

OUTOKUMPU EXPLORATION AUSTRALIA PTY LIMITED

Report No: R41.20  
File No: 2.41.9  
Filename: 241GM110.RT1

OPEN FILE

135001

ANNUAL REPORT TO 20 AUGUST 1991  
EL 14/85 - MT CATTLEY

TCR  
91-3304

MINES	
File Ref. E.L. 14/85	
17 OCT 1991	
Doc. Ref.	
Action Officer	Initials
REFER	TO
CORRES.	15.10.91
(FOLIO 93)	
Resubmit to	Date

For: Outokumpu Exploration Australia Pty Limited  
77 Pacific Highway, NORTH SYDNEY NSW 2060

By: G. McKay

Date: 14 October 1991

Note: 2/9/93

MR R POLTOCK  
supplied a copy  
of appendix -

re Drill log MCD 6.  
- this already in report  
- he also stated

that all drill  
core has been  
lodged at Morrison  
Core store

- Refer G. Oakes  
D Duncan  
S Remington

DISTRIBUTION:

1. OEA library
2. Pancontinental Mining
3. Dept Resources & Energy

PART 1

	<u>Page</u>
1. Introduction	1
2. Stratigraphic Drilling MCDD6	2

APPENDIX

Summary Drill Record - MCDD6

FIGURES

1. EL 14/85 Interpreted Geological Plan (Scale 1:25,000)
2. EL 14/85 Interpreted Geological Section (Scale 1:5,000)

PART 2

EXPLORATION PROGRESS REPORT EL 14/85 - MT CATTLEY.  
(W. Herrmann, 21 January 1991; 22 pages, 9 figures, 7 appendices)

## 1. INTRODUCTION

This report contains details of the exploration carried out on Exploration Licence 14/85, Mt Cattley, for the twelve months ended 20 August 1991. EL 14/85 was originally granted for an area of 47 sq km and has been subsequently reduced to 25 sq km.

During the twelve months ended 20 August 1991, the following programme was completed:

- \* Geochemical sampling of the Tasmanian Division of Mines and Mineral Resources stratigraphic drill hole MXRD1 (total depth 750.5m). This drillhole was completed in August 1990. The entire sub-Tertiary section of MXRD1 core below 184.6m was side grind filleted in 10m lengths and analysed for Cu, Pb, Zn, Ag, Mn, Fe, Mg, Cr, Ti, Zr, Y, Nb, Ba, Ca, Na, K by Analabs using ICP analysis (see details in Part 2).
- \* A report on the geochemistry was prepared by Dr A.J. Crawford of the University of Tasmania in November 1990 (see details in Part 2).
- \* Downhole TEM surveying of MXRD1 was conducted in November 1990 by McSkimming Geophysics and reported by Dr J. Bishop of Mitre Geophysics (see details Part 2).
- \* Sampling and geochemical analysis of core from drillholes MCDD4 and MCDD5 was carried out by W. Herrmann (see details in Part 2).
- \* After interpretation of the most beneficial location, a stratigraphic drillhole, MCDD6, was drilled to 798m in June-July 1991 by Outokumpu (= proposed drillhole "B").
- \* Geologically logging of core from MCDD6 has been carried out. Selected fillet grind sampling of the core and geochemical analysis is currently being conducted.

Aberfoyle Resources have expressed an interest in joint venturing into the area and are currently reviewing the data.

## 2. STRATIGRAPHIC DRILLING MCDD6

MCDD 6, a stratigraphic drill hole designed to intersect correlates of the Que-Hellyer Volcanics interpreted to exist beneath Tertiary basalt on the western limb of the Black Marsh Syncline, was collared on 12 June and completed on 29 July 1991 at a depth of 798m.

MCDD 6 Collar co-ordinates: AMG 399200E/5404790N approx.  
 " azimuth : 315 deg.(AMG) [303 deg.Mag]  
 " inclination: -65 deg; RL: 670 masl

### Summary Geological Log:

0-329.2m	Tertiary basalt flows, associated breccias
329.2-337.3	Unlithified and lignitic Tertiary silt, sand and gravel; sub horizontally layered.
-----	
337.3-360.6	thinly bedded turbiditic grey to black siltstone with subordinate interbedded sandy micaceous quartzwacke and felsic volcanic wacke. Younging up hole. Bedding trends 285 deg. (AMG) and dips 40 deg. to South.
360.6-364.0	Felsic volcanoclastic wacke, medium grained, crudely stratified.
364.0-383.3	Felsic pumiceous tuff-breccia.
383.3-387.9	Mixed felsic volcanoclastic wacke and vitric tuffaceous siltstone.
387.9-400.1	Black siltstone.
400.1-529	Feldspar phyric andesite.
529 -616.8	Aphyric andesite
616.8-674.2	Feldspar phyric andesite.
674.2-676.3	Andesitic volcanoclastic wacke, medium to coarse grained and crudely stratified.
676.3-752.6	Andesitic breccia; medium to coarse grained mass flow type epiclastic and auto breccias with scattered large blocks of aphyric andesite.
752.6-798	Aphyric andesite, some zones of hyaloclastite and auto breccia.
798m	EOH.

MCDD6 intersected a sub Tertiary basalt sequence of turbiditic siltstones, felsic volcanoclastics, black siltstone and andesitic lavas, breccias and minor volcanoclastics which is substantially analogous to part of the basement sequence in MXRD1 and which appears to represent correlates of the lower part of the Southwell subGroup, the Que River Shale and the Que-Hellyer Volcanics.

An andesitic wacke and approximately 60m thick group of andesitic epiclastic breccias below it, are correlated with the "Mixed Sequence" of the QHV which hosts both Que River and Hellyer massive sulphide deposits. The "Mixed Sequence" was barely developed in MXRD1 but its significant thickness in MCDD6 is regarded as very encouraging.

Apart from minor sphalerite-galena-chalcopyrite in carbonate veins near the top of the andesite sequence there is no significant sulphide mineralisation or evidence of hydrothermal alteration.

The core has been geologically logged and a preliminary interpretative geological plan and section has been prepared (Figures 1 & 2). Selected fillet grind sampling of the core and geochemical analysis is being conducted.

005

135006

5 cm

398000 E

399000 E

400000 E

401000 E

5408000 N

5407000 N

5406000 N

5405000 N

5404000 N

5403000 N

OCU

OCU

OCU

ACA

ACA

QNV lower  
QNV upper

40°?

MCB2

MCB2

MCB2

MCB5

MCB3

MCB5

MCB3

GRS

MAC 22

SSG

SBD 10

MAC 20

40

TAC

TAC

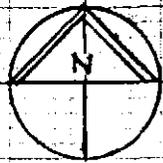


FIGURE 1



outokumpu

EXPLORATION AUSTRALIA PTY. LTD.

EL. 14/85 - MT. CATTLEY

INTERPRETED GEOLOGICAL PLAN

AT ~350 M A.S.L.

(Scale 1:200. W.M. SURFACE)

NW

135007 SE

399000 E 5405000 N AMG

Middlesex Road

700 m ASL

MCDD6

MXRD 1 (approx; projected orthogonally)

600  
500  
400  
300  
200  
100  
SL.

Tb

Ts

Ssg (siltstones)

Ssg (felsic volcanics)

Qrs

(black siltstone)

QHV - "upper andesites + basalts" ?

Andesitic volcanlastic necks

QHV - "lower andesites + basalts" ?

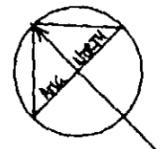
Acs ?

FIGURE 2

LEGEND:

- 
- 
- 
- 

5 cm



SCALE: 1:5000

MCDD6

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

DATE: 8/91  
 GEOL: [initials]  
 DWN: [initials]  
 CHKD: [initials]

EL 14/85 - MT. CATTLEY  
 INTERPRETED GEOLOGICAL SECTION  
 SECTION ABWORTH 315° AMG

APPENDIX:

SUMMARY DRILL RECORD - MCDD6

## SUMMARY DRILL RECORD

Area: Mt.Cattley, EL 14/85; Tas. Hole No: MCDD 6  
 Drilled: 12 June - 29 July, 1991 Total Depth: 798.0m

## Collar co-ordinates:

AMG: approx: 399200 E 5404790 N R.L.: ~670m ASL  
 Azimuth: 315 AMG; 303 Magnetic  
 Inclination: -65 deg.

Hole Surveys:	Depth (m)	Azimuth (Mag.)	Dip
	50	303.5	-63.5
	100	304	-63.5
	150	302	-63.5
	200	308	-63
	250	308.5	-63
	300	307.5	-63
	350	316	-63
	400	318	-62.5
	450	317.5	-62.5
	500	319	-62
	550	318.5	-61
	600	320	-61
	650	320	-60
	700	323	-59.5
	750	321	-58
	798	323	-58

Drill Rig: Longyear 44  
 Contractor: Diamond Drilling Tasmania (P. Sharp)  
 Drilling Notes:

HQ core: 0 - 73.8m

NQ core: 73.8 - 798.0m

Drilling fairly straightforward except for zone of clayey, oxidised (Tertiary) basaltic breccia at about 180m depth; this unit included some plastic clayey zones which appeared to squeeze in to the hole and required patient re-reaming whenever the drill rods were re-run.

100% core recovery.

Class 12 32mm PVC casing to bottom of hole.

Logged by: W. Herrmann  
 Date: June - August, 1991

Target : Stratigraphic hole designed to elucidate the stratigraphic and structural interpretation and exploration significance of andesitic volcanics previously intersected by PanFin and DMMR sub basalt drilling between Middlesex and Beecroft Roads. Specifically to intersect correlates of the Que-Hellyer Volcanics on the western limb of an interpreted southwesterly plunging syncline west of MXRD1.

**Summary Result :**

MCDD6 intersected a sub Tertiary basalt sequence of turbiditic siltstones, felsic volcanoclastics, black siltstone and andesitic lavas, breccias and minor volcanoclastics which is substantially analogous to part of the basement sequence in MXRD1 and which appears to represent correlates of the lower part of the Southwell subGroup, the Que River Shale and the Que-Hellyer Volcanics. The Que River Shale correlate (black siltstone) in MCDD6 is considerably thinner, by a factor of about 0.25, than in MXRD1. Conversely, andesitic lavas and breccias which overlie a distinctive thin unit of andesitic volcanoclastic wacke and are tentatively correlated with the upper andesites and basalts of the Que-Hellyer Volcanics, are substantially thicker, by a factor of about 1.5, in MCDD6 compared to MXRD1.

The andesitic rocks intersected do not contain (megascopically apparent) hydrothermal alteration or significant sulphide mineralisation assemblages.

Oriented core measurements of bedded sediments overlying the Que River Shale correlate in MCDD6, indicate that the bedding trends about 285 deg. (AMG) and dips at about 40 deg. to the south.

**Abbreviated Geological Log :****MCDD 6**

0-329.2m	Tertiary basalt flows and associated breccias.
329.2-337.3	Tertiary silt/sand/gravel.
337.3-360.6	Turbiditic grey siltstone and subordinate interbedded wackes. Bedding trends about 285 deg. (AMG) and dips at 40 deg. to South.
360.6-364.0	Felsic volcanoclastic wacke.
364.0-383.3	Felsic pumiceous tuff-breccia
383.3-387.9	Mixed felsic volcanoclastic wacke and vitric tuffaceous siltstone.
387.9-400.1	Black siltstone.
400.1-529	Feldspar phyric Andesite
529 -616.8	Aphyric Andesite
616.8-674.2	Feldspar phyric Andesite
674.2-676.3	Andesitic volcanoclastic wacke, medium to coarse grained and crudely stratified.
676.3-752.6	Andesitic Breccia; medium to coarse grained mass flow type epiclastic and auto breccias with scattered large blocks of aphyric andesite.
752.6-798	Aphyric andesite, some zones of hyaloclastite and auto breccia.
798m	EOH.

MCDD 6

## Geological Core Log

W. Herrmann, August 1991

Depths  
(m)

Depths (m)	Description
0-337.3	<u>Tertiary cover sequence:</u>
0- 10.5	Weathered brown clayey basalt.
10.5- 19.1	Olivine phyric basalt; pale grey, sparsely (3%) vesicular, occasional clayey weathered zones.
19.1- 20.5	Weathered reddish brown vesicular basalt.
20.5- 47.7	Glassy vesicular basalt; brownish to dark blackish grey colour. Vesicles ~10% vol, some partly filled with grey clayey material. Intermittent zones of brownish oxidation throughout.
47.7- 55.0	Olivine phyric basalt; pale-dark grey, vesicles ~40% in upper 1m decreasing to ~5% below. Includes a few reddish oxidised zones but mostly fresh.
55.0- 64.6	Olivine phyric basalt; similar to above but apparently a separate flow unit.
64.6-173.4	Sequence of thin, mostly vesicular basaltic flow units. Generally dark blackish grey, rather glassy but sometimes olivine phyric in more massive sections. Vesicles variable 1~30%, possibly indicating flow tops.
173.4-186.7	Basaltic volcanic breccia. Variable brownish and reddish (oxidised) clasts and lesser grey (unoxidised) clasts of mostly quenched glassy basalt in a granular silty-muddy-ashy matrix. Clasts generally 5-30mm, variably wispy/deformed angular or sub-rounded, matrix supported with clast content increasing downhole possibly indicating a graded mass flow breccia unit. The upper part, 174-174.4m, includes a 40cm unit of fine grained purplish grey volcanoclastic siltstone with planar bedding intersecting at ~50 deg. to LAOC. The unit overall is rather oxidised and clayey, particularly below 178m; this zone caused some problems and delays in drilling due to plastic clay closing in on the hole.
186.7-194	Olivine phyric basalt; pale grey, fine grained and unoxidised except for narrow brown selvages to occasional greenish grey clay/zeolite veins. Distinctly magnetic.
194 -201.7	Basaltic breccia. Possibly a hyaloclastite, variable fragment size upto 50mm, matrix of pale greenish grey amorphous looking clay/zeolite/? rich material. Variably oxidised.
201.7-210	Olivine phyric basalt; dark grey and rather glassy, occasionally finely vesicular; fresh.

- 210 -225.9 Basaltic breccia, probably hyaloclastite. Variable clast size upto 50mm but usually <20mm, angular to subrounded mainly of dark glassy olivine phyric basalt, some vesicular scoriaceous basalt and occasional well rounded xenoliths of Px+Ol ultramafic peridotite in a matrix of fine pale grey basaltic ash often altered to pale greenish/blue grey soapy clay/zeolite.
- 225.9-243.3 Olivine phyric basalt. Pale grey, massive, non vesicular, occasional xenoliths of peridotite, fresh and magnetic.
- 243.3-275.8 Basaltic agglomerate. Very fragmental, abundant small and large (to 150mm) angular to rounded clasts of basalt, generally matrix supported in basaltic ash which in places has crude wispy foliation suggestive of ash flow. Generally rather porous and friable but still quite fresh and distinctly magnetic.
- 275.8-278.3 Basalt; fine grained, dark grey, massive, non-vesicular.
- 278.3-284.9 Basaltic agglomerate; similar to unit 243.3-275.8m.
- 284.9-311 Basalt; fine grained, dark grey, massive, generally non-vesicular, occasional rounded xenoliths of coarse peridotite and vesicular basalt; distinctly magnetic.
- 311 -318.5 Basaltic agglomerate; similar to unit 243.3-275.8m.
- 318.5-329.2 Basalt; fine grained, grey, massive; slightly brecciated near base with rare clasts of baked sandy sediment.
- 329.2-337.3 Unlithified silt/sand/gravel. Dominantly a rather massive dark grey carbonaceous muddy silt with minor lignitic bands but locally pebbly and well stratified and sometimes graded (with facing uphole). Clasts are generally matrix supported, angular to rounded and consist of semi weathered basement lithologies including black siltstone, pale grey laminated felsic vitric tuff/siltstone and amygdaloidal andesite. A single core orientation survey at 331m indicates the bedding is sub horizontal.
- 337.3-798 Cambrian? basement sequence:
- 337.3-360.6 Turbiditic grey siltstone.
- Dominantly thinly bedded to laminated medium to dark grey fine grained siltstone, the paler bands tending to be somewhat "cherty" possibly

including some felsic vitric ash, interlayered with quite subordinate (10%) beds of medium grained, pale grey sandy micaceous wacke. The most substantial sub-unit of wacke occurs at 339.2-339.7m and there are a few others to 120mm thick between 347.3 and 348.5m and near 358.6m; they are distinctly micaceous and contain some pale greenish feldspar grains suggesting a mixed metasedimentary and felsic volcanic provenance. There is abundant facing evidence including flame structures, load casts, cross stratification and grain size grading which consistently indicates the facing to be uphole. The finer grained siltstone is generally well bedded with consistent planar bedding intersecting the core at angles from 50 to 80 deg. to LADC.

Measurements as follows:	343m	70deg.	to LADC
	346	70	"
	347.6	65	"
	350.3	60	"
	352	60	"
	354.4	60	"
	356	55	"
	359	50	"
	359.7	80	"
	360.4	60	"

Oriented core specimens were obtained at 352m and 355m and indicate bedding orientations as follows:

352m :	strike 290 (AMG),	dip 40 south;
355m :	" 280 "	" 45 "

The rock is virtually unmineralised apart from traces of disseminated pyrite (and perhaps chalcopyrite) most notably in the coarser wacke layers and in some of the darker, slightly graphitic, siltstone beds. There are rare narrow veinlets of white calcite at irregular intervals and orientations, generally <1/m of core, but these are not associated with significant sulphide mineralisation.

The lower contact at 360.6m is sharp, planar and conformable to bedding and is marked by a 1cm thick band of mixed felsic volcanic/silty sediment containing about 40% disseminated, blebby pyrite.

360.6-364

## Felsic volcanoclastic wacke.

A crudely stratified medium grained felsic epiclastic sediment composed of crystals of creamy to greenish grey feldspar (1-2mm, 10-30%) and clear grey often euhedral quartz (1-3mm, ~5%) and occasional wispy "fiamme" of pale olive/apple greenish sericitised pumice clasts contained in a medium grained sandy/silty gray matrix of felsic volcanic ash. Pumice clasts increase in the lower 0.5m of the unit and the lower contact is essentially transitional over a few tens of centimetres. Generally not well sorted; the crude but regular stratification is identified by occasional 1cm bands of darker grey crystal rich vitric ash; this banding is parallel to a weak eutaxitic/compaction foliation and to the bedding lamination in the overlying siltstone.

Bedding/banding intersects the core at about 65 deg to LAOC.

An oriented core specimen from 360.9m has allowed the following bedding orientation measurements:

360.5m:	strike	285 (AMB),	dip	35 south;
360.7	"	290	"	35 "
361.1	"	300	"	33 "
361.3	"	290	"	35 "

364 -383.3

## Felsic pumiceous tuff-breccia.

An unsorted and unstratified felsic epiclastic rock composed of prominent apple green coloured wispy clasts (fiamme) of qtz + feldspar phyric sericitised pumice and angular, irregular or subrounded rigid clasts of grey to pinkish grey fine grained glassy rhyolite-dacite supported in a murky pale grey, siliceous ashy matrix. The clast size is rather variable from 2-50mm but averages 10-20mm and they generally constitute about 10-20% of the volume increasing to 20-25% with increasing average clast size towards the base of the unit. This rock probably originated as a partly graded mass flow epiclastic deposit. The wispy fiamme define a crude compaction foliation which intersects the core at about 60 deg. to LAOC. A 12cm thick bed of pale grey vitric tuffaceous siltstone at 381.7m exhibits thin bedding laminations which intersect the core at 60 deg. to LAOC. The lower contact is fairly sharp and conformable with bedding below but does not represent a major compositional change.

383.3-387.9

Mixed felsic volcanoclastic wacke and vitric tuffaceous siltstone.

A generally well stratified epiclastic wacke of essentially felsic volcanic composition and sub-divisible as follows:

- 383.3-384 medium grained pale grey felsic volcanoclastic sandstone; bedding intersects core at 750 deg to LADC.
- 384 -387 dominantly fine grained to almost cherty thinly laminated grey to dark grey tuffaceous siltstone with thin laminae and occasional beds upto 10cm thick of sandier volcanoclastic material; a few wispy qtz + feldspar pumice clasts between 384-384.5m. Bedding planes intersect core at 40-50 deg to LADC.
- 387 -387.9 sandy felsic wacke consisting of feldspar and quartz crystals and small, often flattened, lithic fragments to 10mm in a pale grey vitric/siliceous matrix with weak planar eutaxitic/compaction foliation intersecting core at 50-60 deg to LADC.

The entire unit contains a trace (<0.3%) of disseminated pyrite and rare traces of brown sphalerite in occasional carbonate veinlets (eg: at 386m) but is not significantly mineralised or hydrothermally altered.

The lower contact is very sharp but broken and associated with a centimetre or two of grey clayey pug suggesting a minor fault contact; the 1m above the contact contains a few short zones of moderately intense fracture cleavage.

387.9-400.1

Black siltstone.

A fine grained dark grey to black siltstone, locally rather massive but generally with fine pale grey silty laminae defining the bedding planes. The orientation of bedding is slightly

variable :	388.2m	:	80 deg to LADC
	390.4		55 "
	393		60 "
	395.2		70 "
	398.7		55 "
	399.6		subparallel to LADC

(indicating minor slumping near the contact)

The unit is generally not significantly mineralised but there are occasional thin trains of pyrite crystals and framboids upto 20mm, usually subparallel to bedding.

400.1-529

Feldspar phyric Andesite.

Generally: a feldspar phyric extrusive andesite composed of moderately abundant (~10%) stumpy tabular phenocrysts of plagioclase scattered throughout a pale green/blue grey fine granular/glassy matrix. The rock is variably massive, amygdaloidal, weakly flow structured or brecciated and can be crudely texturally subdivided as follows:

- 400.1-410 "Pepperitic" andesitic breccia; with irregular andesite clasts partly matrix supported in a dark grey cherty siliceous base.
- 410 -432 Andesitic autobreccia?; small to medium (upto 100mm) fragments of andesite (40-50% vol.) in a slightly paler andesitic matrix. A 50mm wide fracture vein at 416.2m contains coarse crystalline pale brown sphalerite and minor chalcopyrite; there are occasional disseminated specks of pyrite (<0.2% vol) but the rock is otherwise not significantly mineralised.
- 432 -434.5 Andesitic "pepperitic" hyaloclastite? breccia; angular to irregular fragments of andesite in a dark grey cherty siliceous matrix containing minor (~0.5%) disseminated pyrite, many fragments have paler bleached, perlitically fractured margins.
- 434.5-490 Andesitic autobreccia?: essentially similar to interval 410-432m but containing short intervals of massive coherent, somewhat amygdaloidal andesite. Prominent amygdales first appear at about 448m, generally constitute about 2-5% of vol. and consist of two types:
- \* small, <3mm, semi flattened or teardrop shaped amygdales filled with dark chlorite?; sometimes defining a weak flow fabric.
  - \* larger, 2-10mm, rounded and

often semi spherical amygdales filled with white carbonate. There are sporadic, locally to 2-5% of vol., brittle fracture veins filled with white and straw coloured carbonate; one of these at 437.8m contains coarse slugs of galena and minor chalcopyrite but the veins otherwise do not contain significant sulphides.

490 -529 Massive/pillowed Andesite: feldspar phyrlic and amygdaloidal as above but tending to be of massive coherent or pillowed lavas; pillows identified by patchy light and dark colouration, zones of weak flow fabric, bleached selvages, and (especially from 493-499m) some characteristic swirly patches of dark cherty interpillow material with traces (<1%) of pyrite.

Patchily developed jigsaw breccia with massive vuggy carbonate infill occurs locally but is devoid of sulphide mineralisation. Carbonate veining and breccia fill increases rather sharply below 505m and in the interval 505-605m probably averages around 2% of volume although quite erratically developed; some individual veins are upto 300mm thick. Feldspars remain clearly outlined and apparently fairly unaltered. The matrix component of autobrecciated sections is typically bleached? a shade paler than the fragments perhaps indicating some low grade diagenetic? alteration but this is not associated with significant pyrite mineralisation.

529 -616.8

Aphyric amygdaloidal Andesite.

529m marks a fairly abrupt change to aphyric andesite but otherwise of similar colouration and amygdale type to that of the unit above. The andesite is generally pale green/blue grey with fine "granular" (devitrified glassy?) matrix with carbonate and chlorite? amygdales (locally abundant, variable from 1-30% vol) sometimes defining a weak flow fabric. The rock appears to be a pillowed lava with pale, massive blocks and pillows, tending to be highly amygdaloidal near the margins, separated by short zones of darker "chloritic" green grey glassy? partly auto or hyaloclastically brecciated lava.

As above, there is fairly abundant white carbonate in veins and breccia infill but it is not associated with significant sulphide. Carbonate content diminishes to ~1% vol below 605m.

616.8-674.2 Feldspar phyric Andesite.

616.8m marks another abrupt change back to feldspar phyric amygdaloidal andesite megascopically similar to that above 529m. Stumpy tabular euhedral phenocrysts of grey fresh looking feldspar (~2mm, ~5% vol) small rounded / elliptical dark chlorite? filled amygdales (~5% vol) and sparser, larger white carbonate filled amygdales occur in a fine grained or glassy pale green grey matrix. The contact at 616.8m is sharp and associated with a 10cm thick deformed bed? of sandy andesitic wacke. This is underlain, down to about 632m, by an andesitic lava breccia, probably of hyaloclastic origin, in which small to medium sized (<150mm) often subrounded, elliptical and flattened fragments of not very rigid looking amygdaloidal andesite are closely crowded with a sparse interstitial, angular/shardy medium grained granular matrix. Below 632m the rock is alternately of coherent-massive andesite and brecciated character with sections upto a couple of metres thick representing either thin flows or large blocks and pillows separated by more or less fragmental hyaloclastic? andesitic breccias as above.

White carbonate veins and breccia infilling are present in patches, locally to 10% of vol. and averaging perhaps 1% of vol., but are not associated with significant sulphide mineralisation.

674.2-676.3 Andesitic volcanoclastic wacke.

This is a uniformly greenish grey coloured, medium to coarse grained, crudely stratified sediment of essentially intermediate volcanic derivation. The coarser "beds" of upto 20cm thickness are composed of andesitic lithic grains to about 5mm grainsize and occasional clasts of 10-40mm diameter. The rather indistinct bedding appears to be planar and intersects the core at about 60 deg. to LAOC.

676.3-752.6

## Andesitic breccia.

This is a consistently medium to coarse fragmental unit composed dominantly of aphyric amygdaloidal andesite.

The upper part, above about 680m, has a mass flow epiclastic character with small to medium sized (upto 50mm) angular, irregular or subrounded clasts of mixed pale and dark, mostly aphyric andesite, comprising about 50% of the rock volume, supported in a matrix of fine granular and/or murky de-vitrified andesitic detritus.

Below 680m the rock has the appearance of an andesitic lava breccia with rather abundant fragments and blocks of pale, aphyric, amygdaloidal andesite (2-30cm, av:10-15% vol.) in a breccia base composed of finer, rather angular fragments of dark greenish grey amygdaloidal andesite (5-30mm, ~60% vol.) separated by a rather sparse interstitial matrix of pale, murky devitrified? andesitic glassy material and/or white carbonate. The angular form of the dark fragments and the tendency to a jigsaw fit pattern in places, is suggestive of an origin as auto-brecciated lava (with, perhaps, local superimposition of hydraulic brecciation and carbonate infill) rather than mass flow epiclastic deposition.

The lower part of the unit, below 745m, is essentially a fairly indeterminate transitional zone between the andesitic breccia above and the rather more coherent andesite below.

White carbonate veining is common throughout the unit, and locally intense; a zone of carbonate + quartz veins of upto 20cm thick in the interval 696-700m is associated with strong marginal to semi-pervasive pale buff coloured bleaching of the host rock which is, however, devoid of significant sulphide mineralization. Elsewhere the andesite appears to be relatively unaltered and unmineralized.

752.6-798

## Aphyric (weakly amygdaloidal) Andesite

This rock unit has a more uniform pale greenish grey colouration and consists dominantly of fairly massive coherent andesite lava or lava pillows but nevertheless includes numerous short

sections of medium grained fragmental hyaloclastic and/or auto-brecciated andesite.

The coherent andesite is pale greenish grey, aphyric and containing fairly sparsely distributed (generally <1-2% vol.), often semi aligned amygdales of the familiar two types:

- i) small, elliptical, dark chlorite-pumpellyite? filled amygdales and:
- ii) larger, rounded amygdales of white carbonate sometimes stained reddish by minor hematite. Hematite is also present as a minor constituent of the carbonate matrix in some breccia zones.

The interval 768.7-770m is of hyaloclastite breccia consisting of small splintery/angular fragments of aphyric andesite matrix supported in a base of pale grey murky siliceous or carbonate rich material.

Below about 776m short sections or blocks of coherent andesite are interspersed with zones of fragmental character giving the impression of a partly pillowed, partly auto/hyaloclastically brecciated flow unit.

The andesite in this unit generally appears to be fresh and unaltered, without significant sulphide mineralisation apart from occasional specks and vesicle filling slugs of pyrite.

798.0

End of Hole.

PART 2

EXPLORATION PROGRESS REPORT EL 14/85 - MT CATTLEY  
January, 1991

## OUTOKUMPU EXPLORATION AUSTRALIA PTY LIMITED

Report No: R41.18  
File No: 2.41.9  
Filename: 241WH101.RT1

EXPLORATION PROGRESS REPORT  
EL 14/85 - MT CATTLEY  
January, 1991

For: Outokumpu Exploration Australia Pty Limited  
77 Pacific Highway, NORTH SYDNEY NSW 2060

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

Date: 21 January 1991

DISTRIBUTION:

1. OEA library
2. Pancon
3. W.Herrmann

## TABLE OF CONTENTS

	Page
1. Summary	4
2. Introduction	5
3. Tenure	5
4. MCDDs 4 and 5: Geochemical Results	5
5. Stratigraphic Drilling	7
5.1 Drilling Results	
5.2 MXRD 1 Drill Core Geochemistry	
5.3 Downhole TEM Survey	
6. Lithostratigraphic and Structural Interpretation	10
7. Discussion of Possibilities for Further Exploration	15
8. References	21

## LIST OF FIGURES

	Scale
Figure 1: EL 14/85 Location Map	1:50,000
Figure 2: EL 14/85 Regional Geological Interpretation	1:25,000
Figure 3: Section A - A <sub>1</sub> Geological Interpretation	1:5000
Figure 4: Section B - B <sub>1</sub> Geological Interpretation	1:5000
Figure 5: Section C - C <sub>1</sub> Geological Interpretation	1:5000
Figure 6: Section D - D <sub>1</sub> Geological Interpretation	1:5000
Figure 7: Section E - E <sub>1</sub> Geological Interpretation	1:5000
Figure 8: Section F - F <sub>1</sub> Geological Interpretation	1:5000
Figure 9: EL 14/85 TEM Coverage & Depth of Tertiary Basalt Colver	1:25,000

## LIST OF APPENDICES

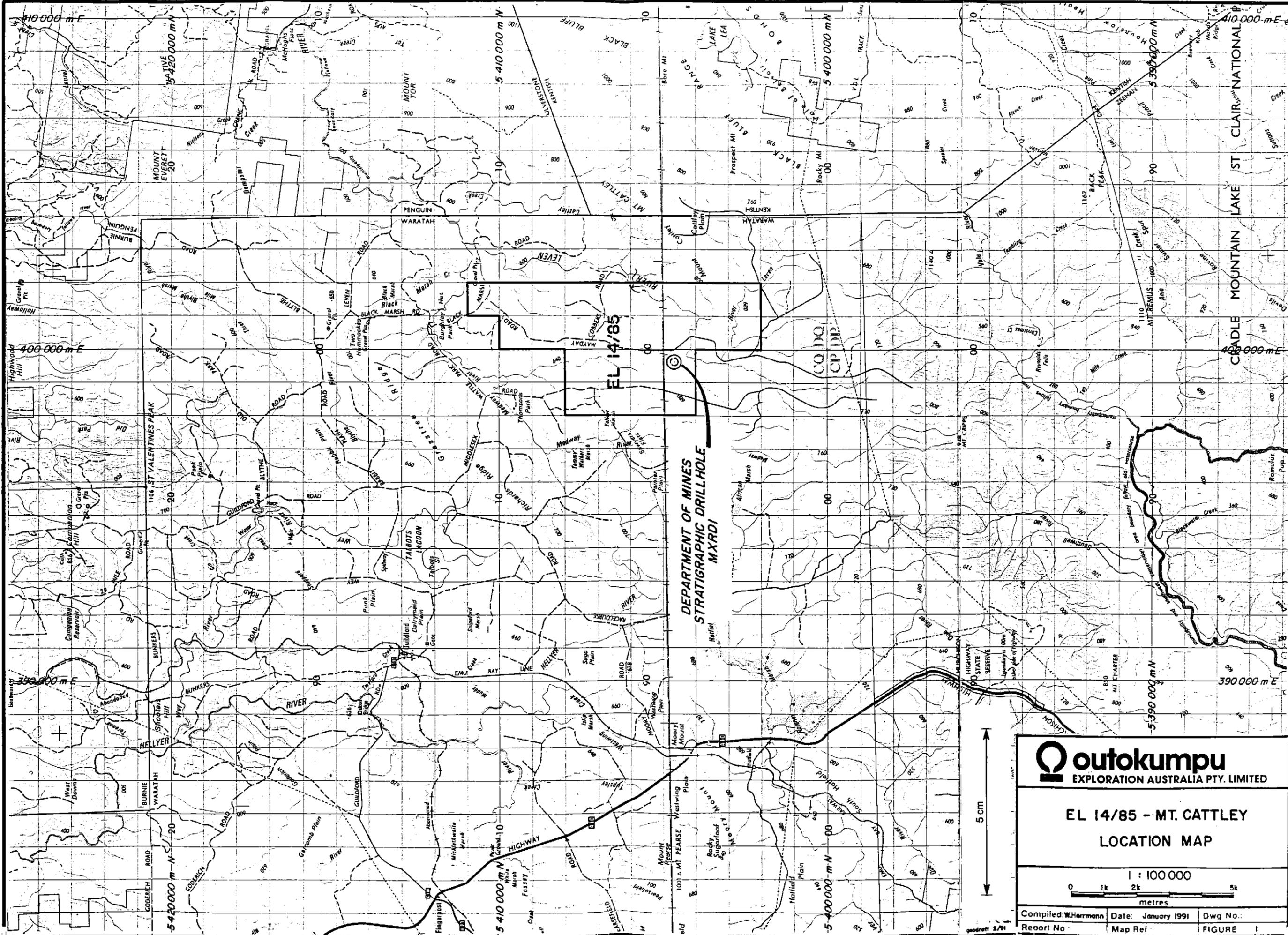
- Appendix I: Summary Drill Records and Assay Data  
MCDDs 4 and 5
- Appendix II: Summary Drill Record and Geological Core Log  
MXRD 1
- Appendix III-a: List of Analytical Sample Numbers for MXRD 1  
III-b: MXRD 1 Analytical Data (ANALABS: 999.66.08.7388)  
III-c: Analytical Standard
- Appendix IV: A.J. Crawford, 1990; Report on Geochemistry  
and Implications of Lavas in Dept of Mines  
Drillhole MXRD-1 on Outokumpu EL 14/85, Mt Cattley
- Appendix V: Dr J.R. Bishop, 1990; Interpretation of DHEM  
Survey, DDH MRB1 (MXRD 1), Mt Cattley (E.L. 14/85)
- Appendix VI: S. Collins, 1990; Mt. Cattley Geophysical Review
- Appendix VII: Summary Geological Drill Logs: SBDPs 10, 14, & 15

## 1. SUMMARY

A recent stratigraphic drilling program undertaken by the Tasmanian Division of Mines and Mineral Resources has substantially contributed to litho-stratigraphic and structural interpretation of the largely Tertiary basalt covered Cambrian ? sequences of the Mt. Cattley area.

It can now be confidently interpreted that the andesitic-basaltic volcanics of the southwestern part of EL 14/85 are correlates of the Que-Hellyer Volcanics which are known to host two significant massive sulphide deposits. The correlates of the Que-Hellyer Volcanics are considered to have empirically high prospectivity for volcanogenic massive sulphide deposits. In EL 14/85 they appear to be restricted to about 4km of strike length and are entirely covered by Tertiary basalt estimated to range from sixty to two hundred metres in thickness. Possibilities for further exploration of this zone utilizing geophysical, stratigraphic drilling and litho-geochemical methods are discussed in this report.

It is postulated that the dominantly felsic volcanic sequences underlying the northwestern and southeastern parts of the licence are correlates of the upper part of the Central Volcanic Complex (of the Mt. Read Volcanics) similar to those of the Mt. Block- Tullabardine area. These rocks are considered to have lowish- moderate prospectivity principally in relation to the presence of weakly lead-zinc anomalous minor black shale units. These represent a lower priority target which could be further investigated by extension of TEM coverage, perhaps with the GEFINEX system which has previously been proved to be an effective black shale detector in this environment.



**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

**EL 14/85 - MT. CATTLEY**  
LOCATION MAP

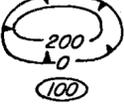
1 : 100 000

0 1k 2k 5k metres

Compiled: W.Hermann Date: January 1991 Dwg. No.:  
Report No. Map Ref. FIGURE 1

geodrett 2/91

### LEGEND



Edge of Tertiary Basalt cover also showing 200m thickness contour for Tertiary Basalt/Sediment cover

Spot thickness of Tertiary Basalt/Sediment cover (in metres) estimated from T.E.M. geophysical soundings

Grid baseline

Gridline surveyed by EM-37

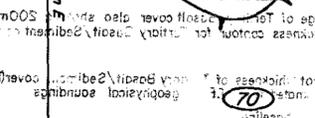
Gridline surveyed by GEFINEX 400-S EM

Areas of good coupling for EM-37 survey (interpretation by S.Collins, 1990)



Drillhole location and identification vertical thickness of Tertiary cover (in metres)

### LEGEND



Edge of Tertiary Basalt cover also showing 200m thickness contour for Tertiary Basalt/Sediment cover

Spot thickness of Tertiary Basalt/Sediment cover (in metres) estimated from T.E.M. geophysical soundings

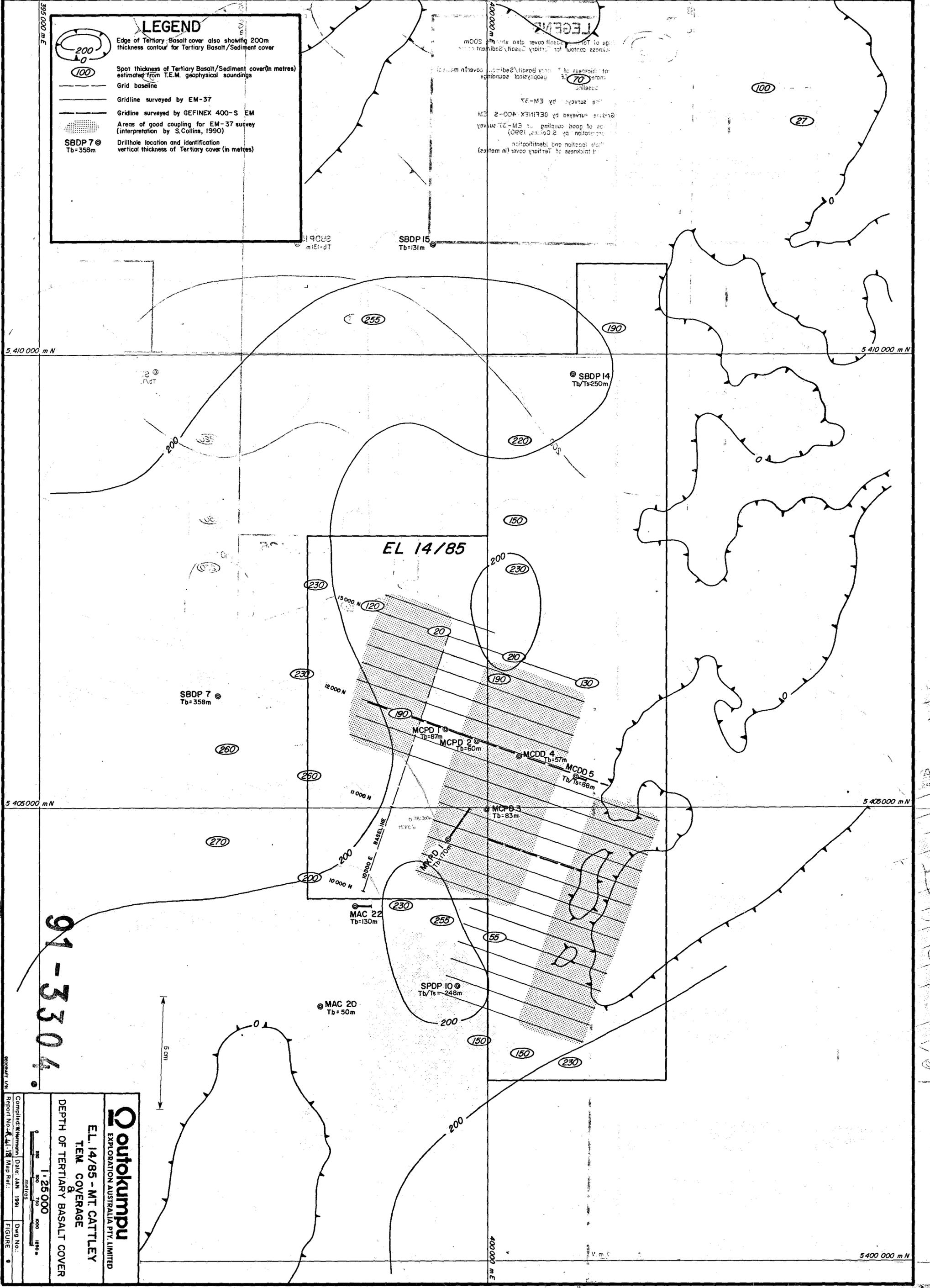
Grid baseline

Gridline surveyed by EM-37

Gridline surveyed by GEFINEX 400-S EM

Areas of good coupling for EM-37 survey (interpretation by S.Collins, 1990)

Drillhole location and identification vertical thickness of Tertiary cover (in metres)



EL 14/85

SBDP 7  
Tb=358m

SBDP 14  
Tb/Ts=250m

SBDP 15  
Tb=131m

MAC 20  
Tb=50m

MAC 22  
Tb=130m

SPDP 10  
Tb/Ts=248m

MCPD 1  
Tb=70m

MCPD 2  
Tb=60m

MCPD 3  
Tb=83m

MCPD 4  
Tb=57m

MCPD 5  
Tb/Ts=88m

91-3304



**outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
TEM COVERAGE  
DEPTH OF TERTIARY BASALT COVER

1:25000

0 500 1000 1500 metres

Compiled: Whiteman, Date: JAN 1991  
Report No.: EL 14/85 Map Ref.: FIGURE 9

## 2. INTRODUCTION

Exploration Licence 14/85 covers an area of approximately 25 sq. km. in the Mt. Cattley - Surrey Hills district of northwestern Tasmania and is being explored for volcanogenic base metal sulphide deposits by Outokumpu Exploration Australia P/L in joint venture with Pancontinental Mining Ltd. (PanFin).

This report represents a compilation and discussion of the results of geological investigations carried out in the area since the last comprehensive report of June, 1989; (Herrmann, 1989b).

That previous exploration report discussed the results of sub-basalt exploration and structural interpretations upto and including the diamond drill testing, per drillholes MCDD 4 and MCDD 5, of two GEFINEX EM anomalies which were subsequently attributed to formational conductors.

Since then, major improvements in the sub basalt structural and litho-stratigraphic interpretation have been enabled by stratigraphic drilling carried out by the Tasmanian Division of Mines and Mineral Resources. The major part of this report is concerned with these results and their implications for possible further exploration in the area.

Also presented are, previously unreported, geochemical analyses of split core from representative sections of MCDDs 4 and 5.

## 3. TENURE

EL 14/85, originally granted for an area of about 47 sq km, was reduced in 1990 to an area of 25 sq km.

The licence expiry date is August 20, 1991.

## 4. MCDDs 4 and 5 : GEOCHEMICAL RESULTS

Although megascopic logging of core from drill holes MCDD 4 and 5 had indicated a virtual absence of sulphide mineralization in the former and mainly weak vein style mineralization in the latter, limited geochemical analyses were carried out as a routine check.

A total of 45 samples of 1/2 sawn core were analysed. These were mostly of one metre lengths spaced at intervals of about ten metres downhole, with slight adjustments in some cases to ensure that the sampled metres did not cross lithological boundaries. In this way, "representative" samples of all major lithotypes were obtained at fairly regular intervals down the holes.

135029

The samples were analysed by ANALABS, of Burnie, for the following elements:

Cu, Pb, Zn, Ag	by method 101	(AAS)
Ba	by method 401	(XRF)
Au	By method 309	(30g Fusion/AAS)

The sample numbers, depth intervals and analytical results are tabulated in the "Summary Drill Records" for MCDDs 4 and 5, included here as Appendix I.

The 25 samples from MCDD 4 indicate that gold and silver are consistently below detection limits and base metals are generally at low background levels with most lead and zinc values below 200ppm and peaking at 205ppm and 670ppm respectively.

These results tend to confirm the essentially unmineralized nature of the ~120m thick sequence of turbiditic micaceous greywacke/siltstone and interbedded felsic pumiceous tuffs, breccias and epiclastic sediments intersected by MCDD 4.

In MCDD 5 that part of the sequence intersected above 210m depth shows rather more geochemical character with lead and zinc values ranging upto 0.82% and 2.8% respectively.

The group of 14 one metre length samples of (unoxidised) core between 115m and 203m (excluding the sample from 196.6-196.7m) have mean lead and zinc values of 870ppm and 1180ppm respectively but with copper levels remaining below 100ppm and gold and silver below detection limits. This relatively high background level of lead and zinc appears to be attributable to the widespread but minor vein style mineralization reported in the core logs which has been interpreted (Herrmann, 1989a) to be of late or post tectonic, possibly Devonian, origin.

The Zinc Ratios [ $100\text{Zn}/(\text{Zn}+\text{Pb})$ ] of these 14 samples range from 3 to 88 with a mean value of 73 and standard deviation of 22. Although this mean is within the characteristic range for volcanogenic massive sulphides (Large and Huston, 1986) the standard deviation is rather high suggesting that in this case the Zinc Ratio data is equivocal or perhaps reflecting the small sample population.

Sample Number A104539 from the interval 196.6-196.7m is exceptional in that it contains about 0.2% Cu, 0.25% Pb, 2.8% Zn, 11g/t Ag and a trace of gold at 0.03g/t. This is from a "band" of black cherty mudstone containing upto 20% pyrite and lesser sphalerite, galena and chalcopyrite which is one of three narrow bands of semi massive sulphides occurring within cherty vitric tuff between 189m and 197m. The crudely layered, possibly bedding concordant, nature of the sulphides and the high zinc to lead ratio suggests a possible syngenetic origin for this mineralization.

## 5. STRATIGRAPHIC DRILLING

During August 1989, the Tasmanian Division of Mines and Mineral Resources (DMMR) proposed a programme of further sub basalt stratigraphic drilling to elucidate the structural and litho-stratigraphic interpretation and exploration significance of andesitic volcanics previously intersected in PanFin's drill holes MCPD 1, 2 & 3 between Beecroft and Middlesex Roads. Petrographic and geochemical studies of these rocks by Dr. A.J. Crawford (summarized in: Herrmann, 1989b) had indicated a likely correlation with the footwall andesites of the Que-Hellyer Volcanics although the structural/stratigraphic interpretation favoured at that time suggested that they could represent a younger phase of andesitic vulcanism at a higher stratigraphic level within the Southwell Subgroup.

In consideration of the exploration value of the proposed stratigraphic drilling it was agreed between the DMMR and PanFin that the latter would arrange and provide:

- \* geological input into the planning of the drilling,
- \* PVC casing,
- \* downhole TEM logging,
- \* side grind sampling and assaying of drill core,
- \* geochemical assay data to the DMMR to be treated as Open File Data.

The drilling, to be carried out by the Drilling Section of the DMMR, was planned to proceed in two stages:

1. Drilling of a short "orientation" hole near MCPD 1 in order to obtain oriented core from which to determine the direction of dip in bedded greywacke, previously intersected in MCPD 1 and considered to underlie the andesite.
2. Drilling of a second "stratigraphic" hole to achieve maximum intersection of the prospective andesite sequence at a location determined according to the results from the orientation hole. (Two possible hole locations had been suggested by Herrmann, 1989b, but determination of the direction of bedding dip at MCPD 1 was a critical factor in choice of alternative.)

### 5.1 Drilling Results

The first stage orientation hole was drilled in August-September of 1989. It was collared about 40m east of MCPD 1, inclined at about 70 degrees to the west and drilled to a depth of 138.2m. The hole passed through the base of Tertiary basalt at about 88m and then intersected a sequence of (weathered) vesicular andesite, felsic fragmental mass flow/tuff and bedded greywacke siltstone identical to that of MCPD 1. Core orientation measurements (enabled with gear generously lent by A. McNeill of Aberfoyle Exploration P/L) indicated that the bedding in the greywacke was upright and dipped at about 35-40 degrees to the

030

south east, (J.Pemberton, pers. comm.). This finding supported the structural interpretation of a probably south plunging synclinal axis between MCPD 1 and MCDD 4 as previously speculated in Figure 2 of Herrmann, 1989b.

Accordingly, the DMMR desgned the stratigraphic hole to be collared about 1200m south of MCPD 1, to be drilled with a steep inclination on a north northeasterly azimuth to intersect the sequence close to the axis of the interpreted syncline. Due to various delays on drilling rig and crew availability this hole, designated MXRD 1, was not commenced until March 1990 at which time it was precollared by percussion drill to a depth of 78m. Coring was commenced in late April and terminated at a depth of 750.5m in August 1990.

After passing through the base of Tertiary basalt at 184.6m depth the hole intersected a sequence (downhole) of turbiditic siltstone/greywacke and felsic pumiceous tuff/breccia separated by an intrusive sill? of dolerite, a 50m thick unit of black siltstone/shale, underlain by two major "andesitic" extrusive units of a total thickness of about 250m, in turn underlain by a series of turbiditic greywacke and siltstone intercalated with minor felsic pumiceous tuff and volcanoclastic sediments. Depositional structures in the turbidites indicated that the sequence was younging up the hole and a single core orientation shot at 214.5m (carried out by the writer with downhole tools kindly lent by S.Richardson of Hellyer Mining Ltd.) indicated the approximate orientation of bedding to be: Strike 325 deg. (AMG) and Dip 40 deg. to the southwest.

A geological log and Summary Drill Record of MXRD 1 is included here as Appendix II.

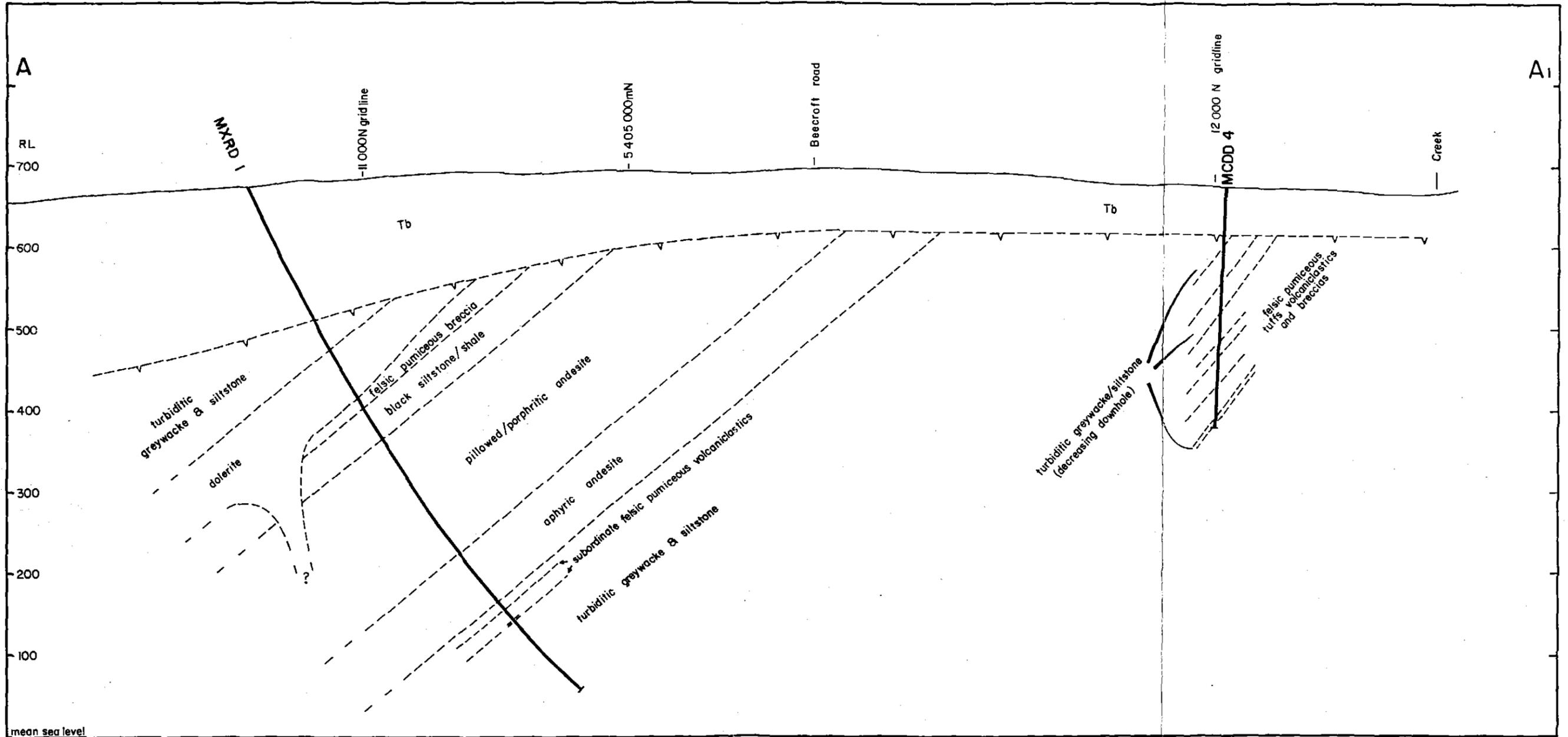
Interpreted geological long, oblique and cross sections are presented as Figures 3,4 and 5.

The location of MXRD 1 and sub Tertiary basalt traces of the major basement units (interpreted from the sections and other drilling data) are shown in plan on Figure 2.

The sequence intersected by MXRD 1 bears considerable lithological and sequential similarities to that of the Que-Hellyer area and it was apparent by the time the hole had reached 400m depth that a direct litho-stratigraphic correlation was likely. This has been strongly supported by Dr.Crawford's interpretation of the MXRD 1 geochemical data (Crawford, 1990; included here as Appendix IV) and there now seems to be consensus amongst geologists familiar with the results that this is the case.

## 5.2 MXRD 1 Drill Core Geochemistry

The entire sub Tertiary basalt section of the MXRD 1 core, below 184.6m, was side grind filleted with sampling runs keyed to lithological boundaries but otherwise of 10m lengths.



91-3304.

5 cm

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

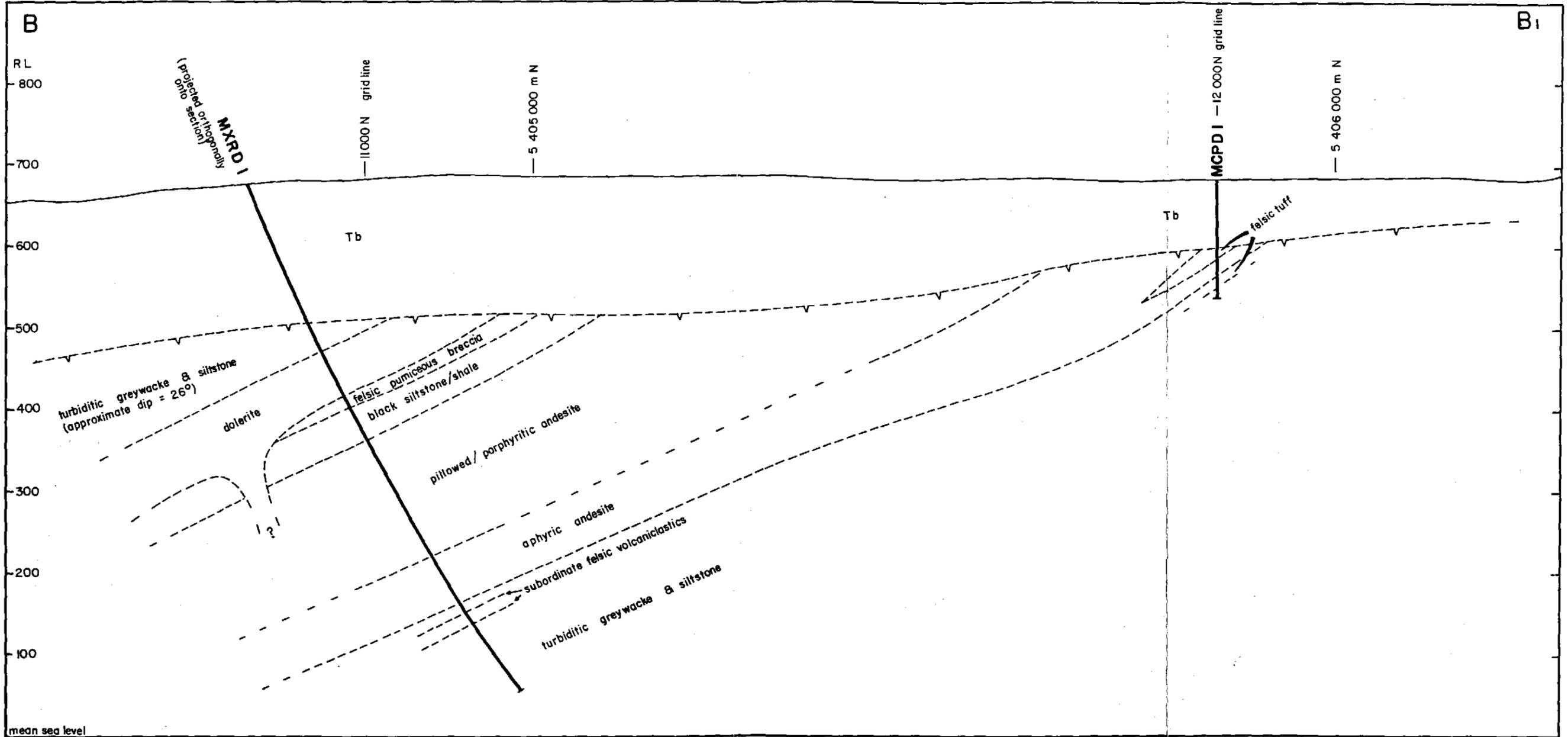
EL 14/85 - MT. CATTLEY  
SECTION A - A1  
GEOLOGICAL INTERPRETATION

1 : 5000  
0 50 100 200 250  
metres

Compiled: W.H. Date: 1/91 Dwg No.:  
Report No.: Map Ref.: FIGURE 3

032

135033



91-3304.

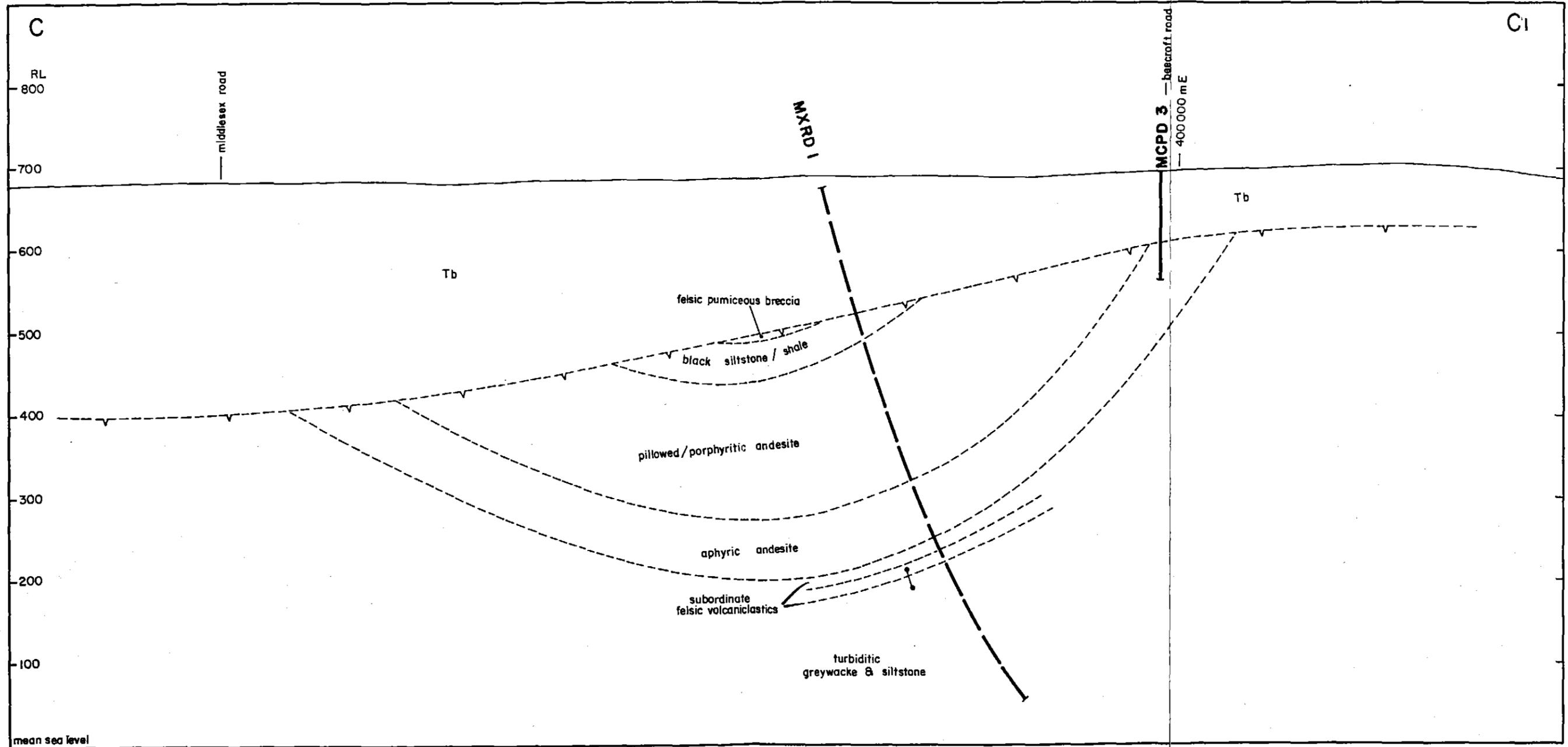
**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
SECTION B - B1  
GEOLOGICAL INTERPRETATION

Scale: 1:5000  
0 50 100 200 250 metres

Compiled: W.H.	Date: 1/92	Dwg No.:
Report No.:	Map Ref.:	FIGURE 4

product 2/91



91-3304.

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

E.L. 14/85 - MT. CATTLEY  
SECTION C - Ci  
GEOLOGICAL INTERPRETATION

1:5000  
0 50 100 200 250  
metres

5 cm

Compiled: W.H.	Date: 1/91	Dwg No.:
Report No.:	Map Ref.:	FIGURE 5

Duplicate samples were taken every tenth sample and three external standard samples (of material provided by Aberfoyle Exploration P/L) were included in the batch. This provided a total of 81 samples for geochemical analysis.

The samples were analysed by ANALABS for the following elements:

Cu, Pb, Zn, Ag, Mn, Fe, Mg, Cr, Ti, Zr, Y, Nb, Ba, Ca, Na, K by Method 201  
(ICP-OES)

Au by Method 309 (30g fusion/AAS)

Included in this report as Appendix III are:

- a) a list of sample numbers and respective depth intervals,
- b) analytical results  
(ANALABS Report No. 999.66.08.07388)
- c) a list of "expected" ranges of values for the Aberfoyle standard sample material.

Although it is apparent that the ICP analytical method produced systematically low Zinc results (see also Appendix III-c) the geochemical data tends to confirm the core log observation that the sequence intersected is relatively unaltered and essentially unmineralized. Gold and silver values are generally at or close to the lower detection limits whilst copper, lead and zinc are generally below 200ppm with the latter two occasionally ranging upto about 500ppm.

The geochemical data was assessed by Dr. A.J. Crawford and his report is included here as Appendix IV. Although finding some disadvantages with the ICP analytical method (such as the suspiciously low Fe, Mg, Cr values and absence of P2O5 and LOI data) Dr. Crawford was able to geochemically subdivide the mafic volcanics (megascopically logged as "andesites" by this writer) into five chemical-stratigraphic units. He considered that the upper four units (2 to 5 of Crawford, 1990) from 360-525.2m depth had geochemical characteristics similar to the Hellyer basalts (which overlie the orebody there) and the lower unit (6) from 530- 597.8m depth was chemically similar to the Que Footwall Andesites of the Que-Hellyer Volcanics and also to the andesites previously cored in MCPD 2.

Overall, Dr. Crawford concluded that the MXRD 1 sequence could be confidently correlated with that of the Que-Hellyer area. These findings are consistent with the conclusions drawn from his earlier petrographic and geochemical studies of andesites intersected in MCPDs 2 and 3, (Crawford, 1989)

It also appears that the turbiditic sediments in the upper part of the hole, considered to be correlates of the Southwell Sub-group, and those of the lower part of the hole, which must be correlates of the Animal Creek Greywacke, can be geochemically distinguished by the high Ti and Fe and low Cr levels of the former.

### 5.3 Downhole TEM Survey

MXRD 1 was cased to the bottom of the hole with 32mm Class 12 PVC pipe to enable downhole TEM logging.

The survey was carried out in November, 1990 by McSkimming Geophysics using a SIROTEM Mk 2 system under the supervision of Dr. J. Bishop of Mitre Geophysics. Dr. Bishop's report on the survey details and interpretation is included here as Appendix V. (That report refers to the DMMR stratigraphic drill hole as MRB1 which was the original name applied by the drilling crew to the core boxes but was later changed to MXRD 1 by geologists in the DMMR.)

Dr. Bishop's interpretation of the TEM data is that no significant responses were recorded in logging the hole. Weak responses were recorded around 180m and 350m depths coinciding with and attributable to unconsolidated sediments near the base of Tertiary basalt and the weakly conductive black shale unit respectively.

These results are consistent with the core log observation of a lack of significant sulphide mineralization or hydrothermal alteration in the hole and results of the previous PanFin surface EM-37 survey which apparently did not detect any responses attributable to sulphide bodies or the black shale unit.

Steve Collins, of Arctan Services in a mid 1990 memorandum to Outokumpu, (Collins, 1990; reproduced here as Appendix VI) has suggested that 100m dipole-dipole IP surveys or late time TEM data, if available, might be useful for mapping the sub basalt trace of the black shale unit. Petrophysical measurements of four samples of the black shale from MXRD 1 (in Appendix V) indicate that the lithotype does have a significant IP effect.

## 6. LITHO-STRATIGRAPHIC AND STRUCTURAL INTERPRETATION

The recent two hole stratigraphic drilling programme undertaken by the DMMR has contributed substantial information to enable improvements in the interpretation of sub Tertiary basalt stratigraphy and structure.

Oriented core samples from the redrill of MCPD 1 and from MXRD 1 support the interpretation of a south southwesterly plunging axis which is aligned with and most likely continuous with that recognized by surface mapping further north at North Cobbers Road and in river exposures near Black Marsh Road. In the latter area the synclinal axis appears to have a shallow northerly plunge.

MXRD 1 has virtually confirmed the correlation between the mafic volcanics there and the Que-Hellyer Volcanics, (QHV). This requires a major revision of the previously accepted interpretation that all of the volcanic rocks and associates of the Mt. Cattley area were correlates of the Southwell Subgroup (SSG) which overlies the Que River Shale (QRS), further south.

In particular, the turbiditic greywackes underlying the QHV correlates in MCPD 1 and MXRD 1 must be regarded as correlates of the Animal Creek Greywackes (ACG) which underlie the QHV in the Que River-Hellyer mine areas. The simplest structural interpretation implies that the sediments exposed at North Cobbers and Black Marsh Road areas are also correlates of the ACG.

The occurrence of felsic pumiceous tuffs, volcanoclastics and jumble breccias intercalated with turbiditic sediments in the ACG correlate at the bottom of MXRD 1 is an identical lithological association with that intersected in MCDD 4 although in the latter case felsic pyro/epi clastics are somewhat more abundant; both sub sequences face to the south west and I reasonably confidently interpret that they are depositionally continuous, as depicted in Figure 3, probably with MCDD 4 lying somewhat stratigraphically lower than the end of MXRD 1.

Further east, the relationship between sequences cored in MCDD 4 and MCDD 5 is more obscure since the holes do not overlap, the critical Leven River section immediately north of the intersection of Cobbers and Upper River Roads is covered by Tertiary basalt and I have not had an opportunity to examine the likely contact zones on the Leven River - Cattley Creek divide or in the river section immediately downstream of their confluence. However, the following points of evidence are available:

- \* the contact between turbiditic greywackes and felsic pyro/epiclastics (units Cdg and Cdt of Pemberton and Vicary, 1988) in the Leven River below its confluence with Cattley Creek appears to be conformable with both units facing west.
- \* the sequence in MCDD 5 faces northwest and could conceivably be on the eastern limb of the major syncline trending through MXRD 1.
- \* exposures in the Leven River basement window near Upper River Road are dominated by felsic, graded coarse to fine, massflow type pyro/epiclastics and thick cherty vitric tuff-siltstone units with some feldspar phyrlic rhyolitic lavas, lava breccias and two types of felsic porphyritic intrusives. The sequence here appears to dip and face west to northwestward and the mass flow and cherty vitric units are lithologically identical to those of MCDD 5. Depositional continuity between the river sequence and MCDD 5 seems most likely.

- \* the smaller basement window in the Leven River just north of Basin Road exposes similar cherty vitric tuff-siltstones at its northern end which are succeeded upstream (southward) by a southeasterly dipping and facing group of felsic pumiceous tuffs, felsic lithicwackes and volcanoclastic sandstone/siltstone in turn succeeded, upstream and up stratigraphy, by (rather strongly cleaved) slaty micaceous siltstone which are intruded ? at the southern end of the window by rhyolitic fine grained quartz porphyry.

On the western side of the major MXRD 1 - Cobbers Road syncline a similar arrangement of lithotypes occurs in:

- \* the Medway River where a south east facing sequence of turbiditic micaceous greywacke/siltstone with intercalated felsic epiclastics and pumiceous breccias is underlain by felsic cherty vitric tuff-siltstones and crystal tuffs.
- \* SBDP 14 where the basement lithotype intersected immediately below the Tertiary basalt/sediment cover is a medium grained micaceous greywacke (249.9-250.8m) which is succeeded down hole by a complex, upward facing sequence dominated by felsic cherty vitric tuff-siltstones, felsic mass flow breccias and a feldspar phyrlic rhyolite extrusive unit. A summary core log of SBDP 14 is included here in Appendix VII. (The 0.9m section of greywacke immediately below the Tertiary cover is succeeded downhole by a 2m zone of puggy and broken core with substantial core loss which raises the possibility that the greywacke represents a large floater lying on the Tertiary erosion surface; I can't discount this but prefer to regard the greywacke segment as representing the very base of the ACG correlate in the core of the syncline and the broken/ puggy zone as an indication of selective Tertiary weathering along the contact or perhaps a faulted contact or minor fault displacement along a depositional contact.)

From these several observations, on both sides of the syncline, it is apparent that turbiditic micaceous greywacke/siltstones with intercalated felsic tuffs, volcanoclastics and pumiceous jumble breccias which can be reasonably correlated with the ACG are consistently underlain by felsic volcanic assemblages dominated by cherty vitric tuff-siltstones, tuffs, mass flow breccias and some feldspar phyrlic rhyolitic extrusives and intrusive porphyries. Representatives of this assemblage occurring in SBDPs 14 and 15 and in the river basement windows have considerable (megascopically recognizable) similarity to the felsic rocks of the Tullabardine area (in Pancontinental's former EL 42/85 - Lake Mackintosh) which have been assigned to the "youngest units of the Central Volcanic Complex" (CVC), (McNeill and Corbett, 1989). On this basis, and their position stratigraphically beneath correlates of the ACG, I propose that the felsic volcanic assemblages of the Mt. Cattley area are also

correlates of the CVC. It may be argued that the similarity of intrusive porphyries in both areas is not evidence of lithostratigraphic correlation, since the intrusives may be younger than the hosts in both area, but the close similarity of the quartz-feldspar-biotite porphyry in SBDP 15 to fragments in rhyolitic breccias in SBDP 14 suggests a co-magmatic relationship.

The indications from the river exposures are that the contact between the upper CVC correlates and the ACG correlates, in the Mt. Cattley area, is essentially conformable. Although somewhat transitional, as indicated by the felsic volcanoclastics and tuffs intercalated with the turbidites, the boundary nevertheless seems to be abrupt in that where they are present, the turbidites seem to be dominant whilst in the underlying felsic volcanics there seems to be a virtual absence of clastic sediments of exotic provenance apart from fairly thin units of black shale as occur in MCDD 5 and SBDP 14. For mapping purposes, I propose that the boundary between ACG and upper CVC correlates occurs at the base of the lowest micaceous greywacke unit.

This re-assignment of the felsic volcanic assemblage of the Mt. Cattley area, from Southwell Subgroup to upper CVC correlates, removes the need to invoke a major fault structure as hypothesised by Crawford (1990) and Herrmann (1990a). The local structure, I now envisage, can be simply accommodated by ACG correlates occupying the core of the fairly open MXRD 1 - Cobbers Road syncline, with underlying upper CVC correlates extending away to the north west towards Two Hummocks (perhaps with an anticlinal hinge in that direction) and to the south east where they are folded in a rather tight anticline with the axis running along the Leven River through the Basin Road and Upper River Road windows. The greywacke/siltstone unit exposed at the eastern end of the former window and near SHELL's drill hole CRD 86-1 is probably continuous and probably represents the lower part of the ACG correlates on the east flank of the Leven anticline. I'm not familiar with the exposures east of this greywacke unit nor the area northwards to Cattley Creek and beyond so the following comments are highly speculative. However, if the aforementioned greywacke/siltstone unit is a lower ACG correlate then there are three possibilities for the strip of apparently mainly felsic volcanics between the greywacke and the east facing (?) volcanoclastic conglomerate Tyndall Group correlates (TGC) and overlying siliciclastic Denison Group correlates (Oc) to the east:

- \* the strip comprises a continuous, east facing and remarkably thinned sequence equivalent to the ACG, QHV, QRS and SSG.
- \* there is a major fault discontinuity with west side up displacement juxtaposing ACG correlate with upper SSG or possibly TGC correlates.
- \* The TGC correlates rest with transgressive unconformity on, perhaps tightly folded, correlates of ACG, SSG and

maybe upper CVC.

Under this structural/stratigraphic interpretation QHV correlates, within EL 14/85, appear to be restricted to the core of the southerly plunging synclinal fold outlined by MCPDs 1,2,3 and MXRD 1; a strike length of about 1s inferred for the sub basalt trace of the QHV.

The western limb of this fold is largely inferred by the southeasterly dip indicated by the single oriented core measurement obtained during the DMMR redrill of MCPD 1. The strike of this western limb is virtually unconstrained except by Aberfoyle's drill holes MAC 20 and MAC 22 which, according to anecdotal information, intersected SSG type felsic pumiceous tuffs and breccias and therefore are probably in a stratigraphic position above the QRS correlate.

Quite recently, (Herrmann, 1990b), I was fairly convinced that the eastern limb of the syncline was fairly well constrained by SBDP 10. This vertical hole drilled through the base of gravels and clays underlying Tertiary basalt at 248m and then intersected a non stratified unit of felsic pumiceous/lithic breccia to 316.3m, passing on into felsic pumiceous tuff interlayered with fine grained cherty vitric tuffaceous siltstone to the bottom of the hole at 321.1m. This sequence is lithologically similar to the units lying between the base of the dolerite and the top of the QRS correlate in MXRD 1 which leads me to suspect that SBDP 10 was terminated only a few metres above the QRS correlate.

However, the SBDP 10 lithotypes are also disconcertingly similar, in a general sense, to the felsic breccias and cherty vitric tuffs which I have postulated are correlates of the upper CVC as typified in SBDP 14. In consideration of the relative proximity of postulated upper CVC correlates, with a southwesterly rather than south south westerly strike trend, in the southern basement windows of the Leven River there is a possibility that SBDP 10 intersected upper CVC correlates. Observations which present relatively weak arguments against this correlation are:

- ADK/KC
- \* the upper CVC ? breccia units in SBDP 14 are relatively thin, mostly under 20m and never exceeding 50m in (downhole) thickness whilst that of SBDP 10 appears to have a minimum true thickness of 50m.
  - \* the pumiceous clasts in the felsic breccia of SBDP 10 are typically prominently quartz and feldspar phyrlic, identical to those of the unit underlying the dolerite in MXRD 1 but rather contrasting with the dominantly feldspar phyrlic pumiceous clasts in breccias of SBDP 14. The distinctive quartz-feldspar-biotite porphyry of SBDP 15, which occur as clasts in breccias of SBDP 14, are not evident in breccias of SBDP 10 and MXRD 1.

Even more alarming is the possibility that the southwestward projection of the sub basalt trace of the Leven anticlinal axis

passes to the north of SBDP 10 which could locate the hole in SSG correlates on the southeastern limb of the anticline. Both of these cases would imply that the MXRD 1 syncline is quite tightly appressed with the trace of the QRS on the eastern limb having a south westerly trend and lying perhaps a kilometre west of SBDP 10.

## 7. DISCUSSION OF POSSIBILITIES FOR FURTHER EXPLORATION

On an empirical litho-stratigraphic basis the correlates of the Que-Hellyer Volcanics (QHV), which have been found to occur under Tertiary basalt cover in the southwestern part of EL 14/85, are considered to have high prospectivity for polymetallic volcanogenic massive sulphide deposits. However, the prospective sequence is covered by Tertiary basalt estimated to range between 60m and 200m in thickness which substantially reduces the findability of any deposits in this area and must discount the subjective prospectivity rating to, perhaps, moderate.

Under the latest regional litho-stratigraphic/structural interpretation postulated in the preceding chapter, substantial parts of the northwestern and southeastern areas of the licence are underlain, again mostly under Tertiary basalt cover, by a felsic volcanic and intrusive assemblage which appears to correlate with the upper part of the Central Volcanic Complex (CVC) as exposed in the Mt. Block-Tullabardine area. These rocks are not known to host economically significant volcanogenic deposits. In the general Mt. Cattley area these possible upper CVC correlates include minor black shale units; for instances: in drill holes MCDD 5, SBDP 14, and CRAE's CN 1 and at Two Hummocks. Such black shale units occurring within dominantly felsic volcanic assemblages could, under the volcanogenic model of ore deposition, be regarded as potentially favourable host horizons for VMS deposits. The subjective prospectivity rating for these rocks could therefore be moderate, with the Tertiary basalt factor reducing this to, perhaps, lowish-moderate.

The interpreted correlates of the Animal Creek Greywacke (ACG), Southwell Subgroup (SSG), Tyndall Group conglomerates (TGC) and siliciclastic Owen Conglomerate (OC and OCU), which appear to underlie the remainder of the licence, elsewhere are not known to contain economically significant volcanogenic deposits and on an empirical basis I estimate a fairly low prospectivity for these stratigraphic units.

Whatever subjective calibration is applied to these empirical prospectivity ratings it seems that, at this stage of exploration, the stratigraphic divisions interpreted for EL 14/85 can be ranked for VMS prospectivity as follows:

highest	-	QHV
		upper CVC
		QRS
		SSG
		ACG
		TGc
lowest	-	Oc

The QHV correlates seem to be restricted to about 4km of strike length, folded about a south southwesterly plunging synclinal axis, in the southwestern corner of EL 14/85 as indicated on Figure 2.

The thickness of Tertiary cover over this zone appears to be in the range 60 to 200m. Most of the eastern limb of QHV correlates has been covered by the 1987 EM-37 survey for which the transmitting loops appear to have been appropriately located for good electromagnetic "coupling" for stratiform conductors; (Collins, 1990; Appendix VI). The extent of EM-37 coverage and zones of good coupling are portrayed on Figure 9. The northern nose of the fold has been covered by a couple of lines of EM-37 but coupling was not good for the western part of the hinge zone; the major part of the western limb, ~2km of strike length, has not been covered by TEM.

The indications to date, from megascopic geological drill core logging and litho-geochemical data, are that those parts of the QHV correlates intersected in MCPDs 1,2,3 and MXRD 1 are not significantly mineralized. However, Crawford (1989) observed that the andesites in MCPD 2 had suffered pervasive sericite + carbonate alteration of considerably greater intensity than is normally associated with regional burial metamorphism as seen in the Mt. Read Volcanics but more typical of alteration around the Que River deposit. No petrographic study of the MXRD 1 intersection has been possible to date.

Possibilities for further exploration of the QHV correlates in EL 14/85 are:

- 1 extend TEM coverage over western limb of syncline and follow up by drilling any conductive targets.
- 11 100m dipole-dipole survey in attempt to map the QRS correlate as suggested by S. Collins, (1990) and follow up by optimized stratigraphic drilling. There are some doubts about the effectiveness of IP through possibly chargeable Tertiary basalt and some doubts about its cost effectiveness in comparison to the more definitive ? technique of blind stratigraphic drilling. EM-37 apparently did not detect a conductive response

attributable to the QRS correlate on the eastern limb and DHEM in MXRD 1 recorded only a weak response from this unit. The 30m thick black shale unit in MCDD 5 similarly gave only a weak response in DHEM survey whereas the original interpretation of the GEFINEX data (Hattula, 1988) indicated the presence of "a highly conductive body". This suggests that GEFINEX may be a very good detector of black shales beneath basalt cover and could be a better substitute for IP in trying S.Collins' mapping concept.

- 111 systematic wide spaced stratigraphic drilling and routine downhole TEM surveying around the postulated fold structure with systematic/co-ordinated detailed litho-geochemical, petrographic and isotopic studies (as distinct from the previous rather ad hoc studies) to identify any stratigraphic or alteration/mineralization trends which might point to VMS deposits. This should, soon, include detailed litho-geochemical, petrographic etc. study of MXRD 1 and review of MCPDs 2 and 3.

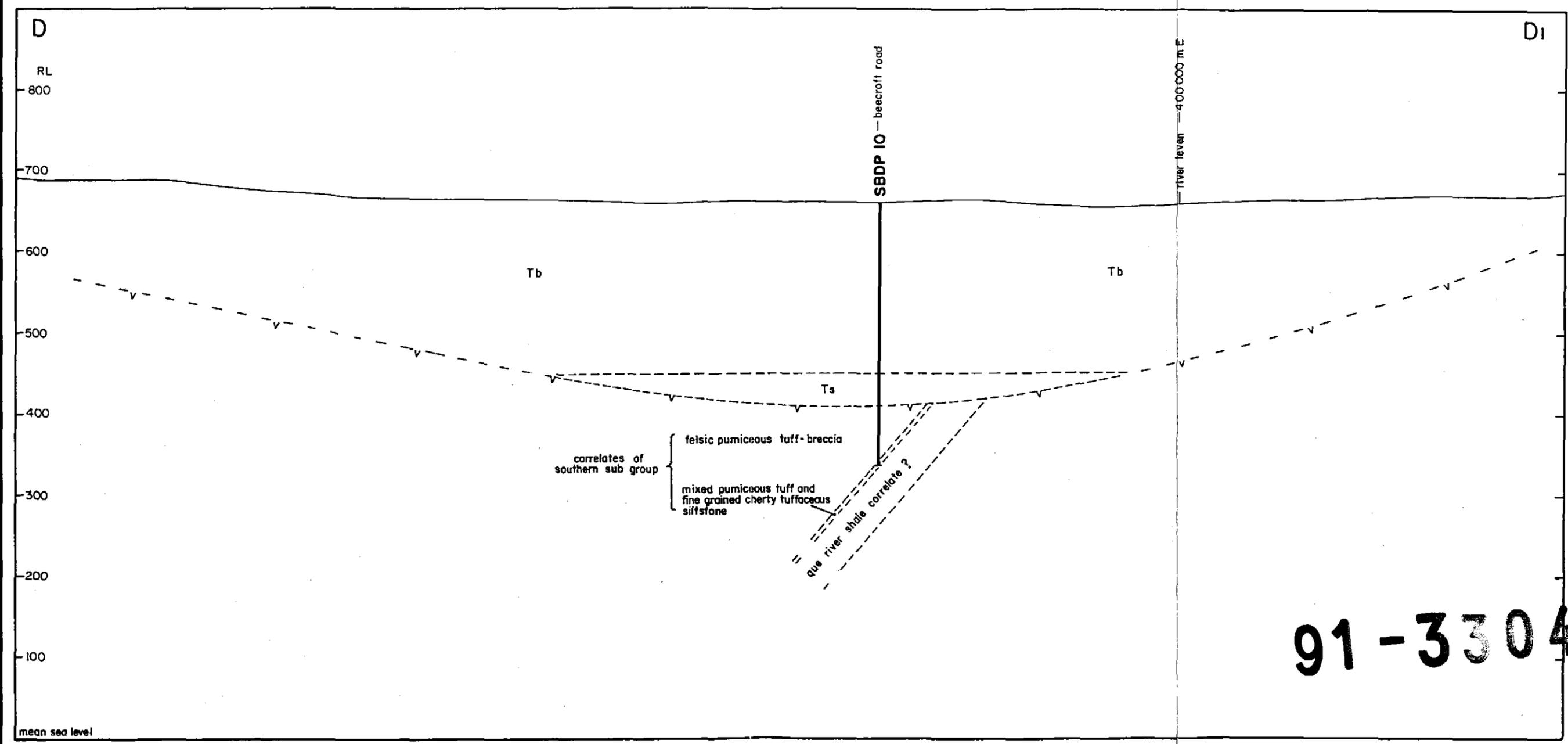
I favour a concurrent or sequential combination of possibilities 1 and 111.

Figures 2 (plan) and 7,8 (sections) show suggested locations for two stratigraphic drill holes, A and B, which I have designed to test the andesitic parts of the sequence approximately one kilometre along strike from MXRD 1, respectively on the eastern and western limbs of the fold.

It is considered that the 1 km spacing is a reasonable starting point for the following reasons:

1. A hypothetical 10 million tonne stratiform VMS deposit could have approximate dimensions of 300m x 300m x 20m thick. I have made a very brief review of descriptions of the alteration zones associated with known Tasmanian deposits of this type and it seems that the peripheral quartz-sericite-pyrite alteration typically extends some 200m laterally from the ore or footwall stringer zone position. A hypothetical diameter for significant footwall alteration could therefore be around 700m. Since most of the Tasmanian deposits seem to be elongated in the strike direction, the alteration zone dimension could be well be greater than 700m along strike.

Dr. Bishop has advised (pers. comm.) that the hypothetical 10 million tonne deposit should be detectable by downhole EM at a radius of upto about 200m from a drill hole if the deposit is of relatively high conductivity similar to Hellyer, and is continuous; ie: substantially in one body. This is consistent with the guesstimate for the radius of alteration zone and it would seem that there is a reasonable chance of snagging the hypothetical deposit with 1 km spaced holes.



91-3304

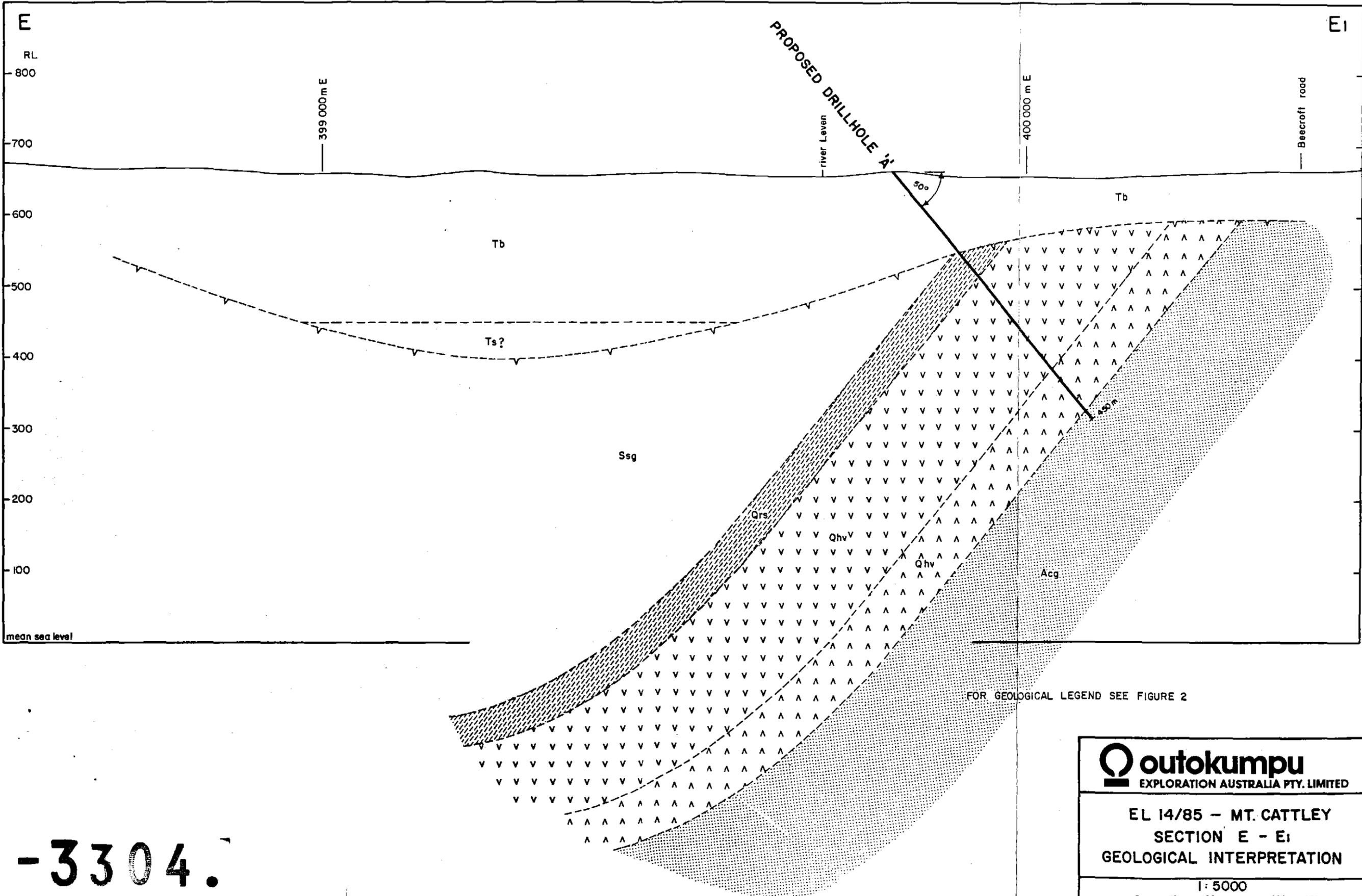
5 cm

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
SECTION D - D1  
GEOLOGICAL INTERPRETATION

1 : 5000  
0 50 100 200 250 metres

Compiled: W.H.	Date: 1/91	Dwg No.:
Report No.:	Map Ref.:	FIGURE 6



FOR GEOLOGICAL LEGEND SEE FIGURE 2

91-3304.

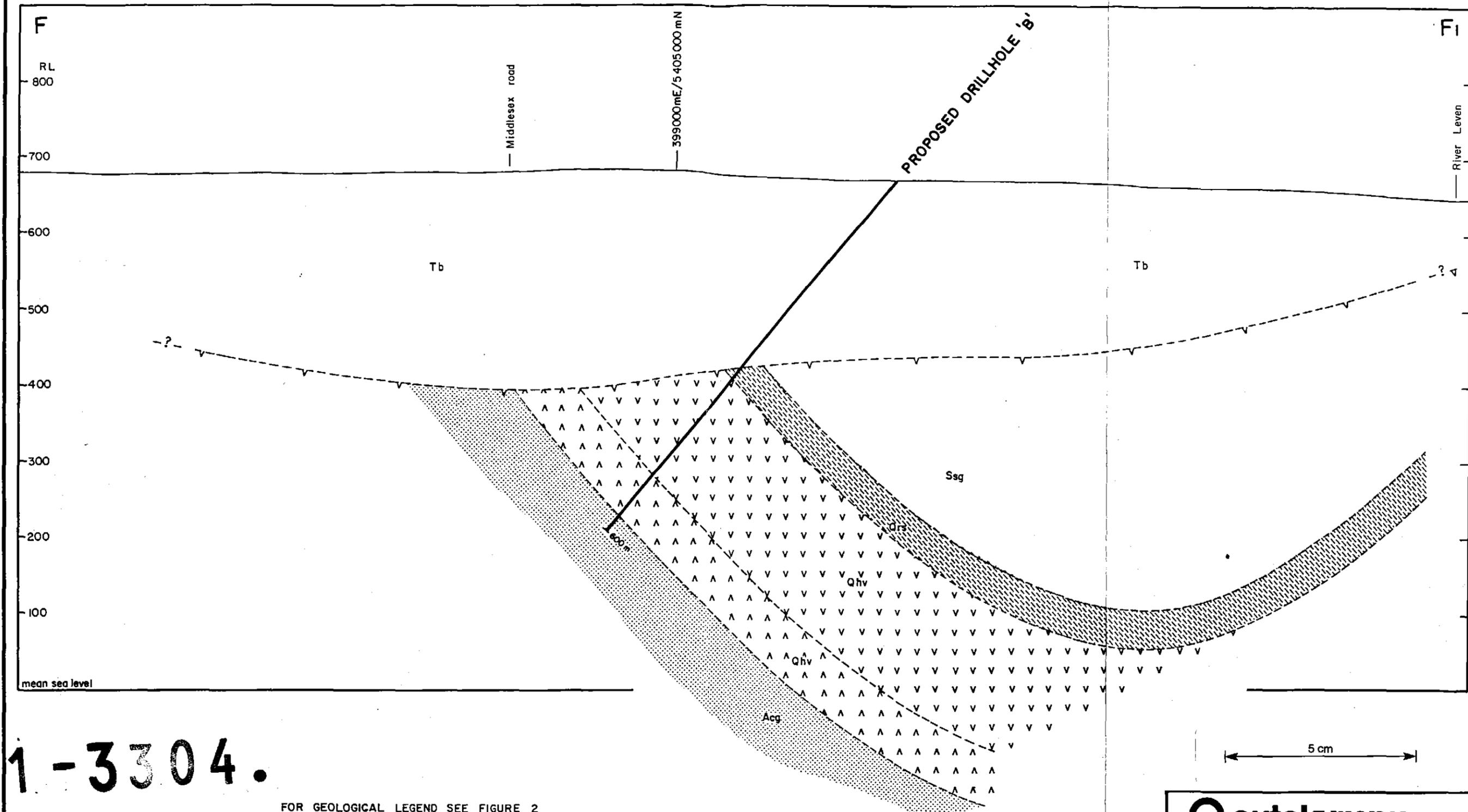
**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
SECTION E - E1  
GEOLOGICAL INTERPRETATION

1: 5000  
0 50 100 200 250  
metres

Compiled: W. Herrmann	Date: JANUARY 1991	Dwg No.:
Report No	Map Ref	FIGURE 7

geodraft 2/91



91-3304.

FOR GEOLOGICAL LEGEND SEE FIGURE 2

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
SECTION F - F1  
GEOLOGICAL INTERPRETATION

1 : 5000

0 50 100 200 250  
metres

Compiled: WHerrmann	Date: JANUARY 1991	Dwg No.:
Report No.:	Map Ref.:	FIGURE 8

geodraft 2/91

2. The target sequence is not known to outcrop and the structural interpretation is based on sparse drilling and oriented core information and the risk of missing the target therefore increases with distance from MXRD 1. This particularly applies to the western limb.

**Hole A** has been designed on the basis that SBDP 10 (1 km to the south) appears to have stopped just above the upper contact of the black shale unit (Figure 6, Section 5403000N) and the assumption that the sequence here strikes a few degrees east of north and dips at about 50 degrees to the west. (Layering and compaction foliation in tuff/sediments at bottom of SBDP 10 intersect core at about 30-50 deg. to LAOC indicating a dip of 40-60 deg. in this vertical hole.)

The optimum collar position on section 5404000N (Figure 7) seems to be about 399810E for a hole of ~450m depth inclined at 50 deg. to the east.

Factors in favour of this hole are:

- \* it should test the "Que-Hellyer" equivalents about 1km along strike from MXRD 1 and MCPD 3.
- \* The hole can be reasonably well targetted due to structural and stratigraphic inferences drawn from SBDP 10 although there some agonizing doubts about the correlation of this hole, as discussed above in Chapter 6.

Factors against:

- \* The Tertiary basalt here appears to be relatively thin and should have been amenable to EM 37 survey; there is some doubt as to whether the survey adequately covered this zone. The transmitter loop immediately to the north would have been well coupled to the basement structure but there are no reported anomalous responses.
- \* The collar of suggested Hole A is on the boundary of the EL.

**Hole B:** The western limb of the syncline is less well defined than the eastern and is largely inferred from the south easterly dip indicated by a single (slightly controversial) oriented core measurement taken in the DMMR re-drill of MCPD 1. The strike of this limb is virtually unconstrained except by the results of Aberfoyle's drill holes Mac 20 and Mac 22 which reputedly (I haven't seen the cores) intersected SSG type felsic pumiceous tuffs and breccias and therefore probably are in a stratigraphic position above the black shale unit.

Factors against drilling of this Hole B are:

- \* The Tertiary basalt appears to be greater than 200m thick.
- \* The structure is less constrained and the hole cannot be precisely targetted.

- \* Both of the above factors influence the depth of the hole and it is apparent that a minimum of 600m depth would be required for a complete intersection of the QHV correlate sequence assuming the thicknesses are equivalent to those in MXRD 1 and the hole was fortuitously collared.

A third possibility for further stratigraphic drilling of the Q-H sequence is to deepen SBDP 10. If my interpretation, diagrammatically portrayed in Figure 6, is correct, this hole terminated within a few metres of the upper contact of the QRS correlate. Deepening of this hole by another 450m might intersect the full sequence of QHV correlates. I took an opportunity to inspect the collar of this hole last November and found that although there is no casing, steel or PVC, at the collar and it has been crudely plugged with a branch from a tree, the hole appears to be open at the collar and the water level was visible about 1 metre below the surface. Although this hole offers some savings in that it is "pre-collared" to 321m, it is not a great bargain because it is a vertical hole which would provide an uneconomical intersection of the sequence dipping at about 50 degrees and would not enable oriented cores to be obtained.

The fact that it lies outside EL 14/85 is a further disincentive.

The interpreted upper CVC correlates of the northwestern and southeastern parts of the licence represent, in my opinion, a lower priority for VMS exploration. The internal stratigraphy is at this stage very poorly known but it seems that the prospectivity is related mainly to the occurrence of black shale units within the dominantly felsic volcanic assemblage.

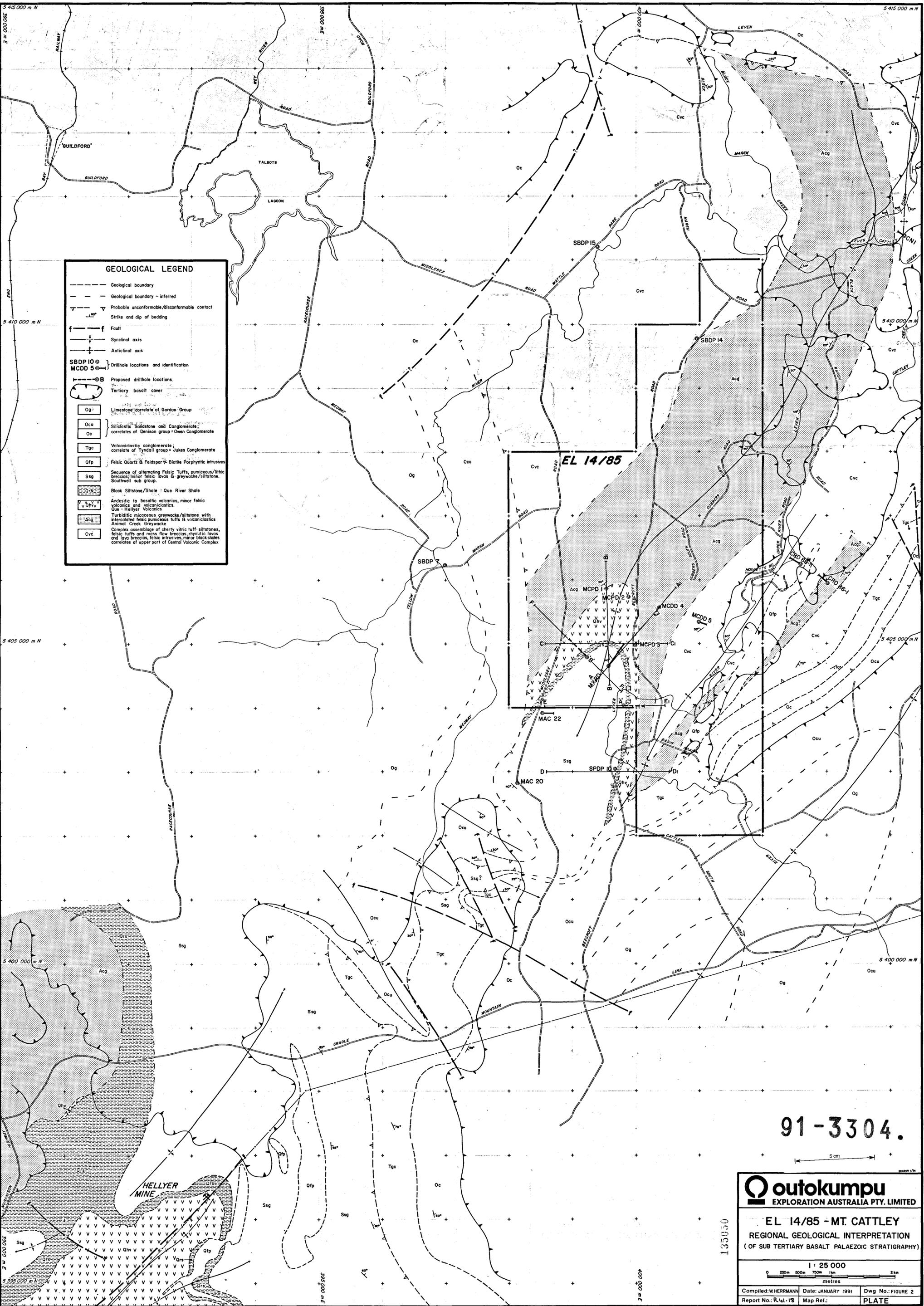
In MCDD 5 black shales and enclosing cherty vitric tuff-siltstones are weakly anomalous in lead and zinc, ranging upto about 1200ppm Pb and 4000ppm Zn. Although the lead-zinc values appear to be largely attributable to observed veinlet style mineralization the Zinc Ratios for the limited data are not entirely inconsistent with those typical of VMS deposits. In this hole a 15cm thick band of black cherty mudstone with upto 20% semi massive pyrite and sphalerite of possibly conformable character and syngenetic origin contains 0.2% Cu, 0.2% Pb, 2.8% Zn and 11g/t Ag.

CRAE's drillhole CN 1, at Cattley North some 2km east of the northeastern corner of EL 14/85, intersected a 7m thick unit of siltstone/shale which averages 390ppm Pb and 1600ppm Zn with VMS type Zinc Ratios although the mineralization has been described as minor sulphides in quartz + carbonate veinlets.

Black shales in the vicinity of a minor barite occurrence at Two Hummocks are also known to be weakly anomalous in lead and zinc. CRAE's percussion drill hole TH 1 intersected a 5m thick black shale unit which averaged 800ppm Pb and 320ppm Zn.

Possibilities for further exploration for VMS type mineralization in the interpreted upper CVC correlate in EL 14/85 could include:

- \* more detailed geochemical analyses of the black shale horizons in MCDD 5 and SBDP 14 with the objective of recognizing any higher base metal grades and attempting to establish the style of mineralization.
- \* extension of systematic TEM coverage in the northwestern and eastern parts of the licence. The upper CVC correlates of the southern part have already been largely covered by EM-37. The northernmost line over this area was 12000 N on which GEFINEX detected a strong conductor which was subsequently tested by MCDD 5 and attributed to the 30m black shale unit. In consideration of this technical success GEFINEX might be the most appropriate geophysical method for any further black shale hosted VMS exploration.



**GEOLOGICAL LEGEND**

- Geological boundary
- - - Geological boundary - inferred
- ▽ Probable unconformable/disconformable contact
- Strike and dip of bedding
- f Fault
- ~ Synclinal axis
- ~ Anticlinal axis
- SBDP 10 @ MCDD 5 @ Drillhole locations and identification
- ⊙ Proposed drillhole locations
- Tertiary basalt cover
- Og Limestone correlate of Gordon Group
- Ocu Siliclastic Sandstone and Conglomerate; correlates of Denison group + Owen Conglomerate
- Tgc Volcaniclastic conglomerate; correlate of Tyndall group + Jules Conglomerate
- Qfp Felsic Quartz & Feldspar ± Biotite Porphyritic intrusives
- Ssg Sequence of alternating Felsic Tuffs, pumiceous/lithic breccias; minor felsic lavas & greywacke/siltstone, Southwell sub group.
- Qrs Black Siltstone/Shale - Que River Shale
- Andesitic to basaltic volcanics, minor felsic volcanics and volcanoclastics; Que - Healyer Volcanics
- Turbiditic micaceous greywacke/siltstone with intercalated felsic pumiceous tuffs & volcanoclastics
- Animal Creek Greywacke
- Cvc Complex assemblage of cherty vitric tuff-siltstones, felsic tuffs and mass flow breccias, rhyolitic lavas and lava breccias, felsic intrusives, minor black shales; correlates of upper part of Central Volcanic Complex

91-3304.

5 cm

**Outokumpu**  
EXPLORATION AUSTRALIA PTY. LIMITED

EL 14/85 - MT. CATTLEY  
REGIONAL GEOLOGICAL INTERPRETATION  
(OF SUB TERTIARY BASALT PALAEOZOIC STRATIGRAPHY)

1:25 000  
0 250m 500m 750m 1km 2km  
metres

Compiled: WHERMANN Date: JANUARY 1991 Dwg No.: FIGURE 2  
Report No.: R.41.13 Map Ref.: PLATE

135050

400 000 m E

135051

## 8. REFERENCES

- Bishop, J.R. 1990 Interpretation of DHEN survey, DDH MRB 1, Mt. Cattley EL 14/85. (Consultant's Report to Outokumpu)
- Collins, S. 1990 Review of Mt. Cattley Geophysical Data. (Consultant's Memo to Outokumpu)
- Crawford, A.J. 1989 Geochemistry and correlation of lavas in Mt. Cattley drill holes MCPD 2 and 3, EL 14/85. (Consultant's report to Outokumpu)
- Crawford, A.J. 1990 Report on geochemistry and implications of the lavas in drillhole MXRD 1, EL 14/85. (Consultant's report to Outokumpu)
- Hattula, A. 1988 Multifrequency EM Soundings in the Mt. Cattley area, Tasmania. Outokumpu Oy Nordic Exploration
- Herrmann, W. 1989a Report on drill testing of two GEFNEX-EM anomalies at Mt. Cattley, EL 14/85 - Tasmania. Outokumpu Exploration Aust. P/L.
- Herrmann, W. 1989b Annual Report to July 20, 1989 EL 14/85, Mt. Cattley, Tasmania. Summary of results and interpretations; 1988-89 exploration programme. Outokumpu Exploration Aust. P/L.P
- Herrmann, W. 1990a Notes on the sub basalt geological interpretation of EL 14/85 - Mt. Cattley and surrounding areas. Outokumpu Exploration Aust. P/L.
- Herrmann, W. 1990b Possibilities for further stratigraphic drill holes at Mt. Cattley - EL 14/85. Outokumpu Exploration Aust. P/L.



**Appendix I:**

**Summary Drill Records and Assay Data  
MCDDs 4 and 5**

135054

## SUMMARY DRILL RECORD

Area: Mt. Cattley, EL 14/85; Tas. Hole No: MCDD 4  
 Drilled: 21-11-88 to 2-12-88 Total Depth: 301 m  
 Co-ords: 11330 E 12000 N R.L.: ?  
 AMG: approx. 400335 E 5405505 N R.L.: 670 m

Hole Surveys:	Depth (m)	Azimuth (M)	Dip
	0	277	-80
	50	278	-80.5
	100	278.5	-80
	150	282.5	-80
	200	284.5	-79.5
	250	288.5	-79
	300	291	-79

Drill Rig: Longyear 44  
 Contractor: Diamond Drilling Tasmania, (P. Sharp)  
 Drilling Notes: HQ: 1.5 - 56.7m  
 NQ: 56.7 - 301m  
 Drilling fairly straightforward throughout.  
 Full core recovery. All steel casing recovered.  
 32mm PVC casing to bottom of hole.

Logged by: W. Herrmann  
 Date: Dec. 1988

Target : Designed to test Gefinex Anomaly No.1; source interpreted as a 40m thick sub-horizontal lens lying between 11200E and 11450E on 12000N, at a depth of 150-180m below surface.

Summary Result: MCDD 4 intersected the base of the Tertiary basalt at 58.5m and passed into a (Cambrian) basement sequence of alternating turbiditic greywacke/siltstone, fine to medium grained felsic epiclastic sediments, felsic pumiceous/lithic tuffs and mass flow type breccias involving all three lithotypes. Oriented core measurements indicated that this sequence consistently faces and dips to the south-west at about 60 degrees.

The sequence is essentially unmineralized.  
 A lithological source for the Gefinex anomaly is not apparent in the core.

## Abbreviated Geological Log :

MCDD 4

Depth (m)	Lithotype	Abbrev.
0 - 1.5	No core recovered.	
1.5 - 18.0	Tertiary basalt (oxidised)	
18.0 - 57.8	" " (unoxidised)	
57.8 - 57.9	Sandstone	
57.9 - 58.1	Tertiary basalt	
58.1 - 58.5	Unlithified sand	
58.5 - 74.5	Turbiditic Greywacke/Siltstone	Cdg
74.5 - 79.8	Felsic pumiceous Tuff	Cdp
79.8 - 84.6	Felsic tuffaceous/epiclastic Siltstone	Cdes f
84.6 - 87.4	Felsic tuffaceous/epiclastic Sandstone	Cdes m
87.4 - 91.1	Felsic tuffaceous/epiclastic Siltstone	Cdes f
91.1 - 92.9	Felsic tuffaceous/epiclastic Sandstone	Cdes m
92.9 - 93.5	Felsic pumiceous Tuff	Cdp
93.5 - 96.5	Felsic tuffaceous/epiclastic Sandstone	Cdes m
96.5 - 98.0	Felsic pumiceous Tuff	Cdp
98.0 - 100.9	Felsic tuffaceous/epiclastic Sandstone	Cdes m
100.9 - 114.4	Felsic pumiceous Tuff	Cdp
114.4 - 116.0	Felsic tuffaceous/epiclastic Sandstone	Cdes m
116.0 - 121.7	Felsic lithic-pumiceous Tuff	Cdlp
121.7 - 143.0	Turbiditic Greywacke/Siltstone	Cdg
143.0 - 144.8	Felsic pumiceous-lithic epiclastic Sst.	Cdes m
144.8 - 155.4	Turbiditic Greywacke/Siltstone	Cdg
155.4 - 156.1	Felsic pumiceous-lithic epiclastic Sst.	Cdes m
156.1 - 158.1	Turbiditic Greywacke/Siltstone	Cdg
158.1 - 170.7	Pumiceous epiclastic Breccia	Cdp-g
170.7 - 171.8	Fault Zone	FZ
171.8 - 175.0	Felsic pumiceous Tuff	Cdp
175.0 - 176.4	Pumiceous epiclastic Breccia	Cdp-g
176.4 - 178.8	Felsic pumiceous Tuff	Cdp
178.8 - 188.0	Pumiceous epiclastic Breccia	Cdp-g
188.0 - 215.5	Felsic lithic-pumiceous Tuff	Cdlp
215.5 - 248.0	Pumiceous epiclastic Breccia	Cdp-g
248.0 - 250.6	Felsic pumiceous Tuff	Cdp
250.6 - 250.9	Felsic tuffaceous/epiclastic Sandstone	Cdes m
250.9 - 256.1	Pumiceous epiclastic Breccia	Cdp-g
256.1 - 290.8	Felsic pumiceous Tuff	Cdp
290.8 - 293.1	Pumiceous epiclastic Breccia	Cdp-g
293.1 - 298.0	Turbiditic Greywacke/Siltstone and felsic epiclastic Sandstone	Cdes m
298.0 - 301.0	Felsic pumiceous Tuff	Cdp
301.0	EOH	

Assays :

MCDD 4

Sample No.	Interval (m)	L/type	(ppm)				(g/t)	
			Cu	Pb	Zn	Ba	Ag	Au
A104501	60 - 61	Cdg	45	205	670	340	x	x
502	70 - 71	"	20	150	295	300	x	x
503	80 - 81	Cdes f	10	80	85	280	x	x
504	85 - 86	Cdes m	20	20	50	290	x	x
505	101 - 102	Cdp	15	35	80	280	x	x
506	110 - 111	"	10	35	70	340	x	x
507	120 - 121	Cdlp	15	40	310	170	x	x
508	130 - 131	Cdg	20	45	110	330	x	x
509	140 - 141	"	20	60	70	340	x	x
510	150 - 151	"	10	30	40	220	x	x
511	160 - 161	Cdp-g	25	105	570	340	x	x
512	170 - 171	FZ	15	100	55	210	x	x
513	180 - 181	Cdp-g	20	60	100	380	x	x
514	190 - 191	Cdlp	15	45	110	340	x	x
515	200 - 201	"	20	50	100	400	x	x
516	210 - 211	"	20	35	190	510	x	x
517	220 - 221	Cdp-g	15	35	60	560	x	x
518	230 - 231	"	10	45	50	446	x	x
519	240 - 241	"	20	25	60	380	x	x
520	249 - 250	Cdp	20	20	55	560	x	x
521	260 - 261	"	15	20	55	540	x	x
522	270 - 271	"	10	20	45	460	x	x
523	280 - 281	"	20	20	65	360	x	x
524	291 - 292	Cdp-g	20	55	120	370	x	x
A104525	300 - 301	Cdp	15	55	85	470	x	x

Methods: (Analabs) 101 101 101 401 101 309  
 Detection Limits: 5 5 5 10 .5 .01  
 ("x" indicates below detection)

Sample Type: 1/2 sawn core

ANALABS; Report No: 999.66.08.0642, Date : 24/8/89

135057

## SUMMARY DRILL RECORD

Area: Mt.Cattley, EL 14/85; Tas. Hole No: MCDD 5  
 Drilled: 7-12-88 to 21-12-88 Total Depth: 244.6 m  
 Co-ords: 12000 E 12000 N R.L.: ?  
 AMG: approx: 401015 E 5405275 N R.L.: ~660 m

Hole Surveys:	Depth (m)	Azimuth (H)	Dip
	0	097	-62
	50	101	-63
	100	102	-63
	150	101	-64
	200	102.5	-63.5
	244	103.5	-63

Drill Rig: Longyear 44  
 Contractor: Diamond Drilling Tasmania  
 Drilling Notes: HQ: to 51m, subsequently reamed to 112m.  
 NQ: 51-244.6m  
 Drilling generally straightforward except for unconsolidated gravels at base of Tertiary basalt.  
 Approx. 106m of HQ casing stuck in hole; 6-112m. 32mm PVC Class 9 casing to bottom of hole.

Logged by: W.Herrmann  
 Date: Dec, 1988

Target : Designed to intersect Gefinex Anomaly 2; source interpreted as a 20m thick, moderately west dipping lens centred at about 175m below 12100E/12000N.

Summary Result: MCDD 5 intersected a sequence of Tertiary basalt underlain by about 25m of unconsolidated gravels before passing into Cambrian basement at 97m. The basement sequence comprised a thick unit of graded felsic mass-flow sandstone/breccia underlain by a 30m thick unit of pyritic black siltstone, in turn underlain by cherty felsic/vitric tuffaceous siltstone. Oriented core measurements indicate an average bedding dip of about 55 degrees to the northwest and facing in the same direction.

Sulphide mineralization is restricted to widespread but minor qtz + carb + py + gn + sp veinlets and a few narrow bands of more massive, perhaps stratiform, py + sp in black mudstone. The Gefinex anomaly appears to be attributable to the black siltstone unit.

## Abbreviated Geological Log :

MCDD 5

Depth (m)	Lithotype	Abbrev.
0 -	core recovered.	
1.5 - 69.7	Tertiary basalt	
69.7 - 83.7	Unlithified siliceous sand and gravel	
83.7 - 90.9	Basaltic lapilli-vitric tuff	
90.9 - 97.0	Siliceous cobble/gravel	
97.0 - 119.0	Felsic lithic epiclastic Sandstone	Cdes
119.0 - 146.0	Felsic epiclastic Breccia	Cdeb
146.0 - 157.5	Pyritic black Siltstone	Cdbs
157.5 - 160.2	Felsic vitric tuffaceous Siltstone	Cdev
160.2 - 176.0	Pyritic black Siltstone	Cdbs
176.0 - 177.3	Felsic vitric tuffaceous Siltstone	Cdev
177.3 - 181.8	Pyritic black Siltstone	Cdbs
181.8 - 181.9	Fault zone	FZ
181.9 - 201.1	Felsic vitric tuffaceous Chert	Cdev
201.1 - 202.0	Pyritic black Siltstone	Cdbs
202.0 - 244.6	Felsic vitric tuffaceous Chert	Cdev
244.6	EOH.	

## Assays :

MCDD 5

Sample No.	Interval (m)	L/type	(ppm)				(g/t)	
			Cu	Pb	Zn	Ba	Ag	Au
A104526	110 - 111	Cdes ox.	35	90	930	1350	x	x
527	115 - 116	Cdes	15	240	865	880	x	x
528	120 - 121	Cdeb	15	135	555	1150	x	x
529	130 - 131	"	15	145	230	670	x	x
530	140 - 141	"	20	160	580	930	x	x
531	149 - 150	Cdbs	65	325	805	640	x	x
532	155 - 156	"	85	1150	4050	440	x	x
533	159 - 160	Cdev	20	260	650	640	x	x
534	163 - 164	Cdbs	25	100	1550	460	x	x
535	170 - 171	"	65	310	2250	350	x	x
536	176 - 177	Cdev	50	300	1650	420	x	x
537	185 - 186	"	10	140	335	790	x	x
538	189 - 190	"	20	325	1300	760	x	x
539	196.6-196.7	Py+Sp in Cdbs	1950	2050	2.8%	520	11	.03
540	201 - 202	Cdbs	15	395	1450	570	x	x
541	202 - 203	Cdev + vns	5	8200	260	1000	x	x
542	210 - 211	Cdev	5	35	65	970	x	x
543	220 - 221	"	5	30	35	990	x	x
544	230 - 231	"	5	50	45	970	x	x
A104545	240 - 241	"	10	35	20	840	x	x

Methods: (Analabs) 101 101 101 401 101 309  
 Detection Limits: 5 5 5 10 .5 .01  
 ("x" indicates below detection)

Sample Type: 1/2 sawn core

ANALABS; Report No: 999.66.08.0642, Date : 24/8/89

**Appendix II:**

**Summary Drill Record and Geological Core Log  
MXRD 1**

## SUMMARY DRILL RECORD

Area: Mt. Cattley, EL 14/85; Tas. Hole No: MXRD 1

Drilled: March - August, 1990 Total Depth: 750.5m

Co-ords: E N R.L.:  
 AMG: 399555 E 5404652 N R.L.: 674.2m

Hole Surveys:	Depth (m)	Azimuth (H)	Dip
	0	020	-70
	246	022	-59
	414	023	-56.5
	520	025	-54
	738	031	-42.5

Drill Rig: Longyear 38

Contractor: Drilling Division, Tas. Department of Mines

Drilling Notes: Percussion precollar: 78m  
 NQ coring: 78 - 418m  
 BQ coring: 418 - 750.5m  
 Drilling straightforward throughout, 100% core recovery. All steel casing recovered. Class 12 32mm PVC casing to bottom of hole.

Logged by: W. Herrmann

Date: June - August, 1990

Target : Stratigraphic hole designed to elucidate the stratigraphic and structural interpretation and exploration significance of andesitic volcanics previously intersected by PanFin's sub basalt drilling between Middlesex and Beecroft Roads.

Summary Result : MXRD 1 intersected an approximately 250m thick sequence of andesitic (extrusive) volcanics which are overlain by a 50m thick unit of black siltstone/shale and underlain by a sequence of turbiditic greywackes and siltstones with minor felsic pumiceous tuff and volcanoclastic sediments, of unknown thickness.

The assemblage bears considerable resemblance to the stratigraphy of the Que River - Hellyer area and the following lithostratigraphic correlations can be tentatively proposed:

MXRD1 black siltstone/shale = Que River Shale.  
 MXRD1 andesites = Que-Hellyer Volcanics.  
 MXRD1 turbiditic greywackes and minor felsics = Animal Creek Greywacke.

061

Megascopic lithological similarities of the MXRD1 andesites with those of MCPDs 1,2 and 3 and the MXRD1 greywackes and minor associated felsics with those of MCPD 1 and MCDD 4 are also evident.

MXRD1 will substantially contribute to an improved interpretation of the structure and stratigraphy of the Mt. Cattley area. The rocks intersected by MXRD1 do not appear to be significantly mineralized or hydrothermally altered and an equivalent to the Que-Hellyer ore hosting "mixed sequence" is not readily apparent. Although the MXRD1 andesites seem on textural grounds to be subdivisible into two major units, it is not yet clear how these may relate to the subdivisions within the Que-Hellyer Volcanics.

#### Abbreviated Geological Log :

Depth (m)	Lithotype
0 - 184.6	Tertiary basalt and associated breccias
184.6 - 225.2	Turbiditic Siltstone and Greywacke
225.2 - 292.4	Dolerite
292.4 - 301.5	Felsic, pumiceous Tuff-Breccia
301.5 - 305	Mixed Felsic Epiclastic and Black Siltstone/ Shale
305 - 352.6	Black Siltstone / Shale
352.6 - 355.5	Felsic/Mafic lithic epiclastic Breccia
355.5 - 525.2	Andesite
525.2 - 525.5	Andesitic volcanoclastic wacke.
525.5 - 597.8	Andesite
597.8 - 598	Greywacke
598.0 - 608.4	Felsic pumiceous Tuff and epiclastic Sandstone
608.4 - 610.2	Felsic volcanoclastic Siltstone
610.2 - 626.7	Turbiditic Greywacke and Siltstone
626.7 - 628.3	Pumiceous epiclastic jumble Breccia.
628.3 - 750.5	Turbiditic Greywacke and Siltstone

062

HXRD 1

## Geological Core Log

W. Herrmann  
August, 1990.

0 - 80 m	Percussion precollar in Tertiary Basalt, no samples retained.
80 - 148.5	Basalt (Tertiary)  Not logged in detail, consists of variably fine grained, massive, amygdaloidal and vesicular basalt.
148.5 - 154	Gravel (Tertiary)  Partly oxidized, semi consolidated coarse to medium grained polymictic conglomerate / agglomerate including clasts of exotic Cambrian-Ordovician (?) rocks and Tertiary basalt.
154 - 169.6	Basaltic Tuff (Tertiary)
169.6 - 172.4	Basalt (Tertiary)  Fine grained - glassy amygdaloidal basalt with a few 50mm sized xenoclasts of altered dunite ?
172.4 - 175.9	Basaltic Tuff (Tertiary)  Medium grained / fragmental basaltic tuff, oxidized to reddish brown colour.
175.9 - 179.5	Basalt (Tertiary)  Fine grained - glassy amygdaloidal basalt with a few 50mm sized xenoclasts of altered dunite ?
179.5 - 182.5	Basaltic Tuff (Tertiary)
182.5 - 183.5	Basalt (Tertiary)
183.5 - 184.6	Basaltic Tuff / Hyaloclastite (Tertiary)
***** 184.6	Unconformable contact. *****
184.6 - 190.6	Siltstone (oxidized)  Fine grained siltstone / mudstone, locally finely laminated with bedding at about 70 deg. to LAOC; mostly oxidized to reddish brown and olive brown colour.

## 190.6 - 225.2 Turbiditic Siltstone and Greywacke

Thinly interbedded fine grained, dark grey to black siltstone and paler grey fine to medium grained sandy greywacke and lithicwacke. Siltstones dominant over wackes in proportion of about 3:1; abundant facing evidence (flame structures etc.) indicating younging uphole. Below 201m there are some ~30cm units of medium to coarse grained lithicwacke with grainsize grading fining uphole; also some indications of soft sediment deformation in the coarser units but bedding is consistently at 65-70 deg. to LAOC.

\*\*\*\* 214.5m Core Orientation: indicates approximate orientation of bedding is:  
 strike: 325 deg (AMG)  
 dip : 40 deg to SW

## 225.2 - 292.4 Dolerite

A massive, medium to fine grained holocrystalline rock of uniform pale greenish grey colour weakly mottled by paler grey semi-porphyrific feldspars? (0.5-2mm grainsize). The composition appears to be of about 60-70% plagioclase ? feldspar with smaller (0.5-1mm) interstitial grains of translucent pale olive green pyroxene ? and minor (1%) fine specks or thin blady plates of magnetite or ilmenite; the rock is not detectably magnetic. Preliminary petrographic examination by J. Pemberton of a specimen from 254.9m indicates a dolerite composition and sub-ophitic fabric; pyroxenes are reportedly fairly fresh but plagioclase apparently strongly altered.

The upper contact is sharp and apparently conformable against the overlying siltstones, the upper 5m or so is very fine grained and aphyric with a gradational increase in grainsize downwards, probably representing a chilled margin. The 0.5m interval immediately below the upper contact is amygdaloidal with rounded amygdales upto 10mm filled with creamy-white carbonate. The lower contact also is sharp and apparently conformable with compaction foliation in the underlying pumiceous breccia although the actual contact is marked by a 1cm thick zone of brecciation infilled with carbonate. The lower contact is also associated with an approximately 4m thick chilled margin ? of finer grainsize. The contact relations are consistent with a sill like intrusive origin for the dolerite.

The internal structure is generally quite massive but cut by thin veinlets of white carbonate which are generally <2mm thick, occasionally upto 20mm, and averaging perhaps 10/m of core. The rock is essentially unmineralized except for a trace of very pale brown sphalerite associated with a fractured, 2cm wide band of fine grained, chilled dolerite? at 284m depth.

292.4 - 301.5 Felsic, pumiceous Tuff-Breccia

A somewhat variably coloured felsic fragmental rock ranging from dark greenish grey to pale greenish grey, olive green and pale pink. It generally is composed of fairly abundant (10-30%) subrounded to angular or flattened-wispy, small to medium sized (5-30mm) clasts of felsic volcanics supported by a medium grained matrix (1-2mm) of pinkish or grey feldspar crystals, quartz crystals and fine vitric ashy material. The clast lithologies include pinkish brown to grey fine grained aphanitic rhyolite?, fine quartz-feldspar porphyritic rhyolite? and very prominent olive green wispy/flattened pumice fragments which are typically quartz and feldspar phyrlic. These "flamme" define a fairly distinct compaction foliation which cuts the core at about 70-80 deg. to LAOC. There is a greater abundance of clasts, especially pumiceous clasts, of >10mm in the lower half of the interval suggesting an overall upward fining and possibly indicating that it represents part of a single mass flow unit. Apart from sericitization / devitrification of pumice, the rock appears to be quite fresh and unaltered; there are traces of disseminated pyrite but not exceeding 0.1% of volume.

301.5 - 305 Mixed Felsic Epiclastic and Black Siltstone/Shale

This interval consists of patches of pumiceous material intermixed with dark grey somewhat cherty mudstone (indurated shale) separated by layers, upto 0.5m thick, of fairly well bedded felsic epiclastic sandstone and some finer silty shale. It is essentially a transitional lithotype between the felsic breccia above and the black siltstone/shale below. Some of the bedded sandy layers are faintly graded suggesting a fining uphole. The upper contact is sharp and conformable with the orientation of bedding. There is a narrow, 5-10cm, minor shear or fault at 301.7m.

## 305 - 352.6 Black Siltstone / Shale

A fairly massive, uniformly black, carbonaceous fine grained siltstone, locally shaly or fissile parallel to bedding. It is compositionally massive between 310 and 346m but is moderately well bedded, even thinly laminated near the upper and lower contacts with subordinate thin pale grey silty laminae defining the layering. The bedding laminations seem to be very consistent and cut the core at 65-70 deg. to the LAOC.

The black siltstone is generally weakly pyritic but there are occasional large framboids, to 20mm, within the upper 5m of the interval and patches and laminae of pyrite rich siltstone, especially within a few metres of the upper and lower contacts. Maximum pyrite content is in the range 2-5%.

A 1cm thick silty wacke bed at 349.4m has faint grainsize grading indicating fining (younging) uphole. Below 350.4m silty and fine sandy "epiclastic" beds become prominent (~30%); these are substantially composed of reworked ? felsic and mafic ? volcanic / pyroclastic materials and commonly contain about 5% pyrite as disseminated specks and framboids. At 350.5m there is a 40mm subangular clast of altered ? fine grained andesite ? dusted with fine disseminated pyrite and minor specks of brown sphalerite. There is evidence of minor soft sediment slumping at 350.6m. The lower contact is sharp, more or less conformable to bedding, although slightly irregular due to the coarse pebbly nature of the underlying material.

## 352.6 - 355.5 Felsic/Mafic lithic epiclastic Breccia

A medium to coarse grained, mottled pale to dark greenish grey rock consisting of abundant pinkish grey feldspar crystals/fragments (~20% of vol.; 2-3mm grainsize) and locally abundant subrounded clasts of fine grained, altered ? andesite (5-15% of vol.; <5-30mm size) in a somewhat foliated matrix of pale greenish grey sericitic, devitrified glassy ? material. The andesitic clasts are usually dusted with fine pyrite and minor (~0.2%) disseminated pyrite is ubiquitous in the sericitic matrix. Crystal feldspars appear to be fairly fresh. The rock has the general appearance of a felsic mass flow unit which has incorporated abundant andesitic pebbles. The lower contact is marked by minor shearing.

066

135067

## 355.5 - 525.2 Andesite

A variably pale, medium or dark greenish grey intermediate extrusive rock which is variably pillowed, brecciated or massive. The fundamental rock composition appears to be weakly porphyritic with sparse small tabular prismatic grains of altered ? plagioclase ? in a medium to fine grained, probably partly glassy, matrix. It is generally amygdaloidal, sometimes intensely amygdaloidal (upto 15% of vol.) with large (upto 15mm) rounded or irregular amygdales filled with white carbonate and smaller elliptical amygdales filled with dark green chlorite ? +/- carbonate.

The meso structure of the rock is quite variable:

- Above 360.6m the andesite is rather brecciated, probably representing hyaloclastic fragmentation with interfragmental dark grey cherty sediment.
- From 360.6 to ~385m the rock is pillowed with pillows upto around 0.5m diameter and thin interpillow zones of dark grey cherty sediment usually containing considerable pyrite in disrupted thin bands. (eg: Photo #1, 367.9m)
- From 385 to ~458m the andesite is mostly rather brecciated and locally intensely brecciated and pillow margins are not generally apparent but in places there is a mottled bleaching which may be related to interpillow hyaloclastite zones; eg: 436-437m. The most prominent form of brecciation, however, appears to be a late stage "hydraulic" form of brecciation in which angular to splintery fragments of andesite, with a jigsaw type fit, are contained in an abundant pale grey matrix largely composed of carbonate and a little finely milled andesite. The andesite fragments within these breccia zones appear generally to be unaltered but may sometimes have a narrow dark fringe or selvedge with or without traces of fine disseminated pyrite. These zones of intense brecciation are very common over short intervals of upto a few metres; eg: near 443m; (Photo #2).
- From 458 to 525.2m the andesite is mostly massive, not notably affected by brecciation and mainly of medium to dark greenish grey colour. It is here consistently amygdaloidal with some of the larger type (white carbonate) amygdales also dusted with reddish hematite. Pillow margins are not apparent and this interval may represent a fairly massive single flow unit.

Post brecciation carbonate veins and veinlets (which cut through the re-cemented "hydraulic" breccia zones) are ubiquitous and commonly range upto 50 per metre of core but are mostly devoid of sulphides. Traces of chalcopyrite and pyrite occur occasionally, most commonly in amygdales or as fine disseminations in the andesite matrix, but the overall grade is not expected to exceed 400ppm copper.

525.2 - 525.5 Andesitic volcanoclastic wacke.

A thin unit of medium greenish grey coloured sedimentary rock composed of fine granular volcanoclastic material, probably mainly andesitic but with some grey cherty silica. It exhibits faint grainsize layering, probably bedding, which intersects the core at about 70 deg. to LAOC. The lowermost 2cm is rather pyritic, containing an estimated 10% pyrite. The upper contact is conformable with the bedding ? layering; the lower contact is irregular, disrupted by veins and the irregular pillowed top of the andesite unit below. This is evidently a thin interflow epiclastic sediment unit.

525.5 - 597.8 Andesite

Immediately below the sediment bed (above) occurs an andesite of uniform and different textural character. The rock has a uniform pale greenish grey colour, is apparently non porphyritic of very fine grained or glassy/aphanitic texture locally with faint, possibly flow, banding. The usual two types of amygdales (large white carbonate filled and smaller dark chlorite? +/- carbonate filled) are locally present but generally do not exceed 5% of volume. ( Photo # 3; ~535m )

The upper 10m of the interval contains a few patches or bands of medium to fine grained cherty sediment (rather like the lithotype in the interval 525.2 -525.5m) in some cases associated with minor hyaloclastite ? breccia and marginal bleaching; these are probably inter pillow zones, they commonly contain a little pyrite especially at the margins of the (suspected) andesite pillows. Similar evidence of pillow margins ?, hyaloclastite breccia ? and interstitial dark grey cherty sediment occurs below 568m and especially below 580m but is not apparent in the interval 535-568m which possibly represents a single massive flow unit.

The faint flow fabric, where evident (essentially a weak preferred orientation of the small dark elliptical amygdales) is semi planar and intersects the core at about 60 deg. to LAOC.

The lower contact is somewhat irregular, possibly due to the hyaloclastically ? brecciated character of the lower 20cm of the unit. ( Photo # 4)

597.8 - 598

## Greywacke

Fine to medium grained quartz rich micaceous wacke with minor felsic volcanoclastic component. Faintly bedded; layering slightly disrupted by soft sediment slump.

598.0 - 608.4

## Felsic pumiceous Tuff and epiclastic Sandstone

Most of this interval is of mottled pale and dark olive greenish grey coloured rock consisting of abundant small wispy to irregular shaped clasts of olive green glassy/devitrified feldspar phyric rhyolitic pumice (1-50mm, 20-50% of volume) in a fine ashy pale greenish to pale grey base of sericite/silica/carbonate. There are occasional rigid lithic clasts of pinkish-brownish grey fine grained feldspar phyric dacite ? but the great majority of clasts are pumiceous and flattened. The rock has a crude compaction ? foliation which intersects the core at about 60 deg. to LAOC.

Below 605.5m there is an alternating succession of felsic pumiceous tuff (as above) with crudely bedded sandy felsic volcanoclastic wacke. This is composed of reworked, semi sorted felsic pyroclastic/epiclastic materials varying from silty to coarse sandy grainsize; usually fairly well stratified with bedding planes intersecting core at around 70-80 deg. to LAOC. The upper contact appears to be depositional, conformable and planar at about 65 deg. to LAOC.

The lithotypes of this interval are depicted in Photos # 4 and 5.

The interval is not significantly altered or mineralized but contains the usual trace (<0.1%) of disseminated pyrite. There are a few spots of pale green fuchsite ? staining in the upper 2m. Carbonate veining, in contrast with the overlying andesites, is here of very minor development.

069

The lithotypes in this interval bear a strong megascopic resemblance to the felsic pumiceous tuffs and associated felsic epiclastic sediments intersected in MCDD 4.

608.4 - 610.2 Felsic volcanoclastic Siltstone

A fine grained, well sorted siltstone of felsic tuffaceous/epiclastic derivation; it has a uniform pale dove grey colour and is generally fairly massive but locally finely bedded. There are minor soft sediment slump structures but bedding is generally planar at 70-80 deg. to LAOC. There is a single large framboid? (20mm) of pyrite just above the lower contact.

The unit is depicted in Photo # 5.

610.2 - 626.7 Turbiditic Greywacke and Siltstone

Thinly interbedded grey fine to medium grained sandy greywacke and dark grey to black siltstone and shaly siltstone. The greywacke appears to be fairly quartz rich, with some detrital mica but fairly minor felsic volcanoclastic component. Individual beds range from 5mm to 1m in thickness but generally fall in the range 50 - 200mm thickness. Greywacke is dominant over dark siltstone by a factor of about 3. Abundant facing evidence, in the form of grainsize grading, lode casts, flame structures and truncated cross bedding, indicate the younging direction to be uphole. There are minor soft sediment slump structures but bedding is generally planar and intersects the core at 70-80 deg. to LAOC.

The finer siltstones are black but not particularly pyritic; I estimate an overall average of < 0.1% pyrite. There is an isolated, 20mm, blob of semi massive pyrite associated with minor chlorite and reddish brown sphalerite at 618.1m. Carbonate veining is not prominent, with veins of generally < 5mm thick averaging about 5 per metre of core.

626.7 - 628.3 Pumiceous epiclastic jumble Breccia.

A slump deformed chaotic mixture of felsic pumiceous tuff, dark fine grained volcanoclastic siltstone and greywacke.

It is compositionally and texturally very similar to the several units of pumiceous epiclastic breccias intersected in the lower half of MCDD 4. It is interpreted to have

formed by disruption of unconsolidated siltstone / greywacke by incursion of a felsic pumiceous mass flow.

628.3 - 750.5 Turbiditic Greywacke and Siltstone

Compositionally and texturally identical to lithotypes in interval 610.2 - 626.7m. The greywacke is dominant over dark siltstones by a factor of about 5 in the upper part of the unit, increasing to a factor of about 10 towards the end of the hole. There is abundant facing evidence indicating a younging direction up the hole. Bedding is generally planar at 70-85 deg. to LAOC but there is local evidence of minor slump deformation and syndimentary brecciation (rip up clasts) of black siltstone/shale. There are occasional small framboids ? of pyrite but pyrite content overall is estimated at < 0.2%. There are occasional veins and zones of veins (as in interval 636 - 646.5m) of milky white quartz and cream coloured carbonate but these are essentially devoid of sulphides.

750.5

End of Hole.

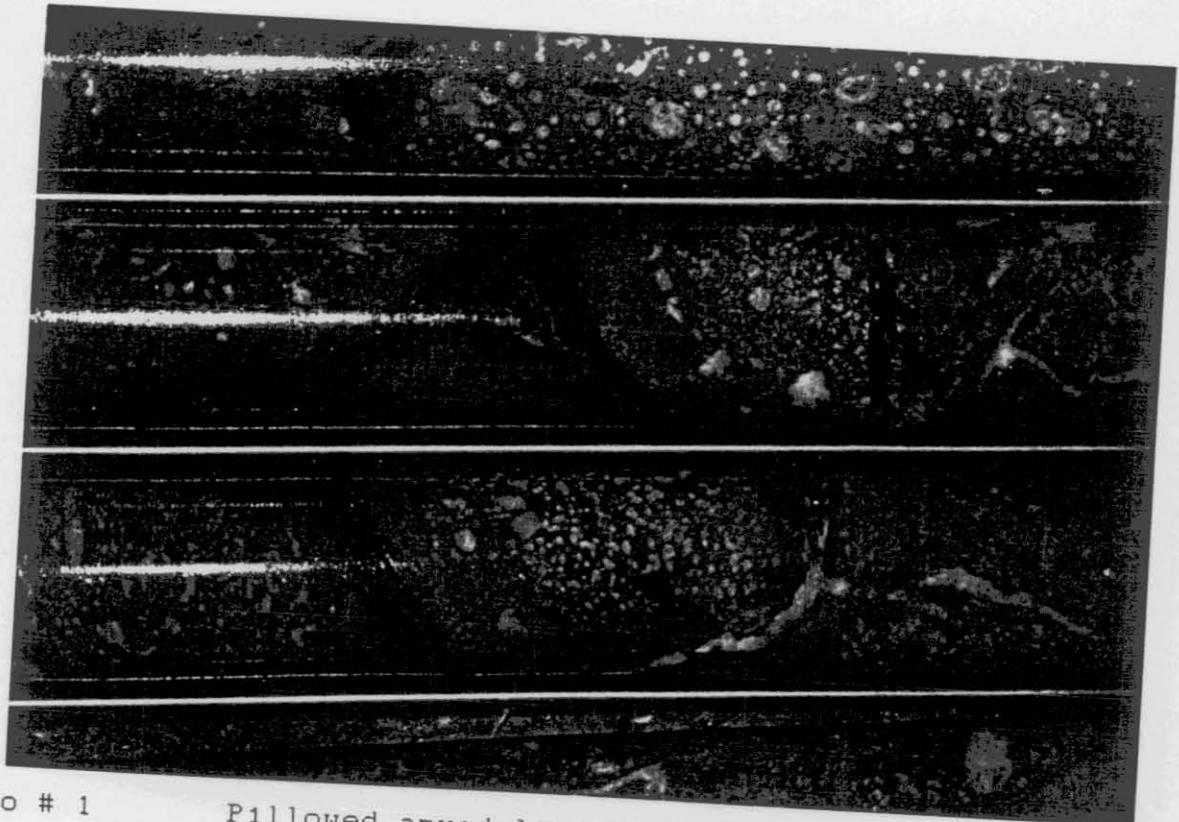


Photo # 1

Pillowed amygdaloidal andesite with narrow pillow selvages and interpillow pyritic cherty sediment; MXRD 1, 367.8m.

135072

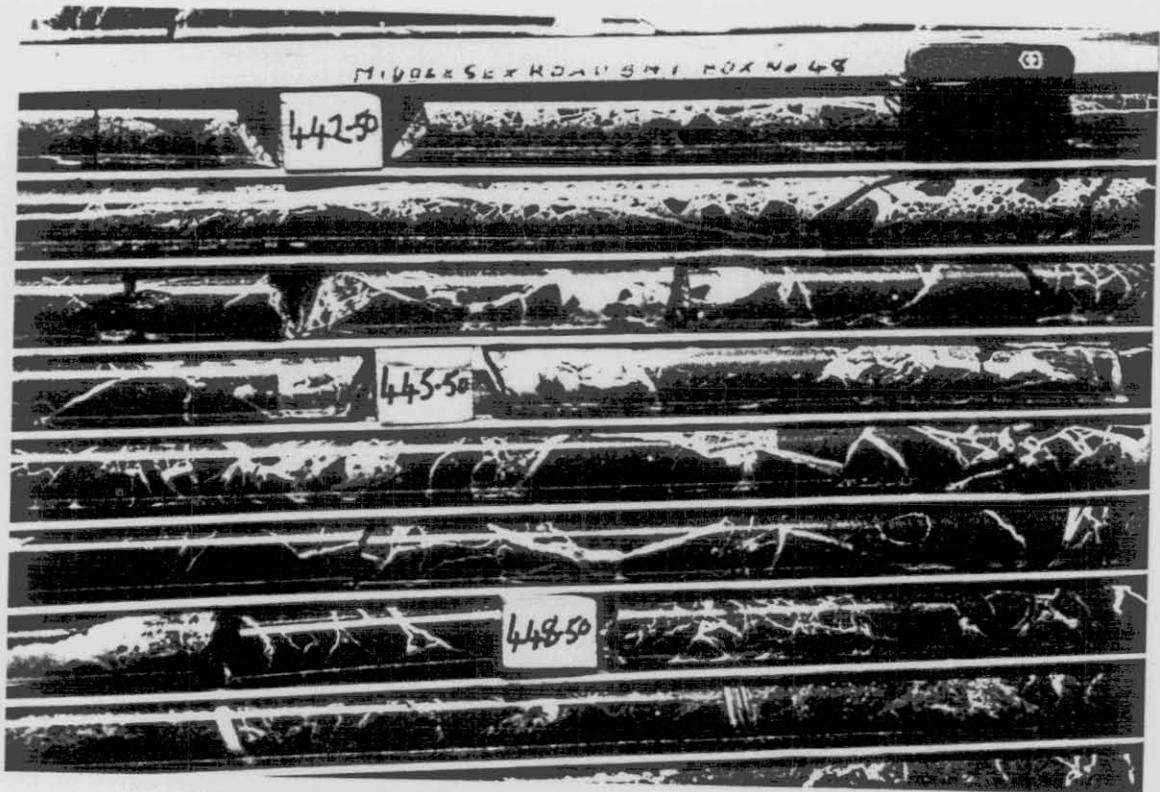


Photo # 2 Brecciated andesite; MXRD 1, depths as shown by the core blocks.



Photo # 3 Andesite; MXRD 1, depths as shown by the core blocks.



Photo # 4

Lower contact of lower Andesite, showing brecciation in lower 20cm of andesite and underlying units of greywacke and felsic pumiceous tuff. MXRD 1, depths as shown by the core blocks.



Photo # 5

Stratified felsic epiclastic sandstone, volcanoclastic siltstone and underlying turbiditic greywacke - siltstone. MXRD 1, depths as shown by the core blocks.

**Appendix III:**

- III-a List of Analytical Sample Numbers for MXRD 1
- III-b MXRD 1 Analytical Data (ANALABS: 999.66.08.7388)
- III-c Analytical Standard

List of Analytical Sample Numbers for MXRD 1

---

Sample Type: Side-grind of diamond drill core.

Analysis: by ANALABS, Burnie for:  
Cu, Pb, Zn, Ag, Mn, Fe, Mg, Cr, Ti, Zr, Y, Nb, Ba, Ca, Na, K,  
by method 201 (ICP-OES)

Au by method 309 (30g fusion/AAS)

Sample Number Depth Interval, MXRD 1 (m)

---

A105701	Standard	(Aberfoyle)
702	184.6 - 190.6	
703	190.6 - 200	
704	200 - 210	
705	210 - 220	
706	220 - 225.2	
707	225.2 - 230	
708	230 - 240	
709	240 - 250	
710	636 - 646.5	Duplicate of A105769
711	250 - 260	
712	260 - 270	
713	270 - 280	
714	280 - 290	
715	290 - 292.4	
716	292.4 - 297	
717	297 - 301.5	
718	301.5 - 305	
719	305 - 310	
720	590 - 597.8	Duplicate of A105757
721	310 - 320	
722	320 - 330	
723	330 - 340	
724	340 - 350	
725	350 - 352.6	
726	352.6 - 355.5	
727	355.5 - 360	
728	360 - 370	
729	370 - 380	
730	510 - 520	Duplicate of A 105746
731	Standard	(Aberfoyle)
732	380 - 390	
733	390 - 400	
734	400 - 410	

...../cont.

Sample Number	Depth Interval, MXRD 1 (m)	
A105735	410 - 420	
736	420 - 430	
737	430 - 440	
738	440 - 450	
739	450 - 460	
740	410 - 420	Duplicate of A105735
741	460 - 470	
742	470 - 480	
743	480 - 490	
744	490 - 500	
745	500 - 510	
746	510 - 520	
747	520 - 525.2	
748	525.2 - 525.5	
749	525.5 - 530	
750	330 - 340	Duplicate of A105723
751	530 - 540	
752	540 - 550	
753	550 - 560	
754	560 - 570	
755	570 - 580	
756	580 - 590	
757	590 - 597.8	
758	597.8 - 598	
759	598 - 603	
760	260 - 270	Duplicate of A105712
761	Standard	(Aberfoyle)
762	603 - 608.4	
763	608.4 - 610.2	
764	610.2 - 620	
765	620 - 626.7	
766	626.7 - 628.3	
767	628.3 - 630	
768	630 - 636	
769	636 - 646.5	
770	730 - 740	Duplicate of A105780
771	646.5 - 650	
772	650 - 660	
773	660 - 670	
774	670 - 680	
775	680 - 690	
776	690 - 700	
777	700 - 710	
778	710 - 720	
779	720 - 730	
780	730 - 740	
A105781	740 - 750.5	(EOH)

070

135077

APPENDIX III-b.

**ANALABS**

A division of MacDonald Hamilton &amp; Co. Pty. Ltd.

Phone (09) 458 7999

52 Murray Road, Welshpool, W.A. 6106

Telex AA92560

FAX: 004 31 8890

**ANALYTICAL REPORT No.** 999.66.08.07388

THIS REPORT MUST BE READ IN CONJUNCTION WITH THE ACCOMPANYING ANALYTICAL DATA

ORDER No.

PROJECT

20232

Mt Cattley

DATE RECEIVED

RESULTS REQUIRED

19/09/90

ASAP

Outokumpu Exploration Aust  
Suite 2, Level 6  
77 Pacific Highway  
Sydney NSW 2060

No. OF PAGES  
OF RESULTSDATE  
REPORTEDNo.  
OF COPIES

TOTAL No. OF SAMPLES

8

03/10/90

1

81

STATE OF SAMPLES	REFER BELOW	SAMPLE NUMBERS	PRE-TREATMENT						ANALYSIS				
			DRY	CRUSH	SPLIT	PUL- VERISE	SIEVE	OTHER SEE REMARKS	NONE	REFER TO ANALYSIS SECTION	PREPARATION	METHOD	
		<A 1057,01/81	PU	Prep: 00	010,011,012,013,016						Au, AuChk/309		
		<A 1057,01/81	PU								Cu, Pb, Zn, Ag, Mn, Fe, Mg, Cr, Ti, Zr, Y, Nb, Ba, Ca, Na, K/201 (ICP-OES)		

RESULTS

W. Herrmann

TO

RSD 1066

Devonport

Tasmania 7310

RESULTS

Outokumpu Exploration Aust

TO

Suite 2, Level 6

77 Pacific Highway

Sydney NSW 2060

REMARKS

STATE OF SAMPLES	ANALYSIS - PREPARATION	ANALYSIS - METHOD
whole core	perchloric acid A1	atomic absorption AAS
split core	hydrochloric acid A2	x-ray fluorescence XRF
cutting	nitric acid A3	spectrophotometry SPEC
rock	aqua regia A4	colorimetry COL
soil	nitric-perchloric A5	chromatography CHR
pulp	HF mixture A6	titration TTN
water	HF under pressure A7	other chemicals means CHEM
tissue	fusion A8	miscellaneous MISC
stream sediment		fluorescence FLUOR
heavy mineral		Inductively coupled plasma ICP

AUTHORISED OFFICER

*Gentian*

## ANALABS

135078

A Division of Incharge Inspection and Testing Services Australia Pty Ltd.

## ANALYTICAL DATA

SAMPLE PREFIX

REPORT NUMBER

REPORT DATE

CLIENT ORDER No.

PAGE

		999.66.08.07388				03/10/90	20232			1 OF 8	
TUBE No.	SAMPLE No.	Au	AuChk	Ag	Ba	Ca	Cr	Cu	Fe	K	
1	A 105701	0.010	-	<5	1043	2.890	725	115	7.09	1.00	
2	A 105702	0.010	-	<5	534	0.292	111	120	6.83	2.23	
3	A 105703	<0.008	-	<5	509	3.250	112	87	5.83	2.47	
4	A 105704	0.015	-	<5	519	4.070	103	96	5.05	2.71	
5	A 105705	0.020	-	<5	420	3.990	86	82	5.52	2.74	
6	A 105706	0.015	-	<5	399	3.980	96	83	5.02	3.07	
7	A 105707	0.015	-	<5	317	6.540	95	6	5.57	2.14	
8	A 105708	0.015	-	<5	847	3.720	103	5	5.28	0.97	
9	A 105709	0.010	-	<5	860	4.080	127	5	5.29	0.73	
10	A 105710	0.015	-	<5	380	4.610	275	22	3.51	2.14	
11	A 105711	<0.008	-	<5	769	4.520	119	6	5.53	0.49	
12	A 105712	0.020	-	<5	751	6.260	122	7	4.91	0.97	
13	A 105713	0.010	-	<5	706	5.460	120	6	5.52	1.07	
14	A 105714	<0.008	-	<5	414	6.310	113	7	5.15	0.58	
15	A 105715	0.010	-	<5	585	9.430	108	6	4.51	1.75	
16	A 105716	0.010	0.015	<5	322	3.910	11	9	1.25	2.16	
17	A 105717	0.015	-	<5	351	3.590	13	17	1.37	2.49	
18	A 105718	0.015	-	<5	532	3.300	29	56	3.58	2.86	
19	A 105719	0.015	-	<5	578	2.140	101	80	6.02	2.48	
20	A 105720	0.010	-	<5	583	6.010	20	13	4.88	3.11	
21	A 105721	0.010	-	<5	551	2.550	89	67	4.75	2.27	
22	A 105722	0.010	-	<5	721	2.940	95	57	3.86	2.60	
23	A 105723	<0.008	-	<5	840	2.500	92	60	3.92	2.50	
24	A 105724	0.020	-	<5	901	2.900	89	56	3.75	2.54	
25	A 105725	0.020	-	<5	1099	2.630	107	128	4.83	2.79	

Results in ppm unless otherwise specified

T = element present; but concentration too low to measure

X = element concentration is below detection limit

- = element not determined

AUTHORISED  
OFFICER

078

## ANALABS

A Division of Inchcape Inspection and Testing Services Australia Pty. Ltd.

135079

## ANALYTICAL DATA

SAMPLE PREFIX

REPORT NUMBER

REPORT DATE

CLIENT ORDER No

PAGE

		999.66.08.07388				03/10/90		20232		2 OF 8	
TUBE No.	SAMPLE No.	Au	AuChk	Ag	Ba	Ca	Cr	Cu	Fe	K	
1	A 105726	0.020	-	<5	1891	1.600	30	24	3.55	4.46	
2	A 105727	0.010	-	<5	935	2.540	44	72	5.01	1.96	
3	A 105728	0.025	-	<5	540	9.290	338	83	5.61	0.82	
4	A 105729	0.025	-	<5	269	10.340	417	133	5.37	0.13	
5	A 105730	0.030	-	<5	4858	7.510	672	138	6.35	0.35	
6	A 105731	0.010	-	<5	1005	2.820	636	114	6.78	0.97	
7	A 105732	0.030	0.020	<5	333	10.620	414	101	4.75	0.05	
8	A 105733	<0.008	-	<5	947	7.100	474	95	5.89	0.42	
9	A 105734	0.020	-	<5	883	7.990	442	83	5.56	0.32	
10	A 105735	0.030	-	<5	1238	12.150	403	111	5.15	0.28	
11	A 105736	0.025	-	<5	664	9.050	207	80	5.28	0.33	
12	A 105737	0.030	-	<5	896	7.950	408	79	4.92	0.83	
13	A 105738	0.025	-	<5	1288	10.930	138	34	4.71	0.63	
14	A 105739	0.025	-	<5	1033	6.590	214	50	5.78	1.19	
15	A 105740	0.020	-	<5	997	12.390	341	105	4.24	0.21	
16	A 105741	0.015	-	<5	753	3.240	529	66	6.33	0.58	
17	A 105742	0.010	-	<5	783	8.780	360	113	5.38	0.35	
18	A 105743	0.020	-	<5	653	6.460	536	65	6.16	<0.05	
19	A 105744	0.025	-	<5	1325	7.720	521	63	5.91	<0.05	
20	A 105745	0.020	-	<5	1669	8.080	469	68	5.60	0.11	
21	A 105746	0.015	-	<5	4690	7.060	658	136	6.12	0.34	
22	A 105747	0.020	-	<5	1238	9.740	611	124	5.63	0.20	
23	A 105748	0.010	0.020	<5	495	4.730	130	119	5.07	1.90	
24	A 105749	0.020	-	<5	521	4.630	51	47	5.47	1.96	
25	A 105750	0.010	-	<5	679	2.200	87	60	3.55	2.32	

Results in ppm unless otherwise specified  
 T = element present; but concentration too low to measure  
 X = element concentration is below detection limit  
 - = element not determined

AUTHORISED  
OFFICER

*Jenkins*

073

135080

# ANALABS

A Division of Inchcape Inspection and Testing Services Australia Pty. Ltd.

## ANALYTICAL DATA

SAMPLE PREFIX		REPORT NUMBER			REPORT DATE		CLIENT ORDER No.		PAGE	
		999.66.08.07388			03/10/90		20232		3 OF 8	
SAMPLE No.	Au	AuChk	Ag	Ba	Ca	Cr	Cu	Fe	K	
A 105751	<0.008	-	<5	515	6.070	43	65	5.28	1.98	
A 105752	0.020	-	<5	524	5.230	48	26	5.44	2.15	
A 105753	0.020	-	<5	402	6.920	40	34	4.94	1.55	
A 105754	0.015	-	<5	316	6.170	34	20	5.29	1.21	
A 105755	0.025	-	<5	365	6.290	28	18	4.80	1.86	
A 105756	0.020	-	<5	430	6.060	27	13	5.25	2.20	
A 105757	0.010	-	<5	545	5.000	22	12	4.49	2.90	
A 105758	0.015	-	<5	400	5.890	68	22	3.43	2.16	
A 105759	0.015	-	<5	543	4.160	90	27	3.32	3.01	
A 105760	0.025	-	<5	685	5.950	116	8	4.62	0.90	
A 105761	<0.008	-	<5	935	2.710	681	116	6.63	0.96	
A 105762	<0.008	-	<5	530	3.520	78	31	3.76	2.65	
A 105763	0.010	-	<5	570	2.090	45	39	2.66	2.74	
A 105764	0.010	0.015	<5	340	3.750	224	25	2.95	1.83	
A 105765	0.035	-	<5	376	3.560	182	28	3.70	2.04	
A 105766	0.015	-	<5	826	1.550	45	44	3.42	4.45	
A 105767	0.015	-	<5	332	4.500	193	30	3.66	1.70	
A 105768	0.010	-	<5	270	3.580	219	22	3.07	1.40	
A 105769	0.010	-	<5	382	4.540	225	22	3.54	2.12	
A 105770	0.015	-	<5	302	3.590	232	34	3.66	1.86	
A 105771	<0.008	-	<5	239	5.690	304	28	2.89	1.45	
A 105772	0.025	-	<5	290	4.900	233	22	3.12	1.55	
A 105773	0.020	-	<5	297	3.890	221	40	2.40	1.48	
A 105774	<0.008	-	<5	219	5.100	203	40	2.66	1.40	
A 105775	0.015	-	<5	229	4.100	246	30	3.41	1.33	

Results in ppm unless otherwise specified  
 T = element present; but concentration too low to measure  
 X = element concentration is below detection limit  
 - = element not determined

AUTHORISED  
OFFICER

*Jenkins*



## ANALYTICAL DATA

SAMPLE PREFIX

REPORT NUMBER

REPORT DATE

CLIENT ORDER No

PAGE

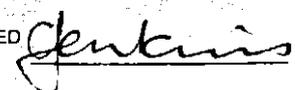
		999.66.08.07388				03/10/90		20232		5 OF 8	
TUBE No.	SAMPLE No.	Mg	Mn	Na	Nb	Pb	Ti	Y	Zn	Zr	
1	A 105701	4.420	6719	2.500	<10	186	2505	18	2034	86	
2	A 105702	1.160	742	0.045	12	<100	6223	35	330	117	
3	A 105703	1.660	1580	0.083	<10	<100	5353	29	154	86	
4	A 105704	1.740	1415	0.058	<10	<100	4608	26	116	92	
5	A 105705	1.880	1109	0.059	<10	<100	4331	26	86	92	
6	A 105706	1.750	970	0.053	<10	<100	4036	27	171	94	
7	A 105707	3.730	770	0.869	10	<100	3820	19	72	69	
8	A 105708	5.760	618	2.270	<10	<100	4206	22	95	74	
9	A 105709	5.320	758	3.340	<10	<100	4223	22	133	77	
10	A 105710	2.670	1402	0.076	<10	<100	2124	19	180	99	
11	A 105711	4.940	701	3.430	<10	<100	4252	22	89	75	
12	A 105712	4.510	774	3.360	<10	<100	3723	20	122	64	
13	A 105713	4.540	841	3.060	<10	<100	4039	22	154	68	
14	A 105714	4.300	841	3.210	<10	<100	4126	22	94	68	
15	A 105715	3.100	1178	1.910	<10	<100	3962	26	84	71	
16	A 105716	0.420	593	1.990	<10	<100	937	24	51	63	
17	A 105717	0.605	717	1.530	<10	<100	1365	29	59	88	
18	A 105718	0.972	631	0.405	<10	<100	2038	37	117	128	
19	A 105719	1.350	752	0.078	<10	172	3455	25	673	112	
20	A 105720	2.400	1883	0.392	<10	<100	3755	21	82	96	
21	A 105721	1.450	708	0.079	<10	<100	3098	25	305	98	
22	A 105722	1.550	621	0.179	<10	<100	3354	24	192	111	
23	A 105723	1.370	409	0.251	<10	<100	3712	24	298	108	
24	A 105724	1.320	432	0.260	<10	<100	3663	25	254	117	
25	A 105725	1.370	454	0.766	<10	100	3627	28	404	142	

Results in ppm unless otherwise specified

T = element present; but concentration too low to measure

X = element concentration is below detection limit

-- = element not determined

AUTHORISED  
OFFICER

082

135083

**ANALABS**

A Division of Incharge Inspection and Testing Services Australia Pty Ltd.

**ANALYTICAL DATA**

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE					
	999.66.08.07388	03/10/90	20232	6 OF 8					
SAMPLE No.	Mg	Mn	Na	Nb	Pb	Ti	Y	Zn	Zr
A 105726	1.350	263	0.799	12	<100	3478	41	216	235
A 105727	2.270	347	2.380	<10	<100	4138	29	268	154
A 105728	2.260	1060	2.440	<10	<100	2501	17	234	64
A 105729	2.680	1079	2.910	<10	<100	2189	14	220	48
A 105730	4.460	1645	1.350	<10	<100	2872	13	272	51
A 105731	4.350	6426	2.490	<10	172	2521	18	1995	78
A 105732	2.860	1276	2.960	<10	<100	2551	19	251	69
A 105733	4.170	1339	2.050	<10	<100	2817	18	274	80
A 105734	4.970	1358	1.960	<10	<100	2620	16	204	75
A 105735	4.510	1461	1.770	<10	<100	2374	15	253	65
A 105736	3.190	1310	2.960	<10	<100	2363	16	400	59
A 105737	2.630	1000	2.450	<10	<100	2530	18	321	86
A 105738	2.580	1484	2.080	<10	<100	2566	23	218	108
A 105739	3.560	1085	1.970	<10	112	3075	24	437	119
A 105740	3.740	1383	1.920	<10	<100	2107	14	487	58
A 105741	5.250	900	2.530	<10	100	3053	15	413	53
A 105742	2.930	1309	2.780	<10	<100	2602	14	164	47
A 105743	5.010	1179	2.270	<10	<100	3317	14	260	62
A 105744	4.860	1311	2.160	<10	<100	3321	19	302	63
A 105745	5.110	1361	2.030	<10	<100	2941	16	206	55
A 105746	4.270	1570	1.340	<10	<100	2797	13	261	48
A 105747	4.070	1464	1.360	<10	<100	2623	13	203	50
A 105748	2.110	983	0.885	<10	463	3214	22	165	97
A 105749	2.240	889	1.280	<10	<100	4579	25	168	143
A 105750	1.300	349	0.237	<10	<100	3533	22	207	104

Results in ppm unless otherwise specified  
 T = element present; but concentration too low to measure  
 X = element concentration is below detection limit  
 - = element not determined

 AUTHORISED  
 OFFICER
 

## ANALYTICAL DATA

SAMPLE PREFIX

REPORT NUMBER

REPORT DATE

CLIENT ORDER No

PAGE

		999.66.08.07388				03/10/90		20232		7 OF 8	
TUBE No.	SAMPLE No	Mg	Mn	Na	Nb	Pb	Ti	Y	Zn	Zr	
1	A 105751	2.170	1192	0.762	<10	<100	4204	23	137	127	
2	A 105752	2.630	1317	0.598	11	<100	4286	22	161	138	
3	A 105753	2.090	1087	1.110	<10	<100	4075	23	160	127	
4	A 105754	2.540	962	1.450	10	<100	4238	23	217	135	
5	A 105755	2.460	1042	0.848	<10	<100	3846	23	129	127	
6	A 105756	2.130	1286	0.715	<10	<100	3621	21	121	100	
7	A 105757	2.290	1903	0.364	<10	<100	3498	20	65	89	
8	A 105758	1.720	2429	0.061	<10	<100	2558	20	50	74	
9	A 105759	1.740	1753	0.145	<10	<100	2584	24	65	95	
10	A 105760	4.340	759	3.220	<10	<100	3646	20	127	63	
11	A 105761	4.260	6333	2.470	<10	177	2446	18	1972	76	
12	A 105762	2.060	1284	0.324	<10	<100	2611	24	95	105	
13	A 105763	1.260	533	0.086	15	181	2646	320	230	142	
14	A 105764	2.340	1127	0.074	<10	<100	1818	16	567	85	
15	A 105765	2.950	1360	0.080	<10	<100	2098	17	263	101	
16	A 105766	2.170	516	0.104	15	235	3837	36	248	191	
17	A 105767	3.090	1244	0.077	12	<100	1831	14	119	83	
18	A 105768	2.290	983	0.059	<10	<100	1712	14	140	71	
19	A 105769	2.720	1334	0.072	<10	141	2103	18	182	97	
20	A 105770	3.190	985	0.103	<10	100	2300	17	421	95	
21	A 105771	2.650	1687	0.056	<10	<100	1421	15	62	43	
22	A 105772	2.820	1283	0.064	<10	<100	1596	13	83	77	
23	A 105773	2.180	938	0.056	<10	<100	1680	12	194	70	
24	A 105774	2.510	1367	0.058	<10	<100	1447	14	140	62	
25	A 105775	2.870	1129	0.072	<10	<100	1746	13	204	76	

Results in ppm unless otherwise specified  
 T = element present; but concentration too low to measure  
 X = element concentration is below detection limit  
 -- = element not determined

AUTHORISED  
OFFICER

*gentianis*



### Analytical Standard Material

---

The material used as an external analytical standard in the batch of MXRD 1 side grind fillet samples (Sample Numbers: 105701, 105731, 105761) was supplied by Aberfoyle Exploration P/L.

A. McNeill (pers. comm.) has advised that this standard material is expected to return analytical results within the following ranges when analysed by AAS and XRF methods:

Cu	115 - 130	(ppm by AAS)
Pb	180 - 250	"
Zn	2300 - 2400	"
Ag	<0.5	"
Au	<0.008	"

Ba	1100 - 1300	(ppm by XRF)
As	15 - 22	"
Ti	2450 - 2500	"
Cr	920 - 960	"
Zr	80 - 90	"

The three samples of standard material analysed in the batch of MXRD 1 samples by ICP-OES and 30g fusion/AAS actually returned results in the following ranges:

	Range	Mean	S.D.	
Cu	114 - 116	115	1	(ppm by ICP-OES)
Pb	172 - 186	178	7	"
Zn	1972 - 2034	2003	31	"
Ag	all <0.5	<0.5		"
Ba	935 - 1043	994	55	"
Ti	2446 - 2521	2491	40	"
Cr	636 - 725	681	45	"
Zr	76 - 86	80	5	"
Au	<0.008 - 0.01			(g/t by fusion/AAS)

From these few results it may be tentatively concluded that the ICP method has produced similar results for Cu, Pb, Ag and Ti but rather lowish values for Zn, Ba and Cr than the more commonly applied methods of AAS and XRF.

**Appendix IV:**

A.J. Crawford, 1990;

Report on Geochemistry and Implications of Lavas in  
Dept of Mines Drillhole MXRD-1 on Outokumpu EL 14/85,  
Mt Cattley

**REPORT ON GEOCHEMISTRY AND IMPLICATIONS OF THE  
LAVAS IN DEPT OF MINES DRILLHOLE MXRD-1 ON  
OUTUKUMPU EL 14/85, MT CATTLEY**

**Anthony J. Crawford  
13/11/90**

**For Outukumpu Exploration (Aust.)**

## SUMMARY

Available chemical data for the Mines Dept Mt Cattley stratigraphic hole MXRD-1 is reviewed, and six lithochemical units are recognized, including an upper unit of dolerite, four basalt units, and a basal andesite unit. The basalts are confidently correlated with the Hellyer Basalts, and the andesites with the Que Footwall Andesites. Black shale overlying the basalts is correlated with the Que Rv Shale, and greywackes underlying the andesites are correlated with the Animal Creek Greywacke. Thus the exact stratigraphic sequence present in the VMS deposit-rich Que-Hellyer area is shown to persist some 10km further north, in the Mt Cattley area. This enhances the exploration potential of the area, but introduces some apparent problems with existing interpretations of the local geology in the Mt Cattley - Back Peak region.

Several recommendations for further drilling are offered, including:

1: deepening Outukumpu hole MCDD-5 to test whether the extensive silicification at the base of the hole is related to fluids associated with a major thrust fault hypothesized to pass just to the east of MCDD-5's collar location; this is a potential analog for the Au deposits in the Henty Prospect, where Au is associated with extensive silicification along the Henty Fault system.

2: drilling an inclined hole southward from a position about 300m due south of the position of MRDD-1, to try to intersect, and drill along the horizon around the contact of the basal basalts (Unit 5) and the underlying andesites (Unit 6). This horizon is equivalent stratigraphically to the "Mixed Sequence" of the Que-Hellyer region, that host both the Que and Hellyer VMS deposits.

MXRD-1 Correlations

I

## INTRODUCTION

In 1987-88, Outukumpu Exploration (Austr.) drilled five holes (MCDD 1-5) in their Mt Cattley EL 14/85, through Tertiary basalt into the unexposed correlates of the Mt Read Volcanics. A petrological-geochemical investigation of the lavas in the lower sections of drillholes MCDD-2 and 3 (Crawford 1989) showed that these were andesitic, and best correlated with the Footwall andesites in the Que-Hellyer region. No correlates of the Hellyer basalts were encountered in these drillholes. Subsequently, the Dept of Mines drilled a stratigraphic test hole MXRD-1 (Fig. 1) about 1.3km due south of MCDD-1, based on information from regional mapping and the Outukumpu drillholes. This was aimed at intersecting correlates of the Hellyer basalt and the economically important 'Mixed Sequence' at Que and Hellyer, that hosts the major VMS orebodies presently being mined. The presence of a relatively thick pile of andesitic to basaltic lavas in MXRD-1, sandwiched between a black shale above and a greywacke sequence below is tantalizingly similar to the mine sequence at Hellyer. Therefore, the main aim of the work I have been asked to carry out in this instance centres on using the available geochemical data to prove or disprove a correlation between the MXRD-1 lava sequence and the Hellyer area lava sequence. If the sequence at Mt Cattley can be confidently correlated with that in the Hellyer-Que area, then this extends the ground with high exploration potential some 10km further north, and demands that sub-Tertiary basalt exploration be employed.

In an Appendix I provide:

1: a lithochemical log of the Mines Dept stratigraphic hole at Mt Charter (MCH-1) with some comments on the chemical units recognized, 2: a brief review of the Que-Hellyer lava stratigraphy and chemistry in the mines area, and 3: a review of the logs and geochemical data provided earlier (Crawford 1989) for the Outukumpu Mount Cattley drillhole MCDD-1 and -2.

The hole MXRD-1 reached a depth of 750m, and was logged in detail by Wally Herrmann. His abbreviated log is shown below. Geochemical data obtained by Analabs on fillet core grinds of the entire core was supplied to me by Wally Herrmann. Before attempting an assessment of the data provided, I offer some comments about the choice of elements that should and should not be selected for analysis in projects aimed at local and regional correlation of volcanics in exploration programs. I also offer some comments on the philosophy of correlations in volcanic terrains.

MXRD-1 Correlations

## LITHOLOGICAL LOG: MXRD-1 (Mt Cattley): W. Herrmann

DEPTH (m)	LITHOTYPE
0 - 184.6	Tertiary basalts and lava breccias
184.6-225.2	Turbiditic siltstones and greywackes
225.2-292.4	Dolerite intrusion
292.4-301.5	Felsic pumiceous tuff-breccias
301.5-305	Mixed felsic epiclastic-black siltstone/shale
305-352.6	Black siltstone-shale
352.6-355.5	Felsic - mafic lithic epiclastic breccia
355.5-525.2	Andesitic lavas and breccias
525.2-525.5	Andesitic volcanoclastic wacke
525.5-597.8	Andesitic lavas and breccias
597.8-598	Greywacke
598-608.4	Felsic pumiceous tuff/epiclastic sandstone
608.4-610.2	Felsic volcanoclastic siltstone
610.2-626.7	Turbiditic greywacke and siltstone
626.7-628.3	Pumiceous epiclastic jumble breccia
628.3-750EOH	Turbiditic greywacke and siltstone

**SELECTION OF ELEMENTS FOR DIAGNOSTIC GEOCHEMISTRY AND REGIONAL - LOCAL CORRELATION OF ALTERED VOLCANICS, WITH PARTICULAR EMPHASIS ON THE MOUNT READ VOLCANICS**

In sequences of altered lavas, it is obvious that different styles of alteration, and variable vein assemblages, produce differing extents and directions of modifications of the primary rock composition. The common vein and alteration minerals and assemblages in Mount Read Volcanic lava sequences, such as calcite, quartz, sericite, chlorite and to a lesser extent pyrite and barite, indicate that SiO<sub>2</sub>, CaO and the alkalis (Na, K, Sr, Rb, Ba..) are all mobile to some extent during both regional burial metamorphism, and more localized hydrothermal alteration. Therefore, in assessing the geochemical data from such lava suites with regard to determining primary affinities or making regional or local correlations, due weight should be put on those elements and element ratios which are known to be essentially immobile during such post-eruptive alteration. These so-called immobile elements are those with a high charge to radius ratio, ie. Ti, Nb, Ta, Hf, Zr, Y, P, rare earth elements (REE), and some transition elements such as Sc, V, and normally Ni and Cr. During several years of studying the geochemistry of the Mount Read Volcanics, most recently the thick basalt-andesite sequences in the subsurface west of Hellyer (Rept. for Placer Expln., 1990), I have found that the following elements and ratios are most useful.

1: TiO<sub>2</sub>, Zr and Ti/Zr. For the Mount Read Volcanics (MRV), and most other suites of arc-related lavas I am familiar with, Nb data is useless, due mainly to its low abundance levels in arc-type lavas. I suggest that it is not worth the expense of analyzing for Nb. I rarely use Y abundances for diagnostic geochemistry. XRF data seems fairly sloppy, and for the MRV I am not convinced that the primary range of Y warrants using this element as a petrogenetic indicator; this is shown, for example, by the remarkably scattered points on the Y - SiO<sub>2</sub> diagram for the Central Volcanic Complex lavas, a data spread much greater than that for much more 'mobile' elements such as CaO (Fig. 2). I suggest also, therefore, that it is not worth analyzing for Y. Perhaps the most useful single discriminant is Ti/Zr; analysis is accurate, and it is apparently very effective in defining magmatic units within a pile of lavas.

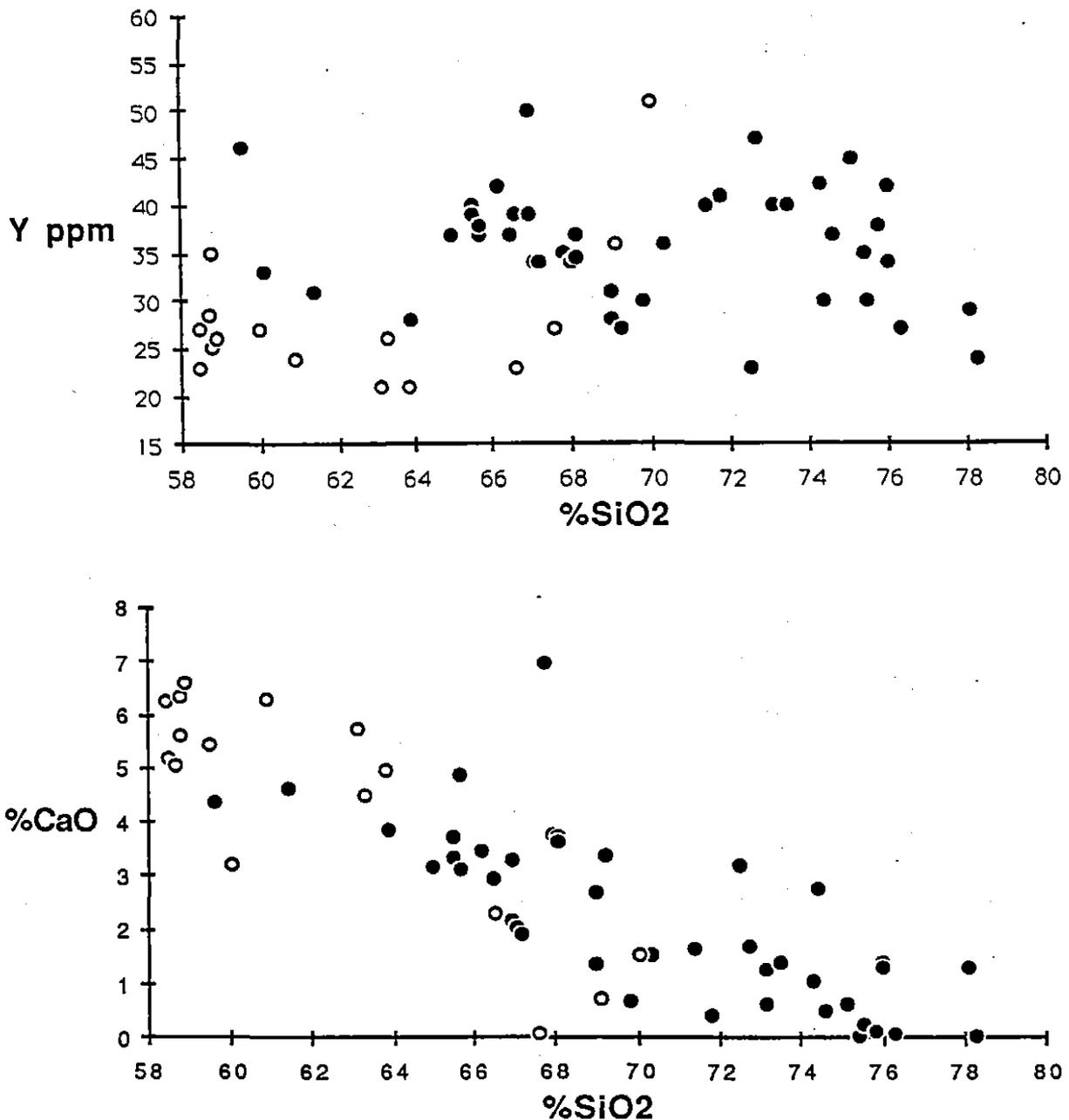


Figure 2: Y-SiO<sub>2</sub> and CaO-SiO<sub>2</sub> plots for Central Volcanic Complex Groups 1 (closed circles) and Group 2 (open circles) lavas, showing the lack of any predictable or interpretable relationship between Y and SiO<sub>2</sub>. CaO is notoriously mobile (calcite veining, albitization of calcic plagioclase), yet for the carefully selected CVC samples analyzed, CaO still shows a broad negative correlation against SiO<sub>2</sub>. In contrast Y, always considered to be a useful immobile element during alteration of lavas, shows a shotgun scatter of primary abundances, and is thus considered to be an uninformative element, not worth analyzing for programs investigating regional correlation of volcanic units.

MXRD-1 Correlations

2: REE patterns. These cost around \$40-60 per sample, but are of exceptional value in the petrogenetic interpretation of the suites involved, and in correlation of lava units. Once units are defined on the basis of major and trace element geochemistry, only a single sample from each unit need be analyzed for REE to obtain optimum information. As shown further on, for the Mines Dept Hole in question (MXRD-1), I can split the dolerite + lava sequence into about 6 petrochemical units (covering some 375m of core). Thus only 6 REE analyses would be sufficient to effectively diagnose this sequence and compare and contrast it with other characterized sequences in the region.

3: Due to the expense and time (~1 month to get data) involved in obtaining REE analyses, I have found P2O5 abundances to be a useful substitute. P2O5 abundances are very useful for local and regional correlations within the Mount Read Volcanics. This is because much of the MRV is composed of high-K andesites and shoshonitic basalts which have generally high P2O5 contents (0.2-1.5%) that are directly proportional to REE abundances. Also, there is an indication from my work that in a given pile of basalts (eg W of Hellyer) at a given MgO content, P2O5 abundances generally increase upwards in the pile.

4: Cr abundances are also useful, both for judging how 'primitive' a lava is in the absence of MgO data, and for differentiating between lava units/suites that have similar Ti/Zr and P2O5 contents. For instance, in the Mines Department Mount Charter hole MCH-1, there is a 150m-thick unit of Hellyer-type basalts with Ti/Zr = 34-44, P2O5 ~ 0.35%, but very low Cr abundances (<70ppm). In the Placer holes that penetrated the same stratigraphic section W of the Murchison Hwy, there are quite a few units of basaltic lavas with similar Ti/Zr and P2O5 contents as this MCH-1 unit, but the Placer basalts have Cr abundances usually in excess of 500ppm, and cannot be the same unit.

5. Of the major elements, MgO is probably the most useful, as it gives an indication of the degree of differentiation of the sample, and can be used in a general way to infer SiO2 abundances. FeO abundances are useful, as FeO vs SiO2 for any group of fairly unaltered Mt Read Volcanics forms a tight inverse correlation (Fig. 3); if FeO falls above the line shown in

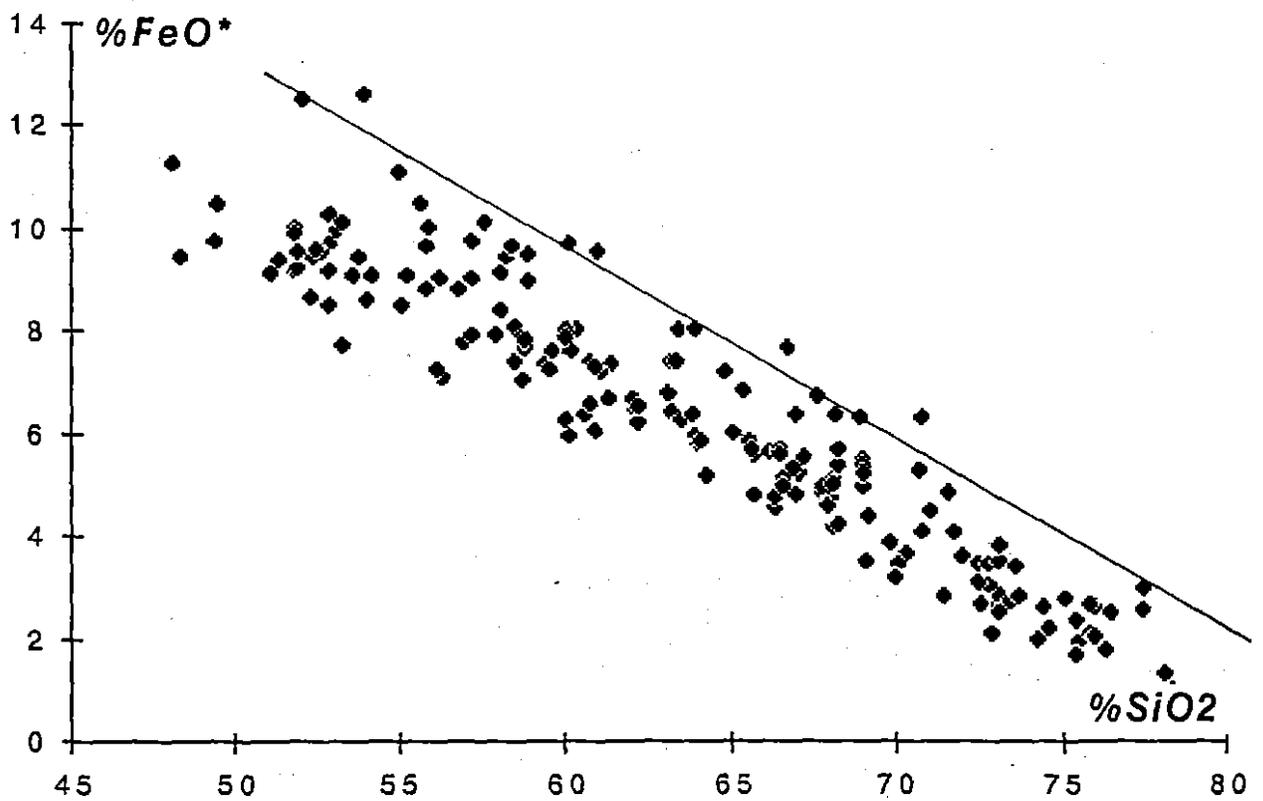


Figure 3: FeO\* versus SiO<sub>2</sub> plot for all analyzed "well-preserved" Mount Read Volcanics, showing the well-defined negative correlation defined as FeO\* decreases in abundance during fractionation. Any sample plotting above the trend might be suspected to show minor pyrite- or magnetite alteration.

MXRD-1 Correlations

5

Figure 3, pyrite- or magnetite alteration/mineralization (albeit volumetrically very small) might be suspected. In the absence of thin section data, this information is useful in assessing alteration style, and whether or not that sample might be useful in diagnostic comparisons with other units/suites in the region. CaO, Na<sub>2</sub>O, K<sub>2</sub>O, Ba, Rb and Sr are generally highly mobile, and their abundances are only useful in assessing extents and styles of alteration; they are of little or no use in regional or local correlation.

Some examples of the utility of the selected elements and element ratios mentioned above are shown below, using data from the MRV. Figure 4a-d shows how simple element ratios such as Ti/Zr and TiO<sub>2</sub>/P<sub>2</sub>O<sub>5</sub> can effectively discriminate the main lava suites within the Mount Read Volcanics. Figure 5 shows how similar 'diagnostic' element ratios and abundances can clearly separate different lava units within a single drillhole, enabling correlation of lava units between holes.

**CORRELATION of STRATIGRAPHIC UNITS in VOLCANIC TERRAINS**

The broad scale regional correlations attempted further on are made with the following provisos and cautions foremost in my mind. Firstly, anybody who has worked in a modern arc-type volcano-tectonic setting such as might be encountered for example, in Indonesia or Japan, is well aware that individual volcanic facies are likely to be variable and impersistent, both along strike away from the source, and laterally. Some lava flows may be extensive along one flank of a volcano, whereas no record of these flows might be evident on the opposite flank of the same edifice. Likewise, pyroclastic eruptions are notoriously directional, and whereas they may be extensive for tens of kilometers in one direction, little evidence of their existence might be preserved or evident in the opposite direction away from the source.

The examples referred to above in Japan and Indonesia etc would all be essentially subaerial volcanic manifestations. Much less is known of submarine volcanism, particularly deep water, explosive, arc-type volcanism. Underlying greywackes, the presence of thick pillow lava sequences, and marine fossils in the Que Rv Shale all indicate that the volcanism that produced the lava pile in the Mt Charter - Hellyer - Mt Cattley region was submarine, and probably quite deep water. Whether

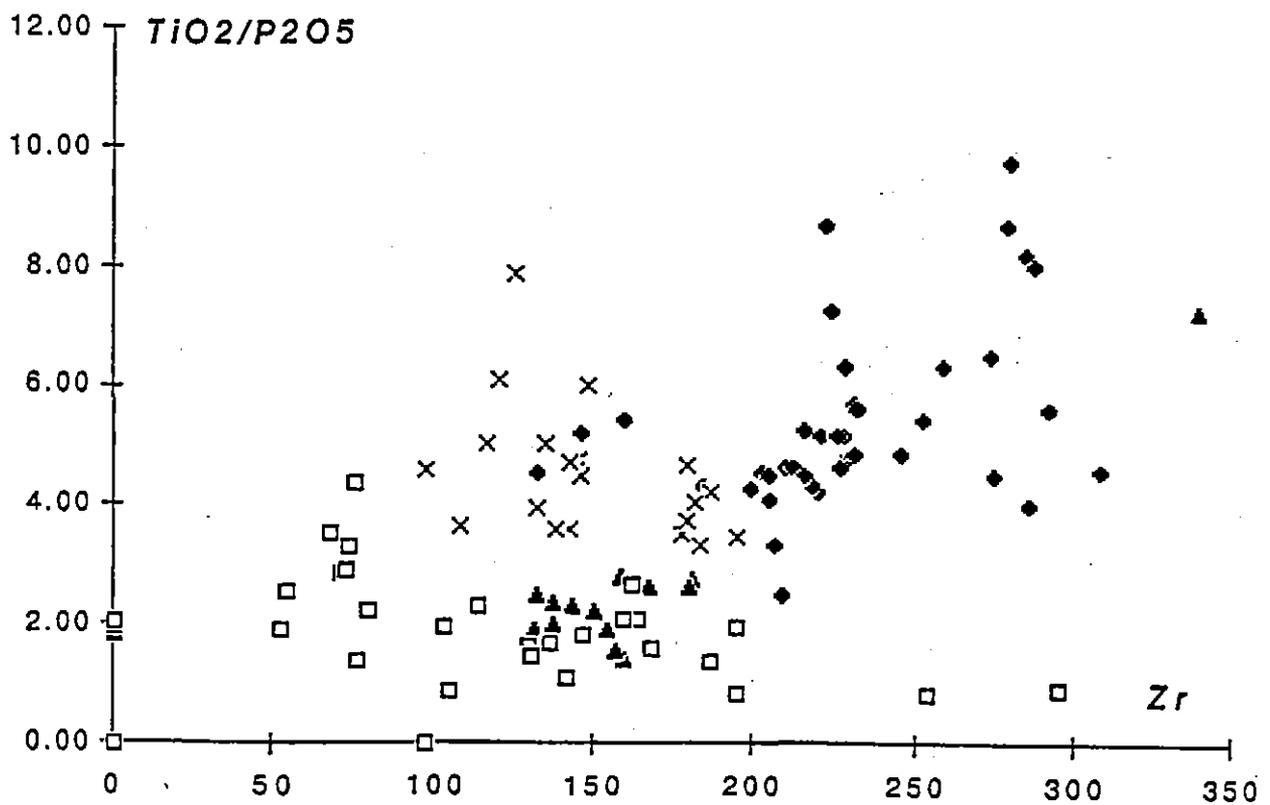
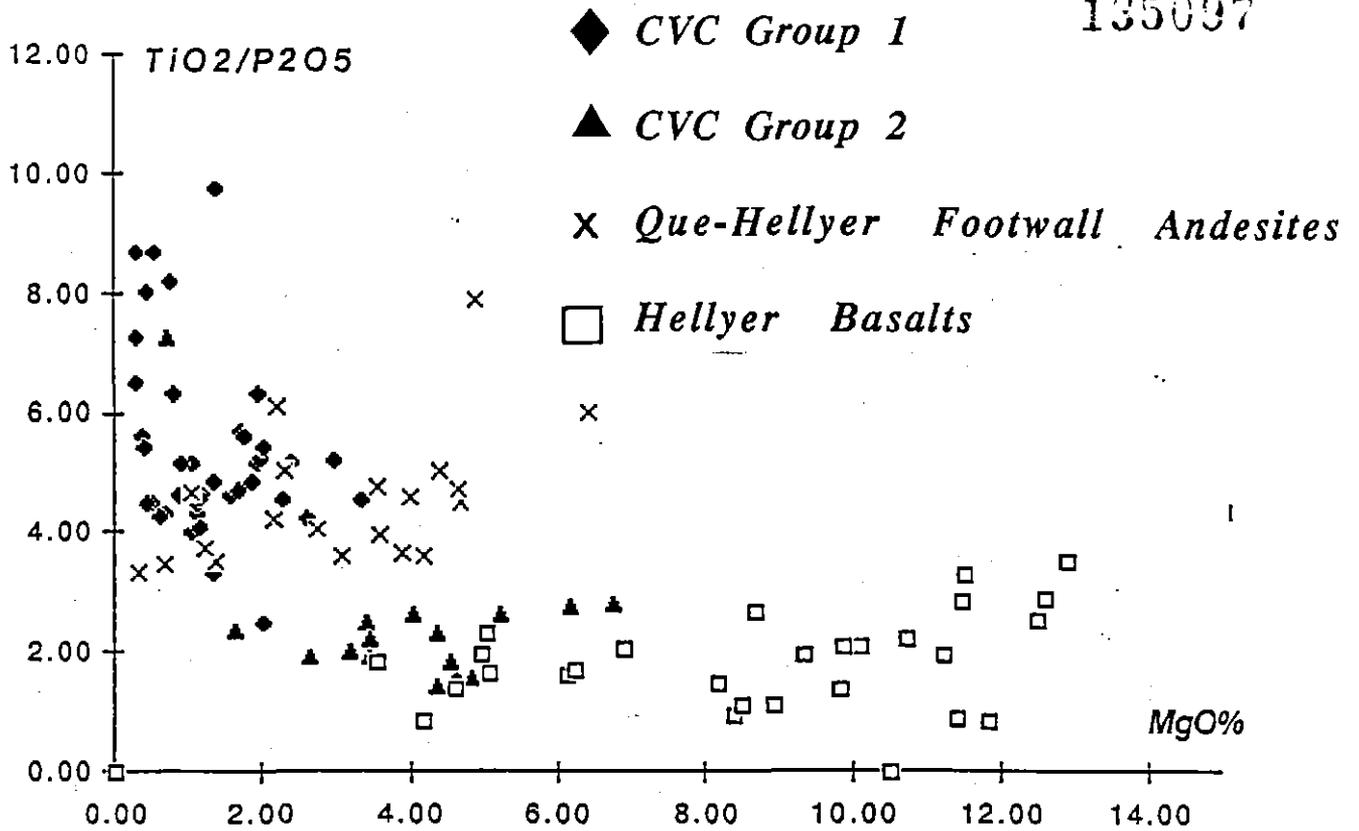


Figure 4a-d: Immobile element variation diagrams using only Ti, P, Mg and Zr, for the main lithostratigraphic units in the Mount Read Volcanics, showing that well-defined compositional fields exist for each group, enabling regional correlation.

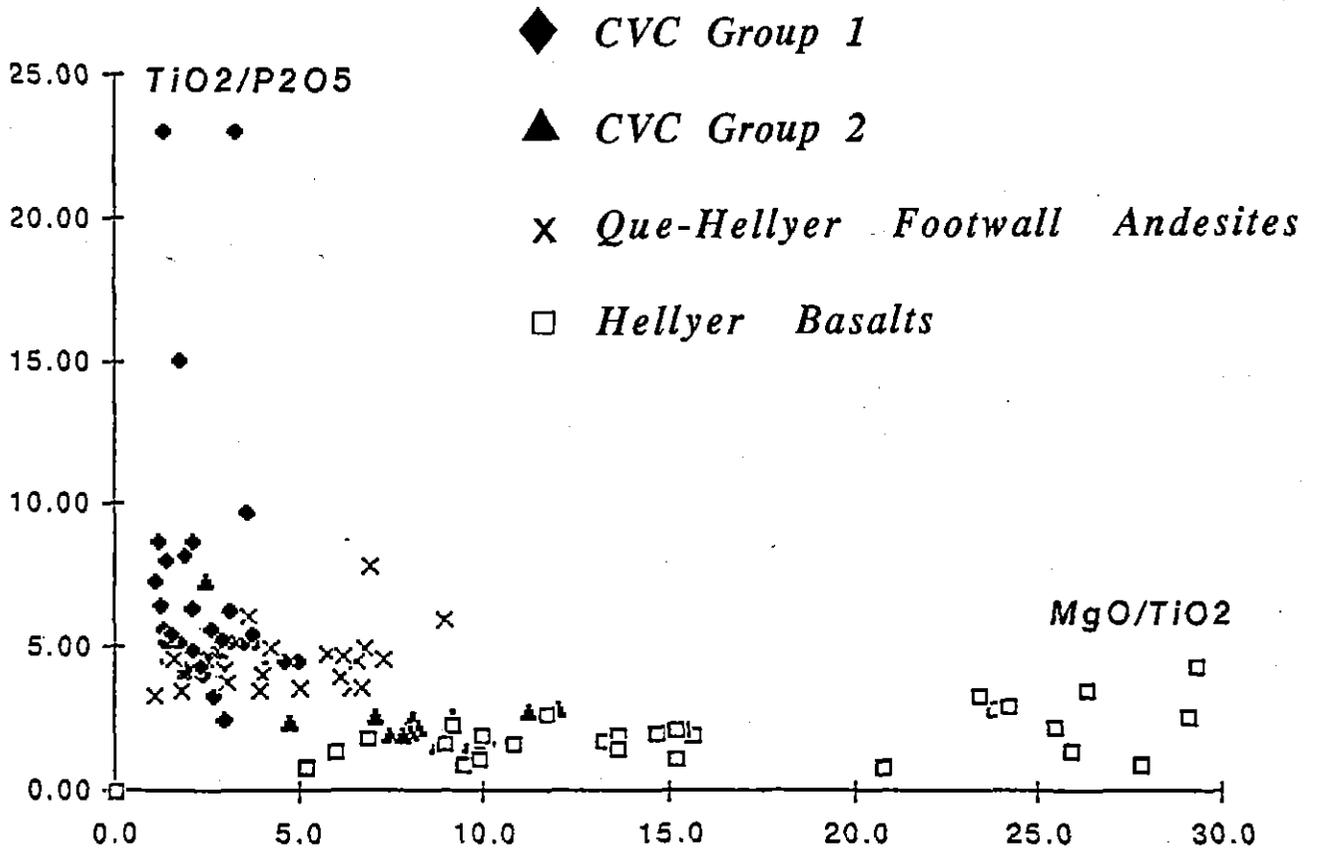
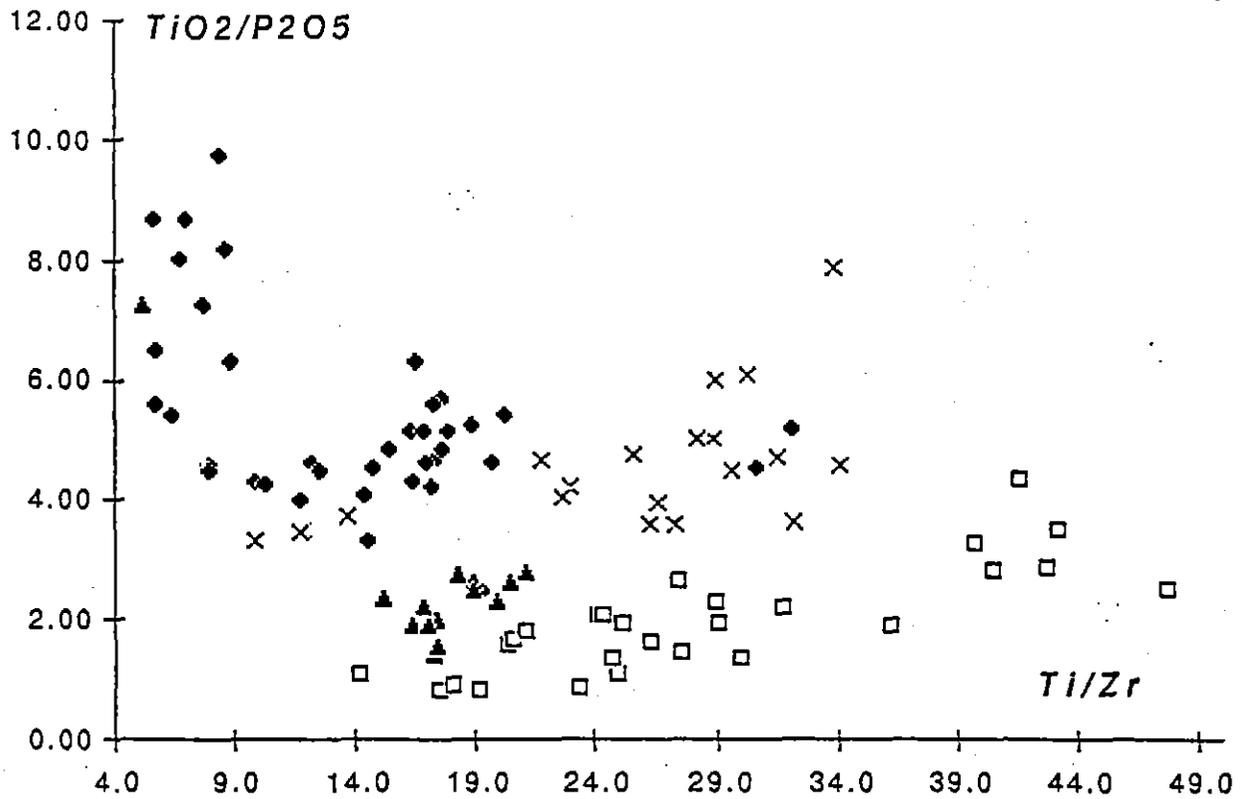


Figure 4a-d (continued): Immobile element variation diagrams using only Ti, P, Mg and Zr, for the main lithostratigraphic units in the Mount Read Volcanics, showing that well-defined compositional fields exist for each group, enabling regional correlation.

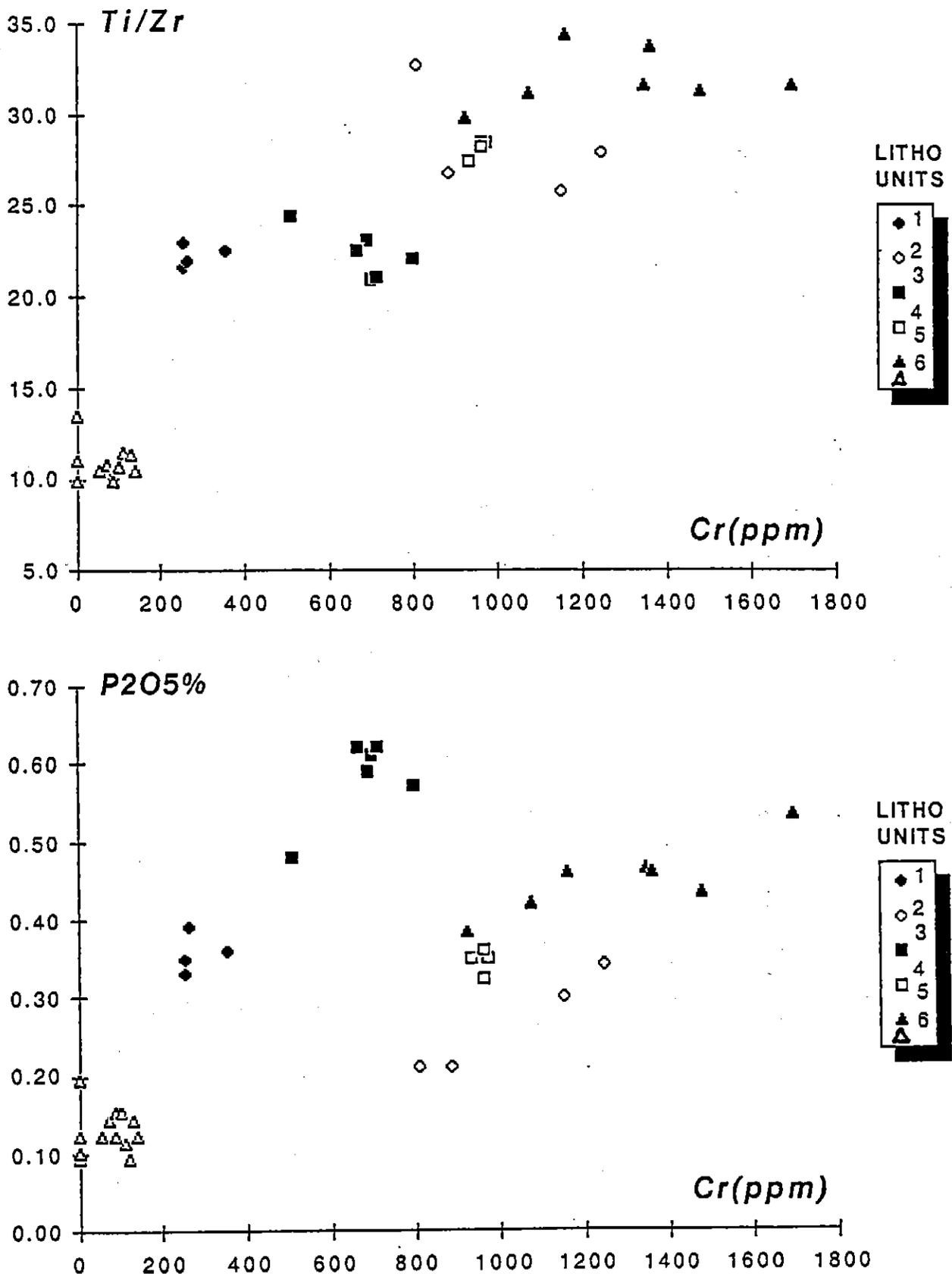


Figure 5: Discrimination diagrams using immobile elements Ti, Zr, Cr and P, showing that distinct compositional lava units within a drilled sequence of lavas (in this case, a hole W of Hellyer) can be clearly distinguished, and thus correlated between holes and regionally.

volcanism in such a volcano-tectonic rift was fault-controlled and diffusely spread along major submarine fissures, or whether it occurred more focussed, as overlapping eruptions from major volcanic edifices, remains unknown, even for many modern such submarine settings. If, in the case of the Que-Hellyer area, the volcanic pile was generated by eruptions from major cones, there would be little reason to expect to be able to correlate individual basaltic (compositional) units over any distance. If volcanism was more fissure-controlled, it is likely that basaltic units might be more extensive and thus traceable over larger distances (1 - 10km ?). Presently, I don't think enough information is available for the area in question to be able to judge whether fissure or focussed eruptions were more important in building up the Que-Hellyer-Bulgobac lava pile. In fact, there is not even enough data, in my opinion, to rule out the possibility that the area between Hellyer - Mt Charter - Mt Cattley - Beulah, originally constituted several subparallel small rifts or basins within a broader submarine volcano-tectonic rift.

A second point to keep in mind is that some compositional features of basaltic lavas reflect only shallow magma chamber processes, whereas others are inherited from their mantle source, and will not change very much with fractionation. For example, the Ti/Zr value, and especially the abundance of P<sub>2</sub>O<sub>5</sub> in basalts with more than 7-8% MgO, essentially reflect their mantle source value. The abundance of P<sub>2</sub>O<sub>5</sub> in the basalts analyzed from the Hellyer - Mr Charter - Mt Cattley area varies by almost a factor of twenty, from about 0.05 - 0.9%, and therefore reflects a source feature. Furthermore, basalts with broad arc geochemical signatures (eg low TiO<sub>2</sub>, Nb abundances) but with more than ~0.2% P<sub>2</sub>O<sub>5</sub> are most unusual and distinctive; those with P<sub>2</sub>O<sub>5</sub> in excess of around 0.4 - 0.5% might be referred to as shoshonites, and carry important tectonic implications. It is worthwhile, therefore, to carefully observe the distribution of P<sub>2</sub>O<sub>5</sub> in the cores analyzed. Unfortunately, P<sub>2</sub>O<sub>5</sub> abundances are not presently available for the MXRD-1 samples analyzed, making correlations to this area tenuous. However, some sensible correlations can certainly be made based on the wealth of data available for andesitic-basaltic lavas from the Hellyer - Bulgobac and Mt Cattley areas.

## CORRELATION OF THE MXRD-1 SEQUENCE

A detailed core log and sections through the stratigraphy around MXRD-1 have been supplied by Wally Herrmann. No petrographic data is presently available. The data provided for the dolerites, basalts and associated lavas from MXRD-1 west of Mt Cattley on Outukumpu's Mt Cattley EL 14/85 can be compared with

- 1: data for lavas in the sequences slightly further east drilled by Outukumpu (Crawford 1989),
- 2: data for the lavas around Hellyer and in the Mines Dept hole MCH-1 at Mt Charter (Corbett and Komysan 1989; Stolz and Large, AMIRA Report August 1988),
- 3: unpublished data from lava sequences beneath the Que River Shale from W of the Murchison Hwy.

As mentioned in the introduction, a key feature of this drillhole is the presence of a volcanic package dominated by andesites and basalts, sandwiched between a lower greywacke sequence and an upper black shale - siltstone sequence. This succession is very reminiscent of that which hosts the major VMS deposits at Que Rv and Hellyer. In the following pages, an attempt is made using available data to prove this correlation with the Hellyer stratigraphy, and hopefully, enhance the exploration potential of this area.

## COMPOSITIONAL GROUPING OF LAVAS IN MXRD-1

### BACKGROUND METHODOLOGY

A problem in interpreting data supplied in the form of the Analabs data for MXRD-1 is that there is no way of determining, in the absence of thin section petrographic descriptions, just how altered the analyzed samples were. This translates into a good deal of uncertainty when interpreting analyzed MgO, FeO etc abundances. Normally, extent of alteration can be judged by a rock's loss-on-ignition contents; these are unavailable for the rocks being examined. Loss on ignition provides a useful guide to how altered a particular sample is, in the absence of

MXRD-1 Correlations

petrographic information. Samples analyzed with 10-12% CaO (for instance, some of those in Units 2 and 3) might reasonably be expected to have high calcite contents (veining?).

This problem can largely be circumvented using abundances of immobile elements, although these abundances might be diluted, for example, by extensive calcite or quartz veining. It is most appropriate, therefore, to use ratios of immobile elements. In this way, any enrichment or dilution factor due to volume loss, or veining by 'normal' vein minerals, applies equally to each element in the ratio, and can be eliminated. Thus Ti/Zr is selected as the most useful and informative ratio. Both these elements are immobile, and this ratio shows two important diagnostic features:

1: it's value decreases relatively smoothly in any comagmatic lava suite from basalt through to rhyolite (Fig. 6a), and

2: within the basalt compositional range (broadly 45-55% SiO<sub>2</sub>), there exists within the Mount Read Volcanics a wide spectrum of initial Ti/Zr values for various parental basalt types. This is due to several factors, mainly source mantle composition control, the extent of melting involved in generating that basaltic magma batch, and the extent of fractionation suffered by the parental basalt before eruption and solidification. In the Hellyer - Cattley - Sock Ck region, basaltic lavas with 6-8% MgO (or more) can have Ti/Zr values anywhere from 18-20 up to 60. Importantly, each magma batch (lava unit, or eruptive unit?) has a distinctive Ti/Zr that may be quite unlike that of the flows above and below it, rendering it possible to determine a relatively simple chemical stratigraphy. This is the approach taken herein.

From the data supplied for the dolerite and lava-lava breccia units logged in MXRD-1, I have distinguished 6 petrochemical units (Fig. 7). These are listed below (MgO data are culled for highly altered samples, such as for margins of dolerite sill):

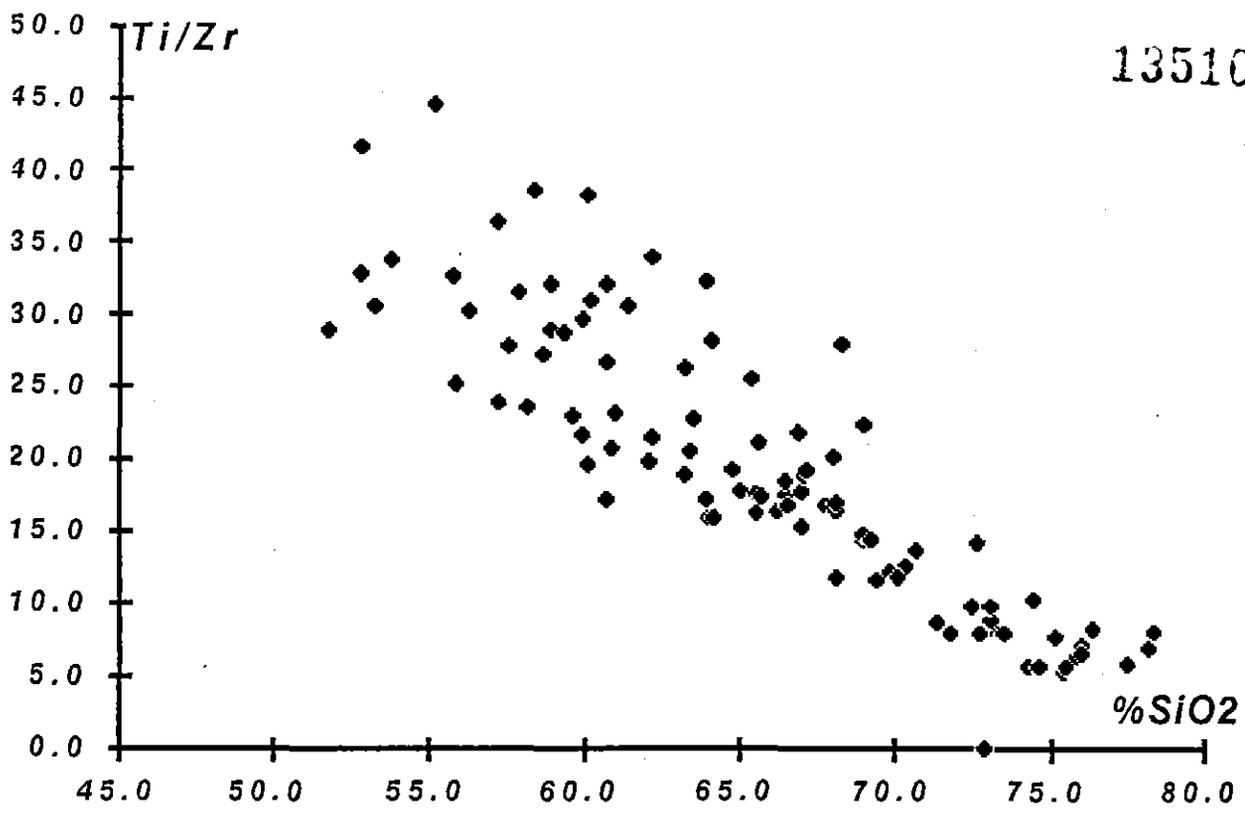


Figure 6a: SiO<sub>2</sub> versus Ti/Zr diagram for Central Volcanic Complex lavas from the Mount Read Volcanics. The general decrease in Ti/Zr with increasing fractionation within a suite enables correct characterization of highly altered lavas (eg chloritized dacites that might otherwise be judged to be andesitic to basaltic based on hand specimen interpretation).

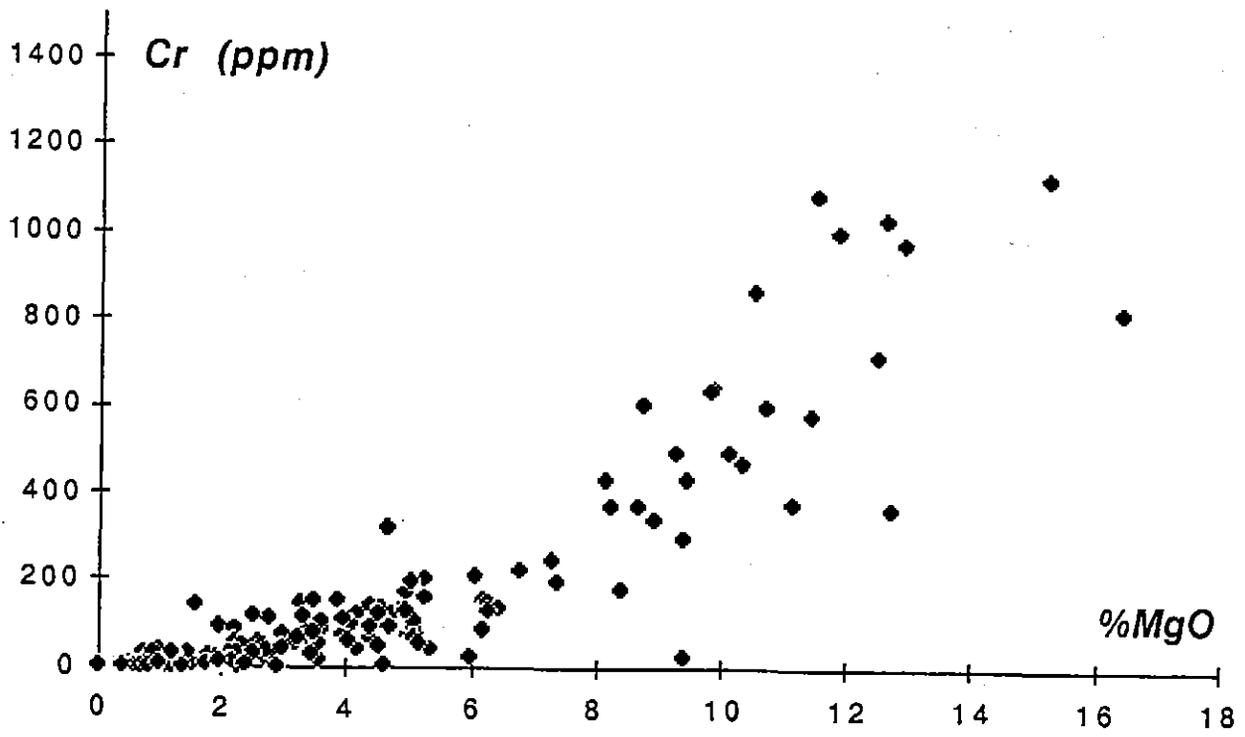
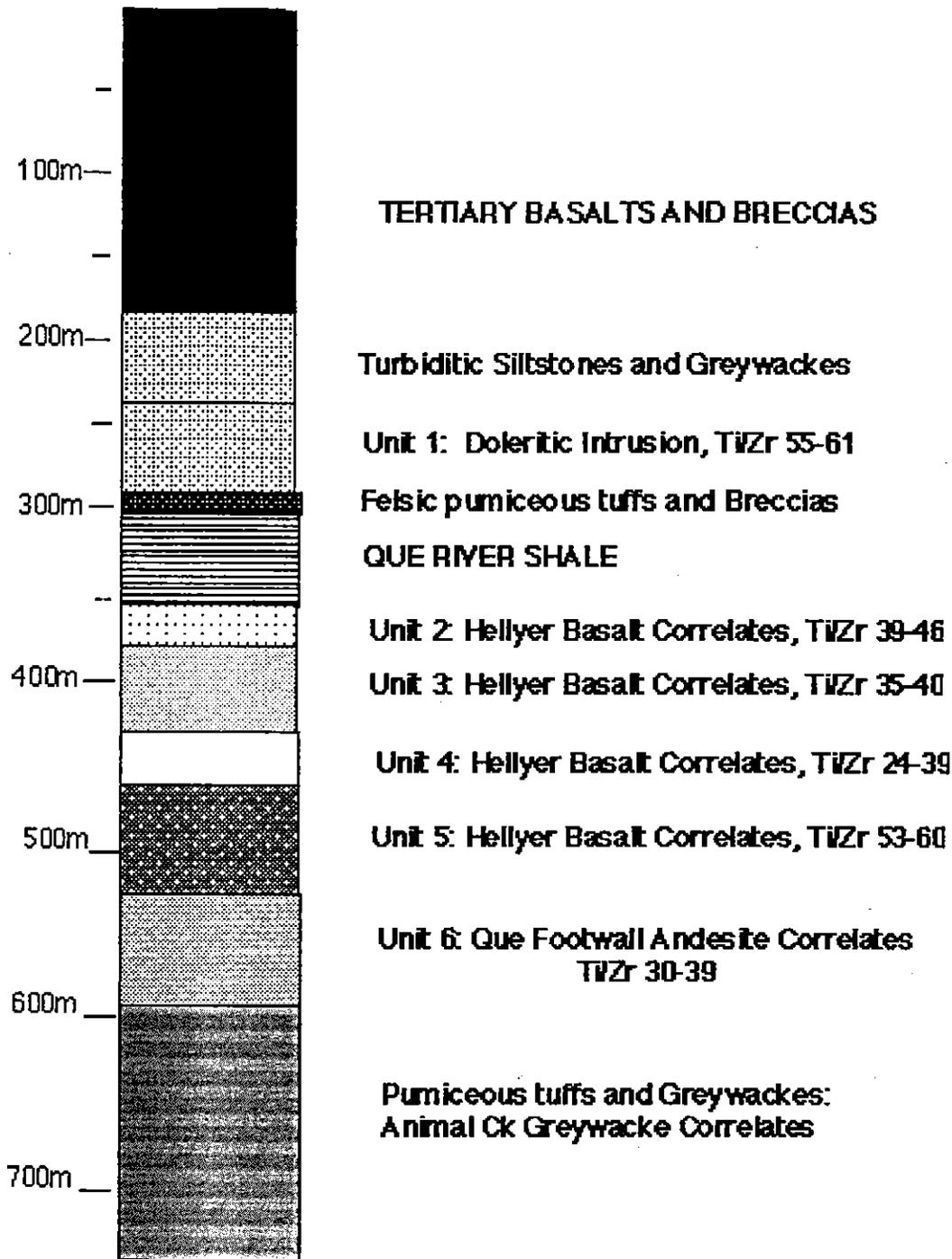


Figure 6b: Plot of MgO versus Cr (ppm) for all analyzed (by XRF) Mount Read Volcanics from the Que-Hellyer region. Note that only basalts with more than around 6% MgO have Cr abundances in excess of 200ppm. This implies that the ICP analytical data for MgO for the samples from MXRD-1 are highly suspect, and probably well below real values.

105



# MXRD-1

Figure 7. Lithochemical log of drillhole MXRD-1, Mt Cattley EL 14/85

MXRD-1 Correlations

## CHEMICAL STRATIGRAPHY OF IGNEOUS ROCKS IN MXRD-1

UNIT	DEPTH(m)	%TiO <sub>2</sub>	Zr (ppm)	Ti/Zr	%MgO	Cr(ppm)
1.	225-297	0.62-0.70	64-77	55-61	4.3-5.8	103-127
2.	360-380	0.37-0.42	48-64	39-46	2.3-2.7	338-417
3.	380-430	0.39-0.47	59-80	35-40	2.9-5.0	207-474
4.	430-460	0.42-0.51	86-119	24-29	2.6-3.6	138-408
5.	460-525	0.44-0.55	47-63	53-60	2.9-5.1	360-658
6.	530-598	0.60-0.71	89-138	30-39	2.1-2.6	22-48

**UNIT 1:** This is an apparently sheetlike dolerite body some 75m thick. Its relatively low MgO, Cr and FeO contents suggest that it is quite evolved. As it intrudes through and above the level of the Que River Shale, it post-dates the typical Hellyer basalts. However, as noted earlier, it shows many compositional features in common with some of the Hellyer basalt correlates in this hole, especially with Unit 5. It is also compositionally similar in some respects to the dolerites occurring around Hellyer Mine and W of Mt Charter (see Corbett and Komysan 1987), although it is a lot more evolved than these rocks. A third correlation which cannot be ruled out on the basis of the available data is with the Jurassic dolerites. In terms of MgO, TiO<sub>2</sub>, Zr and Cr, it is not very different from the average Jurassic dolerite in Tasmania. Only further analysis, including a detailed petrographic examination, can lead to correct correlation of these rocks, and in turn, to a better understanding of their significance in this region.

**UNIT 2:** A section between 360.6m to 380m logged as pillowed andesitic lavas. These have Ti/Zr for two analyses from 39-46. These high values, coupled with the high Cr contents (338-417ppm) are strongly suggestive of a basaltic lava, rather than an andesitic lava. The low measured MgO contents in this unit (2.3-2.8%), and especially in Units 3-5, are puzzling and suggest some strong alteration, or problems with the ICP analytical

method for Cr or MgO. Note in Figure 6b that for all the Mount Read Volcanics analyzed, Cr contents >200ppm are essentially limited to basalts (MgO > 6%). I also note that the Cr contents analyzed by Analabs on the Aberfoyle standard rock are 200-300ppm below the recommended value. If then, the 'real' Cr contents of the analyzed lavas are actually higher than measured, this only exacerbates the problem of high Cr contents and low MgO contents. I suggest (with a great deal of conviction) that both the MgO and FeO contents of these rocks, as measured by ICP, are much lower than their real values, and are almost meaningless. Only relative values of MgO (eg. Unit 6 is always lower than Unit 5) provide some indication of the degree of differentiation of these rocks.

**UNIT 3:** This is a sequence of brecciated lavas from 380-430m. Four of the five analyzed samples have Cr contents >400ppm, again contrasting with the surprisingly low MgO contents (2.9-5%), and implying, in my mind, an analytical problem. However, Ti/Zr values all fall from 35-40 and suggest basaltic precursors.

**UNIT 4:** From 430m to 460m, more brecciated andesites and basalts have Ti/Zr notably lower than the overlying lavas (24-29) due essentially to higher Zr abundances at constant Ti levels. Two of the three analyzed samples (sections) have CaO and Cr contents more like andesites than basalts; this is in keeping with the higher Zr contents of these rocks.

**UNIT 5:** This is a unit extending from 460m to 525m composed of massive amygdaloidal basalts with Ti/Zr = 53-60, and high Cr contents (360-660ppm). Still the analyzed MgO contents are surprisingly low (2.9-5.1%), and probably quite wrong.

**UNIT 6:** From 530-598m, a uniform almost aphyric andesitic lava occurs. This has low Cr contents (22-48ppm), Ti/Zr = 30-39 and MgO contents <3%.

### CORRELATION OF THE MXRD-1 LAVAS

A large database of wholerock and trace element analyses of representative least-altered Mount Read Volcanics (herein MRV) has been compiled, and is being updated regularly. One important reason for assembling these data has been to test whether the various petrologic - stratigraphic units that make up the MRV (eg. Central Volcanic Complex, Western Volcanic Sequence, Tyndall Group..) each have a distinct geochemical signature or 'fingerprint'. This is a first step towards proving that wholerock major and trace element geochemistry is a useful, if not prerequisite, method for within-belt correlation of lava units. If particular lithostratigraphic units within the MRV have no distinctive compositional characteristics that distinguish them from the rest of the lava sequences in the belt, and do not define distinct compositional fields on selected immobile element variation diagrams, then rock chemistry is useless in regional correlation. Fortunately this is not the case

Figure 8 shows discrimination plots using only the elements P, Ti, Zr Cr and MgO, in which each of the four main lithostratigraphic units making up the MRV define clear, generally well-separated compositional fields. Cr is a more effective discriminant in sequences dominated by mafic and intermediate lavas. It was shown in Figure 5 shows plots of Cr abundances versus P<sub>2</sub>O<sub>5</sub> and Ti/Zr for a single drillhole W of Hellyer; individual lava units are very well separated and defined on these plots, and can thus be correlated between drillholes or in a more regional framework.

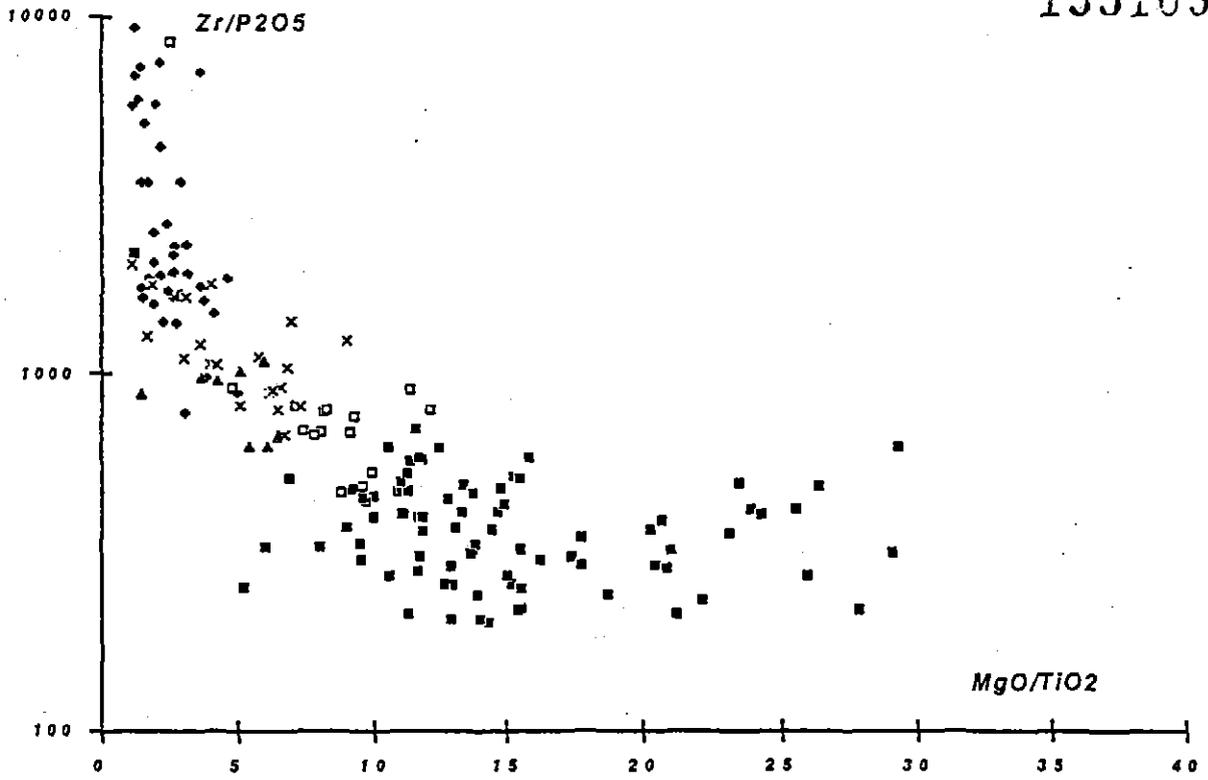
One of the lithostratigraphic units most clearly defined within the MRV are the feldspar-phyric and aphyric andesites occurring in the footwall of the Que and Hellyer VMS deposits (see Figure 8). These Que Footwall Andesites are characteristically lavas with 2-5% MgO, low P<sub>2</sub>O<sub>5</sub> (<0.25%), Cr abundances from 10-100ppm, Zr abundances from 100-200ppm and Ti/Zr values (20-35) generally higher than those for andesites in the underlying CVC Group 1 andesites. In a previous report to Outokumpu (Crawford 1989), the andesitic lavas in the Mt Cattley drillholes MRDD-2 and -3 were correlated with the Que Footwall Andesites. In the new drillhole MXRD-1, the basal (Unit 6 as defined here) andesites

can be confidently correlated (chemically and petrographically) with those in MRDD-2, and with the Que Footwall Andesites.

Although MgO and FeO abundances in the Unit 6 andesites are notably lower than those in the MRDD-2 andesites, I attribute this to the exceptionally poor quality of the ICP data for MgO and FeO; Zr, Cr and TiO<sub>2</sub> abundances compare well, and I predict that P<sub>2</sub>O<sub>5</sub> contents in Unit 6 andesites will also be around 0.18 - 0.20% on an anhydrous basis, as for the MRDD-2 lavas.

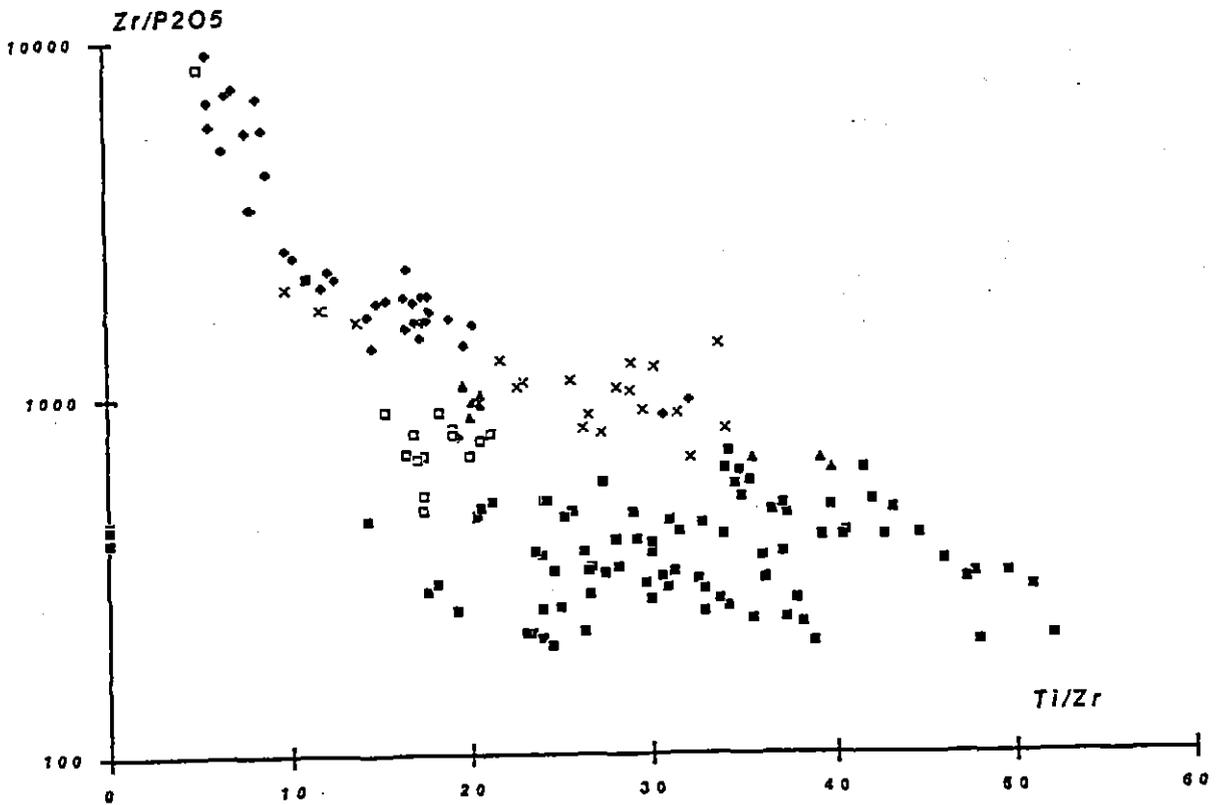
In MXRD-1, between the overlying black shales and the Unit 6 andesites that are correlated with the Que Footwall Andesites occurs a pile of basaltic to andesitic lavas (Units 2-5) about 165m thick. On simple stratigraphic and lithologic grounds, these would almost certainly correlate with the Hellyer basalts. Unfortunately, MgO and FeO values measured for the Units 2-5 lavas are unreliable, and P<sub>2</sub>O<sub>5</sub> contents have not been measured. Useful geochemical data for these lavas include the following: TiO<sub>2</sub> contents are mainly less than 0.55%, Ti/Zr values fall between 24 and 60, but are mainly greater than 35, Cr abundances are mainly greater than 200ppm, up to 658ppm (and are apparently well below 'real' values, as noted above), and Zr contents are less than 120ppm, with most lavas having <80ppm Zr. The only group of lavas within the MRV that consistently match these compositional signatures are the Hellyer basalts (and their correlates much further south, at Lynchford). This is shown on the discriminant diagrams in Figure 9, and makes perfect sense when stratigraphic considerations are taken into account.

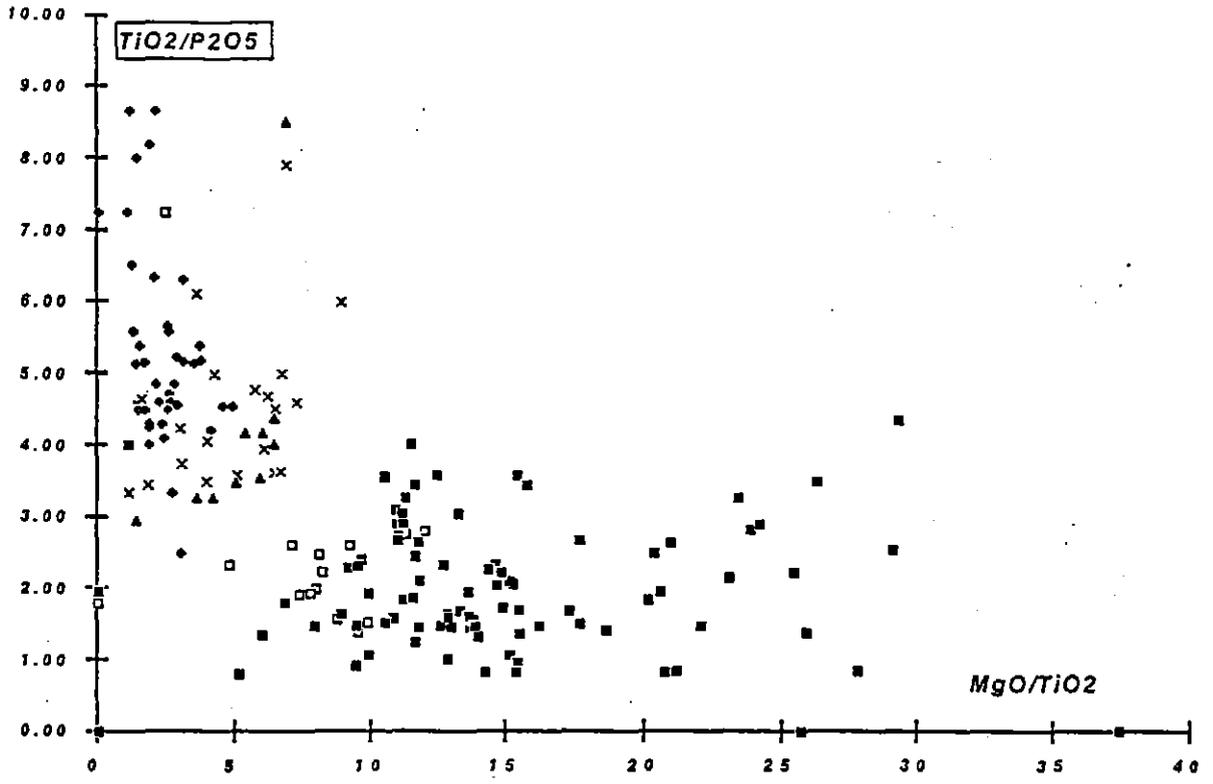
In summary, I have no doubt that the sediment lava sequence drilled in MXRD-1 can be correlated with the sequence in the Que-Hellyer region some 10km further south. The Que River Shale is distinctive in hand specimen, core and compositionally (Ti/Zr ~ 30, whereas most shales have Ti/Zr < 15). The units 2-5 lavas, including pillowed and massive flows of basalt and andesite, are easily correlated with the Hellyer Basalt. The Unit 6 andesites in MXRD-1 are readily correlated with the Que Footwall Andesites of the Que-Hellyer region, and with the lavas in Outukumpu drillhole MCDD-2. Basal micaceous



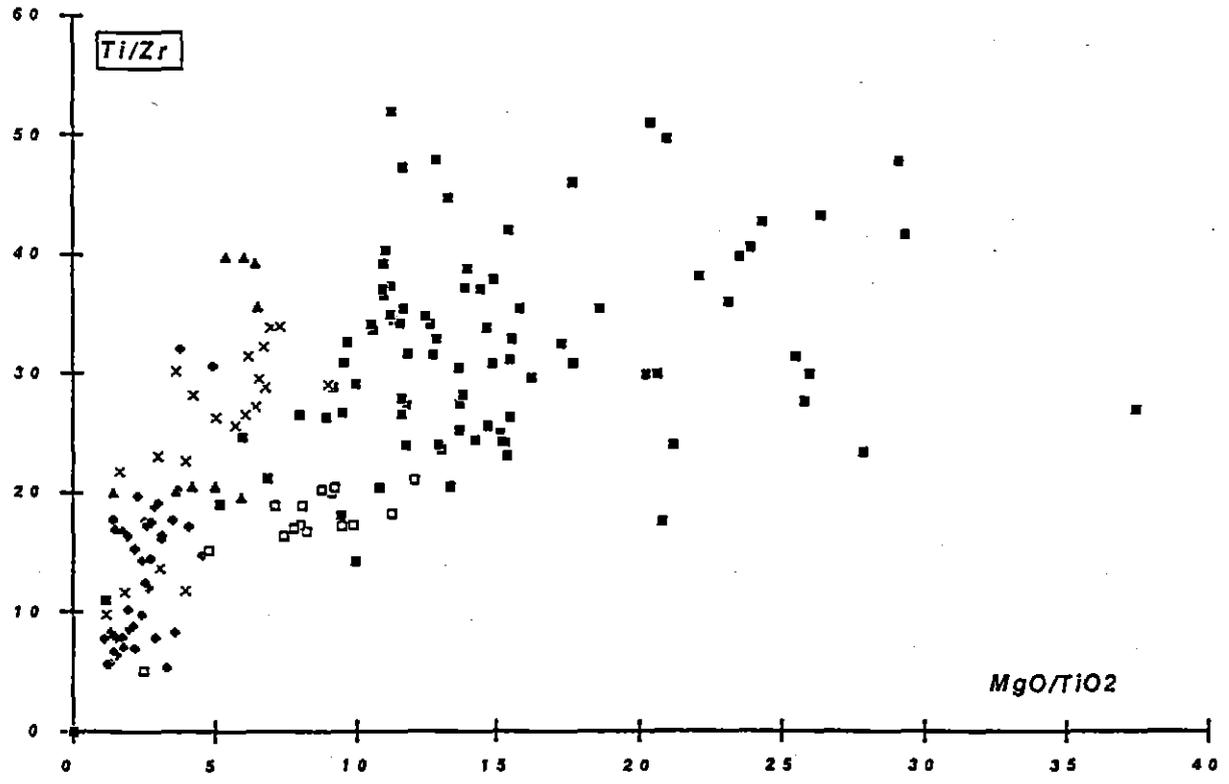
CVC Group 1 ◆ CVC Group 2 □ Mt Cattley MRDD-1 and 2 ▲

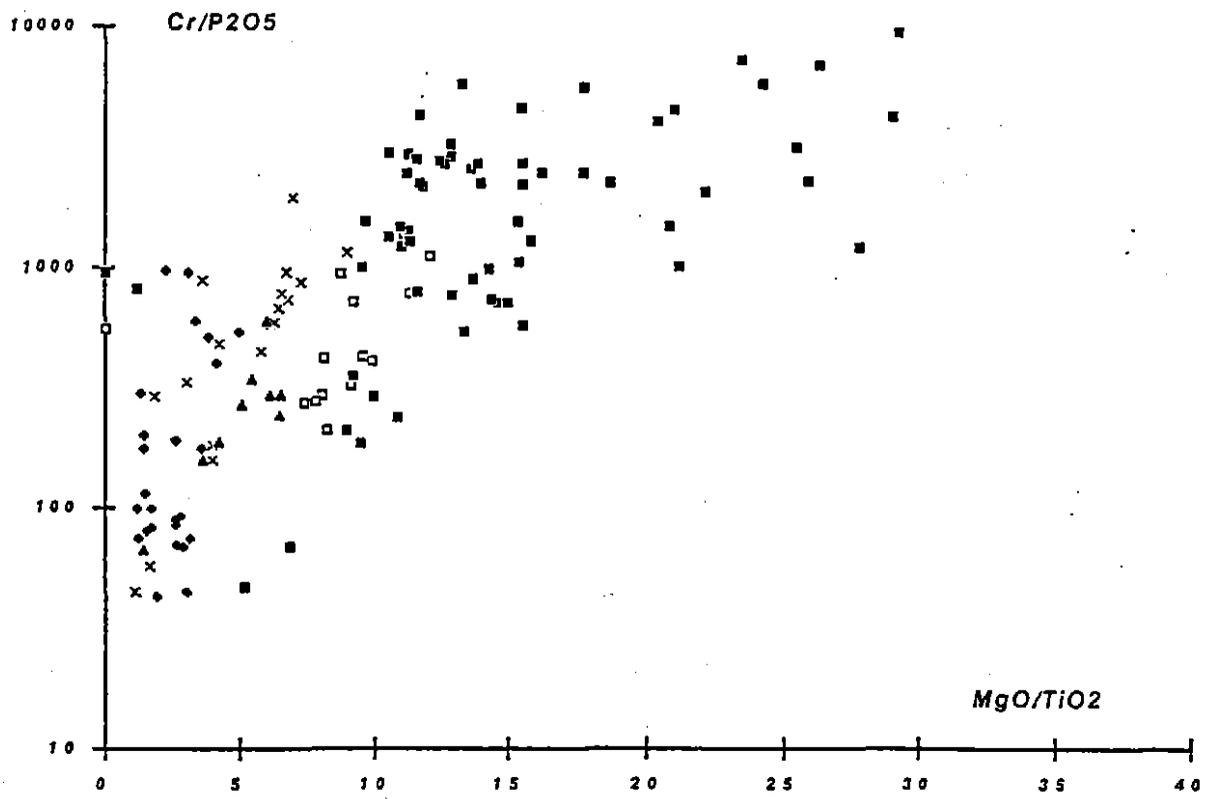
Que-Hellyer Footwall Andesites X Hellyer Basalts ■



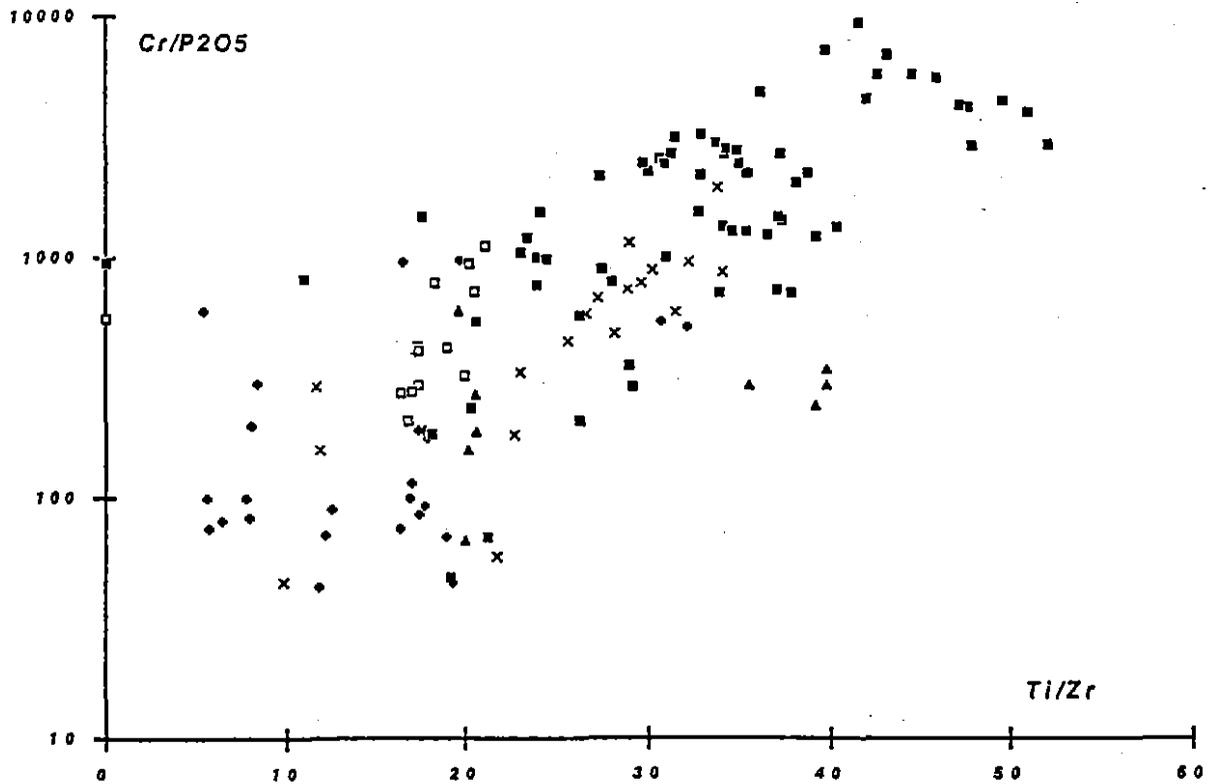


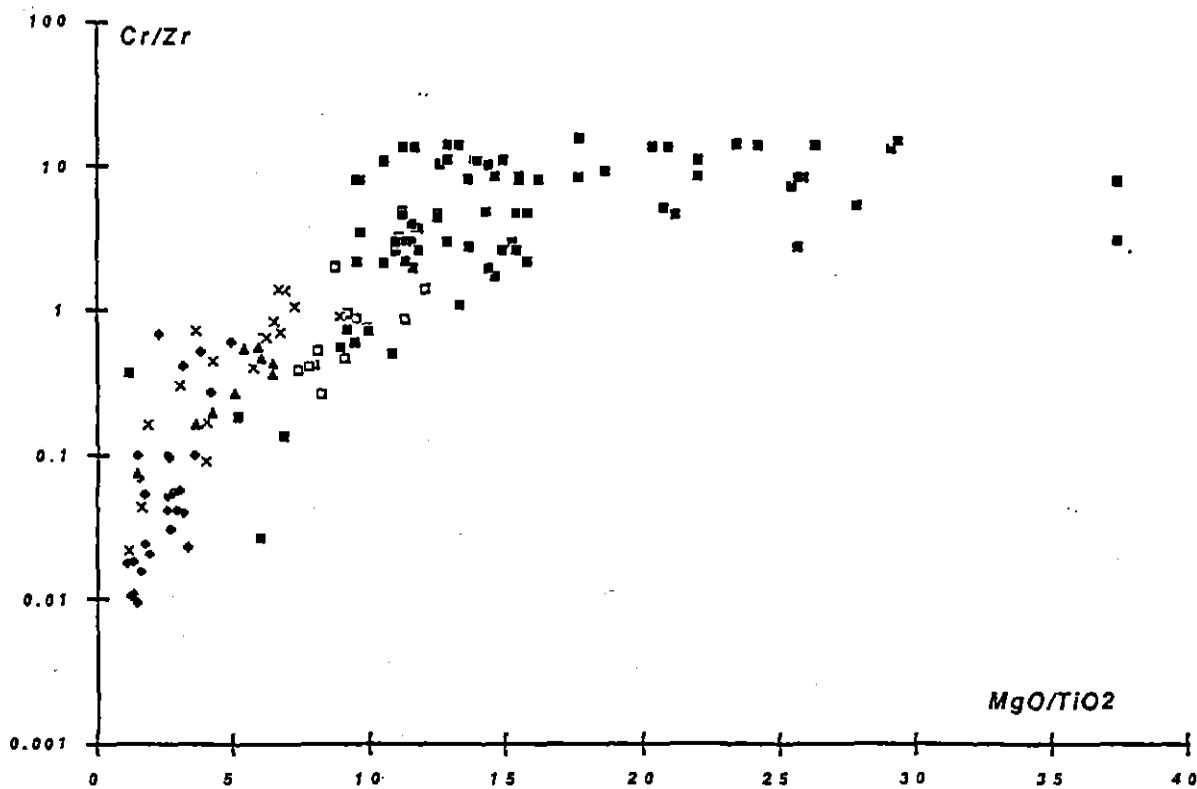
CVC Group 1  $\blacklozenge$  CVC Group 2  $\square$  Mt Cattley MRDD-1 and 2  $\blacktriangle$   
 Que-Hellyer Footwall Andesites  $\times$  Hellyer Basalts  $\blacksquare$





CVC Group 1  $\blacklozenge$  CVC Group 2  $\square$  Mt Cattley MRDD-1 and 2  $\blacktriangle$   
Que-Hellyer Footwall Andesites  $\times$  Hellyer Basalts  $\blacksquare$





*CVC Group 1* ◆ *CVC Group 2* □ *Mt Cattley MRDD-1 and 2* ▲  
*Que-Hellyer Footwall Andesites* X *Hellyer Basalts* ■

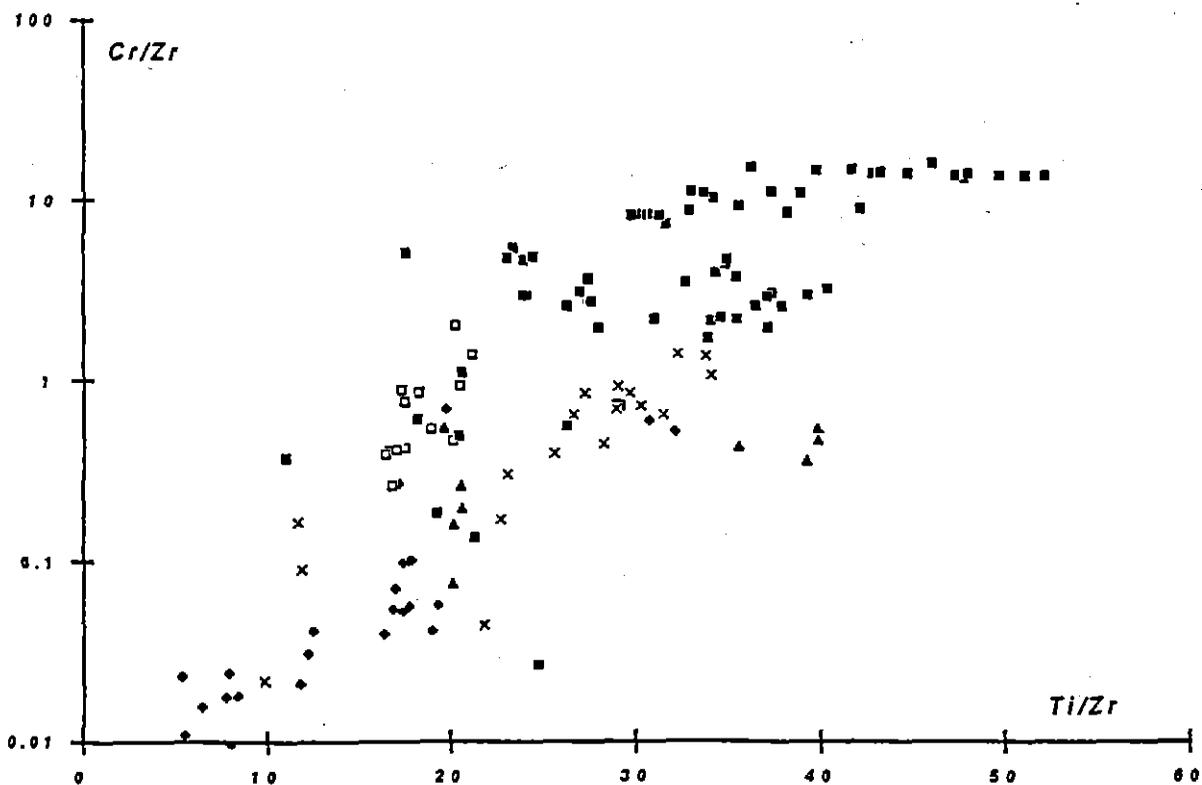


Figure 8: Discrimination plots using P, Ti, Cr, Zr and MgO for the main lithostratigraphic units within the Mount Read Volcanics.

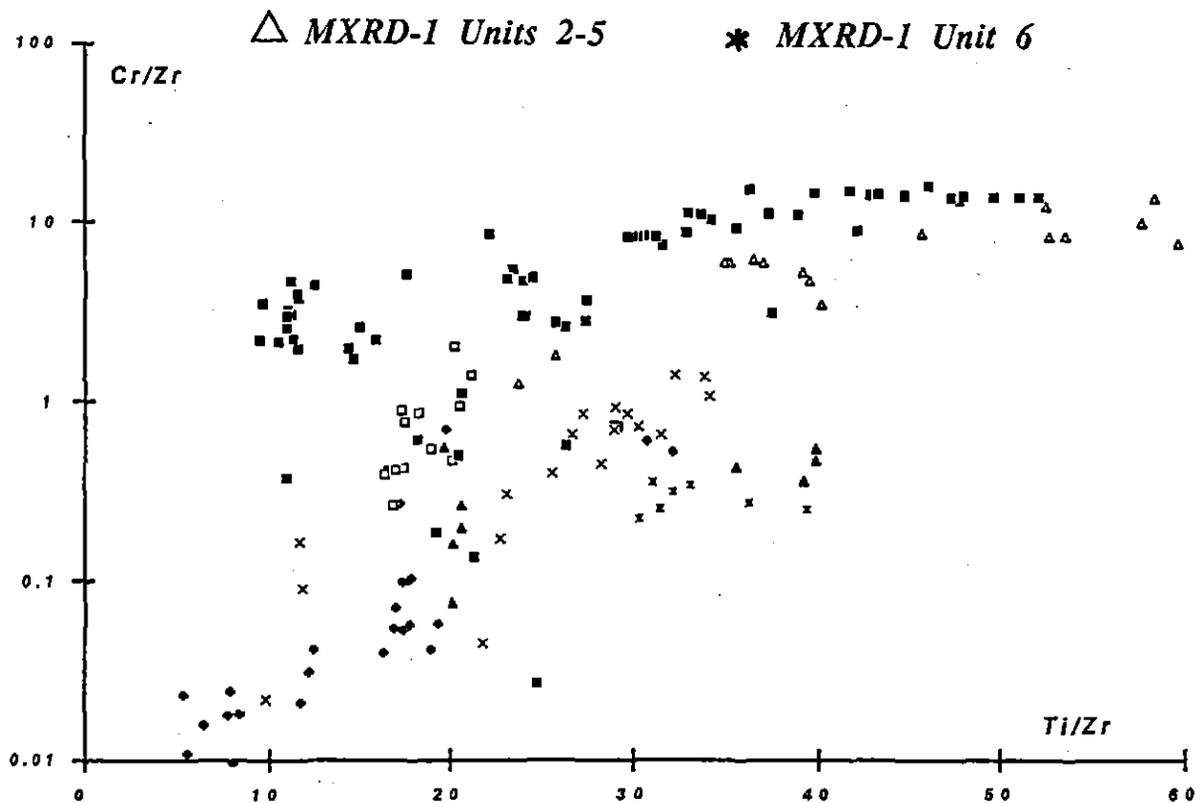
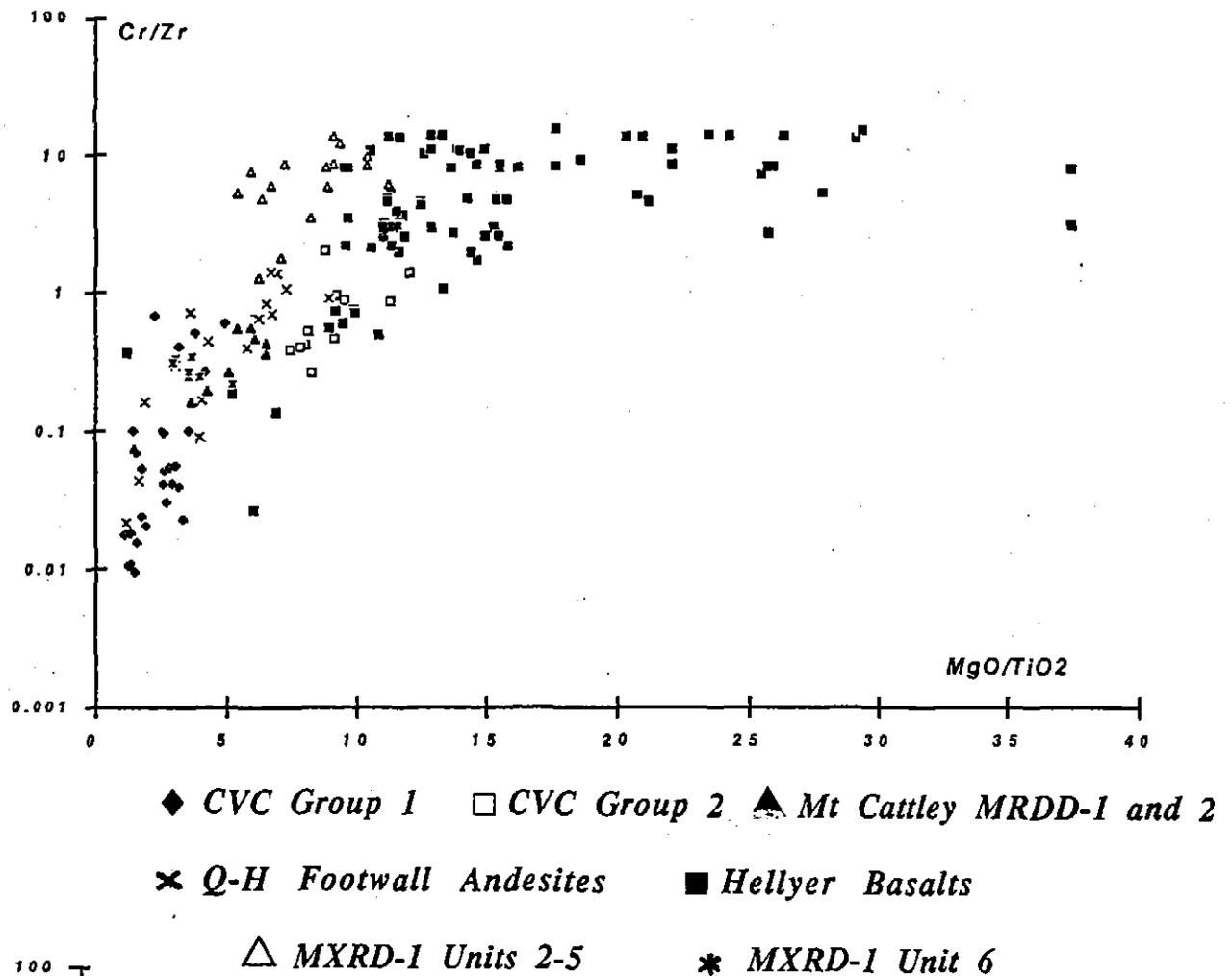


Figure 9: Discriminant diagrams (as in Figure 8) with data points for the analyzed MXRD-1 lavas added. Since ICP Cr abundances are 200-300ppm less than true values (see text), the field of the MXRD-1 basalts would move upwards to overlap with the Hellyer-type basalt field.

greywackes are analogues of the Animal Creek Greywacke further south. Only the intrusive dolerite cannot be simply correlated with other dolerites in the region without more detailed geochemical study.

#### GEOLOGICAL IMPLICATIONS and SITING FUTURE DRILLHOLES

If these correlations are correct, then some interesting hypotheses may be put forward to explain regional geological relationships. One possible major problem is the greywacke outcropping extensively in the Leven Rv in the area between 39802 - 03E 54075-105N. Is this a true Southwell Subgroup greywacke sequence as mapped, or is it, in fact, a correlate of the Animal Creek Greywacke drilled in MCDD-4, some 2km further south? Only careful field and petrographic study of the Leven Rv greywackes will solve this problem. However, it seems reasonable to assume that the plunging syncline indicated from the drillhole data (Figure 1) would extend northward to place Animal Creek Greywacke correlates in the Leven River area, where greywackes are mapped and abundant.

This scenario demands that a major fault exist between the greywacke - lava sequence in the west, and the pyroclastic sequence of the Southwell Subgroup in the east (Figure 1). One possible location of this fault is along the boundary mapped between the greywacke (Cdg) and the pyroclastic-mass flow sequence (Cdts); this is marked in green on Figure 1. Although this hypothetical fault contact occurs in the Leven Rv, and structural data across the contact show no obvious discordance, such a fault (which would be a W-dipping thrust) might be marked by only a 5- to 10m-wide cleavage or shear zone (R. Berry, pers. comm.).

It is important to note that in MCDD-5, black shales and cherty rocks (possibly silicified black shales) occur at the base of the hole, in what could be interpreted to be part of the shear zone associated with this fault (Fig. 1). These could be Que Rv Shale correlates silicified in the fault zone, and are at least 50m thick. If this is the case, a strong analogy might be made with the Henty Prospect Au mineralization, associated with extensive silicification along the Henty Fault. Silicification is much more typical of Cambrian alteration than Devonian alteration within the MRV.

MXRD-1 Correlations

15

If the shales and cherty rocks in MCDD-5 are Que Rv Shale correlates, further faulting of not insignificant throw is demanded to juxtapose the greywacke sequences in MCDD-4 correlated with Animal Ck Greywacke with W-dipping Que Rv Shale correlates only 800m further east in MCDD-5 (see Fig. 1).

The very hypothetical ideas offered above are not of very much use in deciding on placement of a future drillhole. There are two possible strategies as I see it. First, a stratigraphic hole (wildcat!) similar in design and intent to MXRD-1 might be planned, to essentially elucidate the regional structure in the southern part of the EL west of the Leven River. This would provide the most data if directed due east and collared 500-1000m due south of MXRD-1. A second approach might be more pragmatic, aimed directly at exploration potential rather than clarifying local and regional geological relationships. This might involve two separate holes:

- 1: deepening MRDD-5, to test whether the silicification is fault-related and passes into mineralization at depth.
- 2: drilling a new hole as close as possible, given the present fragmentary understanding of local sub-basalt structure, to the horizon equivalent to the mineralized Mixed Sequence at Que and Hellyer. This occurs at a depth of around 525m in MXRD-1, and must 'outcrop' at the sub-Tertiary basalt unconformity somewhere on a line between MRDD-2 and MXRD-1, and on another line between MRDD-3 and MXRD-1. A hypothetical trace of this horizon is marked in brown on Figure 1. It might be possible to drill down the (assumed) synclinal axis at around this horizon, from a position about 300m due south of MCDD-1; this way maximum coverage of the most prospective regional horizon might be gained.

**APPENDIX:****MINES DEPT HOLE MCH-1 at MT CHARTER**

The Mines Department drilled a stratigraphic hole just W of Mt Charter (more than 10km S of Mt Cattley), which was deepened 200m by Aberfoyle Resources Ltd., who had fillet grinds of the entire core section analyzed for Ti, Zr, Cr, Ba and base metals (Corbett and Komysan 1989). The generalized log follows. I have not examined thin sections from this hole:

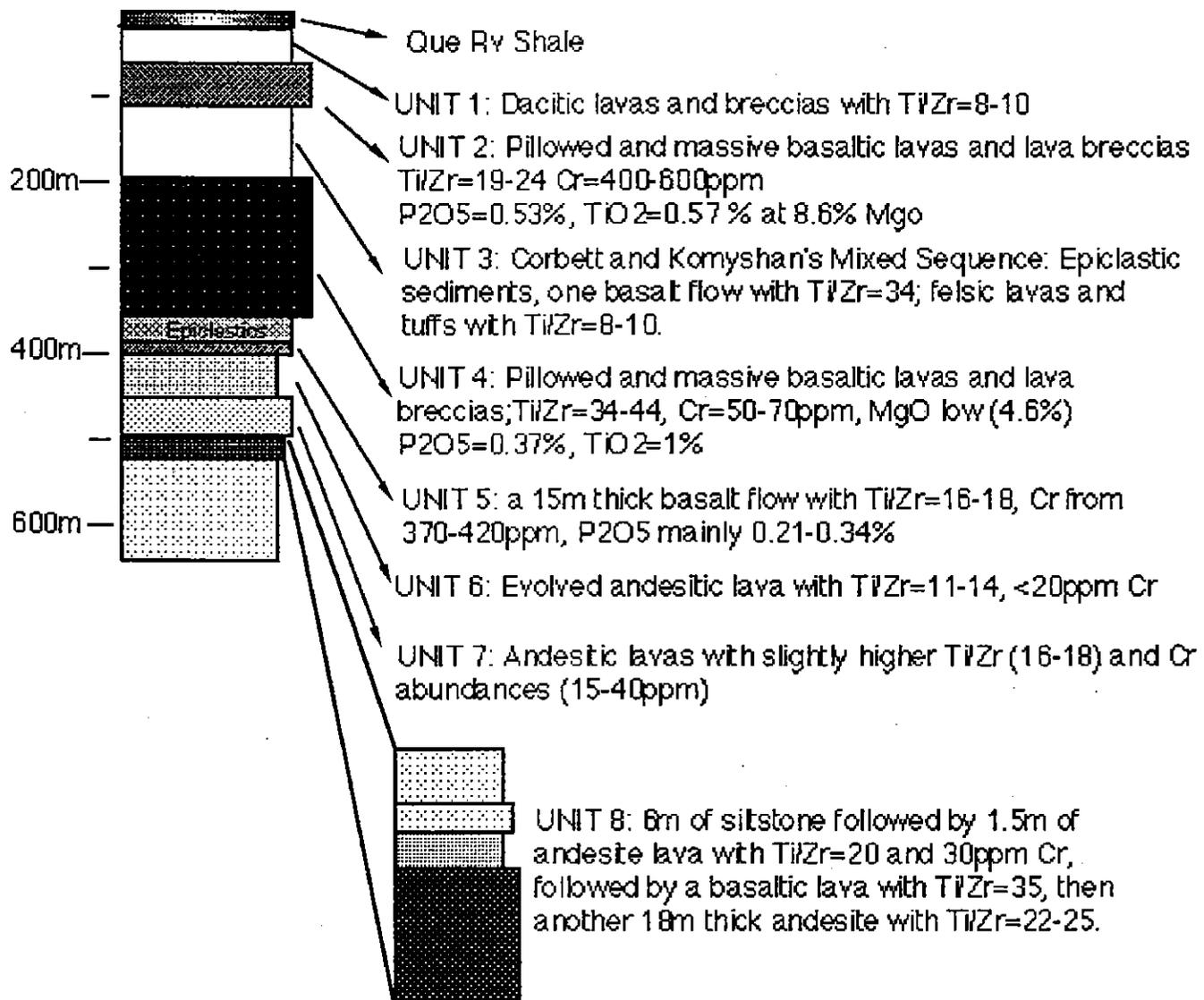
0 - 10.3m	Que Rv Shale
10.3 - 57.7m	Dacitic lavas and lava breccias
57.7 - 115.1m	Basaltic lavas/breccias (Siltstone 115.1-116m)
116.0 - 120.5m	Basaltic lava breccia
120.5 - 178.0m	Dacitic tuffs and lavas, flow banded
178.0 - 195.7m	"Epiclastic Breccia" - dacitic
195.7 - 354.3m	Basaltic lava and lava breccia
354.3 - 359.7m	Sandstone
359.7 - 378.9m	Dacitic lava breccias
378.9 - 399.8m	Andesitic lavas and breccias
399.8 - 459.7m	Dacitic lavas and lava breccias
459.7 - 491.5m	Andesitic lavas/breccias, siltstone 491.5- 497.2m
497.2 - 498.5m	Andesite lava
498.5 - 500.8m	Basaltic lava breccia
500.8 - 518.1m	Andesitic lava and lava breccia
518.1 - 561.7m	Tuffs, tuffaceous sandstones
561.7 - 606.3m	Animal Creek Greywacke

The following lithochemical log (illustrated in Fig. A1) is based on logging notes provided in Corbett and Komysan (1989) coupled with analyses of the entire core (in fillet sections) for Ti/Zr and Cr. In addition, several wholerock analyses from the core are provided in Stolz and Large (AMIRA Rept 1988 ), including an upper basalt from 69.5m - 80.6m, a dacite from 134.7 - 176.0m and a lower basalt from 253 - 265m.

**Unit 1** is a sequence of dacitic lavas and lava breccias from 10.4m - 57.7m, with Ti/Zr = 8-10 and <10ppm Cr.

**Unit 2** consists of basaltic breccias and pillow lavas from 57.7m to 104.5m, with 400 - 600ppm Cr and Ti/Zr from 19-24. Stolz and Large analyzed a core section from this Unit which showed that it has 0.57% TiO<sub>2</sub>, 8.6% MgO and quite high P<sub>2</sub>O<sub>5</sub> (0.53%).

FIGURE A1



MCH-1

MXRD-1 Correlations

17

**Unit 3:** The section from 104.5m down to 197m includes Corbett and Komysan's "Mixed Sequence", comprising epiclastic sediments, a single thin basalt flow (116-120m) with  $Ti/Zr = 34$ , and felsic lavas, tuffs and lava breccias. The felsic rocks have  $Ti/Zr = 8-10$ .

**Unit 4** includes a thick sequence of pillow basalts from 197m to 354.3m. These have  $Ti/Zr$  values mainly from 34 - 44, and low Cr contents (50 - 70ppm). An analysis from Stolz and Large from this Unit, from 253 - 265m, shows it to be a low-MgO (4.6%) basalt with relatively high  $TiO_2$  (1%) and 0.37%  $P_2O_5$ . From 354.3 - 384.6m, epiclastic sandstones and tuffs predominate, then pass down into

**Unit 5**, a 15m thick basalt unit, with  $Ti/Zr = 16-18$ , and Cr from 370 - 420ppm.

**Unit 6** extends from 407m to 460m and is an evolved andesitic unit with  $Ti/Zr = 11 - 14$ , and  $<20ppm$  Cr.

**Unit 7**, extending down to 494.2m, is also andesitic but has slightly higher  $Ti/Zr$  (16 - 18) and Cr (15 - 40ppm). A packet of siltstone 6m thick separates the Unit 7 lavas from

**Unit 8**, that consists of an upper andesite lava only 1.5m thick with  $Ti/Zr = 20$  and 30ppm Cr, followed below by a basalt 2.3m thick with  $Ti/Zr = 35$ , then another andesite about 18m thick with  $Ti/Zr = 22 - 25$ . Below Unit 8 follows a sequence of felsic tuffs and tuffaceous sandstones that pass down into the Animal Creek Greywacke.

**HELLYER and QUE RV MINES SEQUENCES**

The stratigraphy around the Hellyer mine is essentially Que Rv Shale overlying around 200m of Hellyer (or Hangingwall) Basalt, followed by a thin (~10m thick) correlate of the "Mixed Sequence", which in turn, overlies feldspar-phyric andesites equivalent to the Que Footwall Andesites. No detailed chemical stratigraphy of the Hellyer Basalt in this area is published, but according to Jack (1989), the majority of basalts have  $Ti/Zr$  values from 25-35, with occasional higher values (40-60) in some basaltic units. The Footwall andesites are essentially identical to those at Que River, and have  $Ti/Zr$  values mainly from 20-40, low  $P_2O_5$  (0.05-0.20%), and low Cr (mainly  $<100ppm$ ) as expected (see Whitford et al. 1989; Corbett and Komysan 1989). At Que River, only the Mixed Sequence and Footwall andesites section of the stratigraphic pile is exposed;  $Ti/Zr$  values are mainly 20-35,  $P_2O_5$  contents are low ( $<0.20\%$ ) and Cr contents are less than 100ppm.

**MT. CATTLEY LAVA SEQUENCE DRILLED ON EL 14/85**

The following lithologs of the initial Outukumpu Mt Cattley drillholes MRDD-2 and -3 are given, followed by a discussion of their main compositional features (Crawford 1989).

**MCDD 2**

85.1	Vesic. aphyric andesite
93.9	Vesic. aphyric andesite
98.4	Vesic. aphyric andesite
104.4	Vesic. aphyric andesite
106.7	Vesic. aphyric andesite
111	Vesicular bas. andesite
117.1	Vesic. aphyric andesite

**MCDD 3**

103.0	Plag+augite-phyric dacite
104.3	Plag+augite-phyric andesite
118.2	Rhyodacite
121.5	Rhyodacite
122.4	Rhyodacite
126.0	Plag+augite-phyric dacite
128.7	Plag+augite-phyric dacite

**MCDD 2**

Compositions of MCDD 2 and 3 lavas are given in Table 1 (from Crawford 1989). Volatile-free  $\text{SiO}_2$  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. 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 alkalis (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  $\text{K}_2\text{O}$  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

MXRD-1 Correlations

19

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. The  $\text{FeO}^*$  and  $\text{TiO}_2$  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.

**MCDD 3**

These lavas are significantly less altered than those in MCDD 2, as indicated by the lower loss on ignition values. They range from andesites with 62%  $\text{SiO}_2$  and 4% MgO to rhyodacites with 72.5%  $\text{SiO}_2$  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 (see Crawford 1989).

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  $\text{SiO}_2$  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%  $\text{SiO}_2$  and 4.5% versus 4% MgO). It is evident 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  $\text{P}_2\text{O}_5$  contents. These features together indicate that the lavas in MCDD 2 are clearly not comagmatic with those in MCDD 3.

The three MCDD 3 lavas analyzed by AMDEL show essentially the same compositional range 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 (Ti/Zr = 40) are not comagmatic with those in MCDD 3 (Ti/Zr = 20).

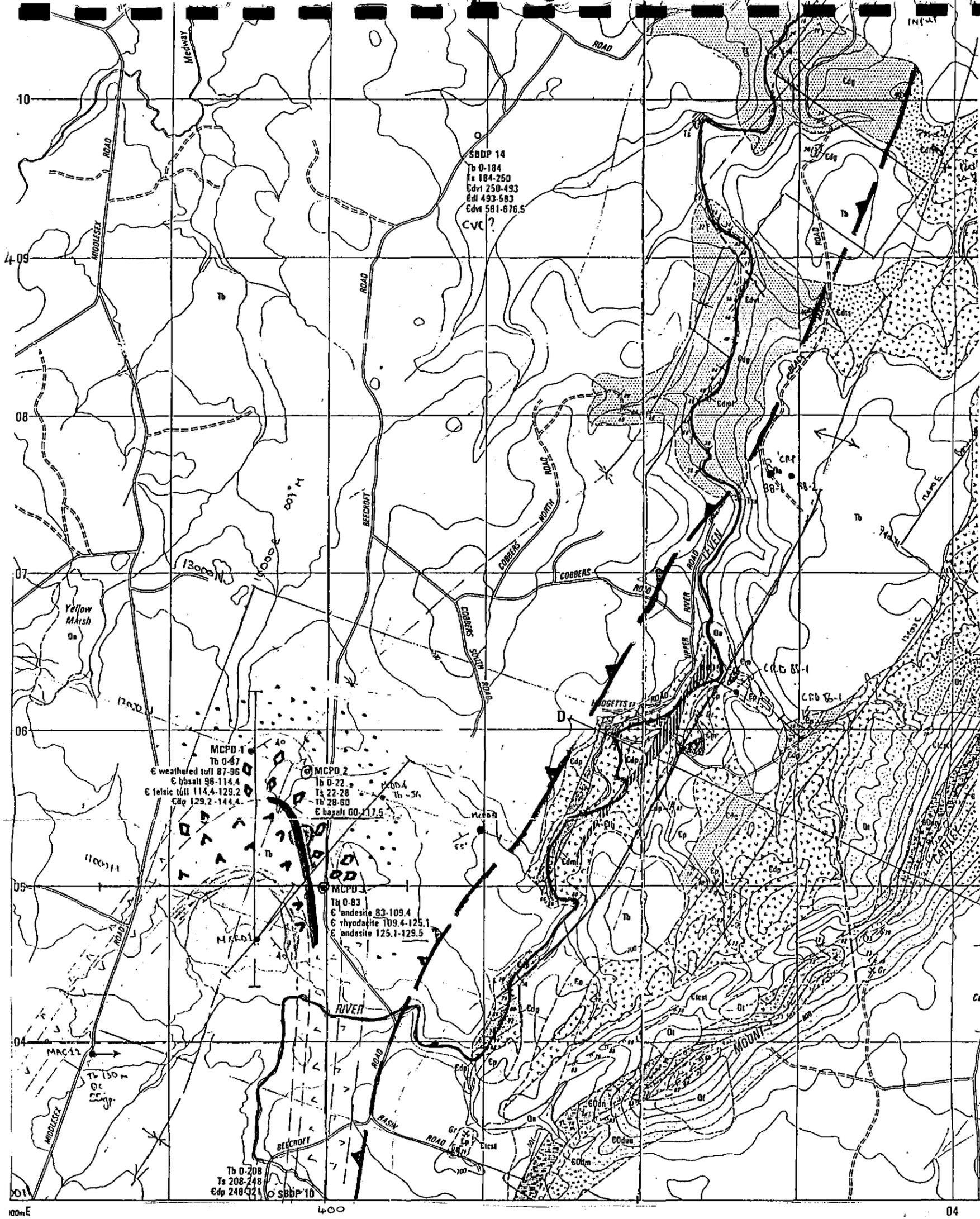
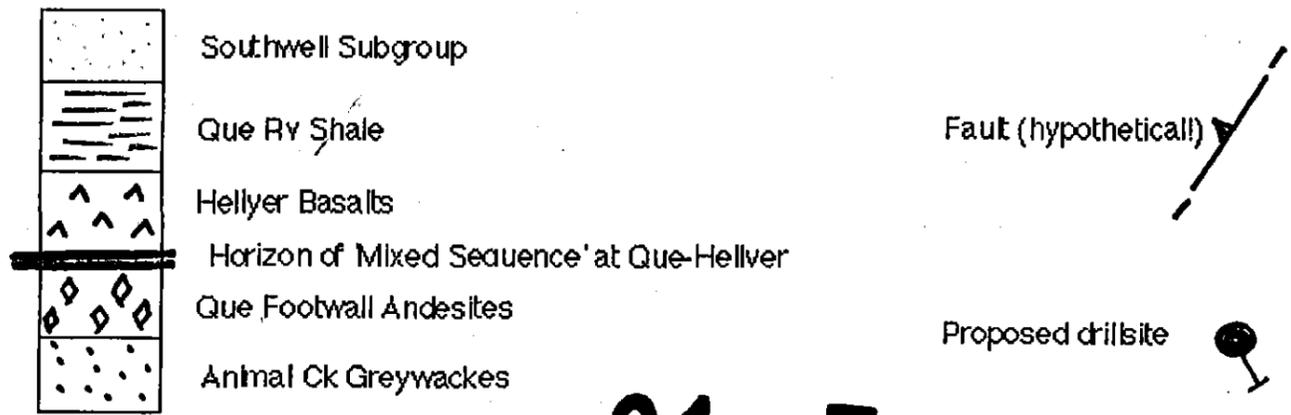


FIGURE 1:



91-3304.

5 cm

Appendix V:

Dr J.R. Bishop, 1990;

Interpretation of DHEM Survey, DDH MRB1 (MXRD 1),  
Mt Cattley (E.L. 14/85)



# MITRE GEOPHYSICS PTY LTD

MINERAL EXPLORATION AND ENGINEERING CONSULTANTS

BUGGS LANE ELLIOTT TASMANIA 7325 PHONE 004-363143

INTERPRETATION OF DHEM SURVEY,  
DDH MRB1, MT CATTLEY (E.L. 14/85).

for

Outokumpu Exploration Australia Pty Ltd

by

Dr J.R. Bishop



## CONTENTS

Summary	2
Introduction	3
Survey Details	3
Interpretation	4
Conclusions and Recommendations	4
References	5

---

 LIST OF TABLES AND FIGURES

Table 1.	Petrophysical Measurements.	6
Figure 1.	Location plan.	
Figure 2.	Cross-section; 399,555mE.	
Figure 3.	DHEM Transmitter loop positions.	
Figure 4.	EM field patterns: Tx loops MRB1/1 & MRB1/2.	
Figure 5.	MRB1 DHEM profile: loop 1.	
Figure 6.	MRB1 DHEM profile: loop 2.	

**SUMMARY**

A DHEM survey has been carried out down DDH MRB1 on E.L. 14/85. This hole was drilled by the Mines Dept as a stratigraphic hole to gain a better understanding of the possible extension of the host rocks to the nearby Que River and Hellyer deposits. The hole intersected volcanics very similar to the Que-Hellyer assemblage, but no conductors were located by the survey.



## INTRODUCTION

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

The prime target is for a similar deposit to the Hellyer deposit, which contains some 17 million tonnes grading 13% Zn, 7% Pb, 0.4% Cu, 160g/t Ag & 2.3g/t Au. This orebody is highly conductive and EM methods are widely used to aid exploration in the region. A brief description of the exploration history over E.L. 14/85 is given in Bishop (1989), which reports on results of earlier drill hole EM (DHEM) surveys.

MRB1, drilled in mid 1990 to a depth of about 750m, had no precise exploration target, but rather was drilled by the Tasmanian Mines Dept as part of their sub-basalt drilling program and has been logged by Herrmann (1990). The hole passed through 184m of Tertiary basalt before entering Cambrian sediments and volcanics. These included approximately 50m of black shales between 305m and 353m. The local structure has been interpreted as a south plunging syncline with MRB1 near the base of the eastern limb. Figure 2 shows a north-south cross-section by Herrmann.

This report presents the results of a DHEM survey down DDH MRB1 from two transmitting loops in November, 1990.

## SURVEY DETAILS

The survey was carried out by McSkimming Geophysics using a Mk 2 Sirotem. Two loops were used: loop 1 was designed to maximally couple with the expected orientation of the target (ie, stratabound) and loop 2, to minimally couple with it. Loop 1 was an irregularly shaped loop at an angle to the grid, approximately 350m x 450m; loop 2 was 400m x 450m along the grid lines (Figure 3). A current of approximately 12 amps was used in both loops. Figure 4 shows cross sections of the EM field patterns from the two loops. Elevated values, probably caused by the conductive Tertiary basalt and gravels, were recorded and thus the standard Sirotem time base was used. The results were presented by the contractor in log form (Figures 5 & 6). This is not suitable for any quantitative interpretation but allows for anomaly recognition.



### INTERPRETATION

The loop 1 results are quite noisy, with a number of small local 'spikes'. These are due to instrumental noise (DC shifts in the probe response), which the operator was able to cure for the next day's survey using loop 2. A station interval of 10m was used, with loop 1 read to 710m and loop 2 to 730m.

The noise from loop 1 has degraded the data, but has not obscured the broad subtle high centred at around 180m. This is similar to the shallow response in MCDD4 reported by Bishop (1989) and is attributed to a response from unconsolidated sediments within the Tertiary basalts. Another possible weak response lies near 350m. This coincides with the black shales and some petrophysical measurements were made of core samples (Table 1). These showed the shales to be barely conductive (0.2 S/m), but a thickness of 50m gives a conductance of 10 S from which a response may be expected. (These measurements also showed that the shales have a significant IP effect and, surprisingly(?), a zero porosity.)

### CONCLUSIONS AND RECOMMENDATIONS

No significant responses were obtained from either loop. The data from loop 1, which should have recorded a response from any stratabound deposit was noisy, but not sufficiently to obscure any significant response: none was defined. Similarly flat results were obtained from the loop 2 survey.

Stratigraphic drilling by Outokumpu and the Tasmanian Mines Dept suggests that the Que-Hellyer host rocks continue north to E.L. 14/85 in a south plunging syncline (although of course the structure may change as rapidly here as it does over the 3 kms from Que to Hellyer). Assuming that DHEM has an effective search radius of at least 100m for an economic deposit (perhaps as little as 1 million tonnes so close to Hellyer), drill hole separation along strike should be at least 500m. Some criterion is required for targeting across strike and the synclinal fold hinge may well have acted as a focus for sulphide accumulation.

J.R. Bishop  
Dec., 1990



## REFERENCES

Bishop, J.R., 1989. Interpretation of downhole EM surveys, Mt Cattley (E.L. 14/85). Mitre Geophysics report 89/01 for Outokumpu.

Herrmann, W., 1990. Geological log of DDH MRB1.



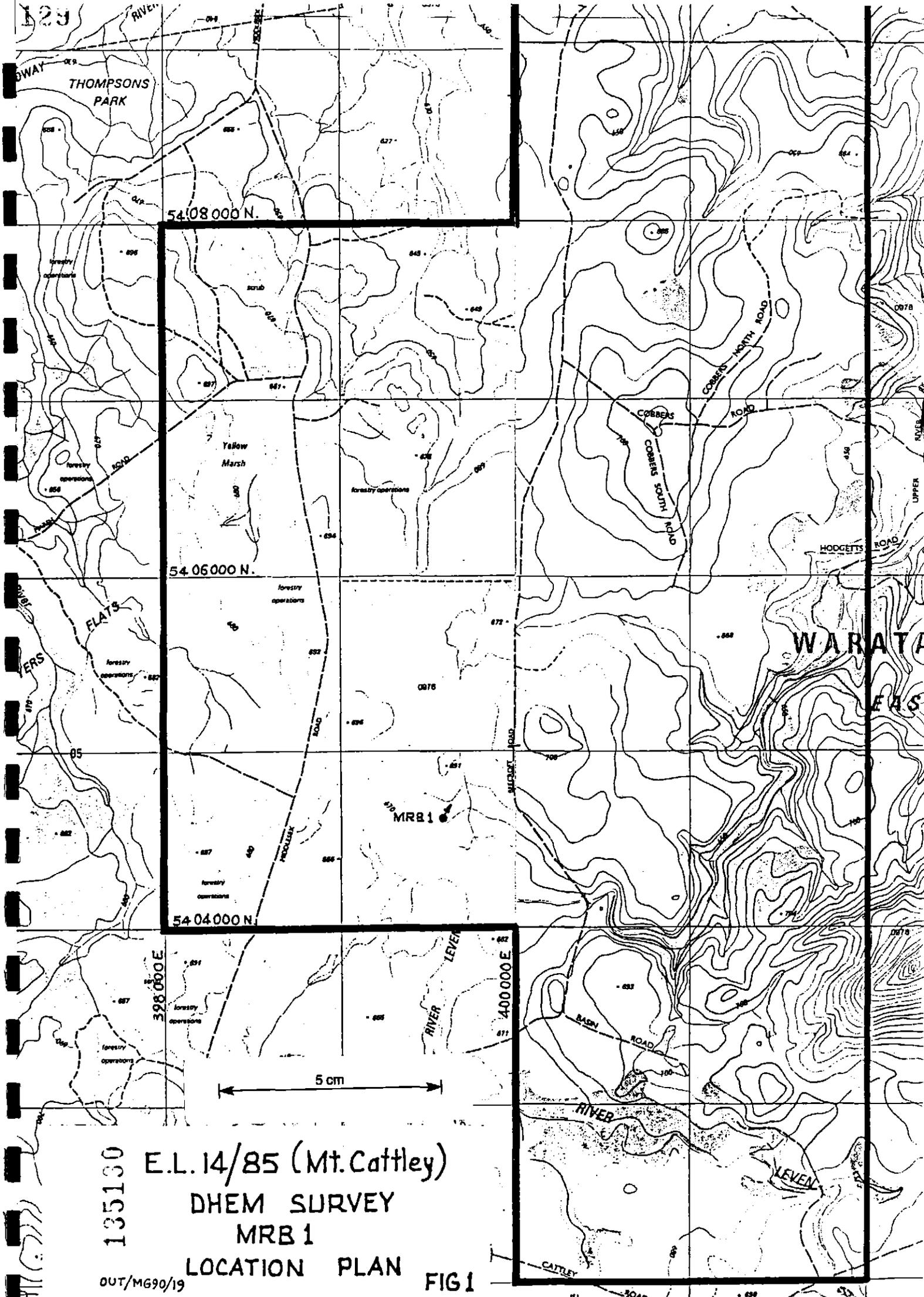
Table 1  
PETROPHYSICAL MEASUREMENTS

DDH MRB1

Lithology: 'black' shale

Sample no.	Depth ( m )	Dry Bulk Density (t/m <sup>3</sup> )	Apparent Porosity ( % )	Conduct. (2.5MHz) (S/m)	Resist. (1Hz) (ohm.m)	IP Effect (mrad)
46/1	306	2.72	0	0.3	1418.	147.
46/2	320	2.70	0	0.2	67.	48.
46/3	335	2.72	0	0.2	113.	37.
46/4	351	2.74	0	0.1	500.	108.

Measurements made at the University of Sydney Petrophysical Laboratory, Nov., 1990.



135130

E.L. 14/85 (Mt. Cattley)

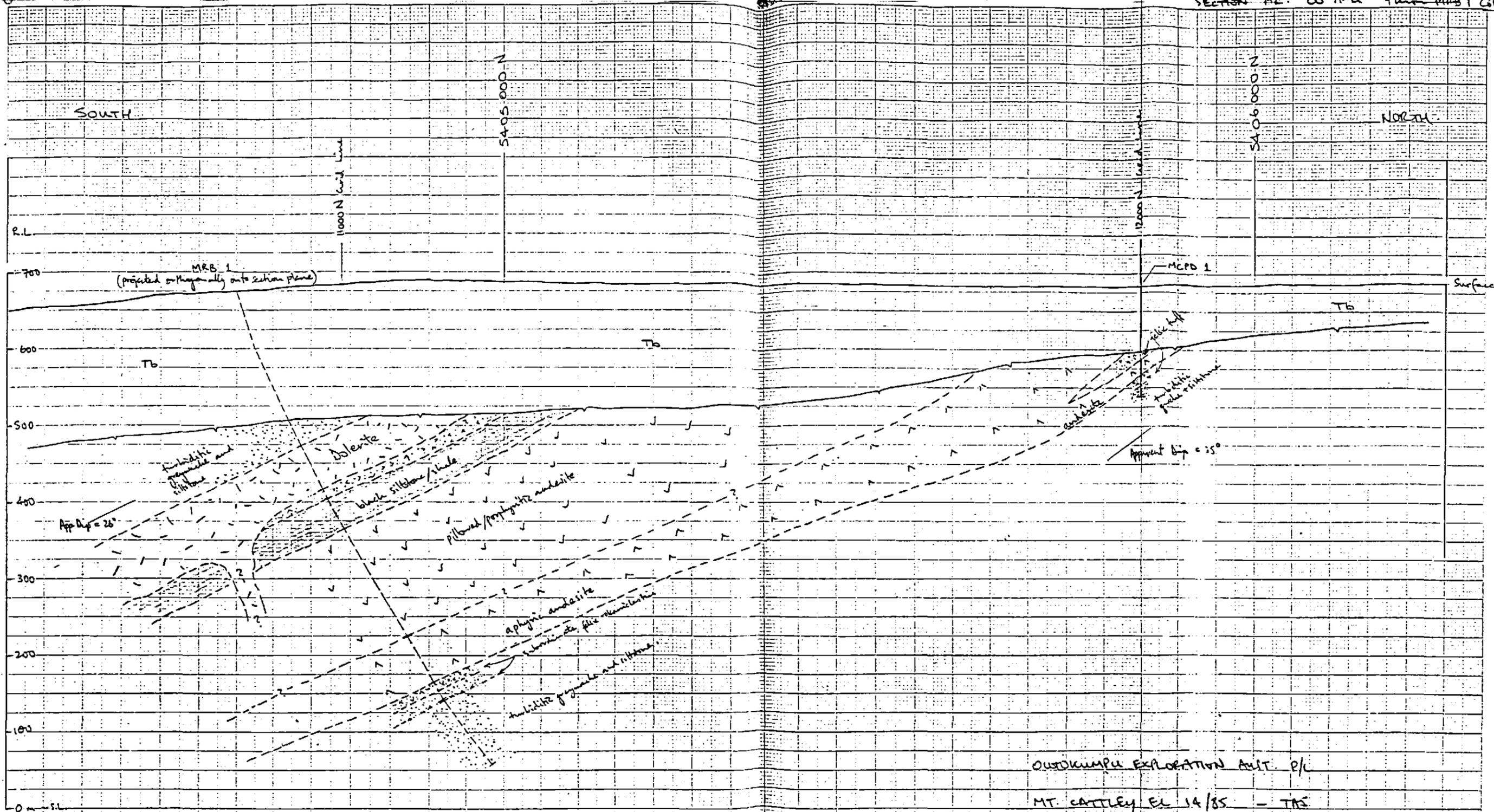
DHEM SURVEY

MRB 1

LOCATION PLAN

FIG 1

OUT/MG90/19



OUTOKUMPU EXPLORATION AULT. P/C

MT. CATTLEY EL 14/85 - TAE

INTERPRETED GEOLOGICAL SECTION 3995.55 E (AMG)

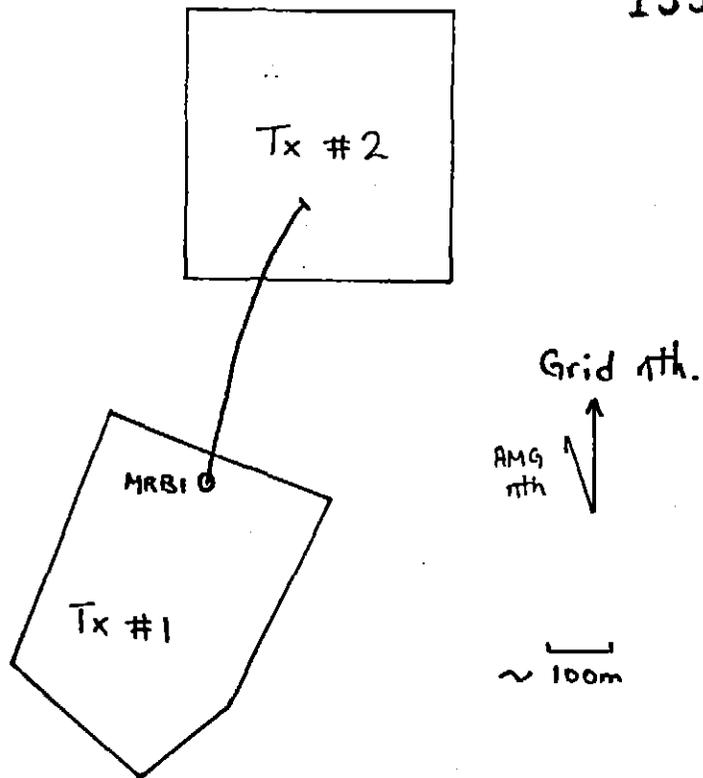
SECTION: DIRECTION: 00° (AMG) THROUGH COLLAR OF MRB 1

SCALE: 1:5000

W. NEUMANN  
August 1990

ref:  
out/M690/19

Fig. 2.



MRB1 LOOP COORDINATES

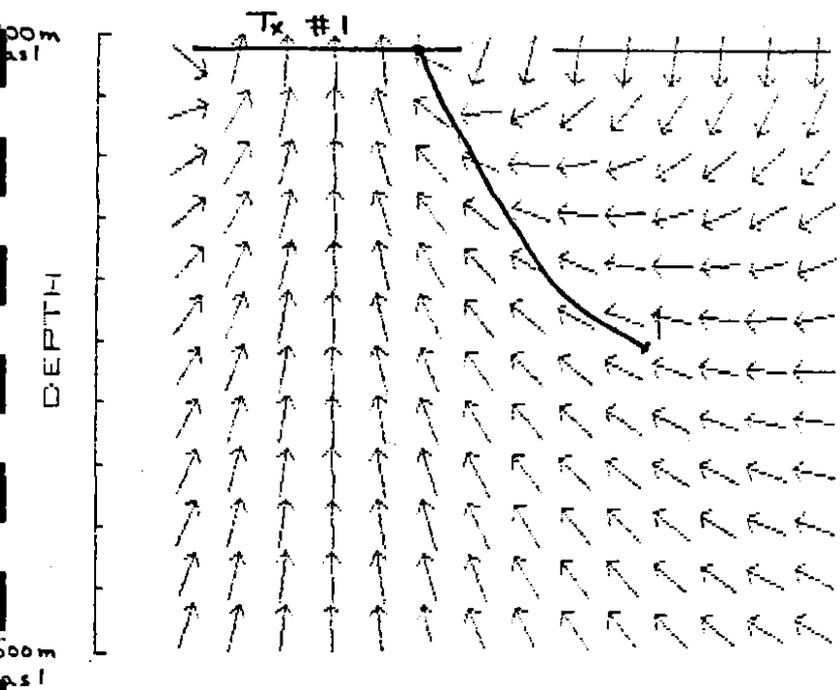
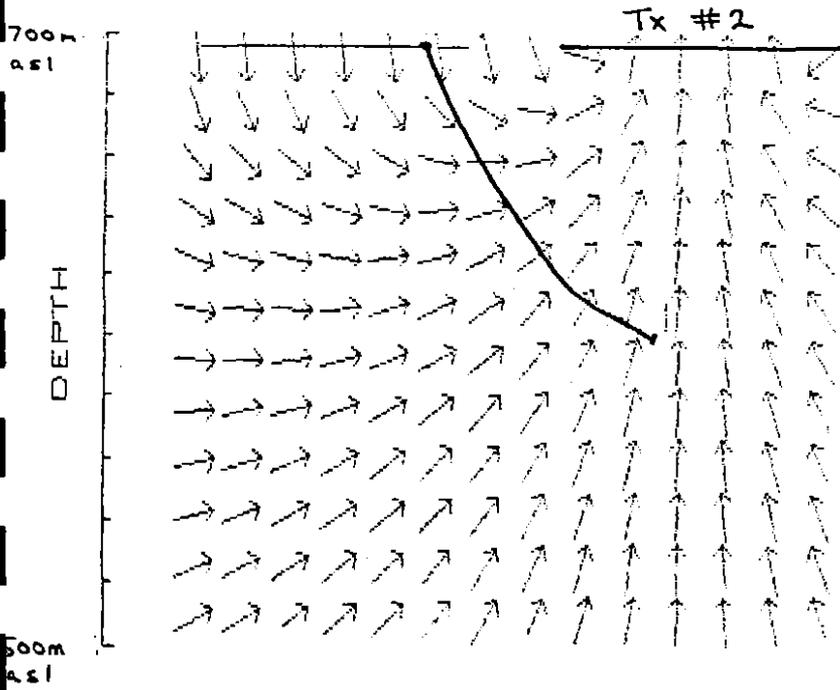
(local grid)

	Easting	Northing
LOOP 1		
	10640.	11050.
	10460.	10640.
	10680.	10470.
	10830.	10560.
	11000.	10870.
	10750.	10950.
LOOP 2		
	10750.	11600.
	10750.	11200.
	11200.	11200.
	11200.	11600.

E.L. 14/85 (Mt Cattley)  
 MRB1  
 DHEM SURVEY  
 Tx Loop Positions

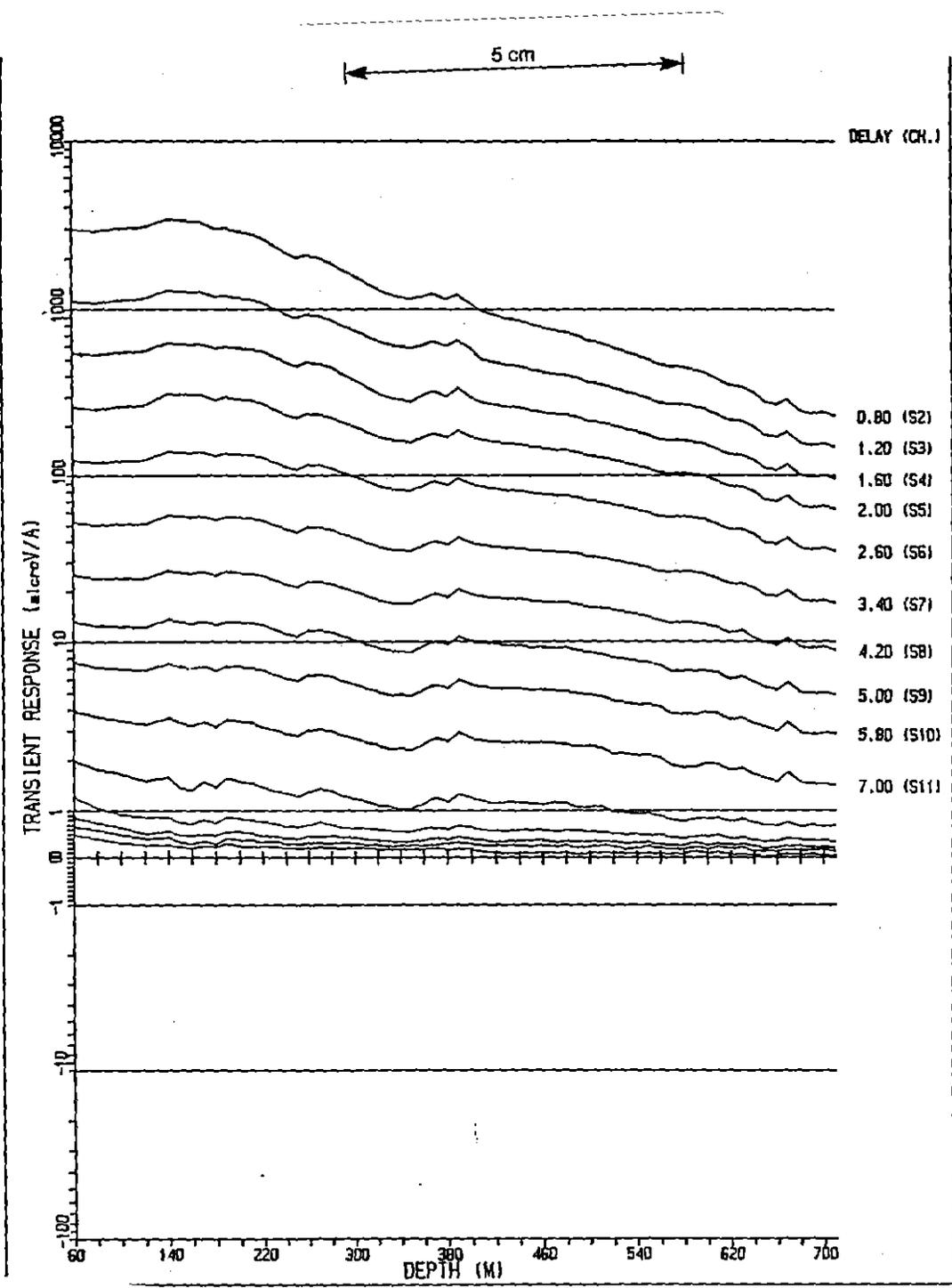
OUTOKIMPU MT CATTLEY

Projected Section from ( 10452.6N, 10584.0E) on Bearing 23.0 Length 1320.0 ...



E.L. 14/85 (Mt Cattley)  
 MRB1  
 DHEM SURVEY  
 EM FIELD PATTERNS

Tx Loops MRB1/1 & MRB1/2



**SURVEY SPECIFICATIONS**

DATA ACQUISITION : McSKINNING GEOPHYSICS

SURVEY DATE : NOV. 1990  
 CONFIGURATION : 400M SQUARE TX. LOOP  
 DRILL HOLE SURVEY

READING INT. : 20 METRES  
 NO. OF STACKS : 1024  
 TRANSMITTER : MEDIUM POWER  
 RECEIVER : SIROTEM II S/N 1224  
 CURRENT : 12.4 AMPS  
 OPERATOR : P McSKINNING

**PLOT SPECIFICATIONS**

HORIZONTAL SCALE - ~ 1:5800  
 VERTICAL SCALE - LOGARITHMIC  
 2.5 cm PER DECADE  
 LINEAR BETWEEN  
 -1 AND +1

TIME DELAYS IN MILLISECONDS  
 E - EARLY TIME WINDOW  
 S - STANDARD TIME WINDOW

OUTOKUMPU

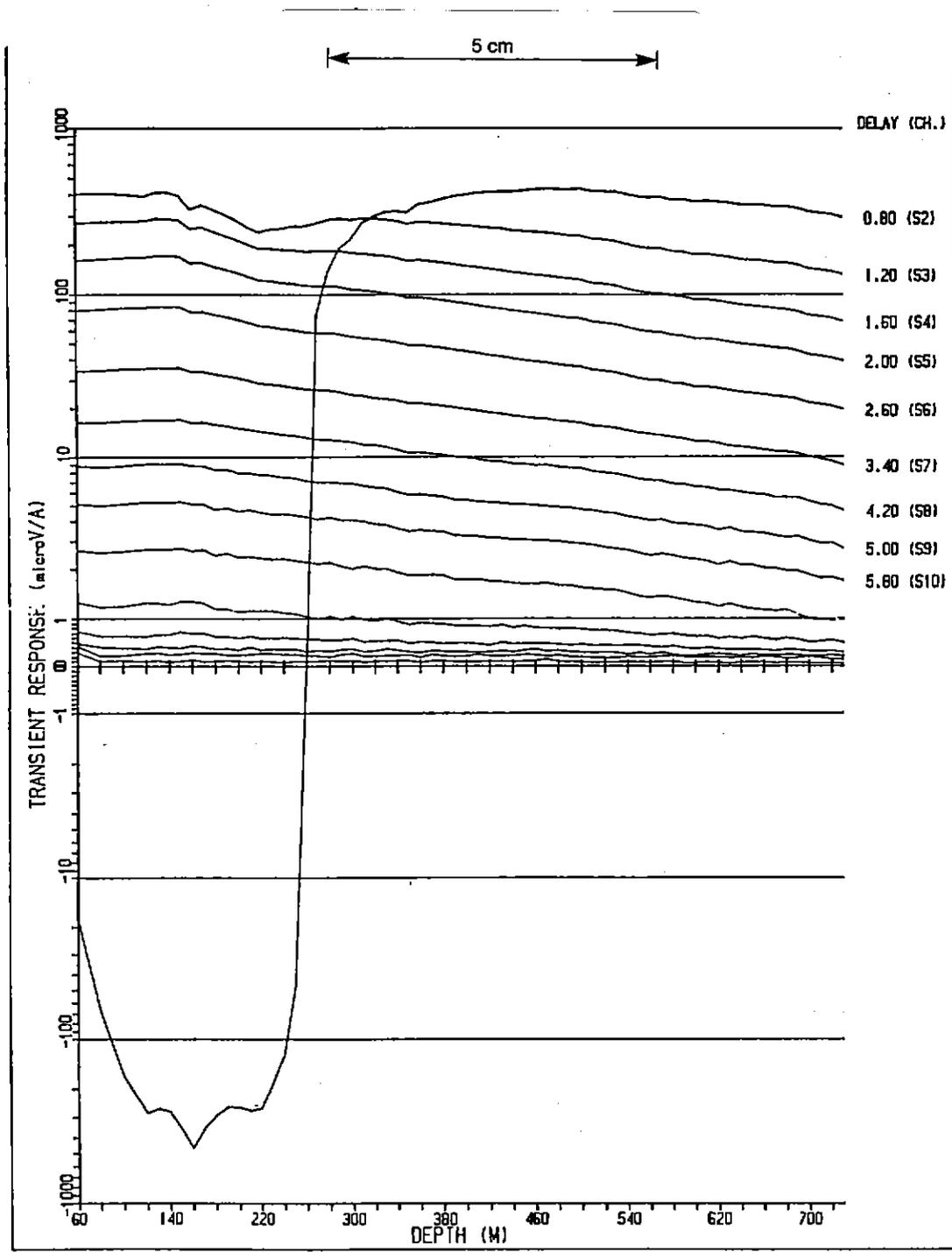
TASMANIA  
 MT. CATTLEY  
 SIROTEM PROFILE  
 LINE MRB1 LOOP 1

ref: Out/MG90/19

130

135134

Fig. 5



### SURVEY SPECIFICATIONS

DATA ACQUISITION : McSKIMMING GEOPHYSICS

SURVEY DATE : NOV. 1990

CONFIGURATION : 450M SQUARE TX. LOOP,  
DRILL HOLE SURVEY

READING INT. : 20 METRES

NO. OF STACKS : 1024

TRANSMITTER : MEDIUM POWER

RECEIVER : SIROTEM II S/N 1224

CURRENT : 12.1 AMPS

OPERATOR : P McSKIMMING

### PLOT SPECIFICATIONS

HORIZONTAL SCALE : ~ 1:5800

VERTICAL SCALE : LOGARITHMIC  
2.5 cm PER DECADE  
LINEAR BETWEEN  
-1 AND +1

TIME DELAYS IN MILLISECONDS  
E - EARLY TIME WINDOW  
S - STANDARD TIME WINDOW

OUTOKUMPU

TASMANIA  
MT. CATTLEY  
SIROTEM PROFILE  
LINE MRB1 LOOP 2

ref: Out/M690/M

Fig. 6.

**Appendix VI:**

S.Collins, 1990;

Mt. Cattley Geophysical Review

ARCTAN Services Pty. Ltd.  
(Incorporated in NSW)

9 Marshall Avenue  
Warrawee, NSW 2074  
Telephone: (02) 489 6836

Memo to: Ian Neuss.

From: Steve Collins

Subject: Mt. Cattley Geophysical Data

I have briefly reviewed the Mt. Cattley geophysical and geological data and note the following points.

1/ The Gefinex system which was surveyed on this prospect uses a layered earth as an interpretation model. As a result of this the interpreted response may often appear as a horizontal body even where this makes no geological sense. In a report by W. Herrmann surprise was expressed that drill hole MCDD4 did not intersect horizontal strata. It is my understanding that the Finnish geophysicists now have a better understanding of the type of response expected over vertical conductors than was the case when this survey was run. I have not attempted to reinterpret the Gefinex data as I am not familiar with the plotting system used and such interpretation is best left to those who are familiar with this. In future, however, it would be advisable to give the interpreters of this data as much information about the likely geological model as possible so they can advise on the validity of the geophysical model used. The Gefinex data produced two responses which were subsequently drill tested. The source of the response tested by hole MCDD5 can be identified clearly as a bed of weakly conducting pyritic siltstone. The source of the response tested by MCDD4 however may require further investigation.

2/ The report on the downhole EM surveys by John Bishop suggests that the observed results for MCDD4 can be explained by the presence of a conducting sand layer at the base of the Tertiary basalt, plus a background response due to the geometry of the EM transmitter relative to the drillhole location. That the sand layer is weakly conducting is undoubtedly true, results for all transmitter locations show an early time conductor which may be an 'in-hole' or 'off-hole' response depending on the transmitter location. This response though easily observed in the data cannot be considered 'strong' as for all transmitter locations it has completely decayed by 2 milliseconds (EM37 channel 14). It is likely that this conducting layer is the source of the Gefinex anomaly. Late time downhole EM values show a broad negative response for transmitter location 1 and a positive to negative asymmetric response for transmitter loop 2. This response was identified by John Bishop as due to a conducting earth or a probe self response complicated by the unusual geometry of the drillhole relative to the geology and the EM transmitter. A further possible explanation would be a conductor located sub parallel to the drill hole, stratigraphically below it. The measured time constant for this response, based on EM37 channels 17 to 20 is 4.3 milliseconds which is an excellent value for a strong conductor. Unfortunately equipment malfunctions at the time of this survey make the accuracy of this

constant somewhat doubtful though the fact that the decay appears to be clearly exponential gives confidence to it. The surface EM37 profiles were carefully examined to determine if the transmitter loops may have been poorly located for coupling with a westerly dipping conductor adjacent to hole MCDD4. The surface EM37 loops were found to have been almost optimally located for such a conductor and no response is visible in this location, suggesting that the original interpretation by John Bishop is correct. It is difficult to recommend further work on this response due to the lack of surface response. A question mark will remain however about the cause of the downhole EM in MCDD4. I recommend that any holes drilled near MCDD4 be logged with downhole EM and careful evaluation of this data relative to that in MCDD4 be carried out. I would also recommend that when more downhole EM data on the whole prospect becomes available that the data for MCDD4 be reevaluated to determine if it does in fact represent an 'anomaly'.

3/ Examination of government air magnetic data for this area indicates that magnetic responses due to the Tertiary basalts completely swamp any buried responses which may help to map the favourable Hellyer andesite horizon. These surficial responses would make surface magnetic surveys also ineffective. It is possible that the magnetic method could be used to determine the depth to the base of the basalt in areas of no Sirotem coverage, but this could be considered only as a desperation measure as current knowledge of the stratigraphy of the area suggests that those areas not covered by the original EM surveys are not in favorable geological units. The gravity technique like the magnetic technique would be very adversely effected by the variable thickness of basalt and even without these problems the chances of locating a massive sulphide body at depths greater than 100 metres using gravity are remote.

4/ Electrical surveys such as dipole dipole IP may be of use in mapping the location of the Que River shale and pyritic horizons within the andesite units in order to give a better definition of the favorable stratigraphic horizons. The chances that IP could directly detect a massive sulphide body at the depths considered here are remote but the use of the tool as a stratigraphic mapper should be considered. The effectiveness of IP in this terrain would depend very much on whether there are IP sources within the basalt. I do not have any information on this but it is likely that John Bishop with his better local knowledge will know. The use of IP in this manner would have to weighed against the cost of further drilling, but it is likely that a carefully run IP survey could aid the location of further drilling to the extent that it becomes cost effective. The cost of dipole-dipole IP surveys (with a minimum spacing of 100 metres) in this environment would be between \$1000 and \$2000 per line kilometre depending on conditions. I estimate that 20 line kilometres of such IP may be necessary to fully cover the favorable horizon with lines at 500 metre spacings. This survey would cost between \$30000 and \$40000. Depending on the cost of drilling and the perceived effectiveness of this approach, this may be considered an acceptable cost. The use of a cheaper technique such as gradient array IP is not recommended as the sand layer beneath the basalt may effectively shield the rocks below from this technique.

5/ The existing surface EM37 data has been examined in some detail to determine whether it is possible to use these data to determine more

closely the stratigraphy of the area. Unfortunately in this environment it is extremely difficult to determine the difference between responses from the basement and the effects due to the transmitter loop interacting with the partially conducting basalt. The reason for this is that the width of a response from below 100 metres will be 400 metres or more wide. This is approximately the same as the dimensions of the transmitter loop and its associated ground response. Often it is possible to discriminate sources by their different decay rates and hence conductivities. On this prospect this may be possible if the original data is available I have not yet examined the possibility of obtaining these data. The EM37 system in its normal survey mode only records data to 7 milliseconds which is barely enough for the surficial responses to decay. As the data stands it is not possible to determine what is a response from the basement shales and what is from surface conductors. Thus the EM data is not of use for stratigraphic mapping in its current state. It may be of use if contour maps of late channel data can be produced.

6/ The location of the EM37 transmitter loops has been examined in relation to current knowledge of the basement structure. It has been found that only approximately 30 percent of the favourable horizon has been surveyed with optimally coupled transmitter locations. In particular the whole of the western limb of the proposed synclinal structure has been surveyed with poorly coupled transmitters. Incidentally, most of this limb is believed to lie beneath 200 plus of basalt and thus may not be cost effective to follow up. The southern half of the eastern limb has also not been surveyed with a suitable transmitter location. If further EM surveys are contemplated here it would be wise to use a system which reads to later time than a standard EM37 system, that is Sirotem, late time EM37 or Utem. It may also be worth using a distant up dip transmitter such as is normally used for Utem surveys. The use of such a transmitter may alleviate some of the problems associated with ground responses having the same shape as those from deep sources.

#### Recommendations for further work:

1/ Attempt to obtain numerical data for EM37 surveys so that the late time data can be contoured. This may help trace the stratigraphy for the prospect.

2/ Consider attempting to map the sub basalt stratigraphy using dipole-dipole IP surveys. John Bishop should be consulted to see if he knows of any other such work in this environment.

3/ Consider the possibility of resurveying with EM in areas of favorable sub basalt geology where no previous work has been done or where the transmitters were poorly coupled to the current geology.

**Appendix VII:**

**Summary Geological Drill Logs:  
SBDPs 10, 14, & 15**

## SUMMARY GEOLOGICAL DRILL LOGS

(W.Herrmann, Sept.1990)

## SBDP 10

0	- 206 (m)	Tertiary basalt.
206	- 248	Unconsolidated gravels and clay, minor lignite.
248	- 316.3	Felsic pumiceous/lithic breccia.
316.3	- 321.1	Felsic pumiceous tuff and intercalated felsic cherty vitric tuff-siltstone.
321.1		EOH

## SBDP 14

0	- 249.9	Tertiary basalt and associated sediments.
249.9	- 250.8	m.g. Micaceous greywacke/lithicwacke.
250.8	- 252.8	Core loss, puggy and broken.
252.8	- 299	Felsic pumiceous/lithic tuff.
299	- 320.1	Felsic volcanic breccia.
320.1	- 391.6	Felsic vitric and vitric/crystal tuffs.
391.6	- 396	Felsic pumiceous/lithic tuff.
396	- 402.4	Felsic lithicwacke.
402.4	- 411.8	Felsic vitric/crystal tuff.
411.8	- 412.1	Black slate.
412.1	- 413.6	Felsic volcanic breccia.
413.6	- 493.2	Interbedded vitric, crystal/vitric tuffs, cherty tuffaceous siltstones and minor felsic breccia units.
493.2	- 582.6	Feldspar phyrlic, quartz amygdaloidal, Dacitic ? extrusive.
582.6	- 628.2	Interbedded vitric, crystal/vitric tuffs, cherty tuffaceous siltstones and minor felsic breccia units.
628.2	- 644	Coarse rhyolitic - dacitic volcanic breccia; pink quartz + feldspar + biotite porphyry in lower 4m closely resembles porphyry in SBDP 15.
644	- 650.2	Mass flow type felsic breccia and lithicwacke.
650.2	- 688	Cherty vitric tuff and tuffaceous siltstone.
688		EOH.

## SBDP 15

0	- 135.4	Tertiary basalt etc.
135.4	- 286	Quartz-feldspar-(biotite) Porphyry. A compositionally and texturally uniform rock consisting of small equant phenocrysts of clear quartz (10%) and feldspar (5-10%) and sparse flakes of sericitized biotite evenly distributed in a fine grained felsic/glassy? matrix of pinkish/orange/buff colour. Matrix is extensively sericitized to pale olive buff colour in association with pervasive stress fractures above 250m depth.
286m		EOH.