Sc	14.8	36.3	24.4
Ti/V	30.4	157.4	284.8
La			
Ce			
Pr			
Nd			
Sm			
Eu			
Gd			
Dy			
Er			
Yb			

TABLE 7: Wholerock XRF analyses of lavas from the *Noddy Creek belt, S of Macquarie Harbour*																
SAMPLE	462A	925	462	385A	123	385	52	977	47	X	58	85	413	150	65	98
SiO2	51.8	52.9	55.2	55.9	57.2	58.1	58.2	59.4	60.1	60.7	62.1	62.2	63.2	63.4	64	64.2
TiO2	0.59	0.56	0.55	0.61	0.67	0.61	0.57	0.48	0.68	0.62	0.66	0.66	0.72	0.55	0.54	0.53
Al2O3	13.9	14.4	15.5	14.9	16.4	16.4	14.6	14.1	14.7	14.9	16.6	16.9	16.5	15.6	15.8	16.2
FeO*	10	10.3	9.06	10	9.03	9.14	9.44	7.35	9.72	7.44	6.5	6.2	6.41	8.03	5.78	5.18
MnO	0.28	0.18	0.21	0.07	0.13	0.12	0.27	0.08	0.1	0.1	0.08	0.11	0.11	0.07	0.06	0.07
MgO	8.9	9.78	5.05	6.06	3.5	5.1	7.27	6.27	3.27	3.3	2.45	2.1	1.94	2.71	1.9	1.97
CaO	9.24	6.01	7.58	5.97	5.13	5.43	3.66	4.26	3.73	7.91	4.86	5.54	3.89	1.89	4.47	4.87
Na2O	2.64	4.58	4.93	2.79	3.21	3.36	3.11	6.67	5.53	2.37	3.21	2.94	2.87	3.6	3.38	3.35
K2O	2.56	1.24	1.72	2.26	4.45	1.59	2.56	1.33	1.99	2.59	3.43	3.15	4.16	4.04	3.9	3.48
P2O5	0.1	0.08	0.11	0.11	0.24	0.16	0.14	0.07	0.14	0.13	0.15	0.16	0.17	0.12	0.16	0.13
LOI	2.37	3.79	1.15	1.45	2.1	2.96	3.27	1.73	1.33	2.93	1.7	2.44	1.6	2.56	1.49	1.6
Ni	198	291	91	81	26		61	112	38	16	11	11	13	16	10	9
Cr	342	638	70	213	82		250	134	151	116	29	30	20	39	19	16
V	211	196	225	185	195		218	182	186	162	152	132	135	169	125	130
Sc	32	28	25	29	24		33	30	28	29	19	18	15	20	16	15
Zr	55	81	74	145			145		107		199	164	228	161	204	199
Nb	3.2	3.4	4.1	7.3			8		7		14	13	13	8	13	14
Y	18	21	20	28			26		24		34	28	38	37	29	29
Sr	262	177	350	271			200		243		292	247	371	123	281	285
Rb	101	15	104	116			76		61		135	117	148	136	161	148
Ba	919	310	403	288	1019		1032	226	695	702	667	793	927	839	721	692
Ti/Zr	64.3	41.4	44.6	25.2			23.6		38.1		19.9	21.5	18.9	20.5	15.9	16.0
Zr/Y	3.1	3.9	3.7	5.2			5.6		4.5		5.9	6.6	6.0	4.4	7.0	6.9
Zr/Nb	17.2	23.8	18.0	19.9			18.1		15.3		14.2	14.2	17.5	20.1	15.7	14.2
Y/Nb	5.6	6.2	4.9	3.8			3.3		3.4		2.4	2.2	2.9	4.6	2.2	2.1
V/Sc	6.6	7.0	9.0	6.4	8.1		6.6	6.1	6.6	6.3	8.0	7.3	9.0	8.5	7.8	8.7
Zr/Sc	1.7	2.9	3.0	5.0			4.4		3.8		10.5	10.2	15.2	8.1	12.8	13.3
Ti/V	16.8	17.1	14.7	19.8	20.6		15.7	15.8	21.9	20.4	26.0	30.0	32.0	19.5	25.9	24.4
La	22.7	21.6		25.4					27.3		55.3				44.9	
Ce	49.9	43.3		57.1					57.8		113.4				97.2	
Pr	5.71	5.14		6.26					6.56		11.6				10.1	
Nd	22.6	20.1		24.7					26		42.3				37.1	
Sm	4.42	3.93		4.87					4.86		7.31				7.08	
Eu	1.15	1.09		1.27					1.1		1.36				1.59	
Gd	3.86	3.82		4.14					4.34		5.95				5.27	
Dy	3.24	3.76		4.43					4.18		5.5				4.75	
Er	2.07	2.37		2.94					2.68		3.54				3.09	
Yb	1.88	2.27		2.47					2.18		3.26				2.88	

TABLE 8: Wholerock analyses of lavas from Miners Ridge					
SAMPLE	W64*	LE196*	C1*	C2*	LE187
SiO2	48.7	47.9	49.7	51.8	48.8
TiO2	0.71	0.40	0.51	0.51	0.51
Al2O3	15.3	16.5	15.7	15.1	13.4
FeO*	11.4	8.59	8.98	13.3	8.84
MnO	0.2	0.18	0.19	0.19	0.20
MgO	12.7	10.3	11.1	9.36	17.40
CaO	6.28	10.91	9.04	4.11	7.37
Na2O	3.07	3.26	3.53	4.32	2.48
K2O	1.56	0.34	0.88	1.24	0.58
P2O5	0.06	0.08	0.03	0.09	0.08
LOI	4.3	3.87	4.45	3.16	5.25
Ni	177	160	182	62	263
Cr	365	470	376	25	3680
V	254	290	253	277	232
Sc	78	43	33	58	39
Zr		27	19	22	25
Nb		<3	<5	4.8	
Y		12	18	20	14
Sr		150	356	72	46
Rb		41	36	36	37
Ba	730	170	237	430	337
Ti/Zr		88.8	160.9	139.0	122.3
Zr/Y		2.3	1.1	1.1	1.8
Zr/Nb				4.6	
Y/Nb				4.2	
V/Sc	3.3	6.7	7.7	4.8	5.9
Zr/Sc		0.6	0.6	0.4	0.6
Ti/V	16.8	8.3	12.1	11.0	13.2
La	1.54	0.69		1.85	
Ce	4.2	1.99		3.54	
Pr	0.7	0.42		0.58	
Nd	3.83	1.95		3.3	
Sm	1.39	0.84		1.66	
Eu	0.35	0.53		0.5	
Gd	2.76	1.87		2.02	
Dy	3.71	2.97		3.11	
Er	2.45	2.59		2.59	
Yb	2.21	2.43		2.52	

TABLE 9: Wholerock analyses of the Mount Read Volcanics from Mount Cattley Drillholes MCPD 2 and 3																				
					Univ.	of	Tasmania						<--------------------			AMDEL	-------------------->		
	1	2	3	4	5		6	7	8	9	10		11	12	13		14	15	16
SAMPLE	Cattley D	Cattley D	Cattley D	Cattley D	Cattley D		Cattley D	Cattley D	Cattley D	Cattley D	Cattley D		2	2	2		3	3	3
	2-111	2-104.4	2-86.1	2-93.9	2-117.1		3-104.3	3-103.0	3-126.0	3-128.7	3-122.4		83-84	105-106	107.7		106-107	110-111	126-127
SiO2	55.81	58.1	60.3	60.6	61.3		62	68.3	68.3	68.9	72.5		62.7	54.4	55.5		62.3	72.7	66.4
TiO2	0.85	0.83	0.80	0.75	0.75		0.67	0.59	0.62	0.59	0.53		0.82	0.71	0.83		0.64	0.57	0.6
Al2O3	17.5	17.4	17.7	15.7	16.0		18.0	15.4	16.1	14.9	14.2		17.2	14.6	17.2		17.5	14.4	16.4
FeO*	9.64	8.43	8.04	6.38	6.67		6.67	5.39	5.72	6.32	3.11		8.76	7.88	8.78		5.95	3.17	7.28
MnO	0.12	0.10	0.09	0.19	0.18		0.07	0.05	0.08	0.07	0.04		0.22	0.17	0.13		0.06	0.03	0.06
MgO	5.88	5.33	5.16	4.04	4.52		3.96	2.96	2.25	2.48	0.75		7.25	4.94	5.87		3.57	1.11	2.79
CaO	3.95	3.62	1.30	6.10	3.97		1.57	0.92	0.38	0.68	1.26		0.94	11.70	5.14		1.13	1.10	0.26
Na2O	2.22	4.17	3.83	3.91	4.21		2.72	2.05	4.39	3.89	4.44		1.51	2.75	2.79		3.33	3.61	3.44
K2O	2.17	1.91	2.56	2.11	2.23		4.21	4.15	2.01	1.98	2.99		0.51	1.96	2.70		3.57	3.13	2.70
P2O5	0.21	0.19	0.20	0.18	0.18		0.19	0.17	0.19	0.18	0.18		0.12	0.03	0.12		0.16	0.15	0.15
LOI	6.92	6.13	4.5	7.13	6.59		4.35	3.23	3.1	2.94	2.14		10.3	10.8	7.4		4.21	2.88	3.22
Ni		6	11	10	8		10	9	16	7	7		33	3	2		4	3	13
Cr		46	59	62	53		53	109	80	102	157		288	43	44		36	6	38
V		212	173	174	181		96	76	71	81	81		115	46	60		11	32	11
Sc		33	28	30	30		20	17	17	15	9								
Zr		127	120	113	113		195	172	185	172	159		115	89	107		189	152	164
Nb		10.8	11.0	8.5	9.2		13.2	11.5	12.7	12.3	11.5		9.2	6.9	6.6		12.6	10.5	12.7
Y		23	26	26	25		33	29	32	30	30		26	32	31		40	38	38
Sr		164	162	179	207		108	101	94	110	127		78	394	147		136	137	80
Rb		78	86	75	76		141	116	82	75	73		5	51	88		110	67	84
Ba		1033	1259	1328	1410		1595	1990	1375	981	1770		299	801	1041		1071	1720	2005
Ti/Zr		39.2	40.0	39.8	39.8		20.6	20.6	20.1	20.6	20.0		42.7	47.8	46.5		20.3	22.5	21.9
Zr/Y		5.52	4.60	4.35	4.52		5.90	5.93	5.78	5.73	5.30		4.42	2.78	3.45		4.73	4.00	4.32
Zr/Nb		11.76	10.90	13.29	12.28		14.80	14.96	14.57	13.98	13.83		12.50	12.90	16.21		15.00	14.48	12.91
Y/Nb		2.13	2.40	3.06	2.72		2.50	2.52	2.52	2.44	2.61		2.83	4.64	4.70		3.17	3.62	2.99
V/Sc		6.42	6.20	5.80	6.03		4.80	4.47	4.18	5.40	9.00								
Zr/Sc		3.85	4.30	3.77	3.77		9.80	10.12	10.88	11.47	17.67								
Ba/Sr		6.30	7.77	7.42	6.81		14.80	19.70	14.63	8.92	13.94		3.83	2.03	7.08		7.88	12.55	25.06
Ti/V		23.5	27.7	25.8	24.8		41.8	46.5	52.4	43.7	39.2		42.7	92.5	82.9		348.8	106.8	327.0
La	28.7		22.4		17		54.4			45.8	36.3								
Ce	64.6		50.2		39.3		116			96.2	80.5								
Pr	7.16		5.74		4.87		13.1			11	9.43								
Nd	26.3		23.1		19.3		47.9			40.1	34.7								
Sm	4.8		4.62		4.27		8.55			6.77	6.36								
Eu	1.58		1.11		1.27		2.13			1.49	1.45								
Gd	4.01		4.41		4.27		6.75			5.03	5.02								
Dy	3.63		4.69		4.03		6.2			4.85	4.9								
Er	2.7		3.02		2.58		3.84			3.42	3.46								
Yb	2.13		2.79		2.35		3.41			3.3	3.59								

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DRILLHOLE MCPD 1

SAMPLE NUMBER: MCPD 1, 127.7 and 128.9m

SUMMARY:

These are virtually identical highly altered and weathered rhyolitic vitric crystal tuff-breccias with *occasional large* lithic fragments of vitric dacite and rhyolite lava, and quite *common pumice fragments.*

HAND SPECIMEN:

These are highly weathered polymict lithic tuff-breccias or epiclastics in which dark angular fragments of feldspar-phyric dacite or rhyolite to 2cm long are most obvious; sample 128.9 contains a large light coloured rhyolite clast at least 6 cm across that contains quartz and altered feldspar phenocrysts. Other components identifiable in hand specimen include abundant cystals of quartz, and detrital feldspar now altered to white clayey material, and small lithic fragments of tuff(?) or shale.

THIN SECTION:

The highly weathered nature of these samples is immediately obvious in thin section, being defined by abundant irregular trains and localizations of rusty red-brown limonite and masses of clay-sericite intergrowths, especially in sample 127.7. Volcanic quartz phenocrysts are abundant in this sample, and are generally less than 0.5mm across. They are typically subhedral or angular crystal fragments, but resorbed subhedra are also not uncommon. They occur both as obvious detrital grains, and as phenocrysts in highly altered rhyolitic lava/vitric tuff fragments. Former feldspar phenocrysts, again occurring as both phenocrysts in lava/tuff or as detrital crystals, are totally replaced by sericite-clay alteration. Similar alteration of the secondary feldspar-rich matrix/groundmass has resulted in even the former outlines of the feldspar crystals being obliterated.

A component of these samples not at all obvious in hand specimen, but not uncommon in thin section, is flattened pumice fragments. These are generally less than 1mm long, and are highly altered to sericite-dominated very fine-grained assemblages. Several slightly rounded, very dark and fine-grained lithic fragments contain altered plagioclase microlites in a groundmass filled with Fe-oxide dust, and may have been vitric andesites, whereas the few large lithic fragments (especially the very large fragment in 128.9) are highly plagioclase-phyric dacitic and rhyolitic lava fragments which contain subordinate resorbed quartz phenocrysts.

These samples are entirely volcanogenic and contain no detrital component from the Precambrian metamorphics. They are polymict in that they contain material from several different volcanic sources (lithologies); the dominant component in the rock is highly altered rhyolitic vitric crystal tuff and pumice fragments, and phenocrysts and crystal fragments from the same source.

SAMPLE NUMBER: MCPD 1, 135.5m

SUMMARY:

This is a quartz-rich micaceaous greywacke with pelitic metamorphic rock fragments and common detrital tourmaline and zircon; it has no volcanic component, and is entirely derived from a local Precambrian pelitic metamorphic terrain.

HAND SPECIMEN:

This sample is representative of the thick sequence of greywackes present in the bottom of the hole. It is a light to medium grey, uniform textured and fine-medium grained massive greywacke.

THIN SECTION:

In thin section, this sample is seen to be a quartz-rich micaceous greywacke. Quartz grains are notably angular and rarely reach 0.5mm across. They are frequently polycrystalline, and such grains have intimately sutured grain boundaries and uneven extinction, typical of quartz from pelitic metamorphic terrains. Lithic fragments up to 1mm long include quartzite, quartz-muscovite schist and some very fine-grained cherty fragments. Detrital muscovite flakes 0.2-0.4mm long are abundant, and chloritized biotite flakes with tiny opaques along cleavage traces are also quite common. Matrix is chloritic and makes up only about 5-10 modal% of the sample. The dominant accessory minerals are green pleochroic tourmaline and subordinate zircon.

This sample has no obvious volcanic component. It is derived totally from the Precambrian pelitic metamorphics, and is strikingly similar to the Animal Creek Greywacke at the base of the Que andesites, and the Miners Ridge Sanstone at the base of the Lynchford sequence.

DRILLHOLE MCPD 2 606103

SAMPLE NUMBERS: MCPD 2, 86.1m, 93.9m, 98.4m, 104.4, 106.7m, 117.1m

LOCATION: PANCON-OUTOKUMPU Mount Cattley EL MCPD 2

SUMMARY:

These six samples, selected to be entirely representative of the Mount Read lava interval in MCPD 2 are all slightly vesicular aphyric meta-andesites with rare plagioclase microphenocrysts and a trachytic (pilotaxitic) orientation of groundmass plagioclase. They all show quite intense sericite and calcite alteration, far more than is typically seen in regionally metamorphosed Mount Read meta-andesites. They are quite similar to lavas hosting the Beulah barite, but unlike the Que-Hellyer basalts and andesites. Petrographically similar aphyric andesites are known, however, from the Lower Basalt in the Hellyer - Mt. Charter area.

HAND SPECIMEN:

Slightly vesicular, aphyric medium grey basic to intermediate metavolcanics with vesicles to 1cm (although mainly <1mm) filled by chlorite and calcite. Calcite veining has broken small areas of the core into jigsaw-fit 'breccia'; calcite veins are generally around 1mm wide, but some larger patches are almost 1cm across.

THIN SECTION:

In thin section, these rocks are seen to be a very uniform textured aphyric and vesicular intermediate volcanics carrying sparse plagioclase microphenocrysts in a plagioclase-rich intersertal- to pilotaxitic-textured groundmass. Plagioclase microphenocrysts are less than 0.3mm across and, like the abundant stout plagioclase prisms dominating the groundmass, they are almost completely altered to very fine-grained sericite and minor calcite. Occasional crystals have preserved areas of albite, indicating a phase of albitization of primary calcic plagioclase before sericitization and carbonation. Very small augite plates interstitial to groundmass plagioclase laths has been completely altered to calcite and very fine-grained albite-quartz mosaics. Groundmass (formerly glassy) mesostasis has also altered to a very fine-grained intergrowth of quartz, albite and pale green chlorite dotted with clots of tiny FeTi oxide grains and occasional larger grains of the same.

Vesicles constitute less than 3 modal% of this rock and are circular to ovoid in section and undeformed. They are filled with either multicrystalline calcite aggregates, or rosettes of pale green chlorite with unusual grey-blue interference colours; chlorite-filled vesicles are frequently lined by a thin layer of secondary quartz and calcite-filled vesicles are frequently lined by sericite. Narrow (<0.5mm) meandering fractures and larger gashes are filled by calcite.

These aphyric lavas, with original abundant plagioclase but sparse mafics were probably andesitic in composition. They are unusual compared to the Que-Hellyer andesites, which are generally more crystal-rich. Similar aphyric andesites occur around the Beulah barite deposit, where they are also pervasively carbonated. The abundant carbonate and sericite alteration in the MCPD 2 andesites is, in my opinion, more intense than normally associated with regional burial metamorphism as seen in the Mount Read Volcanics, and may have a hydrothermal source.

DRILLHOLE MCPD 3 GROUP 1 (4 samples)

SAMPLE NUMBERS: 103.0, 104.3,126.0 and 128.7

LOCATION: PANCON-OUTOKUMPU Mount Cattley EL MCPD 3

SUMMARY:

These lavas are porphyritic andesites with abundant plagioclase phenocrysts, minor augite phenocrysts, and occasional quite large phenocrysts and microphenocrysts of apatite and FeTi oxide in a devitrified and recrystallized glassy groundmass. They are petrographically unlike the andesites in MCPD 2, but are similar to the Que-Hellyer Footwall andesites and andesites from the Beulah area. Metamorphic mineral assemblages are typical of regional low-grade burial metamorphism, and hydrothermal alteration is insignificant.

HAND SPECIMEN:

These are medium grey, fine- to medium-grained intermediate meta-volcanic rocks with sparse calcite-filled vesicles and fractures, and relatively abundant phenocrysts (<1mm long) of altered feldspar and a chloritized mafic phase. They show highly variable degrees of autobrecciation ranging from highly autobrecciated (128.7m) to more massive (104.3).

THIN SECTION:

All these lavas are relatively highly porphyritic, with former phenocrysts of plagioclase, augite, and FeTi oxide in a quenched groundmass which was largely glassy. Plagioclase phenocrysts are euhedral elongate to blocky prisms mainly less than 0.5mm long, and they constitute around 15-20 modal% of these samples. They are all albitized formerly more calcic plagioclase, but most are now more than 70% altered to sericite and subordinate chlorite. Plagioclase phenocrysts often occur gathered together and with occasional former augite phenocrysts in glomeroporphyritic gabbroic clots. Former mafic phenocrysts now altered to pale green chlorite and quartz are far less abundant than plagioclase phenocrysts (probably only 0.5-1 modal%) and rarely reach 0.5mm length. They have shapes suggestive of augite precursors, and like augite phenocrysts in many modern arc andesites, these frequently contain small FeTi oxide microphenocryst inclusions.

A distinctive feature of these rocks is the abundance (~2-3 modal%) and relatively large size of the FeTi oxide phenocrysts. These are often around 0.5 - 0.75mm long and are well-formed to somewhat skeletal octahedra showing some tendency to leucoxene alteration (although without a polished section the extent of leucoxene alteration cannot be assessed).

A second notable feature of these lavas is the relatively abundant, quite large (up to 1mm long) apatite microphenocrysts and (more sparse) phenocrysts. These are generally pencil-shaped hexagonal prisms with a well-developed cleavage or parting perpendicular to the c-axis.

The groundmasses of these lavas were undoubtedly glassy. In autobrecciated sample 128.7, the groundmass preserves beautiful perlitic cracks, yet is now composed of a fine-grained intergrowth of quartz, albite and pale green chlorite. The main variation between fragments and inter-fragment areas in this sample is the greater proportion of chlorite in the groundmass of the fragments. Samples 103.0 and 104.3 have similar 'spotty' groundmasses composed of even-textured intergrowths of quartz, albite, chlorite and minor sericite, crystallizing from devitrifying glass which contained only a small proportion of plagioclase microlites. Sample 126.0 has a finer-grained groundmass, still composed of secondary quartz, albite and chlorite, but showing in this case excellent perlitic cracks in former glass; the cracks are defined by chlorite concentrations. Occasional larger single- or multi-crystal pools of secondary quartz have grown in the groundmasses of both these samples.

Rounded to irregular vesicles in these lavas are filled by pale green chlorite, but are lined by globular masses of secondary quartz. Calcite is a minor vesicle-filling phase in 128.7, but is virtually absent in the other two lavas. There is no sign of any significant hydrothermal alteration overprinting the regional burial metamorphic assemblage, unlike in the MCPD 2 lavas.

These plagioclase+augite+FeTi oxide-phyric lavas are probably compositionally andesites to dacites. The apparent absence of phenocrystal olivine (or its alteration products) and abundance of FeTi oxide phenocrysts also supports a more evolved composition for these rocks relative to the generally more primitive Hellyer basalts and basaltic andesites. Similar lavas are known from the Beulah area, and from the Footwall andesites in the Que-Hellyer sequence. Finally, there is no way that the lavas sampled in MCPD 3 can be petrographic correlates of the aphyric andesites in MCPD 2.

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DRILLHOLE MCPD 3 GROUP 2 (3 samples)

SAMPLE NUMBER: MCPD 3, 118.2, 121.5, 122.4m

LOCATION: PANCON-OUTOKUMPU Mount Cattley EL MCPD 3

SUMMARY:

These samples are massive to flow-banded plagioclase+augite+FeTi oxide+apatite-phyric meta-dacites with devitrified glassy groundmasses showing snowflake textures and perlitic cracks. The alteration assemblage is typical of low-grade regional metamorphism, and local hydrothermal alteration of these lavas has not occurred.

HAND SPECIMEN:

These are massive (118.2, 122.4) to flow-banded (121.5m), pinkish-grey porphyritic dacites with calcite-filled vesicles and phenocrysts of plagioclase and at least one altered mafic phase.

THIN SECTION:

These lavas are porphyritic, with 10-20 modal% of plagioclase phenocrysts, and around 1 modal% of chloritized mafic phenocrysts in a devitrified glassy groundmass. Plagioclase phenocrysts are typically blocky prisms to about 0.5mm long that have been totally albitized, but are now slightly to highly sericitized. Plagioclase phenocrysts commonly occur in glomeroporphyritic clots, both as monomineralic aggregates and with chloritized augite in gabbroic clots. Former augite phenocrysts are much smaller and less abundant than plagioclase phenocrysts, and are totally altered to chlorite and quartz. Large FeTi oxide phenocrysts are relatively common; they are leucoxenized octahedra and resorbed skeletal octahedra usually around 0.2mm long.

As noted already for the Group 1 andesites from this hole, these dacites contain an anomalous amount of well-former apatite microphenocrysts, which occur as both discrete crystals and as inclusions in gabbroic clots and plagioclase and augite phenocrysts.

The groundmasses of these samples were all formerly glassy, but they show somewhat different textures now due to differing styles of devitrification and recrystallization. The flow banding so obvious in much of the core sampling this unit (units?) is totally indiscernible in thin section, and the flow banded sample (121.5m) is indistinguishable from many of the more massive samples. Three samples (118.2, 121.5 and 122.4m) have fine-scale snowflake devitrification textures in the groundmass, defined by a blotchy, irregular intergrowth of secondary quartz, albite and subordinate chlorite and sericite; cleaner pools of secondary quartz are growing in this snowflake groundmass. The distict pink colour of these rocks relative to the MCPD Group 1 andesites may be due to the presence of some secondary K feldspar in the devitrifying groundmass of the dacites, although it is virtually impossible to detect with certainty, and in my experience, secondary albite may commonly be pinkish. The metamorphic mineral assemblage (albite-chlorite-sericite -leucoxene-quartz ± calcite is typical of low-grade burial metamorphism; hydrothermal alteration of these lavas has been insignificant..

Vesicles make up about 3-5 modal% of theses lavas and are usually rounded to ovoid. They are generally filled with polygonal multi-crystalline quartz aggregates in which individual quartz crystals show dusty inclusions defining growing crystal faces. Calcite, sericite and chlorite are less common vesicle fillings. Small fractures and tension gashes are filled by polycrystalline secondary quartz and fairly coarse calcite.

These four lavas are probably dacitic to rhyodacitic, judging by the small proportion of mafic phenocrysts and the snowflake textured, quartz-rich groundmasses. The abundance of large FeTi oxide and apatite phenocrysts strongly implies a genetic link with the darker grey, more mafic (Group 1) andesites in the same hole. I suggest that these lavas are comagmatic with the Group 1 andesites, and were probably derived from similar magmas by fractional crystallization.

SAMPLE NUMBER: MCPD 4, 63.2m and 105.3m

SUMMARY:

These are micaceaous quartz-rich greywackes derived dominantly from a pelitic metamorphic source, but they contain quite abundant calcite in the matrix and also replacing groundmass grains. They are very similar to the greywackes in the bottom of MCPD 1, which in turn, are virtually identical to the Animal Creek Greywacke.

THIN SECTION:

These samples are petrographically identical, and in thin section are seen to be micaceous quartz-rich greywackes. Detrital fragments are dominantly monocrystalline angular quartz grains to 0.3mm that show uneven extinction and ragged and reacted grain boundaries. Also plentiful are polycrystalline quartz grains with intimately sutured grain boundaries, and pelitic quartz-muscovite schist fragments. Detrital muscovite plates are common, and almost opaque mica-shaped plates composed dominantly of chlorite and FeTi oxides almost certainly represent altered biotite. A small proportion of lithic fragments are very fine-grained quartz mosaics, which may represent chert fragments. Strongly zoned brown and green tourmaline grains are a notable accessory.

The matrix makes up only 10-15 modal% of these greywackes and is quite calcite-rich, and contains subequal amounts of chlorite and sericite. Although much of the calcite appears to be replacing both areas of formerly clayey matrix and framework grains, the abundance of calcite suggests that there may have been a carbonate component in the original rocks, and that all the calcite has not resulted from post-depositional invasion by carbonate-rich fluids. There does not appear to be any volcanic component in these samples, that are derived entirely from a pelitic metamorphic source, presumably from the nearby Precambrian. The rocks are highly reminiscent of the Animal Creek Greywacke in the Que-Charter area, and, except fopr the abundance of carbonate in these samples, are vitually identical to the quartz-rich micaceous greywackes in the bottom of MCPD 1.

SAMPLE NUMBER: MCPD 4, 96.2m

SUMMARY:

This is a micaceous siltstone probably derived from Precambrian pelitic metamorphics, with no clear volcanic component.

THIN SECTION:

This is a very fine-grained sedimentary rock, best classified as a siltstone, in which the only identifiable detrital components are very small (<0.1mm) angular quartz grains and small flakes of muscovite. Bedding is not obvious in this section. The quartz grains show features such as patchy and fan-like extinction and occasional multi-crystalline habit which strongly suggest a metamorphic source rather than a felsic volcanic (ie. phenocryst source).

The remainder of the rock is composed of a very fine-grained matrix of mesh-like sericite and pale green chlorite which is overprinted by abundant secondary calcite. Sparse very narrow anastomosing veinlets of calcite transect the rock.

There is no obvious volcanic component in this siltstone, so I would hesitate to add the prefix 'epiclastic' to this rock. To me, it is a more distal and fine-grained equivalent of the greywacke described above.

SAMPLE NUMBER: MCPD 4, 121.6m, 212.4m

SUMMARY:

These are vitric crystal tuffs composed largely of totally sericitized flattened pumice fragments and feldspar phenocrysts, and a minor component of detrital quartz and muscovite of Precambrian pelitic metamorphic derivation.

THIN SECTION:

These samples are pumiceous vitric lithic tuffs dominated by sericitized feldspar phenocrysts and flattened and sericitized pumice fragments. The latter are up to several mm long and are composed essentially of sericite and very fine-grained Fe oxide dust that defines the outline and internal structure of the pumice clasts. Blocky albitized plagioclase phenocrysts to 2mm across are abundant, but have been more than 90% sericitized, and some appear to be set in a highly sericitized matrix of formerly felsic glass; pale green chlorite is a common interstitial phase. In sample 212.4m, feldspar phenocrysts are clustered into several glomeroporphyritic clots. Small (<0.2mm) grains of detrital monocrystalline and polycrystalline quartz and muscovite flakes, more abundant in Sample 121.6m, are clearly derived from pelitic metamorphics rather than being of volcanic origin. Quite large leucoxenized (0.2-0.8mm) FeTi oxide grains are not uncommon, as are prismatic apatite microphenocrysts. These latter minerals are notable phenocrysts in the andesites and dacites described above from MCPD 3, and are not typical of Mount Read Volcanics in general. Some possible link between the intermediate volcanics in MCPD 3 and these pumiceous felsic tuffs is suggested, albeit tentatively.

Four or five dark coloured lithic fragments in rock 121.6m, up to 2mm across, are all slightly rounded feldspar-phyric dacite with small patchy secondary quartz pools crystallizing from the dark rhyolitic matrix.

These rocks are very similar vitric crystal tuffs dominated by pumice fragments and feldspar crystals, but containing a small detrital component derived from the Precambrian metamorphics.

SAMPLE NUMBER: MCPD 4, 240.3m

SUMMARY:

This rock is a chaotic mixture of dark disrupted micaceous siltstone and feldspar-phyric pumice tuff and is interpreted to have formed by violent mixing of the tuff and sediment during disruption of the siltstone by a hot ash flow. It has suffered fairly extensive calcite alteration.

THIN SECTION:

In thin section, this complex rock is seen to be composed essentially of two major domains, although these are intermingled on an intimate scale. The dark coloured domain is a very murky and 'dusty' micaceous siltstone with visible detrital grains of quartz and muscovite to 0.1mm across, and abundant fine-grained secondary calcite in a formerly clayey (now sericitic-chloritic) matrix. The lighter coloured domains are coarser-grained and replaced extensively by coarse calcite. However, it is easy to discern large blocky albitized plagioclase phenocrysts, to 1mm long, often rounded and in polycrystalline clots. Flattened pumice fragments containing some feldspar phenocrysts are a subordinate component of this rock and blend imperceptibly into the siltstone in many places. Contacts between the light and dark domains are exceptionally irregular. Discrete rounded albitized plagioclase phenocrysts also occur within the dark siltstone.

Based on the core in hand specimen, and on the observations above, this unusual rock appears to be a mass flow unit generated by disruption of a still wet (unconsolidated) siltstone by a pumiceous hot ash flow, with consequent mixing and blending of the two fluid units on all scales. I concur completely with Wally Herrmann's diagnosis in the core log.

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SAMPLE NUMBER: MCPD 4, 294.6m

SUMMARY:

This is a fine-grained epiclastic sandstone composed of abundant felsic volcanic detritus, including flattened pumice clasts, abundant albitized feldspar phenocrysts and sericitized formerly glassy dacite fragments, and a subordinate detrital component of metamorphic quartz and muscovite probably derived from the Precambrian.

THIN SECTION:

This rock in thin section is seen to be an epiclastic sediment made up of three major components, feldspar phenocrysts from felsic volcanics, detrital quartz and muscovite from pelitic metamorphics, and flattened pumiceous and other altered glassy felsic lava fragments. Feldspar phenocrysts are up to 1mm long, generally blocky rather than prismatic, and often occur as two or three conjoined crystals; they are all albitized plagioclase, but have been slightly sericitized. They contain trains of chloritized glass inclusions parallel to crystal faces.

Small detrital grains of polycrystalline metamorphic quartz and muscovite flakes are subordinate to the feldspar phenocrysts, but nevertheless are an obvious component. The remainder of the rock (perhaps 40-50 modal%) is composed of flattened and totally sericitized pumice fragments and small (<0.5mm) subrounded lithic clasts which are mainly dark, plagioclase-phyric dacite. Secondary calcite is quite widespread in the matrix of this rock, and also occurs as irregular pools and veinlets.

The mixed metamorphic and local volcanic (including felsic tuffaceous and pumiceous components) constituents of this rock suggest that it is an epiclastic sediment or distal mass flow deposit.

SAMPLE NUMBER: MCPD 4, 301m

SUMMARY:

This rock is a vitric crystal tuff composed almost exclusively of flattened plagioclase-phyric rhyolitic pumice fragments.

THIN SECTION:

This rock in thin section is seen to be a vitric crystal tuff composed almost entirely of coarse, flattened pumice fragments. These felsic pumice fragments contain abundant blocky albitized plagioclase phenocrysts to 0.5mm long which are remarkably free from sericite alteration, but are commonly partly or wholly replaced by calcite. Pumice clasts have totally devitrified to a very fine-grained quartz-albite mosaic with a mesh of pale green chlorite and sericite permeating the devitrified glass. Microphenocrysts of partially leucoxenized FeTi oxide are not uncommon.

DRILLHOLE MCPD 5

SAMPLE NUMBER: MCPD 5, 129.6m and 144m

SUMMARY:

These rocks are coarse epiclastic sandstones containing a major vitric and plagioclase-phyric felsic volcanic component, with a subordinate contribution from a pelitic metamorphic source represented by quartz-muscovite schist and abundant fine grained detrital muscovite flakes. Sample 144m contains more extensive chloritization of vitric fragments than seen in 129.6m.

THIN SECTION:

These rocks are epiclastic coarse sandstones dominated by phenocrysts and phenocryst fragments of albitized plagioclase and quartz that make up around 50-60% of the rocks. Albitized plagioclase phenocrysts are usually 0.5 to 1.0mm long, and are frequently angular crystal fragments which show minimal zoning. They are rarely sericitized, but occasionally contain patchy calcite alteration. Quartz phenocrysts are also generally crystal fragments slightly larger than the feldspars. These usually show scalloped margins due to reaction with the rhyolitic groundmass, while some grains show extensive resorption and rounding. Lithic fragments constitute about 15 modal% of this sample. They include both felsic lavas and subordinate pelitic schists. The lava fragments are vitric to vitrophyric dacitic to rhyolitic lavas with sparse albitized plagioclase phenocrysts set in totally devitrified glass now composed of an extremely fine-grained quartz-albite +minor sericite intergrowth. In sample 144m, the vitric component has altered extensively to pale green chlorite rather than quartz-albite-sericite as seen in 129.6m. The matrix of both rocks is a reworked silty ash composed of material from both felsic volcanic and pelitic metamorphic sources; the latter source is indicated by abundant small muscovite flakes. Patchy calcite alteration of the matrix is commonly associated with localized concentrations of tiny pyrite euhedra.

SAMPLE NUMBER: MCPD 5, 159.6m

SUMMARY:

This sample was an aphyric, non-vesicular vitrophyric rhyolite or rhyodacite shallow intrusive composed of *plagioclase microlites (now sericitized)* in a glassy matrix; the latter has devitrified to a quartz-albite-sericite-chlorite intergrowth which has been fairly extensively altered to calcite.

THIN SECTION:

This rock in thin section is seen to be a non-vesicular, massive aphyric rhyolitic or dacitic lava. It is composed of a homogeneous intergrowth of randomly-orientated, elongate plagioclase microlites to 0.1mm long in a *devitrified glassy matrix* which is dominated by an extremely fine-grained intergrowth of sericite, albite, abundant quartz and minor chlorite, extensively pervaded by patchy calcite alteration. The former plagioclase microlites are totally replaced by sericite; this, and the abundant calcite and sericite alteration of the former glassy groundmass gives this rock a very murky appearance in thin section. Abundant coarser-grained (to 0.4mm) patches of secondary quartz are growing from the devitrified glass, and secondary quartz also fills common small tension gashes and cracks. Small mainly euhedral grains of former FeTi oxide are highly altered, and often show a rim of Fe(Ti?) oxide and a chlorite-filled core.

I have little doubt that this sample was a very shallow intrusive dyke or sill of rhyolite or rhyodacite. The aphyric nature of the sample is unusual.

SAMPLE NUMBER: MCPD 5, 183.2m

SUMMARY:

This sample is a chert traversed by innumerable very fine brittle fracture planes which have been sealed by calcite; the latter also occurs as tiny spots throughout the rock. The ultimate origin of the rock (chemical chert precipitate?.. silicified rhyolitic vitric ash?..) is impossible to determine from thin section examination.

THIN SECTION:

This sample is very difficult to diagnose, even in thin section. It is essentially an exceptionally fine-grained and irresolvable quartz-dominated, homogeneous cherty rock traversed by very narrow veinlets of calcite along brittle fractures; spots of calcite rarely larger than 0.3mm diameter also occur abundantly throughout the rock. No detrital grains are discernible, and the few sericite flakes big enough to be identified in the rock are probably recrystallized. Diffuse small clots and trains of ragged-edged Fe oxide-hyroxide mixtures are also not uncommon, but do not appear to be replacing pyrite.

In hand specimen and in thin section this rock might best be called a chert. Although this sample lacks any sign of bedding , Wally Herrmann notes in his core log that this distinctive unit is banded pink and grey on a millimetre to centimeter scale from 186.5 to 190.6m. Unfortunately, this banded interval was not sampled for thin section work. It may represent either a thoroughly silicified former rhyolitic vitric silty ash, or as is more likely, a chert.

SAMPLE NUMBER: MCPD 5, 231 and 239.9m

SUMMARY:

Thess samples are cherts essentially identical to sample 183.2 above. The only differences are that there are sparse detrital albite grains in 239.9m, and also, the calcite spotting in this sample consists of discrete well-crystallized prisms of calcite rather than the murky blotches present in 183.2m throughout the rock. As for 183.2m, the origin of these rocks (chemical chert precipitate?.. silicified rhyolitic vitric ash?..) is impossible to determine from thin section examination.

THIN SECTION:

These samples are identical to 183.2m in every respect except that:

1. they have abundant well-crystallized calcite prisms spotting the rock, rather than dirty irregular blotches as in 183.2m, and
2. they both contain a number of small apparently detrital albite grains.

The latter's presence in this rock does not help in choosing whether this cherty sequence represents true chert, or silicified vitric ash of rhyolitic composition; rare grains of detrital albite might be expected in either case. Sample 239.9 contains scattered but quite common very small pyrite euhedra.

SAMPLE NUMBER: MCPD 5, 196.6m

SUMMARY:

This sample is a black shale

THIN SECTION:

This sample is very dark grey to black silty shale abutting cherty material identical to the samples 183.2, 231 and 239.9m described above. The nature of the contact between the two units is obscured by calcite alteration. Bedding in the shale has been disrupted, and abundant large, fractured pyrite cubes occur as discrete crystals and veins up to at least 7mm wide. Fairly fine-grained polycrystalline calcite occurs intergrown with the pyrite, and both calcite and quartz have grown in beautifully formed pressure fringes on opposite sides of many pyrite crystals. Irregular patches of honey coloured, very weakly-pleochroic sphalerite and minor intergrown calcite occur scattered throughout the shale hosting the pyrite veins.

In reflected light, the pyrite grains are monomineralic and free of other sulphide inclusions. They are transected by discontinuous narrow veinlets of chalcopyrite and Fe-rich sphalerite, and these phases also form subhedral overgrowths on the margins of pyrite cubes extending into and growing together with deformed calcite in the pressure fringes around pyrite. Sphalerite patches outside the main pyrite vein are speckled by extremely fine-grained chalcopyrite and larger irregular areas of the same mineral, and they also contain occasional small areas of galena.

The sulphide paragenesis in this sample appears to have been the following: diagenetic growth of pyrite bands in the carbonaceous (and perhaps originally pyritic) black shale occurred followed by disruption of

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OUTOKUMPU EXPLORATION AUSTRALIA PTY LIMITED

Report No: R41.11
File No: 2.41.3

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ANNUAL REPORT TO JULY 20, 1989
EL 14/85, MT CATTLEY, NW TASMANIA
VOLUME 2 OF 2
APPENDICES III & IV

For: Outokumpu Exploration Australia Pty Limited
77 Pacific Highway, North Sydney, NSW 2060

By: W. Herrmann, RSD 1066 Devonport, TAS 7310

Date: 26th June, 1989

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606126

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APPENDIX III

REPORT ON DRILL TESTING OF
TWO GEFINEX - EM ANOMALIES
AT MT CATTLEY, EL14/85
TASMANIA

606127

OUTOKUMPU EXPLORATION AUSTRALIA PTY LIMITED

Report No: R41.9

REPORT ON DRILL TESTING OF
TWO GEFINEX - EM ANOMALIES
AT MT CATTLEY EL 14/85 - TASMANIA

FOR: Outokumpu Exploration Australia Pty Limited
77 Pacific Highway, North Sydney, NSW 2060

BY: W. Herrmann
RSD 1066, Devonport, Tasmania 7310

DATE: January, 1989.

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1. INTRODUCTION

This report presents and discusses the results, based on megascopic geological core logging, of a recently completed two hole diamond drilling programme designed to test two GEFINEX EM anomalies in EL 14/85 near Mt Cattley, Tasmania.

The report also gives a brief summary of background exploration history on the exploration licence.

This report was compiled by W. Herrmann under an agreement with Outokumpu Exploration Australia Pty Limited to provide geological supervision and interpretation of the drilling programme.

2. SUMMARY AND CONCLUSIONS

A GEFINEX 400S ELECTROMAGNETIC trial survey carried out in October 1988 led to the recognition of two conductivity anomalies east of Beecroft Road on line 12000N in EL 14/85, Mt Cattley, Tasmania.

Two inclined diamond drill holes of combined depth of 545.6m were drilled in November-December 1988 in order to test for the sources of these EM anomalies.

MCDD4 (TD 301m) was drilled to test the western anomaly centered at about 180m below 12000N/11300E. After penetrating the base of Tertiary basalt cover at about 58m below the surface the hole intersected a steeply south west dipping and facing sequence comprising turbiditic micaceous greywacke/siltstone alternating with felsic pyroclastics and epiclastics and mass flow type breccias combining these lithotypes. The sequence does not contain significant alteration or sulphide mineralisation and the source of the Gefinex anomaly is not yet apparent.

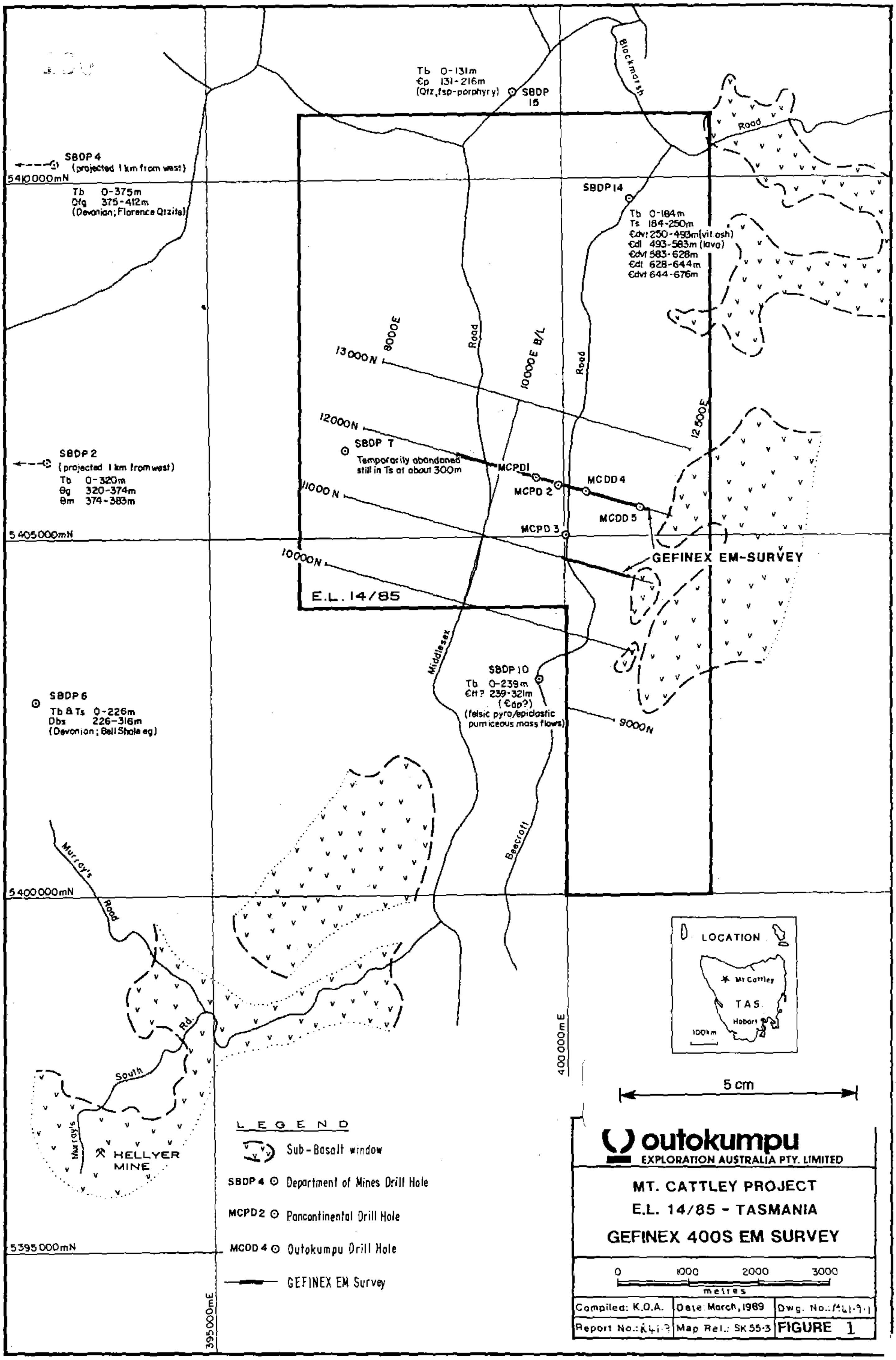
MCDD5 (TD 244.6m) was drilled to test the eastern anomaly centered at about 185m below 12000N/12100E. After penetrating to the base of Tertiary basalt and fluvial sediments at about 88m vertically below the surface the hole intersected a moderately north westerly dipping and facing epiclastic-sedimentary sequence comprising a thick, graded felsic mass flow deposit, underlain by a 30m thick unit of pyritic black siltstones in turn underlain by an at least 50m thick unit of felsic vitric tuffaceous cherty siltstones.

The black siltstones contain several percent of pyrite but otherwise the sequence does not appear to be significantly mineralised or hydrothermally altered.

The Gefinex anomaly is tentatively but fairly confidently attributed to the presence of the black siltstone unit.

Although the drilling programme does not appear to have been successful in locating significant sulphide mineralisation it has provided additional lithological stratigraphic and structural information which allow an improvement in geological interpretation of this largely Tertiary basalt covered EL.

It is suggested that the unusual mafic volcanics previously intersected in MCPD's 1, 2, 3 (1986) are not stratigraphically equivalent to (megascopically) similar rocks of the Que River-Hellyer Volcanic sequence but lie at a considerably higher stratigraphic level near the top of the Dundas Group.


Tb 0-131m
Єp 131-216m
(Qtz,fsp-porphyry)
SBDP 15
Blackmarsh
Road
SBDP 4
(projected 1 km from west)
5410000mN
Tb 0-375m
Dfq 375-412m
(Devonian; Florence Qtzite)
SBDP 14
Tb 0-184m
Ts 184-250m
Єdvt 250-493m(vit.ash)
Єdl 493-583m (lava)
Єdvt 583-628m
Єdt 628-644m
Єdvt 644-676m
8000E
13000N
Road
10000E B/L
Road
12500E
12000N
SBDP 7
Temporarily abandoned still in Ts at about 300m
MCPD1
MCDD 4
MCPD 2
MCDD 5
11000 N
SBDP 2
(projected 1 km from west)
Tb 0-320m
Θg 320-374m
Θm 374-383m
5405000mN
MCPD 3
GEFINEX EM-SURVEY
10000N
E.L. 14/85
Middlesex
SBDP 10
Tb 0-239m
Єf1? 239-321m
(Єdp?)
(felsic pyro/epiclastic pumiceous mass flows)
9000N
SBDP 6
Tb & Ts 0-226m
Dbs 226-316m
(Devonian; Bell Shale eg)
Murray's Road
Beecroft
5400000mN
LOCATION
Mt Cattley
TAS
Hobart
100km
Rd.
South
Murray's
HELLYER MINE
400000mE
5 cm
LEGEND
Sub-Basalt window
SBDP 4 Department of Mines Drill Hole
MCPD 2 Pancontinental Drill Hole
MCDD 4 Outokumpu Drill Hole
GEFINEX EM Survey
outokumpu
EXPLORATION AUSTRALIA PTY. LIMITED
MT. CATTLEY PROJECT
E.L. 14/85 - TASMANIA
GEFINEX 400S EM SURVEY
5395000mN
0
1000
2000
3000
metres
Compiled: K.O.A.
Date: March, 1989
Map Ref.: SK 55-3
FIGURE 1
395000mE

3. EXPLORATION HISTORY

EL 14/85 was pegged in mid 1985 by Pancontinental Mining Limited with the objective of exploring for polymetallic base metal/precious metal volcanogenic massive sulphide deposits of the Que River, Hellyer type.

The licence is centered about 12km NNE and approximately along strike of the Hellyer deposit and it was considered likely that stratigraphic equivalents of the Hellyer-Que River Mine sequence lay within the licence area under a variable but then unknown thickness of Tertiary basalt.

Pancontinental proposed a two stage exploration programme essentially involving:

Stage 1

* Regional geological mapping and stream sediment geochemical sampling over areas of exposed Cambrian basement.

* Stratigraphic precollar-diamond drilling to test depth of basalt cover and obtain basement geological information; particularly to identify alteration "haloes" if present.

Stage 2

* Assuming favourable sequences of Mt Read volcanics were located under relatively shallow (<150m) Tertiary cover.

* Systematic geophysical surveying by TEM methods.

* Drill testing of significant conductive anomalies.

In practice, the exploration programme proceeded as follows:

December 1985 - Geological mapping and stream sediment geochemical sampling (Herrmann, January 1986).

March-June 1986 - SIROTEM survey along Beecroft Road and along five approximately east-west grid lines spaced at 1km apart to give coverage over most of the southern and eastern parts of the licence area. Interpretation of SIROTEM data allowed estimation of basalt thickness and preparation contoured isopach plan. (Dwg No 36/E/2, D. Wilson, June 1986)

September 1986 - Drilling of three vertical percussion-diamond holes (MCPD's 1, 2, 3) to test the accuracy of SIROTEM based Tertiary basalt thickness estimates and to obtain basement lithostratigraphic information. (Herrmann, October 1986)
The results of these three holes, drilled between Beecroft and Middlesex Roads in the central part of the licence, indicated that:

(a) the SIROTEM estimates for Tertiary basalt thickness were acceptably accurate.

(b) Cambrian basement lithologies intersected comprised an assemblage of basaltic, andesitic and rhyodactic volcanics apparently overlying a unit of turbiditic micaceous greywake/siltstone.

These bear some megascopic resemblance to rocks of the Hellyer-Que River. host sequence and although not significantly mineralised or altered were regarded as an encouraging discovery.

May-June 1987 - In view of the previous indications that Tertiary cover in the central eastern part of the licence was acceptably thin and that (empirically) favourable volcanic rocks existed in the basement Pancontinental carried out a detailed (200m line spacing) EM 37 survey over a 3.8 x 2.4km grid.

A few weak conductors were identified, (most notably a linear anomaly along the eastern margin of the grid which was considered to be possibly due to the eastern edge of the basalt cover) but none of these were interpreted as being indicators of massive sulphide deposits.

July 1988 - Outokumpu Exploration Australia Pty Limited took over management of exploration of EL 14/85. Outokumpu proposed a stratigraphic drilling programme to elucidate the stratigraphic setting of the mafic volcanics previously intersected in MCPD's 1, 2, 3. Herrmann and Bishop (Memo 19/7/88) reviewed the geological and geophysical data and found that the basement structural uncertainties were too great to allow confident siting of a single drill hole to achieve this and that previous geophysical methods had been effective but not successful in defining conductive anomalies which could be interpreted to represent massive sulphide deposits. On this basis they (op. cit) suggested several options for further exploration of the area including:

(i) Drilling of several short stratigraphic holes
(ii) Redrilling of MCPD 1 with intention of obtaining oriented cores from bedded sediments which would give direction of dip and allow more confident siting of a long stratigraphic diamond drill hole.
(iii) Extension of EM geophysical surveys over the remaining unexplored northern and western parts of the licence.

October 1988 - Outokumpu carried out a trial GEFINEX 400S EM survey on lines 12000N and 11000N.

Two conductive anomalies were interpreted on line 12000N and it was proposed to test these by diamond drilling despite the negative indications of the previous EM 37 survey.

November-December 1988 - Diamond drilling of MCDD's 4 and 5 to test GEFINEX anomalies on 12000N; Downhole EM logging of holes also planned.

4. GEFINEX 400S EM SURVEY

4.1 METHOD

The GEFINEX 400S is a multifrequency ground electromagnetic dipole system developed by Outokumpu in Finland used for determining electrical resistivity of the ground at different depths.

The system employs a moving horizontal transmitter coil and a simultaneously moving three coil receiver. Transmitter to receiver coil separations can be varied from 100 to 1000m according to ground resistivity and optimum depth resolution is about 70% of coil separation. The system operates on 81 programmed frequencies in the range 2Hz to 20000Hz with 20 frequencies per decade.

Results are electronically recorded and processed to produce a plot of Apparent Resistivity against Depth for the mid point between transmitter and receiver stations.

The system is most suited to detection of near horizontal to shallow dipping layers and reputedly allows accurate interpretation of depth to and lateral extent of such layers. The maximum theoretical depth limit is about 1000m.

The trial GEFINEX survey at Mt Cattley EL 14/85 was carried out during October 1988 by Aimo Hattula assisted in the field by W. Herrmann, C. Cooney and M. Scindcic.

The system was totally portable and used a 20m diameter horizontal transmitting loop with 400m transmitter-receiver separation along the survey line with station intervals of 50m. The level differences between stations (critical for the data processing) were determined to precision of 0.01m with a hydrostatic/electronic levelling device. About 20 stations (equivalent to 1km of line) could be surveyed in a full field day but the average over the six days of the survey was considerably lower due to weather related equipment failures.

It was planned to carry out the trial survey over a total of about 7 line km. (3km on 12000N and 4km on 11000N westward from the basement windows exposed in the Leven River) but due to equipment problems only 2.75km on line 12000N and about 0.5km on line 11000N were completed within the time constraints.

The principal disadvantages of operating the GEFINEX system in Tasmanian conditions seemed to be:

* problems with water entering the electronic instrument cases; (the weather during October was consistently bad) this could probably be overcome with better sealants.

* the difficulties of laying out a planar horizontal transmitting loop of 20m diameter. This was not critical in EL 14/85 where the terrain is mostly flat and the vegetation relatively open but could become impossible in the more typically steep western Tasmanian terrain.

4.2 INTERPRETATION

The GEFINEX data was processed and an initial interpretation carried out by A. Hattula with geophysical/geological input by D. Wilson, K. Airas and W. Herrmann. Final interpretations were plotted in Finland as the high frequency data needed height corrections. The qualitative apparent resistivity sections compiled from the data (Figure 2) show a series of undulating sub horizontal apparent resistivity changes. On the basis of previous (MCPD 1, 2) drilling results the first and second (from the surface) apparent resistivity changes could be attributed to the base of the Quaternary weathering profile and the base of the Tertiary weathering profile. The system did not appear to distinguish an apparent resistivity contrast between Tertiary basalt and the underlying zone of pre basalt basement weathering.

Profiles of apparent resistivity contrasts below the upper two zones were also undulating/sub horizontal tending to be sympathetic to undulations in the upper zones which was of some concern since it was considered that basement structures were likely to have moderate to steep dips.

Two significant conductivity anomalies were identified on line 12000N.

Anomaly I was interpreted as a sub horizontal lense shaped body of up to 40m thickness, 200m lateral width lying at about 150-180m vertically below 12000N between 11200E and 11450E. It was considered to have a low thickness x conductivity product. (Figure 2)

Anomaly II was of lesser extent and thickness, depicted as a 20m thick moderately westerly dipping lense centered at about 175m (depth to top) below 12000N/12100E. (Figure 3)

5. DIAMOND DRILLING: MCDD4, MCDD5

5.1 METHODS

MCDD's 4 and 5 were designed to test GEFINEX Anomalies I and II respectively.

Drilling was contracted to Diamond Drilling Tasmania Pty Limited based in Zeehan. Drilling of the two holes was carried out between 21/11/88 and 21/12/88 using a skid mounted Longyear 44 drilling machine. Drilling rig and rod sled were towed to the drilling sites by Cat D6 bulldozer operated by L. Butler of Tewkesbury under sub contract arrangements with the drilling company. Access to MCDD4 was from Beecroft Road via Beecroft Spur Road requiring clearing of a 100m long track through Eucalyptus plantation forest between the end of the Spur Road and the drill site.

Access to MCDD5 was from Beecroft Road at a point about 300m south of Beecroft Spur Road, with establishment of a bulldozer track around the southern perimeter of the Eucalypt plantation to the intersection of line 12000N near 11550E and thence eastward along the (previously bulldozed) line to the drill site at 12000E.

Oriented NQ drill core specimens were obtained from suitably stratified basement lithologies by means of a Van Ruth Products (WA) core orientation device supplied by the drilling contractor. This device proved to be very effective and provided consistent bedding orientations considered to be reliable even in the steeply inclined (-80 degrees) MCDD4.

The core from both holes is temporarily stored at the property of W. Herrmann, Forth, Tasmania.

5.2 RESULTS

5.2.1 MCDD4

MCDD4 (TD 301m) intersected (remarkably) fresh Cambrian basement rock at 58.5m and then continued in a rapidly alternating succession composed essentially of turbiditic micaceous greywacke and siltstone, fine to medium grained felsic epiclastic siltstone and sandstone, felsic pumiceous fragmental tuffs and mass flow type epiclastic breccias involving a jumbled mixture of all three of the above broad lithotypes. (Refer to detailed Drill Logs in Appendix 1 and Figure 3)

Oriented cores from several well stratified intervals indicate that the sequence is consistently dipping and facing steeply at 55-65 degrees to the south west with an average strike trend of about 325 degrees (AMG) (Thus the sequence intersected in the hole 58.5 - 301m represents about 120m of true stratigraphic thickness.)

The turbiditic micaceous sediments closely resemble the sediments intersected in the interval 129.2 - 144.4m in MCPD 1 and similar rocks are widely exposed in the basement windows in the Leven River north of Cobbers Road and near Blackmarsh Road. The apparent abundance of quartz and mica suggests a preCambrian metasedimentary provenance. All of the felsic epiclastic-tuffaceous lithotypes are compositionally related and clearly of acid volcanic parentage. The well stratified types are clearly epiclastic sediments whilst the more massive pumice rich units are considered to be pyroclastic flows although the presence of rounded rigid rhyolitic and sedimentary clasts in some of these seems to indicate, at least, partly epiclastic origin.

One can envisage a depositional environment for the sequence which is dominantly subaqueous, moderately proximal to emergent felsic volcanoes with deposition dominated by surges of mass flow type felsic pyroclastic materials punctuated by periods of turbiditic sedimentation of different metasedimentary, presumably continental provenance.

The rocks in this sequence are fresh and unaltered containing only accessory traces of disseminated pyrite (average <0.5% Py).

Minor pyrite (<0.5% rock, 5% of veins) and lesser sphalerite (<2%) galena and chalcopyrite (<1%) occur in occasional veins or irregularly developed network veinlets mostly filled with quartz + carbonate +- chlorite. (< 1 vein/10m veins, <2mm wide) these veins appear to be late tectonic stage open space fracture fillings and are not considered to be significant.

It is estimated that base metal grades would generally fall below 200ppm Pb and 200ppm Zn in any metre sampled.

A lithological source to account for the Gefinex Anomaly I is not apparent. The turbiditic sediments contain subordinate (<30%) proportions of dark grey-black presumably graphitic siltstones which maybe slightly less resistive than the other rocks but their positions in the hole do not closely correspond to the interpreted Gefinex conductor. A 1m thick shear/fault zone occurs in the interval 170.7 - 171.75m which lies close to the top of the interpreted conductive body but although the orientation of the fault zone is not known it is unlikely to be sub horizontal.

5.2.2 MCDD5

MCDD5 (TD 244.6m) was designed to test Gefinex Anomaly No II centered at about 185m below 12000N/12100E (Figures 2 and 4). The hole intersected a sequence of Tertiary basalt underlain by approximately 25m of unconsolidated Tertiary fluvial sands and gravels before passing into strongly weathered Cambrian (?) basement at 97.0m. The zone of Tertiary weathering persisted until 112.2m representing a vertical thickness of about 14m.

Below the Tertiary cover MCDD5 intersected a mixed felsic epiclastic-sedimentary sequence commencing with a graded felsic mass flow breccia-stone unit of at least 40m thickness, underlain by an approx. 30m thick unit of pyritic black siltstone with minor felsic tuffaceous siltstone interbeds, which is in turn underlain by an at least 50m thick unit of cherty felsic vitric tuffaceous siltstone with minor black siltstone interbeds.

Oriented core specimens from within the two lower members indicate somewhat variable bedding orientations striking in the range 30-95 degrees AMG and dipping to the NW or N in the range 35-80 degrees. The (arithmetic) average strike orientation is 060 degrees (AMF) and dip 55 degrees to the NW. Uphole grain size fining in the mass flow unit indicates the sequence is facing to the NW. MCDD5 has thus intersected about 120m of true stratigraphic thickness.

The rock types intersected seem to have similar parentage to the two associations found in MCDD4, that is a felsic acid volcanic source, though rather more distal, for the mass flow and vitric tuffaceous siltstone units and a continental (?) metasedimentary source of the black siltstone unit. the latter appears to be compositionally related to the turbiditic sediments of MCDD4 but in MCDD5 the finer grained dark grey to black (graphitic?) siltstone is dominant over the more quartzose fine to medium grained greywacke in the ratio of at least 5 to 1.

I envisage that the rocks of MCDD5 accumulated in an environment of deposition broadly similar, though rather more volcanically distal or quiescent, to that of the association in MCDD4.

The felsic rocks generally appear to be fresh and relatively unaltered. Pyrite occurs as a ubiquitous accessory mineral occurring as fine disseminations, blebs and veinlets in all rock types generally of less than 0.5% per volume but increasing to around 1-2% and locally upto 5% in the black siltstones.

Reddish brown sphalerite, lesser galena and very rare chalcopyrite (but never pyrite) occur sparsely in occasional veins or locally developed networks of veinlets filled with which carbonate +- quartz. In the black siltstone unit they can be seen to cross cut (postdate) syn-dia genetic (?) pyrite blebs and veinlets as well as folded bedding laminations. The veinlet mineralisation (considered to be a late tectonic Devonian? phenomenon) is not significantly developed and it is estimated that in general the rocks would carry <500 ppm Zn and <300ppm Pb in any metre sampled.

In the vitric tuffaceous siltstones, the sulphides are often associated with quartz and carbonate in small (~10mm) rounded blobs rimmed by a selvedge of bleached country rock. these appear to predate the above mentioned quartz + carbonate veinlets but likewise are not significantly developed and are estimated to contribute <200 ppm Pb and <200 ppm Zn to the bulk grade of any one metre.

Three narrow "bands" (10-150mm) of higher sulphide content occur within the vitric tuffaceous mudstone to siltstone unit between depths of 189.4 and 196.7m, in the hole. The thickest of these, 150mm at 196.55 - 196.7m, is a dark grey to black cherty mudstone (?) with approximately 25% pyrite and 20% dark steely greyish brown sphalerite? as coarse (1-5mm) blebs arranged in deformed ? trains and bands, subparallel to the margins of the main band, approximately conformable to the bedding orientation of the enclosing rocks. this band could represent a weak development of syngenetic bedded sulphides and may warrant some further (laboratory) studies although the significance may be somewhat academic rather than economic.

A lithological source for the Gefinex Anomaly No II is immediately apparent in the 30m thick sequence dominated by pyritic black siltstones. These may have sufficient resistivity contrast against the enclosing very siliceous rocks to account for the EM anomaly.

6. <u>DISCUSSION</u>

MCDD's 4 and 5 drilled to test two Gefinex EM anomalies have not intersected significant sulphide mineralisation.

The conductive source for the anomaly tested by MCDD4 is not apparent in the drill core but the EM anomaly tested by MCDD5 maybe attributable to a 30m thick unit dominated by pyritic black siltstones. Downhole EM logging and possible petrophysical measurements of core samples are expected to elucidate the geophysical situation.

The absence of significant sulphide mineralisation and apparent absence of "hydrothermal" alteration in the drill core does not seem favourable for detection of "off hole" conductive massive sulphide bodies by downhole EM.

The lithological association intersected in both holes do not present any surprises and are broadly consistent with felsic volcanic-micaceous turbiditic sequences exposed in basement windows along the Leven River and extending as far northwards as the Denison Group (Late Cambrian-Early Ordovician) unconformity west of Mt Tor as mapped by J. Pemberton (1988).

According to Tas. Dept. of Mines Mt Read project Mapping (Corbett, Pemberton and Vicary; Nov. 1988) this belt of rocks comprises correlates of the Southwell Sub Group which form the upper part of the Dundas Group in the Cradle Mountain Link Road area north east of Hellyer Mine and <u>overlie</u> the Que River Shale and the Que River-Hellyer host volcanic sequence.

Since the facing and direction of dip of sequences in both MCDD4 and 5 (particularly the former) is more or less westwards it seems likely that the interesting mafic volcanics cored in MCDP's 1, 2, 3 lie up stratigraphy from the sequences in MCDD's 4 and 5 in the upper part of (or above ?) the Southwell Sub Group.

As noted by Herrmann and Bishop (1988) this implies that the MCPD mafic volcanics are not stratigraphically equivalent to the Que River-Hellyer Volcanics. The possibility that unknown major fault displacements have upthrown the Que-Hellyer volcanic equivalent to the MCPD 1, 2, 3 level remains valid but seems very unlikely. There is not much lateral "room" for such a fault structure; if present it must lie between MCPD 2 and MCDD 4 which are collared only 530m apart. In addition, the apparently close (conformable?) association between oxidized vesicular rocks thought to be Cambrian andesitic-basaltic lavas in MCPH1 (96-102.2, 103.7-114.4m) with felsic tuffs and turbiditic greywackes and siltstones suggests a stratigraphic continuum with the sequence cored in MCDD4.

Although the turbiditic sediments (greywackes) are areally and stratigraphically widespread in the Southwell Sub Group it is tempting to speculate that the sediments cored in the lower part of MCPD 1 are approximately stratigraphically equivalent to those cored in the upper (sub Tertiary basalt) parts of MCDD4.

The dip and facing of units in MCDD4 is known to be about 60 degrees to the south west and the dip of sediments in MCDP 1 is about 45 degrees, facing upright but direction of dip is unknown. If the stratigraphic equivalence of turbiditic sediments between holes 1 and 4 postulated in the previous paragraph is correct, then the mafic volcanics of MCDP's 1, 2, and 3 would appear to occur near the hinge of a probably southward plunging synclincal fold with its axis somewhere around the longitude of MCPD2.

The unusual steep south westerly dip of the sequence in MCDD4 was certainly unexpected and may merely indicate a minor "drag" fold structure. The direction of dip of sediments in MCPD1 seems to be the key and any future stratigraphic drilling to elucidate the setting of the mafic volcanics here would be best based on redrilling of MCDP1 to obtain oriented core specimens.

The mafic volcanics of MCPD's 1, 2, and 3 still appear to be the highest card so far turned up in the EL 14/85 exploration game. The likelihood that they are not stratigraphically equivalent to but higher than the Que-Hellyer Volcanics removes them one step further from the empirical exploration model originally conceived by Pancontinental Limited. Further petrographic and analytical studies of the MCPD mafic volcanics by Dr A J Crawford is shortly to commence and is expected to further elucidate the relationships or otherwise between these and the Que-Hellyer volcanic rocks.

Without wishing to pre-empt Dr Crawford's findings it seems likely that exploration managers working on the original exploration concept may have to decide whether or not the occurrence of mafic volcanics of similar, or perhaps different, chemical composition to but of higher stratigraphic level than the Que-Hellyer volcanics can be considered favourable indications for the presence of massive sulphide deposits.

7. REFERENCES

Herrmann, W. (1986)	"Notes on the Geology of the Mt Cattley Area, EL 14/85 TAS" (unpub. Report to Pancontinental Mining Ltd)
Herrmann, W. (1986)	"Report on Sub-Basalt Drilling Programme at Mt Cattley EL 14/85, Tas". (Unpub. Report to Pancontinental Mining Ltd)
Herrmann, W. and Bishop J. R. (1988)	"Proposed Stratigraphic Drilling, Mt Cattley EL 14/85, Tas. (memorandum to Outokumpu Exploration Australia Pty Limited)
Pemberton, J. (1988)	"Geology of the Mt Cattley - Mt Tor Area" Tas. Dept of Mines Mt Read Volc. Project 1:25000 Scale Map No 8.
Corbett, K D; Pemberton, J and, Vicary, M.	"Excursion Guide Notes - Cooks Tour of Maps 7 and 8". Tas. Dept of Mines, Mt Read Volcs Project.

8. APPENDICES

8.1 Geological Log MCDD4

8.2 Geological Log MCDD5

8.1 GEOLOGICAL LOG MCDD4

Hole No:	MCDD4
Location	Mt Cattley E.L. 14/85 Tasmania
Collar Co-Ords:	12000N/11330E
Collar Azimuth:	277 Magnetic
Collar Inclination:	-80
Total Depth:	301m
Recovery:	100%

Bore Hole Surveys: (Eastman Single Shot Camera)

Date	Depth (m)	Azimuth M	Inclination
22/11/88	50	278	-80.5
24/11/88	100	278.5	-80
25/11/88	150	282.2	-80
28/11/88	200	284.5	-79.5
30/11/88	250	288.5	-79
2 /12/88	300	291	-79

Drilling Rig:	Longyear 44
Drilling Contractor:	DIAMOND DRILLING TASMANIA
Commenced:	21/11/88
Completed:	2 /12/88
Drilling Notes:	HQ Core 1.5 - 56.7m HQ Core 56.7 - 301m Drilling fairly straight forward throughout with full core recovery. All steel casing extracted. 32mm PVC casing to bottom of hole.

Geological Log By: W. Herrmann

HOLE NO MCDD4 GEOLOGICAL LOG

0-1.5 No Core Recovered.

1.5-18.0 Tertiary Basalt - Oxidized.

Orangey to greyish brown clayed weathered vesicular basalt; minor zones relatively fresh at 5.0 - 7.5m and 16.0 - 17.0m but transition to fresh rock at 18.0m is fairly abrupt.

18.0-57.8 Tertiary Basalt - Fresh

Medium to dark greenish grey coloured fine grained sparsely olivine phyric basalt, commonly glassy, vesicular or amygdaloidal.

57.8-57.9 Sandstone

Medium grained pinkish, quartz rich sandstone, weakly stratified at 50 to IAOC and weakly lithified, rather friable. Contains some wispy flakes of lignified plant remains. Upper contact with chilled vesicular basalt is irregular and has a 10mm thick "baked" selvedge.

57.9-58.1 Tertiary Basalt

Medium greenish grey coloured, fine grained-glassy, chilled amygdaloidal basalt. Amygdale 10% of vol; filled with soft "soapy" pale greyish brown to dark greenish black materials with subconchoidal fracture. Lower contact is irregular in form.

58.1-58.5 Unlithified Sand

Friable sandstone similar to interval 57.8-57.9.
Upper contact is "baked". Only 0.1m core recovered in this interval, represents base of Tertiary Sequence.

58.5-74.5 Turbiditic Greywacke/Siltstone

A laminated to thickly bedded sedimentary rock consisting of alternations of:

i) Medium grained, mid grey coloured micaceous greywacke apparantly consisting largely of subangular grains (0.1-0.5mm) of grey quartz with minor white mica, feldspar, acid volcanic lithic grains and lithic grains of dark grey siltstone as below.
ii) Dark grey to black fissile fine grained siltstone, grain size finer than 0.1mm evidently rather graphitic and micaceous but otherwise probably generally similar composition to (i) above.

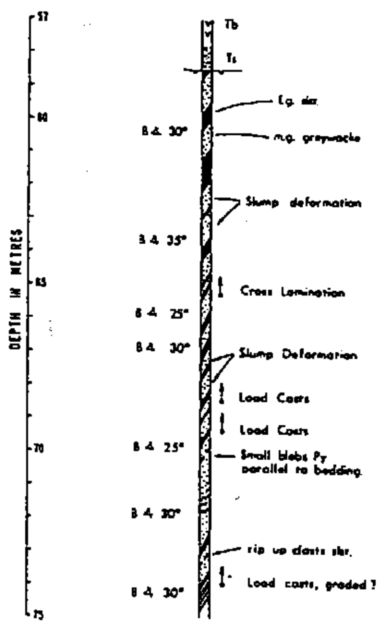
The rocks are locally finely laminated with individual beds down to 2mm thick but generally thinly to thickly bedded in the range 100-1000mm. Evidently turbiditic with common intraformational slump deformation in the greywackes, possible grain size grading, load casting and rare cross lamination. These facing criteria consistently indicate a younging up the hole.

Except where slump deformation is evident the bedding planes appear to be regular and consistently intersect the core at 25-35 to LAOC.

Four separately oriented core specimens allow the following bedding orientations to be determined.

Depth (m)	Bedding Strike (AMG)	Dip
64.5	Unsuccessful due to broken core	
67.5	320	60 SW
68.1	320	63 SW
69.3	345	63 SW

There is a weak fissility parallel to bedding but the rocks are otherwise massive and do not show distinct tectonic cleavage. As shown in graphic log below greywackes are dominant and increase in proportion downhole; overall the greywacke comprises about 70% of the unit intersected.



Mineralization: Pyrite occurs as occasional blebs, sometimes in discontinuous "trains" parallel to bedding (eg: at 70.0m) and as wide- spread but minor dissemination. Overall pyrite content is low, estimated at 0.05% of volume.

Veins and veinlets filled with creamy white carbonate ± grey quartz with traces of pyrite, reddish brown sphalerite and rare galena, chalcopyrite (egs: 59.5, 59.9, 60.5m) are irregularly scattered throughout but are only in significant concentration near the upper contact above 61.0m (5% of vol.) and to a lesser extent in interval 72.5-74.0m (1% of vol.).

There are occasional small grains of reddish brown sphalerite sparsely scattered in the grey- wacke; these maybe detrital but (although there is no apparent spatial association) the reddish brown colour suggests a genetic connection with the (presumed late stage) veinlet mineralization.
Overall base metal estimate: <300ppmPb, <400ppm Zn

* The core is essentially fresh at 58.5m and there are no indications of Tertiary weathering.

74.5-79.8 Felsic Pumiceous Tuff

A blotchy pale grey to olive greenish grey felsic pyroclastic rock consisting of abundant small flattish glassy shards creamy-grey fragments and grains of feldspar upto 2-3 grainsize, and variable but generally prominent amounts of feldspar phyric, flattened olive green pumice fragments all contained in a murky pale grey siliceous matrix. Phenocrysts or clastic grains of quartz do not appear to be present. The pumice clasts are in the range 10-50mm in size and average about 5% of the rock volume but locally (eg: 76.9-77.5m) comprise upto 20% of the volume. There is no distinct grain size sorting or stratification although the partly flattened pumice clasts define a weak planar fabric which intersects the core at about 25-40 to LAOC. The upper contact with greywacke is quite sharp (transitional over about 40mm) and concordant with bedding in the overlying sediments.

Mineralization etc:
Sulphides are restricted to trace quantities of disseminated fine specks and occasional small blebs of pyrite; averages 0.1% pyrite. There are occasional (2-3per metre) veins and vein- lets (upto 10mm) of white carbonate but these are otherwise barren. Feldspars in the rock appear to be essentially fresh.

79.8-84.6 Felsic Tuffaceous - Epiclastic Siltstone

A mid grey to pale greenish grey moderately well stratified rock of grain size mostly <0.1mm and consisting largely of fine silica and glassy shards of felsic volcanic provenance. Slump deformed narrow bands of pumiceous felsic tuff (similar to the unit above) occur in the upper 0.5m and also in the interval 82.3-82.7m. The generally evident stratification and apparent fair grain size sorting suggest a volcanic-epiclastic mode of deposition.

Bedding planes intersect the core at angles of 20-40 to LAOC and there is commonly slight warping or soft sediment slumping of the layering.

Oriented Core Specimen from 83.7m indicates a bedding trend of Strike: 325 AMG, Dip 55 to SW.

Mineralization etc: as for the previous unit; essentially unaltered.

84.6-87.4 Felsic Tuffaceous-Epiclastic Sandstone

A uniform pale grey rock compositionally similar to the above unit but with coarser grain size in the range 0.2-2.0mm. Clastic grains include feldspars, glassy shards and fragments of pumice in a murky grey siliceous matrix. There is overall grain size grading fining upwards through this unit from a sharp lower contact to a very transitional upper contact. It is essentially compositionally continuous with the overlying epiclastic siltstone unit and the two together maybe considered as a single graded epicalstic member of the sequence. This sandstone is not distinctly stratified but the glassy shards and small flattened pumice fragments define a weak planar fabric which intersects the core at about 30-40 to IAOC.

Mineralization etc: as for interval 74.5-79.8
essentially unaltered.

Occasional minor carbonate veins are devoid of sulphides: 120mm thick fibrous quartz + carbonate + minor chlorite vein at 86.7 also without sulphides.

87.4.91.1 Felsic Tuffaceous-Epiclastic Siltstone

Lithology similar to that of interval 79.8-84.6m. Mineralization etc: similarly insignificant trace pyrite as above. Massive quartz + carbonate + chlorite veins in intervals 87.8-88.2m and 88.4-88.6m contain rare traces of pyrite.

91.1-92.2 Felsic Tuffaceous-Epiclastic Sandstone

Graded epiclastic unit similar to interval 84.6-87.4m, contains some fine grained well stratified beds of felsic epiclastic siltstone in the lower 0.9m below 92.0m. Bedding at 35 to IAOC. Lower contact is sharp at 55 to IAOC slightly rotated anticlockwise (to south) from plane of bedding.

92.9-93.5 Felsic Pumiceous Tuff

Lithology and fabric similar to interval 74.5-79.8m. Lower contact fairly sharp at 30 to IAOC concordant with bedding in underlying epiclastic sandstone.

93.5-96.5 Felsic Tuffaceous-Epiclastic Sandstone

Similar to interval 92.0-92.9m.
Well stratified, variable fine to medium grained sandstone, bedding consistently 30-35 to IAOC. Lower contact is sharp.

96.5-98.0 Felsic Pumiceous Tuff

Similar to previous units 74.5-79.8m and 92.9-93.5m. In addition to abundant olive green pumice fragments there are occasional small pinkish rhyolitic lava fragments.

149 606150

98.0-100.9 Felsic Tuffaceous-Epiclastic Sandstone.

As for 93.5-96.5m.

100.9-114.4 Felsic Pumiceous Tuff

Lithology as for interval 96.5-98.0m.
Flattened pumice clasts (fiamme) and crude eutaxitic planar fabric in matrix generally lying at 20-40 to LAOC but apparently irregularly oriented as indicated by Oriented Core Specimen at 103.5m which allowed the following determinations of planar fabric orientation in the interval 103.5-106.0m.

Strike 035 , Dip 77 to SE;
Strike 055 , Dip 50 to SE;
Strike 300 , Dip 70 to SW.

Mineralization: Trace pyrite occurs in fine disseminated specks often within or around pumiceous fragments; occasional coarser blebs. Overall pyrite content estimated at 0.1%Py. Occasional (late stage ?) white carbonate veins are essentially devoid of sulphides.

114.4-116.0 Felsic Tuffaceous-Epiclastic Sandstone

The upper contact is transitional over about 10cm, essentially marked by disappearance of pumice clasts and appearance of weak grain size stratification; otherwise composition resembles the matrix of the overlying unit (ie: 2mm grain size abundant feldspar, glassy shards, possibly quartz in pale grey murkey siliceous matix). There are a few flattened pumic frags near 115m.
Bedding at 30-40 to LAOC.

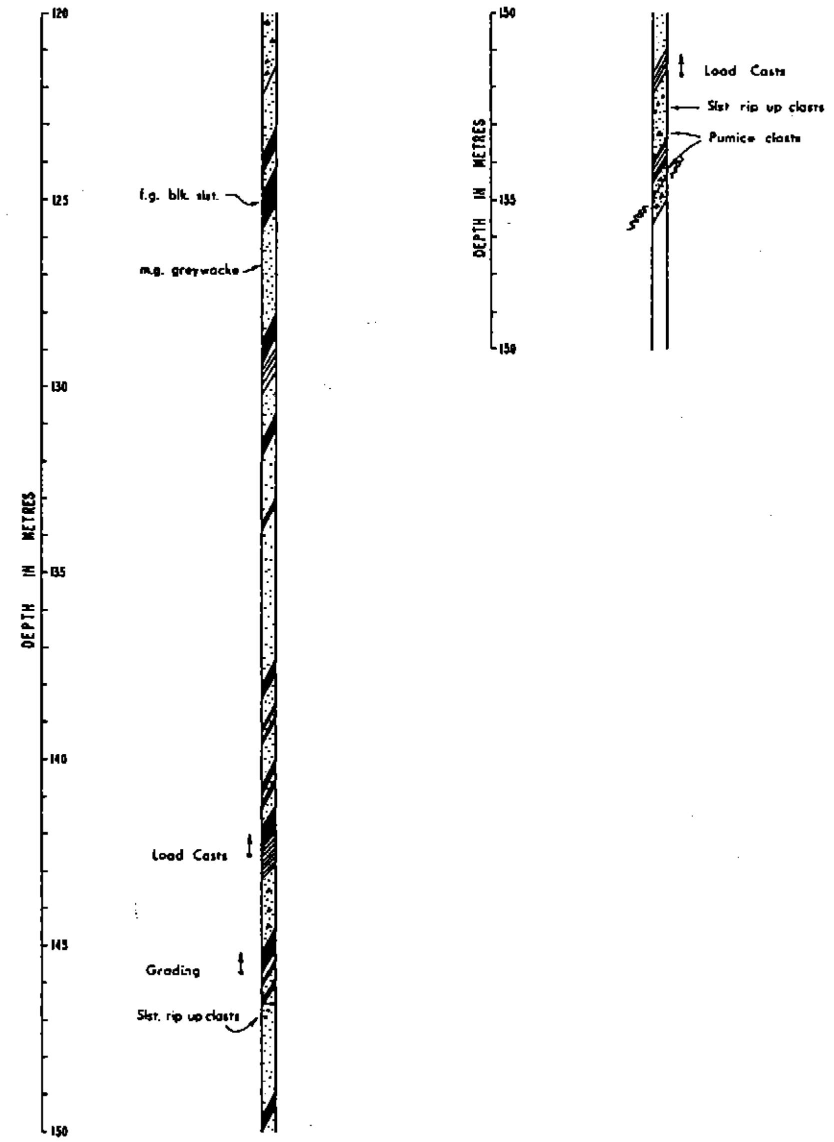
Mineralization: insignificant, as above.

116.0-121.7 Felsic Lithic-Pumiceous Tuff

Clearly compositionally related to the Felsic Pumiceous Tuff units intersected further up the hole, this unit is megascopiclly distinctive by the abundant presence of small to medium sized (2-50mm) rigid lithic clasts constituting about 5% (but locally upto 10%) of the rock volume in addition to the usual olive greenish grey, partly flattened pumiceous fragments which comprise about 10% of the volume. The rigid clasts are of variable angular, platy, irregular or well rounded form and consist mainly of pale grey to pinkish grey feldspar (± subordinate quartz) phyric glassy rhyolitic extrusives with rare occurrences (eg: 120.3, 121.0m) of small clasts of dark grey to black fine grained siltstone.

There is no distict planar fabric, grain size sorting or stratification. It would seem to have had a mass flow type depositional origin and may therefore be considered epiclastic although the abundance of pumice indicates much pyroclastic detritus.
Mineralization:

Disseminated specks of pyrite, often associated with pumice clasts, total 0.1%Py. Occasional small veins of carbonate ± quartz with traces of pyrite and very rare galena (eg: 120.0m).



Mineralization:

Pyrite occurs as widespread disseminated specks and occasional larger blebs and blobs (to about 10mm dia); occasionally seems to be concentrated in bedding parallel trains especially in thin greywacke laminae interbedded in black siltstone. Overall pyrite content estimated at 0.1%Py.

Near the upper and lower contacts (above 125mm and below 140m) there are reasonably intense networks of fine carbonate ± quartz veinlets (approx. 20-100 per metre of core) which locally contain traces of pyrite and rare sphalerite, galena and chalcopyrite.

143.0-144.8 Felsic Pumiceous Lithic Epiclastic Sandstone.

A hybrid lithotype consisting of small to medium sized (2-50mm) flattened olive to dark greenish grey pumiceous fragments (5-10% of volume) supported in a rather well stratified and sorted medium grained sandy matrix consisting largely of partly sericitized felspar and abundant small glassy shards. The bedding at 143.5m is oriented at Strike 335 AMG, Dip 66 SW. The sandy matrix displays a pronounced wavy, wispy, eutaxitic fabric defined by glassy shards which parallel the grain size layering; pumice fragments are also stretched out along this plane. The moderate degree of sericitization suggests that this unit has behaved incompetently under stress and there has been some degree of bedding parellel shear.

Mineralization:

Disseminated pyrite 0.3%
Trace galena in carbonate vein at 143.8m.

144.8-155.4 Turbiditic Greywacke/Silstone

Lithology identical to interval 121.7-143.0. Facing evidence indicates younging up hole. Bedding angles at 15-20 to LAOC.
Mineralization: as for 121.7-143.0m.

Two pumiceous clasts occur at 154.3m and 155.2m. These contain about 5% fine disseminated pyrite and are fringed with narrow (1-4mm) discontinuous selvedges of compact granular /"massive" pyrite. The lower clast also has a coarse slug of reddish brown sphalerite at the selvedge. It seems that the pumiceous clasts have been involved in metamorphic (?) reaction with the enclosing sediment and were focii for mobilized sulphide deposition.

155.4-156.1 Felsic Pumiceous Lithic Epiclastic Sandstone

A similar lithology to that in the interval 143.0-144.8m and likewise quite strongly sheared and sericitized to the extent that the bedding is largely transposed. A small detached sliver of fine grained, black micaceous siltstone occurs about 15cm below the upper contact.

Mineralization: Disseminated pyrite 0.3%.
A single pumiceous clast adjacent to the lower contact is strongly pyritic with 20% pyrite. Many of the pumice clasts have dark selveges, apparently of fine dusty disseminated pyrite.

156.1-158.1 Turbiditic Greywacke/Siltstone

Lithology as for intervals 121.7-143.0m and 144.8-155.4m. Rather disrupted by soft sediment slump deformation. Contains a few fairly pyritic pumice clasts in the lower section below 157.5m.

158.1-170.7 Pumiceous Epiclastic Breccia

A genetically mixed rock type consisting essentially of approximately equal proportions of pale olive green "Felsic Pumiceous Tuff" and medium to fine grained "Turbiditic Greywacke/Siltstone" in an inhomogenous jumble. There is much evidence of soft sediment deformation, disruption and brecciation of the turbiditic sedimentary component.
I interpret the jumble to represent a mass debris flow type of deposit probably formed by violent incursion of an unconsolidated pumiceous pyroclastic or epiclastic debris flow into unconsolidated turbiditic sediments. Since the (Cambrian ?) sequence intersected by this hole is essentially an alternating group of felsic pumiceous tuffs/epiclastics and turbiditic sediments this type of jumbled breccia may also have formed by syndepositional tectonic movements affecting the "basin" of deposition causing gravity flow mobilization of unlithified materials which became brecciated and intermixed by internal turbulence.

The pumiceous material is generally rather sericitized both in the formerly glassy matrix and felspar phenocrysts, generally is rather strongly sheared and typically contains about 1% fine disseminated pyrite. The shearing and wispy nature of pumiceous clasts maybe partly due to soft sediment deformation but is probably largely tectonic. The zones and dismembered fragments of the turbiditic sediments, on the other hand, have evidently yielded by brittle fracture (rather than shear) during tectonic deformation and are commonly cut by an irregular and often intense network of fine carbonate ± quartz veinlets. These are generally barren except for traces of fine pyrite. The veinlets occur in turbiditic sediment components throughout the unit but achieve maximum intersity near the lower contact below 170m where several thick (10-100mm) massive veins of white carbonate + quartz (no sulphides) occur.

170.7-171.75 Fault Zone

Strongly brecciated, sheared and puggy zone containing some fragments of material from above and below.

171.75 - 175.0 Felsic Pumiceous Tuff

A homogenous medium grained felsic pyroclastic (?) rock similar to that in the interval 74.5-79.8m but with lower proportion (2%) of pumiceous clasts and more prominent pale grey siliceous fine grained matrix.

Mineralization: Approx. 0.3% pyrite as fine disseminations throughout, sometimes as fine trains rimming pumice clasts.

175.0-176.4 Pumiceous Epiclastic Breccia

Similar jumbled lithotype to that in interval 158.1-170.7m. The upper contact is strongly brecciated (broken core); a fragment of a 10mm thick laminated quartz vein in this broken zone contains small slugs of pale brown sphalerite and lesser galena.

176.4-178.8 Felsic Pumiceous Tuff

Similar to interval 171.75-175.0m.

178.8-188.0 Pumiceous Epiclastic Breccia

An inhomogenous mixture of pumiceous tuff and turbiditic sedimentary materials as for the intervals 158.1-170.1m and 175.0-176.4m with the addition here of well sorted, stratified pale grey felsic epiclastic sandstone similar to units intersected further up the hole.
(eg: interval 143.0-144.8m)

All three components are closely intermixed with much evidence of soft sediment deformation in the stratified sediments.

The upper 0.4m of the unit is tectonically brecciated with inter fragment spaces filled with puggy greenish grey clay and granulated rock. This brecciation post dates carbonate veining and probably represents a minor, post Devonian (post Tabberaberan orogeny), fault.

188.0-215.5 Felsic Lithic - Pumiceous Tuff

Similar to rock type in interval 116.0-121.7m.
Mineralization: disseminated pyrite, generally 0.2%Py. quartz + carbonate veins not abundant, generally devoid of sulphide.

215.5-248.0 Pumiceous Epiclastic Breccia

Similar to jumbled rock type in interval 158.1-170.7m. Felsic pumiceous material dominant over turbiditic sediment in ratio approx. 2:1.

Mineralization:
0.3% fine dissem. pyrite.
Occasional quartz ± carbonate ± chlorite veins, generaly without sulphide.

248.0-250.6 Felsic Pumiceous Tuff

Similar to interval 171.75-175.0m.
Pumiceous clasts constitute 2% of rock volume.

250.6-250.9 Felsic Tuffaceous - Epiclastic Sandstone

A thin unit of well stratified fine to medium grained felsic tuffaceous sandstone with distinct bedding at about 45 to LAOC.

250.9-256.1 Pumiceous Epiclastic Breccia

Similar lithotype to interval 215.5-248.0m. Felsic tuffaceous material dominant over turbiditic sediment in ratio about 2:1. The turbiditic sedimentary component gradationally becomes less micaeous and increasingly siliceous-cherty down the hole.

Mineralization: 0.2% disseminated pyrite.

256.1-290.8 Felsic Pumiceous Tuff

Familiar felsic tuff similar to interval 74.5-79.8m generally containing about 5% of pumiceous clasts. Local thin bands of fairly well sorted fine to medium grained grey "felsic tuffaceous epiclastic sandstone" occur at:
256.1 - 256.9m; 273.6 - 274.4m; 286.9 - 287.4m
These generally are well stratified (albeit sometimes slump deformed) and possibly represent periods of epiclastic sedimentary reworking at tops of individual flows of pumiceous tuff.

Mineralization: 0.2% fine disseminated pyrite.
Feldspars are generally pinkish grey, apparantly quite fresh. Local pale greenish sericitic alteration of ground mass material appears to be related to tectonic shearing.

290.8-293.1 Pumiceous Epiclastic Breccia

Similar lithotype to that in interval 250.9-256.1m. The sedimentary component of the breccia is dominantly pale grey "<u>felsic</u> tuffaceous-epiclastic sandstone/siltstone" with only minor proportions of micaceous turbiditic sediments. Ratio of pumiceous tuff to sandy sediments is about 1:1.

Mineralization:
0.2% fine disseminated pyrite, rarely locally concentrated upto 1% in thin (2cm) fine tuffaceous cherty siltstone bands.

293.1-298.0 Turbiditic Greywacke/Siltstone <u>and</u> Felsic Epicalstic Sandstone.

A dark grey to pale dove grey medium to fine grained greywacke/siltstone unit with some micaceous (PreCambrian provenanced) quartz rich zones toward the top (above 294m) but dominantly of felsic tuffaceous provenance. Generally well stratified and locally finely laminated but also partly slump deformed. Patches of pumiceous tuff occur at: 294.0-294.5m and 297.0-297.5m.

An Oriented Core Specimen from 300.3m depth allowed the following bedding determinations to be made:

Depth (m)	Strike (AMG)	Dip
293.7	045	55NW
296.4	355	52NW

These are somewhat at variance with bedding determinations elsewhere in the hole and are suspected of being non representative of gross structural layering due to soft sediment deformation.

Mineralization: 0.5% disseminated fine pyrite.

298.0-301.0 Felsic Pumiceous Tuff

Lithology similar to that of interval 171.75-175.0m with pumiceous clasts constituting 5% of the rock volume.

Mineralization: 0.2% disseminated pyrite.

E.O.H.: 301.0m

8.2 GEOLOGICAL LOG MCDD5

Hole No:	MCDD 5
Location:	Mt Cattley E.L. 14/85 Tasmania
Collar Co-Ords:	12000N/12000E
Collar Azimuth:	097 Magnetic
Collar Inclination:	-62
Total Depth:	244.6m
Recovery:	100%

Bore Hole Surveys: (Eastman Single Shot Camera)

Date	Depth (m)	Azimuth M	Inclination
08/12/88	50	101	-63
12/12/88	100	102	-63
14/12/88	150	101	-64
16/12/88	200	102.5	-63.5
21/12/88	244	103.5	-63

Drilling Contractor:	Diamond Drilling Tasmania
Drilling Commenced:	07/12/88
Drilling Completed:	21/12/88
Drillign Notes:	Longyear 44 HQ core to 51m Subsequently reamed HQ to 112m NQ Core 51-244.6m Drilling generally straightforward except for unconsolidated materials at base of Tertiary basalt. Approx. 106m of HQ casing. (6 - 112m depth) stuck in hole 32mm PVC Class 9 casing to bottom of hole

Geological Log By: W. Herrmann

HOLE NO MCDD 5 **GEOLOGICAL LOG**

0 - 1.5 No Core Recovered.

1.5 - 68.8 Tertiary Basalt.

Dark grey fine grained sparsley olivine phyric basalt; commonly glassy, vesicular or amygdaloidal. Amygdales mostly filled with soft pale to dark greenish grey zeolites, sometimes white carbonate. Rock is oxidized (weathered) brown colour above 4.0m.

68.8 - 69.7 Basaltic Hyaloclastite Breccia.

Dark grey to black fine grained to glassy basalt, partly vesicular. Prominent hyaloclastite brecciation on 5 - 5omm scale with inter fragment spaces filled with pale brownish grey clayey devirtrified glass (?).

69.7 - 72.0 Siliceous Cobble/Gravel.
(Recovered: 0.2m)
Fragments of vughy white vein quartz and a few well rounded pebbles of pink quartz sandstone similar to Ordovician "Moina Sandstone".

72.0 - 82.0 Unlithified Sand and Gravel.
(Recovered: 1.5m)
Pale grey unlithified sand and clayey silt locally with fragments of lignified plant materials and minor well rounded pebbles of vein quartz or pink sandstone.

82.0 83.7 Siliceous Cobble/Gravel.
(Recovered: 1.0m)
Fragments of well rounded pebbles, cobbles and small boulders, size range 10 - 250mm. Consist mainly of pink hematitic conglomeratic sandstone (Upper Upper Owen Conglomerate) with subordinate white vein quartz and rare pale grey/siliceous acid volcanic lithtypes.

83.7 - 83.8 Transition Zone.

Siliceous pebbly-sandy grains (as above) supported in a matrix of pale grey (devitrified basaltic vitric tuff. Compaction layering intersects core at about 45 to LAOC.

83.8 - 90.0 Basaltic Lapilli Vitric Tuff.
(Recovered: 5.8m)
Oxidized and clayey, orange brown to purplish brown coloured rock consisting of glassy possibly hyaloclastite brecciated basalt supported in a fine to medium grained matrix of basaltic glassy shards. Compaction foliation generally at 60-70 to LAOC.

90.9 - 97.0 Siliceous Boulder/Gravel.
(Recovered: 1.5m)

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Mainly segments of boulders and cobbles ranging 100-300mm in size, dominantly composed of pink "Upper Upper Owen" conglomeratic sandstone, some white vein quartz. Also some well rounded pebbles 10-50mm in size consisting of quartzite, chert and rare felsic acid volcanic.

97.0 - 119.0 Felsic Lithic - Epiclastic Sandstone

From 97 -112.2m. The core is very strongly oxidised (weathered) to a pale orangey-buff clayey material which retains a granular relict fabric. Core recovery in this interval is about 8m (ie. ~53%). This zone represents the pre-basalt Tertiary weathering profile. There is a very abrupt transition to fresh rock at 112.2m.

The fresh rock below 112.2m is a medium grey coloured massive granular clastic rock ("sandstone") consisting largely of small equant and probably rather rounded grains (0.5 - 1.5 mm dia.) of whitish grey plagioclase feldspar and quartz (fs >> qtz ~ 3:1), minor, small, (<10mm) lithic fragments of acid volcanics, subordinate subangular/interstitial? grains? of dark green-black chlorite (?) all supported in a matrix of very fine grained grey murky siliceous/felsic/possibly glassy? material. The fine matrix constitutes perhaps 50% of the rock volume so there is not good sorting despite the apparent subrounding of coarser clastic.

The lithic fragments, generally constituting <5% of the rock volume, are commonly flattish and irregular in shape but may also be subrounded, they mostly consist of pale pinkish grey feldspar phyric rhyolite or "pumice".

Below 119m there is a gradual increase in proportion of lithic clasts but the boundary is very gradational and the entire interval 97 - 146.0m may be regarded as part of a single graded mass flow deposit.

Other than a slight fining in grain size uphole the rock is quite massive, without stratification.

Mineralization:

Fine disseminated pyrite (of about 0.5% vol.) is ubiquitous, occurring mainly as fine specks dusted throughout the murky grey siliceous matrix but also in pumiceous fragments and as occasional scattered blebs upto 5mm diameter. Scattered small blebs and grains (1-3mm) of reddish brown sphalerite are common and widespread throughout the rock and also appear occasionally in infrequent fine veinlets of quartz + white carbonate. Galena is noted as a rare trace mainly in veinlets an on joint surfaces.

Overall base metal content estimated at:
Pb 300ppm, Zn: 500ppm.

Many joint surfaces (many but not all of which are developed along fracture filling veinlets) are partly coated with a soft "soapy" green to bluish green mineral rather resembling some of the zeolites filling amygdales in the overlying Tertiary basalt but which may be Fuchsite? The rock in general, though siliceous and a little pyritic, seems relatively unaltered; feldspars appear to be fairly fresh.

119.0 - 146.0 Felsic Epiclastic Breccia.

This rock is compositionally and petrogenetically similar to that above but is distinguishable by the greater abundance of lithic clasts. The rock typically consists of moderately abundant, small lithic clasts (5-20%, 2-30mm) and abundant grains and crystal fragments of whitish grey feldspar (30%, 1-3mm) and subordinate quartz (<10%) supported in a murky grey fine grained siliceous matrix.

Clast compositions are variable but dominated by pale to dark grey feldspar phyric "rhyolite" and pumice, pale grey to pinkish grey siliceous cherty vitric tuff with subordinate dark green-grey feldspar phyric pumice clasts (becoming more prominent below 130m). There are occasional (well rounded) clasts of dark grey-black siltstone (eg. at 132m, 145.5m).

There is an overall increase in size and proportion of clasts down the hole but there is no small scale stratification. The poor sorting, matrix supported clasts and grain size grading (fining uphole suggesting younging uphole) indicate a "mass flow" depositional process.

The lower contact at 146.0m is very sharp and perfectly concordant to fine bedding laminations in the underlying siltstone.

Mineralization and Alteration

As for interval 97 - 119m.

146.0 - 157.5 Pyritic Black Siltstone.

Finely laminated dark grey to black siltstone generally with fine scale (1-5mm) laminae of dark, fine grained, probably graphitic siltstone/shale alternating with paler grey, more granular and quartz rich siltstone. There is a 1.5m thick bed of fine sandy "greywacke" at 150.9m but otherwise the unit is vastly dominated by fine grained black siltstone; (graphitic slst/greywacke slst=5).

Above 151m bedding laminations are fairly regular cutting the core at about 75 to LAOC and parallel to the sharp contact with the overlying mass flow breccia unit. Below 151m the bedding angle is more variable from 75 - 50 to LAOC, near 153m depth the angle is briefly sub parallel to LAOC.

Similarly near 156m the bedding angle is as low as 20 to LAOC but returns to 80 near 157m depth.

These sudden changes in bedding angle and considerable small scale faulting are suggestive of low competency tectonic deformation rather than soft sediment slumping.

Van Ruth type core orientation at 151m yeilded bedding orientations as follows:

Depth (m)	Strike (T)	Dip	LAOC
150.2	060	47NW	70
150.6	065	45NW	60
150.65	065	40NW	70
151.05	060	54NW	60
Mean:	062	47NW	

Mineralization

Pyrite occurs throughout this unit most prominently as rounded replacement (?) blobs upto 10mm diameter, often concentrated in bands parallel to bedding (eg: 146.2m depth); also as irregular to rounded blebs replacing outwards from fine pyritic veinlets (eg: 147.9m), thin (1-15mm) bedding parallel bands or veins (egs: 148.8m, 153.1m); and as fine disseminated specks most notably in more granular "sandy" laminae as at 150.9m.

Overall pyrite content is estimated at 1-1.5%Py. Fine veinlets and networks of white carbonate ± quartz occur locally on a minor scale. These are late stage tectonic tension crack fillings; they cut across (postdate) folded bedding lamination (eg: 153m) and also cross cut (postdate) the pyrite veins and blebs (eg: 156m). These carbonate + quartz veinlets carry occasional blebs of red brown sphalerite but not pyrite. Galena has not been noticed. This veinlet mineralization is not significantly developed. Estimated Zn content <500ppm overall.

157.5 - 160.2 Felsic Vitric - Tuffaceous Siltstone.

This interval is uniformly pale greenish grey in colour but contains two textural types:
(i) is very fine grained and cherty beyond megascopic resolution (10 x hand lens) but has a "tuffaceous" look about it and displays fine sedimentary lamination.
(ii) is a rather coarser, finely granular sediment (grain size 0.05 - 0.2mm) generally massive without fine layering but locally with small (upto 3mm) spheroidal-ellipsoidal semi aligned blebs of carbonate (rather resembling amydales in an extrusive rock).

The coarser type (ii) appears to have been mobile and intrudes the finer type (i) material with irregular/brecciated contacts (eg: at 158m) which transect the bedding laminations. This appears to be a form of soft

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sediment brecciation; the fine laminae are locally deformed close to the "intrusive" contacts.

Mineralization

Pyrite occurs in small blebs, veinlets and bedding parallel bands (upto 1mm thick) as in the overlying black siltstone unit but of lower concentration, perhaps 0.5%Py overall.

The core is cut by an irregular, locally quite intense, network of fine quartz ± carbonate veinlets. These clearly cross cut (postdate) the pyrite mineralization. They carry a little red-brown sphalerite and rare traces of galena but usually no pyrite. Overall base metal content estimated at:

Pb < 200ppm
Zn < 500ppm

Both upper and lower contacts appear to be fairly sharp although the latter is marked by intense uncemented tectonic brecciation.

160.2 - 176 Pyritic Black Siltstone.

Lithology and mineralization styles exactly identical to interval 146 - 157.5m.
Average 1-2% pyrite, locally upto 5% pyrite.
Moderate intensity of quartz ± carbonate veinlets, typically 1-3, 20-50/m of core with occasional thicker veins upto 60mm. These veinlets carry minor sphalerite and traces of galena (eg: 165.7m Sp + Gal) but overall base metals estimated at Pb < 200ppm. Zn < 500ppm

The core is extensively broken near the upper contact, with a 10cm puggy zone at 160.7 depth. The entire zone 160.2-162.6 can be considered a fault zone but probably an incompetency effect ("bedding fault") rather than major structure. As in the previous Black Siltstone Unit, the bedding to core axis angles are rather variable, observations as follows:

163.5m	45 LAOC
164.2	30
165.0	15
166.0	0
166.3	40
168.4	20
169.1	50
170.8	45

Van Ruth core orientation at 172.0m yeilded the following bedding lamination orientations:

Depth (m)	Strike (AMG)	Dip
171.4	035	70NW
171.7	030	75NW
172.0	040	75NW
172.2	035	75NW
Mean:	035	74NW

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Depth (m)	Strike (AMG)	Dip
173.0	055	75NW
173.9	055	52NW
174.0	075	40NW
174.1	055	75NW
174.6	055	62NW
175	055	80NW
Mean:	058	64NW

Below 175.3m siltstone is rather cherty probably due to a high content of vitric ash?, suggesting a transitional contract with the unit below.

176.0 - 177.3 Felsic Vitric - Tuffaceous Siltstone.

A pale to medium pinkish grey very fine grained siliceous rock, exhibiting distinct sedimentary layering in places. The rock is very siliceous with a cherty feel and appears to consist of fine felsic tuffaceous material, probably largely devitrified glassy shards; grain size is generally <0.05mm.

Bedding laminations observed are fairly regular at about 60 - 65 to LAOC. "Reconstruction" of drill core from the oriented segment at 172.0m, gave a bedding orientation at 177.0m of: Strike 055 (T) and Dip 52 NW indicating conformability to the enclosing black siltstones. This is also evident at the lower contact, at 177.3m, which is very sharp and conformable though displaced 20mm by a small steeply south dipping reverse fault.

Mineralization

This unit contains about 0.5% pyrite mainly as fine disseminated specks and blebs. Quartz ± carbonate veins are not common (<5/m core) but do contain rare traces of brown sphalerite. Base metal estimated at <500ppm Zn + Pb overall.

177.3 - 181.8 Pyritic Black Silstone.

Lithology and mineralization identical to Black Siltstone units intersected further up the hole.
Average 1.5 - 2% Pyrite.
Estimated Base Metal: <500ppm Zn, <200ppm Pb.

Between 178.6 and 179m there are two angular fragments of vitric tuffaceous siltstone similar to the unit above. These lie on the northern side of the drill hole and represent "silvers" of the overlying unit down faulted on the footwall side of small reverse faults which are oriented at about 320 (T)/85SW.

The lower contact at 181.8 - 181.9m is marked by a 10cm zone of strong shearing/fault brecciation and heavy quartz carbonate veining. The plane of the upper side of the fault zone is oriented at 280 (T) dipping 72 to the north.

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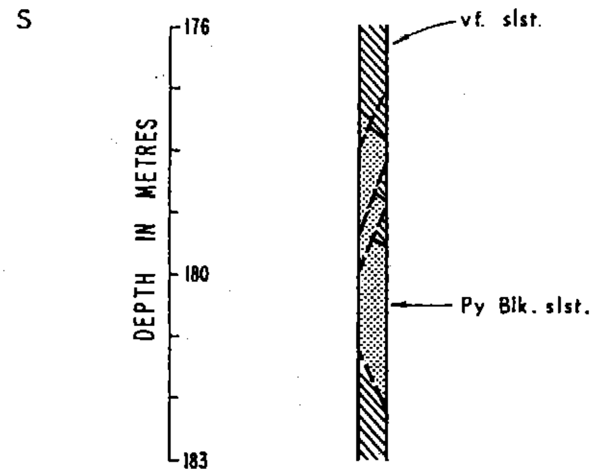

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Bedding laminations within this black siltstone unit are locally quite contorted, possibly due to "drag" associated with faulting. Oriented core (projected from oriented segment at 172m) gave bedding orientations as follows:

178.0m	Strike 070 T / Dip 55 N
179.9m	Strike 065 T / Dip vertical

181.9 - 201.1 Felsic Vitric-Tuffaceous Chert.

This is a rather similar rock type to that in the interval 176.0 - 177.3m but here the grain size is so very fine (essentially beyond resolution at 10 x magnification) that I substitute the term chert for siltstone.

Above 186.5m the rock is massive, uniform pale greyish pink in colour apparently consisting of ultrafine cherty silica. There are locally developed small (<0.5mm) paler "spots" and "clouds of spots" which appear to represent some form of (metamorphic?) alteration; similar bleaching occurs in a nearly ubiquitous network of fine hairline veinlets.

From 186.5 - 190.6m the rock is prominently banded on a millimetric to 5 centimetric scale with alternating colour bands of pink and pale to medium dove grey. The grey bands (or beds) seem to be slightly more "granular" but grain size is still <0.02mm. The grey bands do not contain the pale bleached "spots" or "clouds" of the pink bands and also seem to be less affected by bleaching along hairline veinlets. The banding undoubtedly represents sedimentary layering and is generally subnormal to about 80 to LAOC. An oriented core specimen was obtained at 188.2m but due to adjacent broken zones the orientation of bedding was not determinable here. The bedding is frequently wavy and irregular indicating some soft sediment disturbance.

From 190.6 - 193.6m the core is mostly massive, uniformly greyish pink in colour. From 193.6 - 199m the core is again finely banded (bedded) with alternating pink and grey laminae.

Below 199m the rock is massive, uniformly pale grey and cherty, similar to the grey colour beds of the banded sections above.

These rocks are regarded as distal, suqueously deposited sediments, probably largely derived from siliceous (rhyolitic) vitric ash.

Depth (m)	Strike (AMG)	Dip
195.5	065	35NW
198.8	095	35N

An oriented core specimen from 200m allowed determinations of banding (bedding as above).

Mineralization

Ultra fine disseminated specks of pyrite are ubiquitous throughout the unit.

In places, particularly above 186.5m and below 199m (ie. the upper and lower massive, non banded zones), there are occasional small (<10mm), irregular but well rounded "blobs" of pyritic black siltstone in this hole. The "blobs" are sometimes enveloped by a selvedge of pale bleaching possibly similar to that of the "spots" and "clouds" noted above.

Overall pyrite content is estimated at about 0.5%Py. with upto about 1.5%Py in the zone below 199m. The Pyrite "blobs" and associated bleach-ed selvedges are cross cut (postdated) by very occasional fine (<5mm) veinlets of white quartz + carbonate which contain traces of red brown sphalerite. Overall grade of basemental mineralization is not expected to exceed 200ppmPb, 200ppmZn.

Narrow bands of higher sulphide content occur at three depths:

189.4m: 50mm deformed band of coarsely crystalline near massive pyrite with quartz + carbonate gangue and minor blebs of reddish brown sphalerite.

193.3m: 10mm band of coarse pyrite similar to above.

196.55-196.7m: 150mm band of dark grey-black cherty mudstone (?) with abundant 1-5mm blebs of pyrite (20%) and very dark steely greyish brown coloured semi-translucent (?) sphalerite (?) (20%).

The sulphides, constituting about 40% of the total volume are arranged in partly deformed bands and trains which appear to subparallel the (rather irregular) margins of the 150mm wide band. The pyrite bands are more massive and are coarsely crystalline, with grains partly brecciated and infilled with

165 silica and carbonate.

Projection of the core orientation obtained at 200.0m suggests the following orientations for upper and lower margins of this band:

Upper Contact: Strike 085 (AMG) Dip 60 N which is approximately consistent with trend of the enclosing units.

Lower Contact: Irregular: folded? with a small fold axis approximately tending N-S, plunge horizontal.

This band could be interpreted to represent syngenetic sulphides in a black cherty/shaley host horizon.

201.1 - 202 Pyritic Black Siltstone.

Lithology similar to untis intersected further up the hole; generally finely laminated; a fine "cherty" pale grey vitric tuffaceous layer in the interval 201.5 - 201.6m.

The black siltstone is quite pyritic with 2-3%Py in the usual forms of occurrence, some fine grained pyritic bedding parallel bands (as at 201.35m) very suggestive of syngenetic pyrite. There is a patchily developed brittle fracture network of fine, white quartz + carbonate veinlets with traces of reddish brown sphalerite, expected to contain less than 1000ppm Zn.

Both the upper and lower contacts of the units are somewhat sheared but overall probably conforamable. Projection of oriented core indicates that bedding laminations at 201.4m Strike 040 (AMG) and Dip at 37 to the NW.

202 - 244.6m Felsic Vitric-Tuffaceous Chert

Lithology is similar to that in the interval 181.9 - 201.1m. It is subdivided as follows:

202.0 - 203.5 medium to dark grey banded chert (layering 1-150mm thick) with pinkish chert increasing below 203m.

203.5 - 244.6 massive, structureless, ultra-fine grained (?) cherty rock of uniform pale brownish pink to greyish pink colour.

<u>Mineralization etc:</u>

In the upper 2m (202 - 204m) minor galena and pale brown sphalerite occur in a stockwork of fine fractures and white quartz + carbonate filled veinlets and also locally (eg: 202.5m) as disseminated spots of finely granular sulphide, mainly galena. This upper 2m interval is estimated to contain about 0.2%Pb and 0.1%Zn.

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In the massive rock below 204m sulphides are less prominent and consist mainly of pyrite with subordinate galena and sphalerite. Sulphides occur sparsely in:

(i) Disseminations - mainly pyrite, traces galena; total volume <0.1%.
(ii) Fine sulphide coated fractures - mainly pyrite. (<0.05%).
(iii) Quartz ± carbonate veinlets - minor traces of galena and sphalerite in equal abundance, very rare chalcopyrite (eg: 238m). Never pyrite.

Sulphides occur more prominently in rimmed "blobs" and "blotches", similar to those noted in the interval 181.9 - 201.1m, which appear to be more extreme developments of the bleached "spots" and "clouds" also noted above. These blotches have a rounded or irregular/sub rounded form varying from a few millimetres to a few centimetres in diameter and consist of a core of fine granular grey quartz (?) and carbonate liberally dusted with fine pyrite or with con-centrically arranged blebs of pyrite with lesser sphalerite and less galena. The sulphides are often concentrated near the outer margin of the core. The quartz + carbonate + sulphide core is rimmed by a selvedge of pale buff-grey bleaching alteration usually of similar width to the diameter of the core. These phenomena are irregularly scattered throughout the massive rock below 204m and constitute overall perhaps 1% of the volume. They generally contain <10% sulphide (mainly pyrite) and thus contribute about 0.1% pyrite to the overall average estimated pyrite content of around 0.2 - 0.3%Py. The overall base metal content of the unit is estimated at <100ppm Cu, <300ppm Pb, <300ppm Zn.

In places there is a weak development of close spaced parallel hairline fractures possibly representing weak fracture cleavage development. This appears to be coeval to or post dated by the development of rimmed sulphide bloches. However the latter are definately cross cut (post dated) by the occasional quartz ± carbonate veinlets (eg: at 235.5m).

244.6m E.O.H.

167

MCDD 4 Collar co-ords.
12000N, 11330E
Inclination: -80°
Azimuth: Grid west (SIROTEM Grid)

Target depth: 300m

5 cm

89-2996

606168

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EXPLORATION AUSTRALIA PTY. LIMITED

MT. CATTLEY PROJECT
E.L. 14/85 - TASMANIA
GEFINEX SURVEY
PRELIMINARY INTERPRETATION
SECTION 12000N

0 50 100 150 200 250 300 350
metres

Compiled: K.O.A.	Date: Nov., 1988	Dwg. No.: M41·9·2
Report No.: R41·9	Map Ref.: SK 55·3	FIGURE 2

00 168

GEOLOGICAL REFERENCE

TERTIARY

Tb	Basalt, commonly vesicular/amygdaloidal
Ts	Unlithified sand, minor lignite fragments

CAMBRIAN - MT. READ VOLCANICS

CORRELATES OF THE DUNDAS GROUP (SOUTHWELL SUBGROUP)

€dg	Turbiditic micaceous greywacke and siltstone
€des	Fine grained felsic tuffaceous-epiclastic siltstone
€des	Medium grained felsic tuffaceous epiclastic sandstone
€dp	Felsic Pumiceous Tuff
€dlp	Felsic Lithic-Pumiceous Tuff
€dp-g	Epiclastic "slump" Breccia: comprising €dp, €dg, minor €des

Apparent Dip of Planar structures derived from oriented drill cores:

: Bedding

: Planar compaction/flow? fabric in pryoclastics

MCDD 4 Collar Co-ords: 12000N/11330E
Collar Azimuth: 277 Magnetic
Collar Inclination: -80

BOREHOLE SURVEYS (Eastman Single Shot Camera)

DATE	DEPTH (m)	AZIMUTH (M)	INCLINATION
22/11/88	50	278	-80.5
24/11/88	100	278.5	-80
25/11/88	150	282.5	-80
28/11/88	200	284.5	-79.5
30/11/88	250	288.5	-79
2/12/88	300	291	-79

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89-2996

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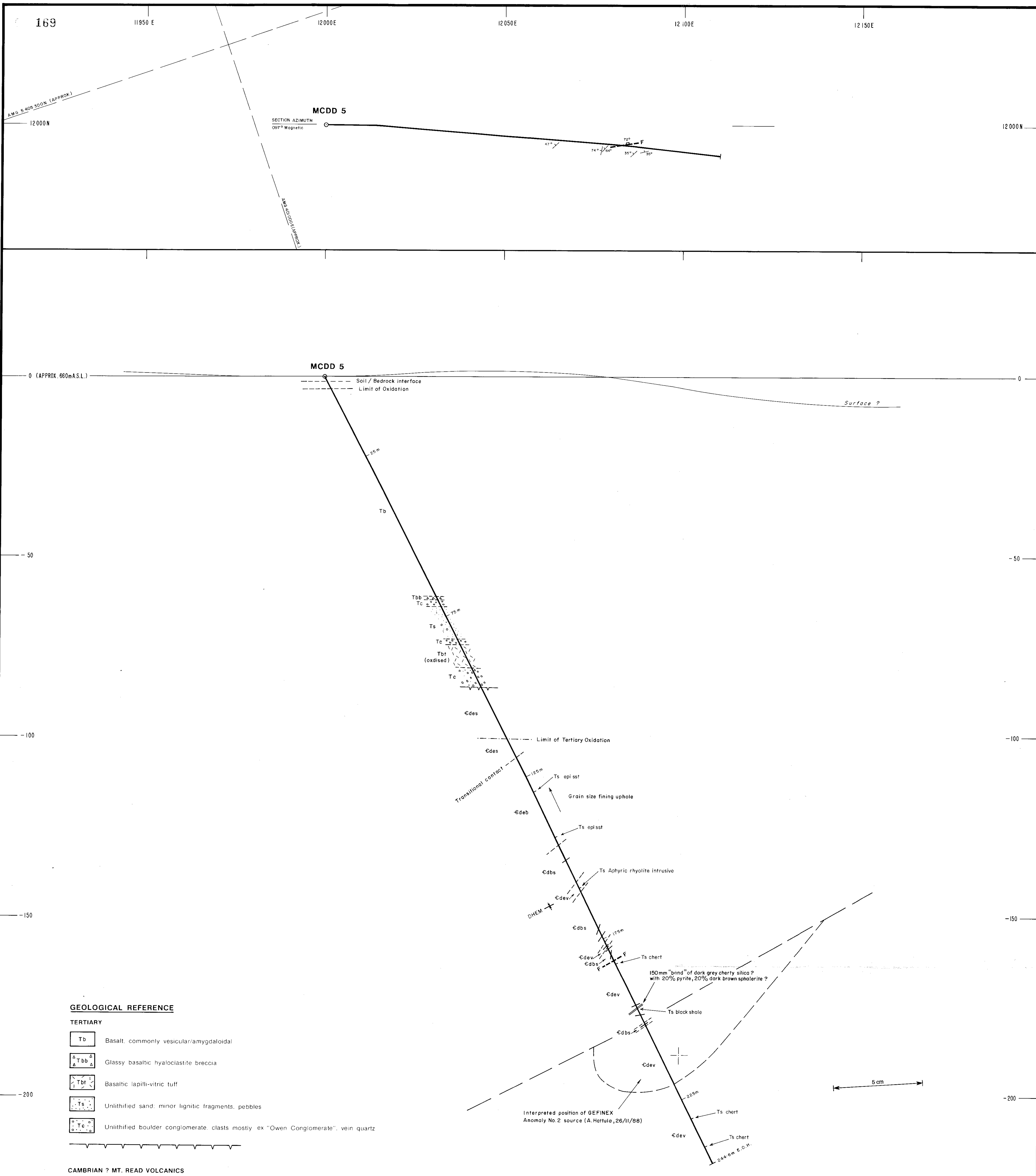
E.L. 14/85 - TASMANIA
MT. CATTLEY PROJECT
GEOLOGICAL SECTION
DRILL HOLE No. MCDD4

SCALE 1:500
0 5 10 15 20 25 30 35 40 metres

Compiled: W.Herrmann	Date: December, 1988	Dwg No.: M41·9·3
Drawn: R.J.Voss	Report No.: R41·9	FIGURE 3



GEOLOGICAL REFERENCE

TERTIARY

- Tb — Basalt, commonly vesicular/amygdaloidal
- Tbb — Glassy basaltic hyaloclastite breccia
- Tbt — Basaltic lapilli-vitric tuff
- Ts — Unlithified sand; minor lignitic fragments, pebbles
- Tc — Unlithified boulder conglomerate, clasts mostly ex "Owen Conglomerate", vein quartz

CAMBRIAN ? MT. READ VOLCANICS

- Ꞓdes — Medium grained felsic volcanolithic/tuffaceous epiclastic sandstone
- Ꞓdeb — Felsic volcanolithic/tuffaceous epiclastic breccia

* Ꞓdes and Ꞓdeb units appear to be part of a single mass flow type deposit with gradual grain size grading up the hole.

- Ꞓdbs — Pyritic black Siltstone/Shale generally with 1-2% pyrite
- Ꞓdev — Fine grained to ultra fine grained siliceous, cherty Felsic vitric tuffaceous? siltstones. Locally well bedded, commonly massive.
- Apparent Dip of bedding from oriented cores

MCDD 5 Collar Co-ords: 12000N/12000E
Collar Azimuth: 097 Magnetic
Collar Inclination: -62

BOREHOLE SURVEYS (Eastman Single Shot Camera)

DATE	DEPTH (m)	AZIMUTH (M)	INCLINATION
8/12/88	50	101	-63
12/12/88	100	102	-63
14/12/88	150	101	-64
16/12/88	200	102.5	-63.5
21/12/88	244	103.5	-63

11950E 12000E 12050E 12100E

606170

89-2996

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EXPLORATION AUSTRALIA PTY. LIMITED

E.L. 14/85 - TASMANIA
MT. CATTLEY PROJECT
GEOLOGICAL SECTION
DRILL HOLE No. MCDD5

SCALE 1:500
0 5 10 15 20 25 30 35 40
metres

Compiled: W.Herrmann	Date: December, 1988	Dwg No.: M41-4
Drawn: R.J.Voss	Report No.: R41-9	FIGURE 4

APPENDIX IV

MULTIFREQUENCY EM SOUNDINGS IN THE
MT CATTLEY AREA, TASMANIA,
OCTOBER TO NOVEMBER 1988

606172

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MULTIFREQUENCY EM SOUNDINGS
IN THE MT CATTLEY AREA, TASMANIA
AND THE BERSERKER AREA, QUEENSLAND,
OCTOBER TO NOVEMBER 1988

By: A. Hattula
Outokumpu Oy Nordic Exploration
Tehtaankatu 2, SF-83500 Outokumpu
Finland
December, 1988

outokumpu MINING

606173

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511 GB

S U M M A R Y

Multifrequency EM dipole-dipole soundings using the GEFINEX 400 S system developed by Outokumpu Electronics were performed in the Mt. Cattley area of Tasmania and the Berserker area near Rockhampton in Queensland. A total of 290 soundings were taken on 2 profiles in the former case and on 11 profiles in the latter.

The Apparent Resistivity versus Depth (ARD) plot of each station was calculated and the results were presented as interpreted apparent resistivity cross sections. These gave structural and stratigraphic information and located some conductive bodies as possible mineralisations.

A high conductive body was detected on Mt. Cattley. The resistivity of the uppermost layers was low (10 - 50 ohm-metres). The depth extent was 200 - 300 m using 400 m coil separation and over 500 m with 800 m coil separation. A 3 - 4 layered model was obtained and many interruptions in continuity of the layers were located.

Nine conductive bodies and the known remaining mineralisation of the Mt. Chalmers mine were located in the Berserker area. The resistivity of the uppermost layer was usually over 100 ohm-metres, and the depth extent 400 - 700 m using 400 - 1000 m coil separations. 2 - 5 resistivity boundaries were detected and interruptions in continuity of the layers were located, as in the Mt. Cattley area.

The results show that the Gefinex 400 S system can be used to distinguish detailed resistivity distributions in flat-lying structures and to locate deep conductive bodies in conductive environments.

1. INTRODUCTION

The GEFINEX 400 S system is a multifrequency electromagnetic dipole-dipole method for determining the electrical resistivity of the ground at different depths inductively using a fixed transmitter-receiver separation and changing frequency to obtain variable penetration. The portable transmitter consists of an electronics unit and a power control unit, a transmitter loop (a 20 m diameter circular loop or a 50 m x 50 m square loop), and rechargeable batteries. The portable receiver consists of a 3-component magnetometer coil, a electronics unit and rechargeable batteries. There is no connecting cable between the transmitter and the receiver.

The fully automatic sounding operation is controlled by the microprocessor in the receiver, using UHF radiophones for communication with the transmitter. The system is capable of simultaneously measuring three orthogonal components of the magnetic field. The measured data are stored in a semiconductor memory in the receiver and can be unloaded via a RS 232 serial port. The memory, 512 kB of battery-secured RAM, can hold the data from 255 stations.

The geometric arrangement of the measuring system is shown in Fig.1. The frequency range is from 2.3 Hz to 19840 Hz and up to 81 frequencies (20 f / one decade) can be selected via the microprocessor program in the receiver. For a normal-sized transmitter loop (diameter of 20 m) the achievable transmitter - receiver separation is typically 400 m depending on the depth and the dimension of the target. A separation of up to 1000 m or even more is possible with a larger loop.

Main advantages of the method are:

Large depth of penetration; large magnetic moment even with low frequencies.

Discrimination of both conductive and resistive layers; wide frequency

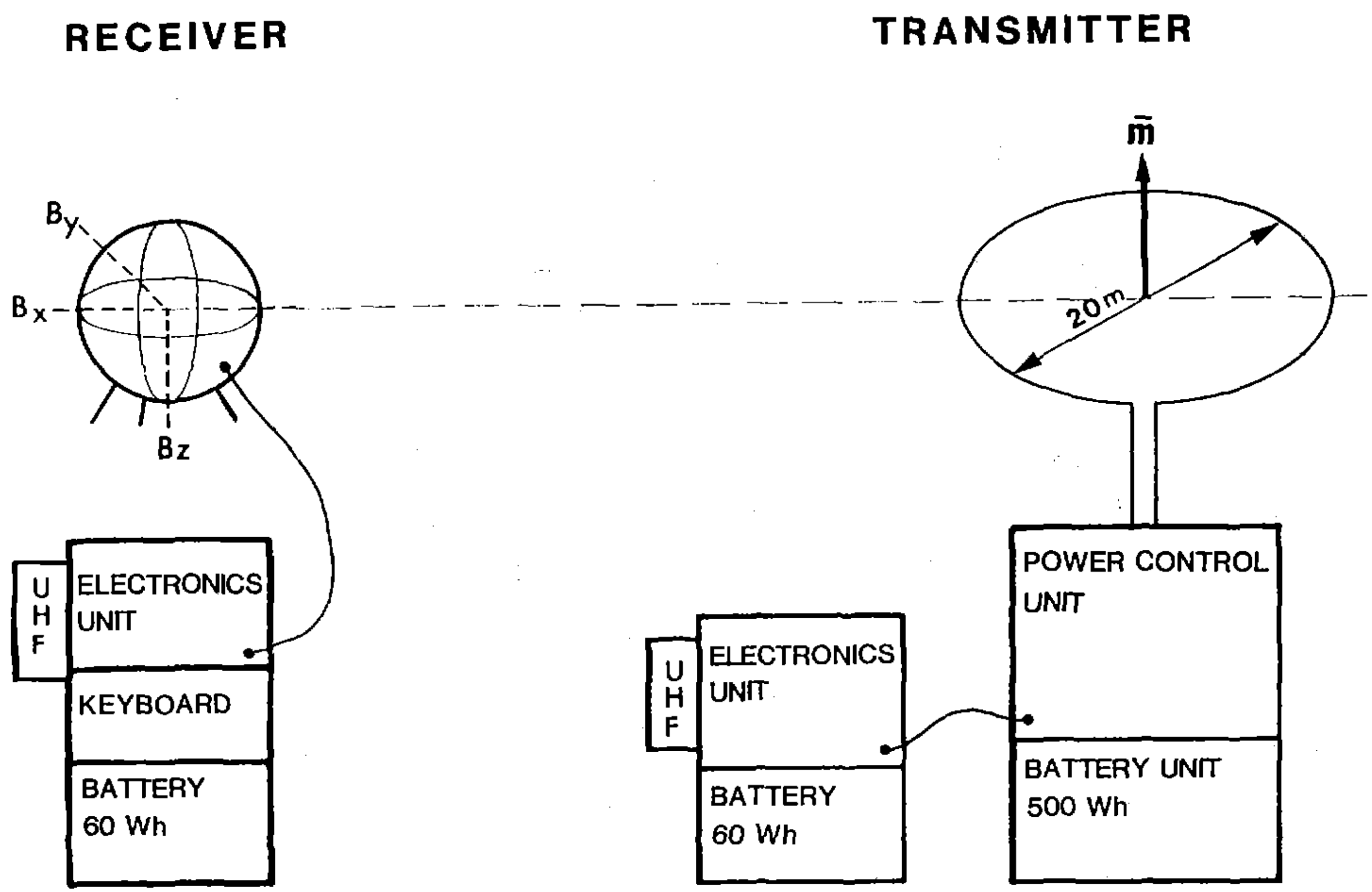


Fig.1. THE GEFINEX 400S SYSTEM

range with several discrete frequencies.

Good resolution in separations of different layers and bodies; geometric orientation and dense frequency range.

Good filters for power line noise.

Portable system; operated by rechargeable batteries.

Limitations of the method are:

Geometric orientation difficulties on rough terrain.

Correction difficulties for large height differences or large tilt angles of the transmitter loop.

Interpretation limitations in the case of vertical structures.

The GEFINEX 400 S system has been developed by Outokumpu Oy Electronics Division.

2. INTERPRETATION

The GEFINEX 400 S system includes a data processing and interpretation program package for IBM compatible Personal Computers. The program consist of:
- receiving program for data transfer from GEFINEX 400 S to PC.
- processing programs for measured data.
- Apparent Resistivity Versus Depth (ARD) interpretation program.
- storing, printing and plotting programs.

A flow chart for measured data during processing is shown in Fig.2.

Interpretation of the measured data is based on the frequency dependence of the ratio Bz/Br, where Bz is the vertical component of the magnetic field and Br the radial horizontal component, using the layered earth model. This dependence is converted into an

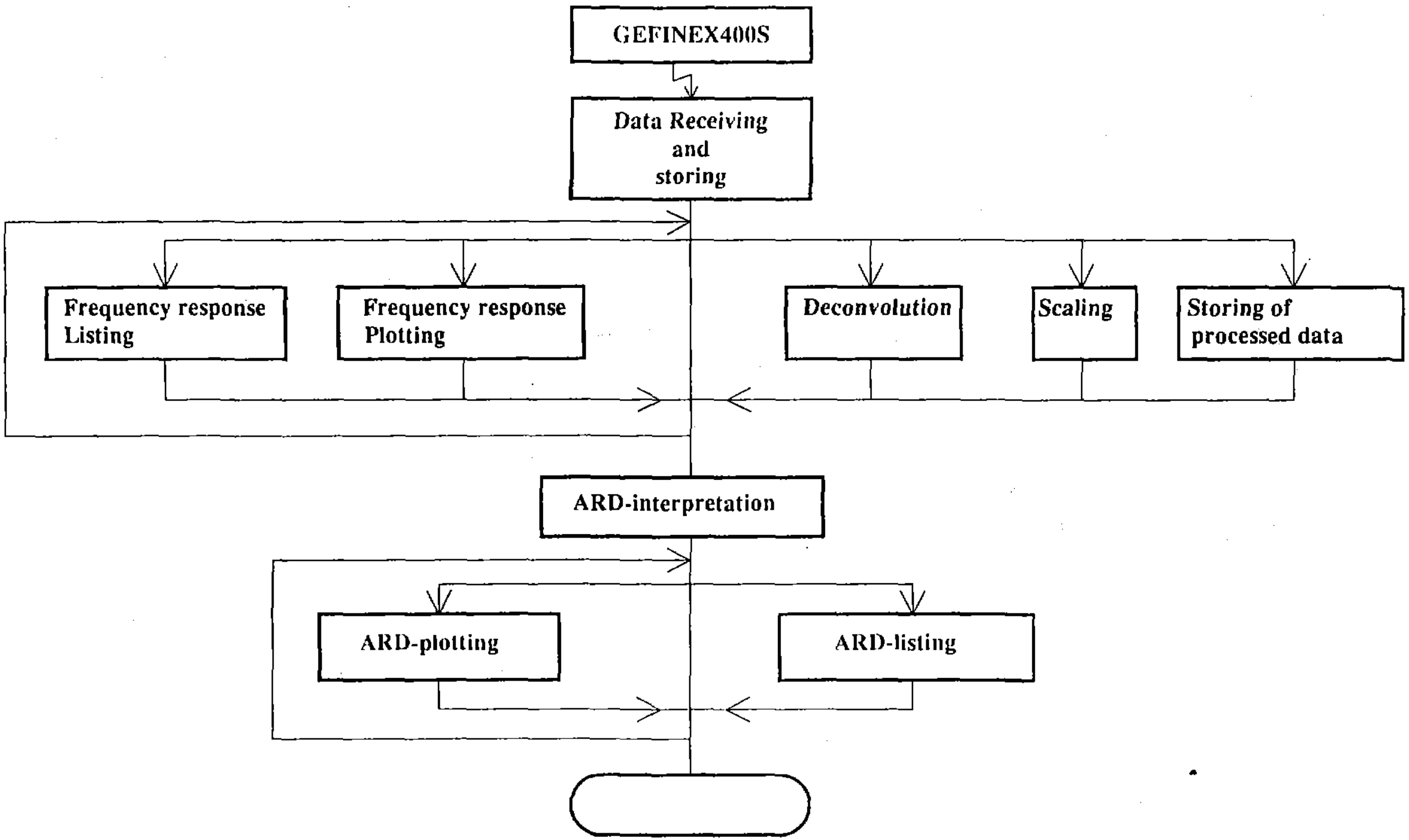


Fig.2. FLOW CHART OF DATA

apparent resistivity versus depth (ARD) plot (Fig.3.). Corrections due to differences in altitude between the transmitter and receiver or to sloping of the transmitter loop can be made during calculation of the plot.

The ARD plot over the homogeneous half-space will be a straight line parallel to the depth axis so that the measured apparent resistivity is then the real resistivity of the half-space. Bends in the ARD plot indicate changes in the resistivity at the corresponding depths. When proceeding from the surface to depth, the ARD curves deviate towards lower apparent resistivity, indicating conducting layers. A horizontal ARD plot means an infinitely good conductor. The angles between the sections of the ARD curve indicate the qualitative resistivity relations.

In the second stage of the interpretation a layer model is fitted to the ARD plot (Fig.4). This inversion program has been produced for a VAX computer and is not interactive.

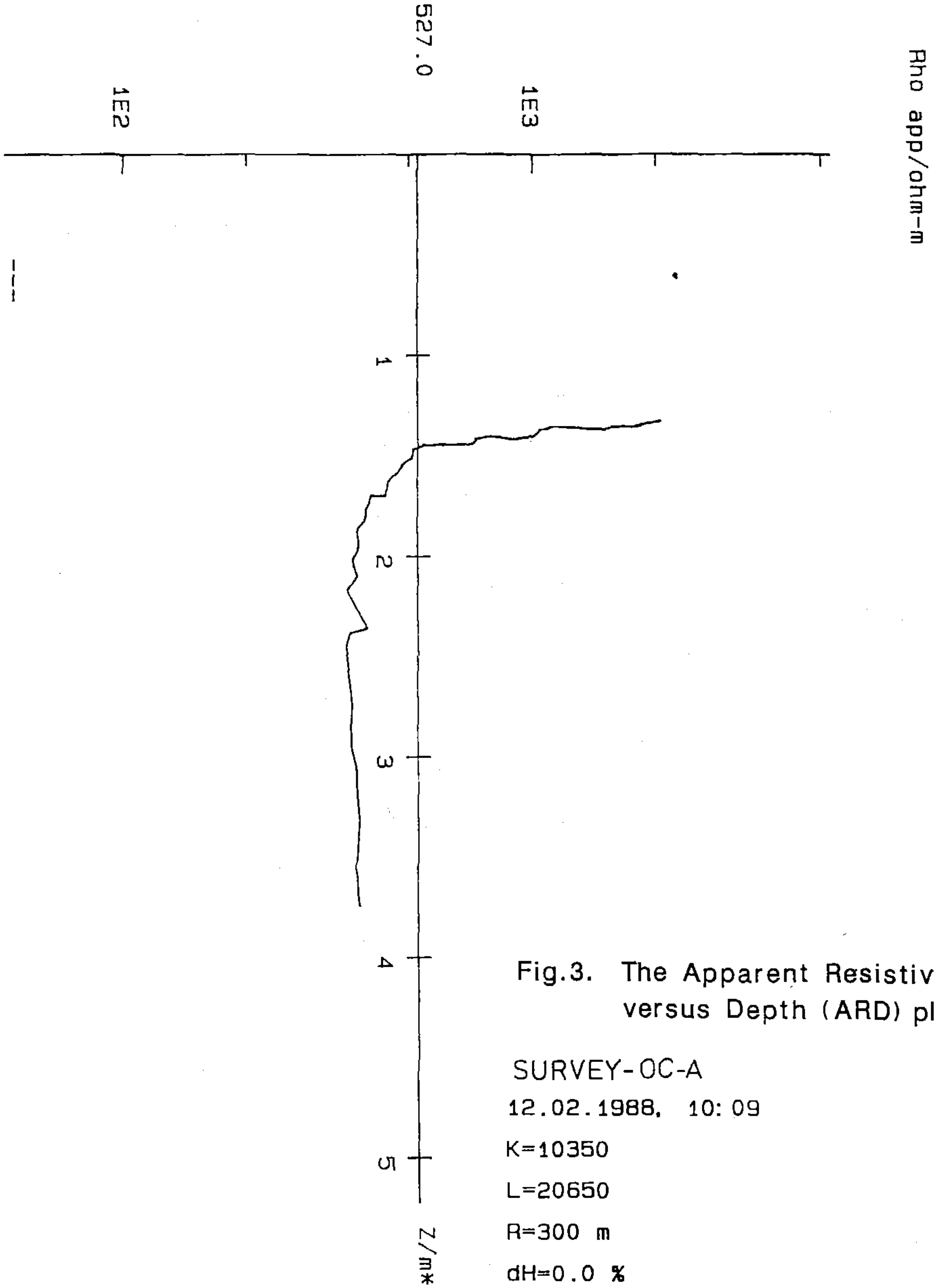


Fig.3. The Apparent Resistivity versus Depth (ARD) plot

SURVEY-OC-A

12.02.1988, 10: 09

K=10350

L=20650

R=300 m

dH=0.0 %

Contrast=1.0E+2

Loop #2, Note 09

Tx tilt sc=000 d lc=000 d

3. SURVEY DETAILS

Multifrequency EM dipole-dipole soundings using the GEFINEX 400 S system were performed in the Mt. Cattley area in Tasmania and the Berserker area near Rockhampton in Queensland.

The field survey on Mt. Cattley was carried out from October 6th to 21st 1988, when 90 soundings were completed on two lines:
12000 N from 9350 E to 12150 E and
11000 N from 1150 E to 12150 E (Fig. 5).
In addition some test soundings were carried out over the Hellyer mine.

At Berserker 10 lines of a GEFINEX 400 S survey were completed between October 25 and November 3, 1988, as shown in Fig. 6. A total of 200 soundings were taken.

The measurements were carried out using the in-line coil configuration, usually with a coil separation of 400 m, but at larger distances at a few stations. The size of the transmitter loop was 20 m except for the largest coil separation on Mt.Cattley. A 50 m x 50 m transmitter loop was used on the flat areas and a 20 m circular loop on the hilly area on the Berserker Grids. The height differences between the transmitter and the receiver were measured using the hydrostatic level RRKM-20. The tilts of the transmitter loop were also measured with the same level in the Berserker area.

The data file numbers and coordinates of the sounding stations are presented in Table 1 for Mt. Cattley and in Table 2 for Berserker.

An initial ARD interpretation of each station was produced in the field and some preliminary summaries in the office of OEA. The final interpretation was compiled in Finland.

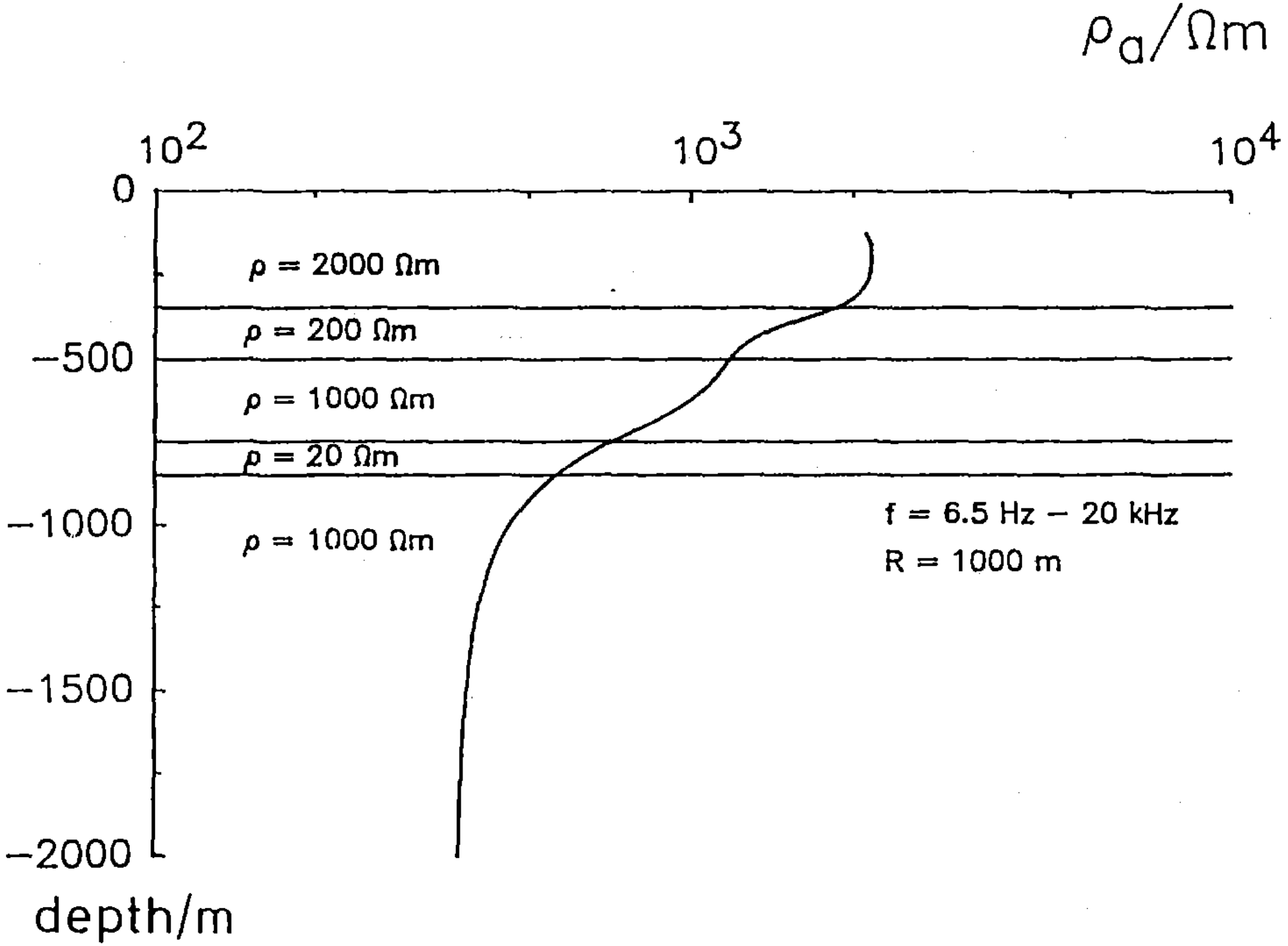
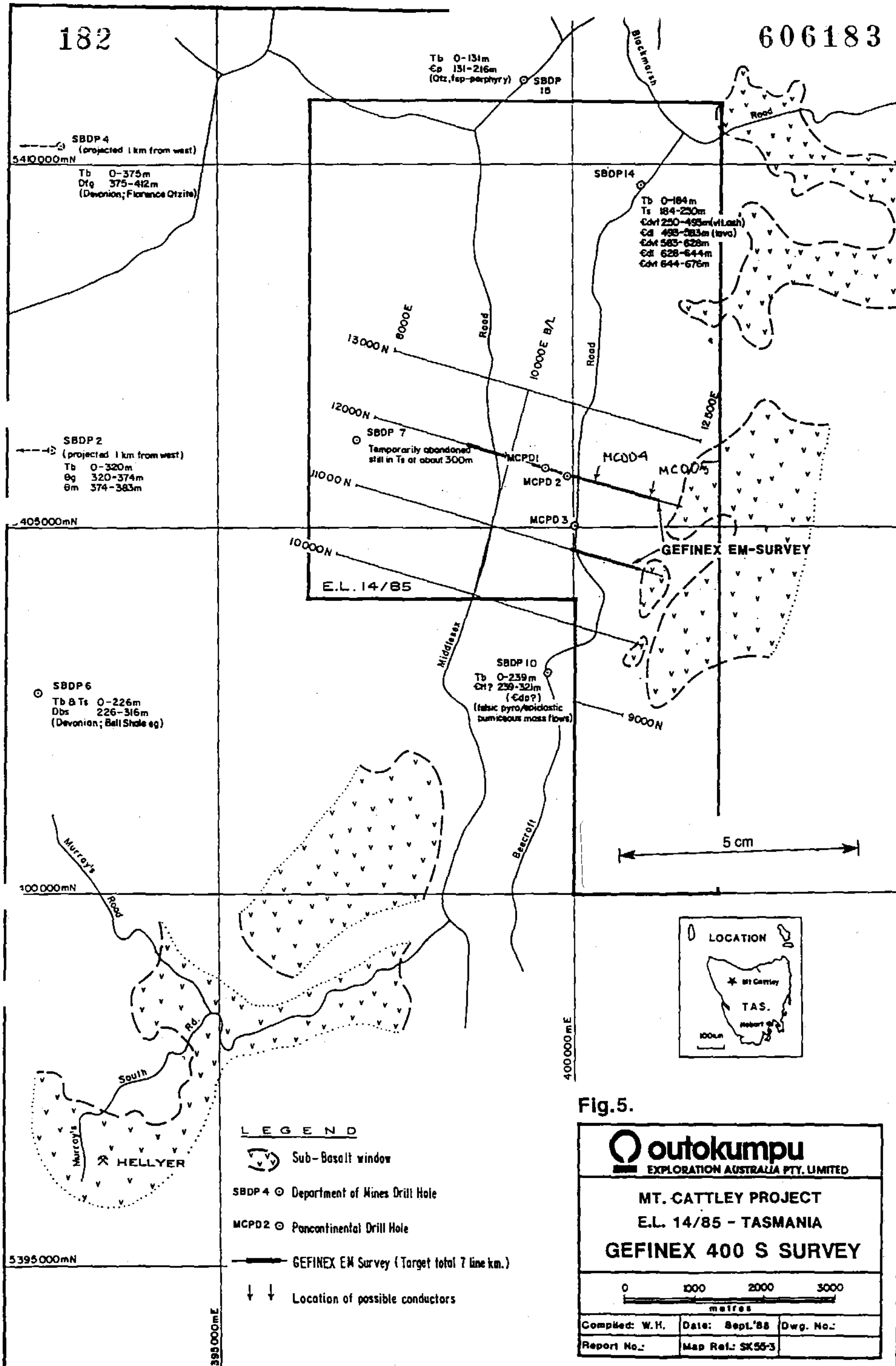


Fig.4. LAYER MODEL INVERSION


Tb 0-131m
€p 131-216m
(Qtz, fsp-porphyry)
SBDP 15
Blackmarsh
Road
SBDP 4
(projected 1 km from west)
5410000mN
Tb 0-375m
Dfq 375-412m
(Devonian; Florence Qtzite)
SBDP 14
Tb 0-184m
Ts 184-230m
€dvt 250-493m (vt.ash)
€dl 493-583m (lava)
€dvt 583-628m
€dl 628-644m
€dvt 644-676m
8000E
13000N
Road
10000E B/L
Road
12500E
12000N
SBDP 7
Temporarily abandoned still in Ts at about 300m
MCPD1
MCPD 2
MC004
MC005
SBDP 2
(projected 1 km from west)
Tb 0-320m
€g 320-374m
€m 374-383m
11000N
405000mN
MCPD 3
GEFINEX EM-SURVEY
10000N
E.L. 14/85
Middlesex
SBDP 10
Tb 0-239m
€f? 239-321m
(€ds?)
(felsic pyro/epiclastic pumiceous mass flows)
9000N
SBDP 6
Tb & Ts 0-226m
Dbs 226-316m
(Devonian; Bell Shale eg)
Murray's Road
Beecroft
5 cm
400000mN
LOCATION
Mt Cattley
TAS.
Hobart
100km
Rd.
South
Murray's
HELLYER
400000mE
Fig.5.
LEGEND
Sub-Basalt window
SBDP 4 Department of Mines Drill Hole
MCPD2 Pancontinental Drill Hole
GEFINEX EM Survey (Target total 7 line km.)
Location of possible conductors
5395000mN
395000mE
outokumpu
EXPLORATION AUSTRALIA PTY. LIMITED
MT. CATTLEY PROJECT
E.L. 14/85 - TASMANIA
GEFINEX 400 S SURVEY
0 1000 2000 3000
metres
Compiled: W.H.
Date: Sept.'88
Dwg. No.:
Report No.:
Map Ref.: SK55-3

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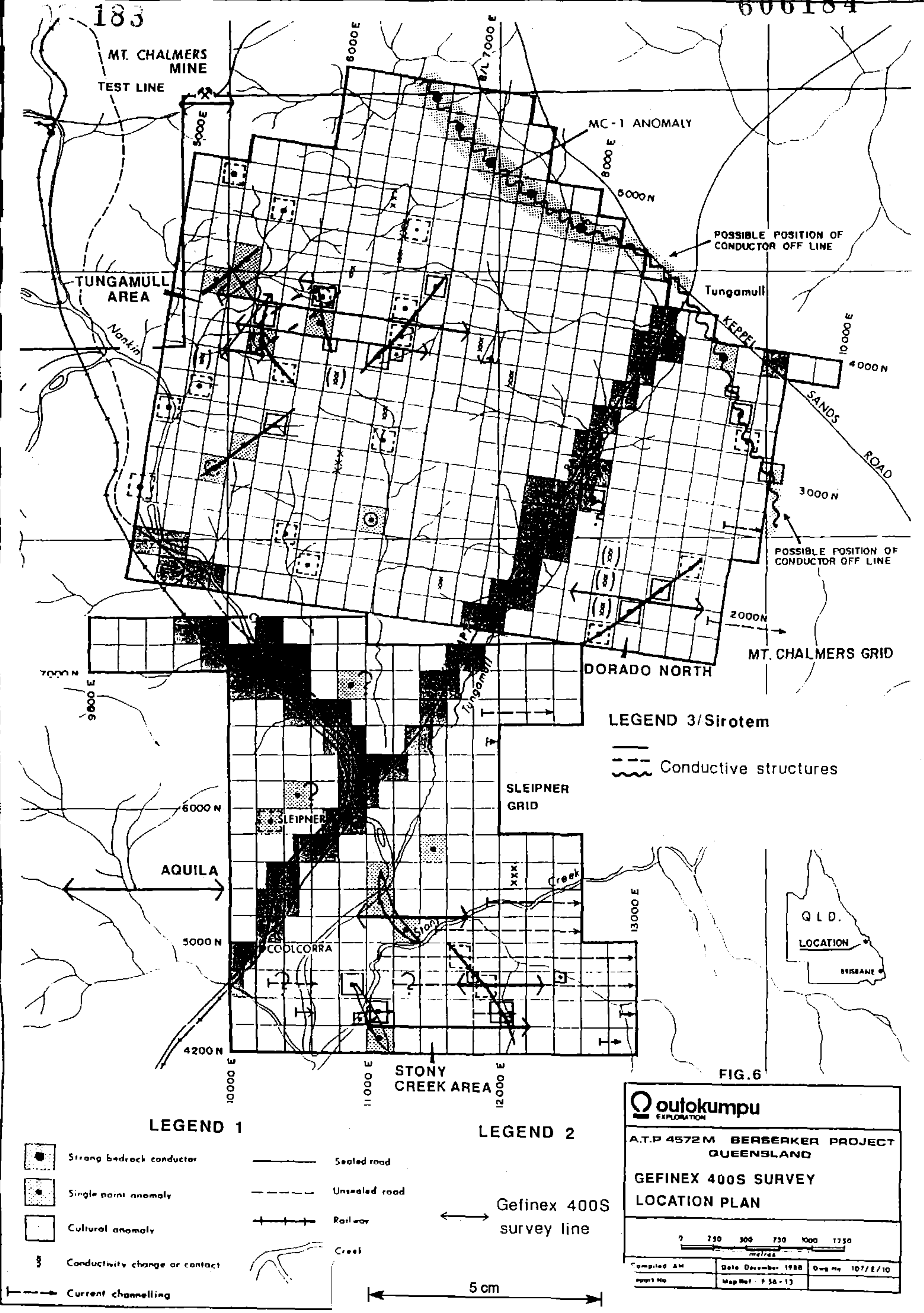

FIG.6

outokumpu EXPLORATION

A.T.P 4572 M BERSERKER PROJECT QUEENSLAND

GEFINEX 400S SURVEY LOCATION PLAN

0 250 500 750 1000 1250 metres

Compiled AH	Date December 1988	Dwg No 107/E/10	
Report No	Map Ref F 56-13		

FIG. 8

MT.CATTLEY
Gefinex 400S sounding
Interpreted apparent resistivity cross section
12000 N

1:5000 5 cm

- 90 Resistivity of the first layer/Ωm
- Very resistive shallow layer
- High conductive layer or body
- Conductor

Apparent resistivity relations:

- Resistive
- Conductive
- High resistivity (thousands of ohm-metres)
- —— Resistivity boundary
- - - - Possible boundary
- v Midpoint of a sounding

606185

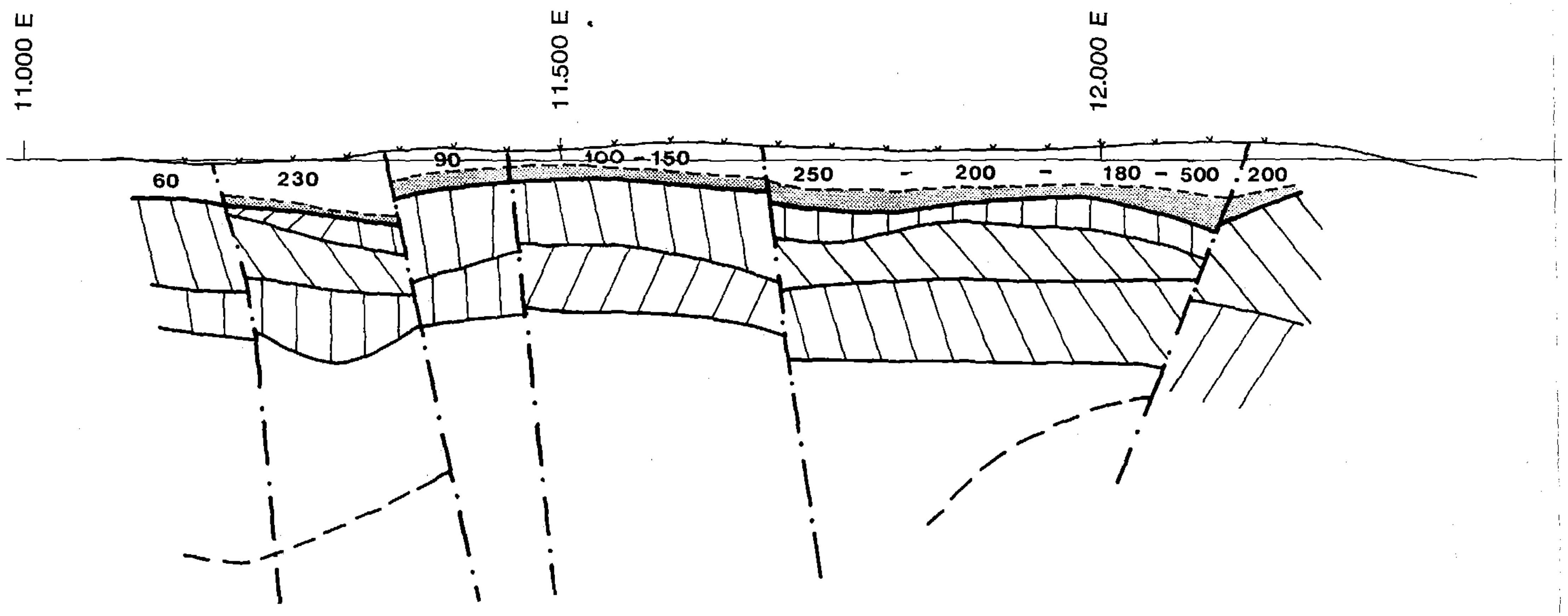

FIG. 7

MT.CATTLEY
Gefinex 400S sounding
Interpreted apparent resistivity
cross section
11000 N

1:5000 5 cm

90 Resistivity of the first layer/Ωm
Very resistive shallow layer
High conductive layer or body
Conductor

Apparent resistivity relations:
Resistive
Conductive
High resistivity (thousands of ohm-metres)
Resistivity boundary
Possible boundary
Midpoint of a sounding

4. RESULTS

The purpose of the Gefinex 400 S survey was to obtain structural and stratigraphic information and to locate conductive mineralisations.

The ARD interpretations of the soundings at Mt. Cattley are in Appendices 1 and 2 and the ARD plots of the Berserker area in Appendices 3 - 20. The ARD plots are presented with and without corrections for height differences between the transmitter and receiver or sloping of the transmitter loop.

Descriptions of the resistivity cross sections are presented in the following.

4.1 Mt.Cattley

The apparent resistivity cross-sections of the lines 11000 E and 12000 E were interpreted using the ARD curve cross sections and separate ARD plots (Fig. 7 and Fig. 8). These sections provide structural and stratigraphic information.

The depths of the wide conductive layers are quite accurate, the more resistive layers being sensitive to the conductivity x thickness product in multilayer cases in particular. Depth interpretation can be improved by layered model inversion or if control is provided by geological or resistivity logging data from nearby boreholes.

<u>The cross section 11000 N</u> (Fig. 7)

The salient features of the resistivity cross section are as follows:

A 3 to 5 flat layer model is recognised.

Except for the western end of the line, the most conductive layer is at a depth of a few metres. This is probably the base of the Quaternary soil or weathering horizon. The thickness of this uppermost layer is not exact, due to the 400 m coil separation.

A slightly better conductive layer is located at a depth of 100 - 150 m in the middle of the section (11500 - 11700 E). The base of this layer may be related to the base of the basalt. To the east, the base of the basalt is probably below the conductive layer and the lower boundaries belong to the bedrock.

Another interpretation of the weak conductor in the middle block is that the conductive layer may be thinner, having better conductivity.

<u>The cross section 12000 E</u> (Fig. 8)

The salient features of this section are:

The uppermost layer in nearly all the blocks has very low resistivity, down to under 10 ohm-m at 11000 E. Beneath this conductive layer is a thin high resistive layer, or else the contrast between the conductive layer and the thick resistive layer is very marked.

The second layer is conductive in 5 blocks (9500, 10300, 10600, 11700 and 11900 E). The conductivity of the two eastern blocks (11700 and 11900 E) is a little lower than that of the others.

A highly conductive body was located at depths of 150 m at the eastern end of the section. If this body is small, as suggested by the ARD plot, its depth will be shallower. Soundings with a broad side coil configuration are needed to locate the position of the body.

A week conductor may be located at a depth of 180 m at 11300 E. This lies near or on the bedrock boundary.

There are numerous interruptions in the resistivity section. The major one, located at 10920 E, divides the layers beneath the Quaternary layers, since they are highly resistive on the eastern side of this possible fault but of low resistivity on the western side. These responses may also be due to the thickness and/or petrophysics of the basalts.

The low resistive layers at the western end of the section are thought to be due to the basalts becoming suddenly thicker.

A sounding using a 800 m coil separation at 11700 E gave the same layer structure as 400 m separation down to the depth of 250 m and a new possible boundary at a depth of 500m.

MT. CATTLEY
GEFINEX 400S SURVEY
SOUNDING STATIONS

DATE	LINE	FILE	STATION	Rx	Tx	R	LOOP
07.10.88	12000N	MTCAT070					
		._00	9800	10000	9600	400	2
		._01	9850	10050	9650	400	2
		._02	9900	10100	9700	400	2
		._03	9950	10150	9750	400	2
		._04	10000	10200	9800	400	2
		._05	10050	10250	9850	400	2
		._06	10100	10300	9900	400	2
		._07	10150	10350	9950	400	2
		._08	10200	10400	10000	400	2
		._09	10200	10350	10050	300	2
HELLYER TEST							
	10800N	._0A	5688	5563	5813	250	2
		._0B	5688	5563	5813	250	2
		._0C	5913	6013	5813	200	2
		._0D	5913	6013	5813	200	2
		._0E	5913	6013	5813	200	2
		._0D	5913	6013	5813	200	2
		._10	5913	6013	5813	200	2
		._11	5938	6063	5813	250	2
		._12	5938	6063	5813	250	2
		._13	5663	5563	5763	200	2
		._14	5638	5513	5763	250	2
		._15	5588	5463	5713	250	2
		._16	5538	5413	5663	250	2
08.10.88	12000N	MTCAT080					
		._00	10250	10450	10050	400	2
		._01	10300	10500	10100	400	2
		._02	10350	10550	10150	400	2
		._03	10400	10600	10200	400	2
		._04	10450	10650	10250	400	2
		._05	10500	10700	10300	400	2
		._06	10550	10750	10350	400	2
		._07	10600	10800	10400	400	2
		._08	10650	10850	10450	400	2
		._09	10700	10900	10500	400	2
		._0A	10750	10950	10550	400	2
		._0B	10800	11000	10600	400	2
		._0C	10850	11050	10650	400	2
		._0D	10900	11100	10700	400	2
		._0E	10950	11150	10750	400	2
		._0F	11000	11200	10800	400	2

		._10	11050	11250	10850	400	2
		._11	11100	11300	10900	400	2
		._12	11150	11350	10950	400	2
		._13	11200	11400	11000	400	2
		._14	11250	11450	11050	400	2
		._15	11300	11500	11100	400	2
10.10.88	12000N MTCAT10O						
		._00.	11250	11450	11050	400	2
		._01	11350	11550	11150	400	2
		._02	11400	11600	11200	400	2
		._03	11450	11650	11250	400	2
		._04	11500	11700	11300	400	2
		._05	11550	11750	11350	400	2
		._06	11600	11800	11400	400	2
		._07	11650	11850	11450	400	2
		._08	11700	11900	11500	400	2
		._09	11750	11950	11550	400	2
		._0A	11800	12000	11600	400	2
		._0B	11700	11500	11900	400	2
		._0C	11800	11600	12000	400	2
		._0D	11850	11650	12050	400	2
		._0E	11900	11700	12100	400	2
		._0F	11950	11750	12150	400	2
		._10	12008	11800	12215	415	2
		._11	12050	11850	12250	400	2
		._12	12100	11900	12300	400	2
11.10.88	11000N MTCAT11O						
		._00	11150	10950	11350	400	2
		._01	11200	11000	11400	400	2
		._02	11250	11050	11450	400	2
		._03	11300	11100	11500	400	2
		._04	11350	11150	11550	400	2
		._05	11400	11200	11600	400	2
		._06	11400	11200	11600	400	2
		._07	11450	11250	11650	400	2
		._08	11500	11300	11700	400	2
		(.-09)	11500	11300	11700	400	2
		(._0A)	11500	11300	11700	400	2
		._0B	11500	11300	11700	400	2
		._0C	11550	11350	11750	400	2
		._0D	11600	11400	11800	400	2
		._0E	11650	11450	11850	400	2
		._0F	11700	11500	11900	400	2
		._10	11750	11550	11950	400	2
		._11	11800	11600	12000	400	2
		._12	11850	11650	12050	400	2
		._13	11900	11700	12100	400	2
		._14	11950	11750	12150	400	2
		._15	12000	11800	12200	400	2
		._16	12050	11850	12250	400	2
		._17	12100	11900	12300	400	2
		._18	12150	11950	12350	400	2

12.10.88	12000N MTCAT12O						
		._00	9800	10000	9600	400	2
		._01	9750	9950	9550	400	2
		._02	9700	9900	9500	400	2
		._03	9650	9850	9450	400	2
		._04	9595	9800	9390	410	2
		._05	9552	9750	9355	395	2
		._06	9552	9750	9355	395	2
		._07	9500	9700	9300	400	2
		._08	9450	9650	9250	400	2
		._09	9400	9600	9200	400	2
		._0A	9344	9550	9138	412	2
13.10.88	12000N MTCAT13O						
		._00	12144	11950	12338	388	2
		(.-01)	12144	11950	12338	388	2
		(.-02)	12144	11950	12338	388	2
		._03	11925	11725	12125	400	2
		._04	11125	10950	11300	350	3
		(.-05)	11700	12100	11300	800	3
		._06	11700	12100	11300	800	3
		(.-07)	11600	12000	11200	800	3
		(.-08)	11600	12000	11200	800	3

Rx = Receiver
Tx = Transmitter
R = Coil separation

LOOP 2 = circular loop of 20m diameter
LOOP 3 = 50m * 50m loop
( ) = failed or repeated record