Australian Mineral Industries Research Association Limited

PROGRESS

REPORT

APRIL 1986

CONTROLS ON GOLD AND SILVER GRADES IN VOLCANOGENIC SULPHIDE DEPOSITS (84/P210)

GEOLOGY DEPARTMENT
UNIVERSITY OF TASMANIA

PROGRESS REPORT - APRIL 1986

CONTROLS ON GOLD AND SILVER GRADES IN VOLCANOGENIC SULPHIDE DEPOSITS (84 / P210)

CONTENTS

INTRODUCTION

Considerable progress has been achieved on the project since the inaugural sponsors meeting in August 1985. In particular our study of the PQ - P north lens system at Que River has led to an exciting re-evaluation of the geological structure of the mine and allowed a simple reconstruction of the prefolding geology and metal distribution. Based on this new interpretation of Que River, and the previous findings at Rosebery, outlined in the accompanying report by Huston and Large (1986), many similarities in metal distribution and geometry are now obvious between the two deposits.

The regional studies to characterise the geochemistry and geological setting of the Mt Read volcanics have concentrated on the silicate and trace element chemistry of a range of lava and intrusive types . Tony Crawford has compiled a considerable data base, which leads us toward a far greater understanding of the primary chemical variations of volcanics in the arc, and has enabled some simple and interesting comparisons with more recent volcanic environments around the world.

Peter Ruxton has commenced a world wide study of gold and silver in volcanogenic deposits and some preliminary findings are presented here which indicate the study will be very beneficial to this project. Project outlines are included for the planned work on the Stirling Valley and Lake Selina areas (Tasmania), Archean VMS deposits in Western Australia and the Balcooma VMS in north Queensland.

The increase in company sponsors from six to ten since the project commenced last year, has enabled us to tackle the stated aims and objectives initially outlined. Two Amira Research Associates (Peter McGoldrick and Peter Ruxton), are employed on a two year contract in addition to a part time research assistant. However the budget remains tight.

Ross Large
Project Leader

<u>AMIRA - UNIVERSITY OF TASMANIA</u>

PROGRESS REPORT APRIL 1986

Structure and Metal Distribution in the PQ - P north Lens System, Que River Mine, Western Tasmania

ROSS LARGE and PETER McGOLDRICK

CONTENTS

AIM :

To study the distribution and genesis of gold and silver relative to base metals, in the PQ lens and associated host rocks at Que River.

SIGNIFICANCE :

In order to develop exploration criteria for precious metal-rich massive sulphide deposits, a detailed understanding of gold and silver distribution and genesis, and their relationship to the base metals, in well drilled deposits such as Que River and Rosebery is vital to this AMIRA project.

SUMMARY :

Work to date has concentrated on resolving the geological structure of the PQ and P north lens system, followed by assay metal contouring of selected sections. Three sections were studied in detail ; 7400N, 7550N and 7700N. Thirty five drill holes on these sections have been logged and plotted in summary format. Assay contours for Cu, Pb, Zn, Au and Ag are given on each section and correlated with the geology. The points of significance to emerge from this work are summarised below.

1) Confirmatory evidence is provided for the theory that the main lenses PQ and P north are on the same horizon folded around a synclinal wedge of flow banded and brecciated hanging wall dacites (Young, 1980).

2) A major feeder zone of intense stringer and disseminated pyrite overlain by massive pyrite-chalcopyrite has been recognised on section 7550N in the axis of the syncline below the folded massive sulphide lens.

3) On this section the PQ lens is folded in a tight to isoclinal W-shaped fold with the P north lens representing the faulted off western limb of the fold.

4) Minor stringer pyrite and stringer galena-sphalerite occurs in altered volcaniclastics stratigraphically below the massive sulphides on both sides of the fold.

5) A narrow zone of fuchsite-carbonate altered basalt (?) breccia occurs on the immediate hanging wall to the massive sulphide and is folded around the dacite wedge.

6) Metal zonation in the massive sulphide lenses is ;

footwall pyrite ----- Cu -----Zn, Pb ----- Ag, Au hanging wall

The W fold is clearly outlined by the pattern and zonation of Cu and Zn. Gold is concentrated along the two synclinal axes.

7) To the south on section 7400N, the W fold merges into a single tight isoclinal syncline. The syncline plunges north, and on section 7700N the two lenses of massive sulphide (PQ and P north) show the opposite facing.

8) A large zone of low grade galena-sphalerite-pyrite stringer mineralisation occurs in the footwall to PQ on the eastern side of the syncline on section 7700N. Significant gold is distributed throughout this stringer zone and will require further detailed study.

INTRODUCTION

The Que River massive sulphide deposit is located at the northern end of the Mt Read Volcanic belt in Western Tasmania . This project commenced in February 1986. Several visits to the mine have been made by Peter McGoldrick and Ross Large amounting to 28 man days on site.

Previous Research

A five year collaborative research programme between C.S.I.R.O. and Aberfoyle was carried out on Que River and it's environs between 1980 to 1985. The main thrust of this project included;

a) Petrological and geochemical studies on the host rocks and their altered equivalents.

b) Sulphur, lead and oxygen isotope studies to determine solution sources and for use in exploration.

c) Preliminary textural and mineralogical studies of base metal sulphides including gold and silver.

Much of this work remains confidential, but one abstract has been published (Whitford, 1984) and several publications are in preparation.

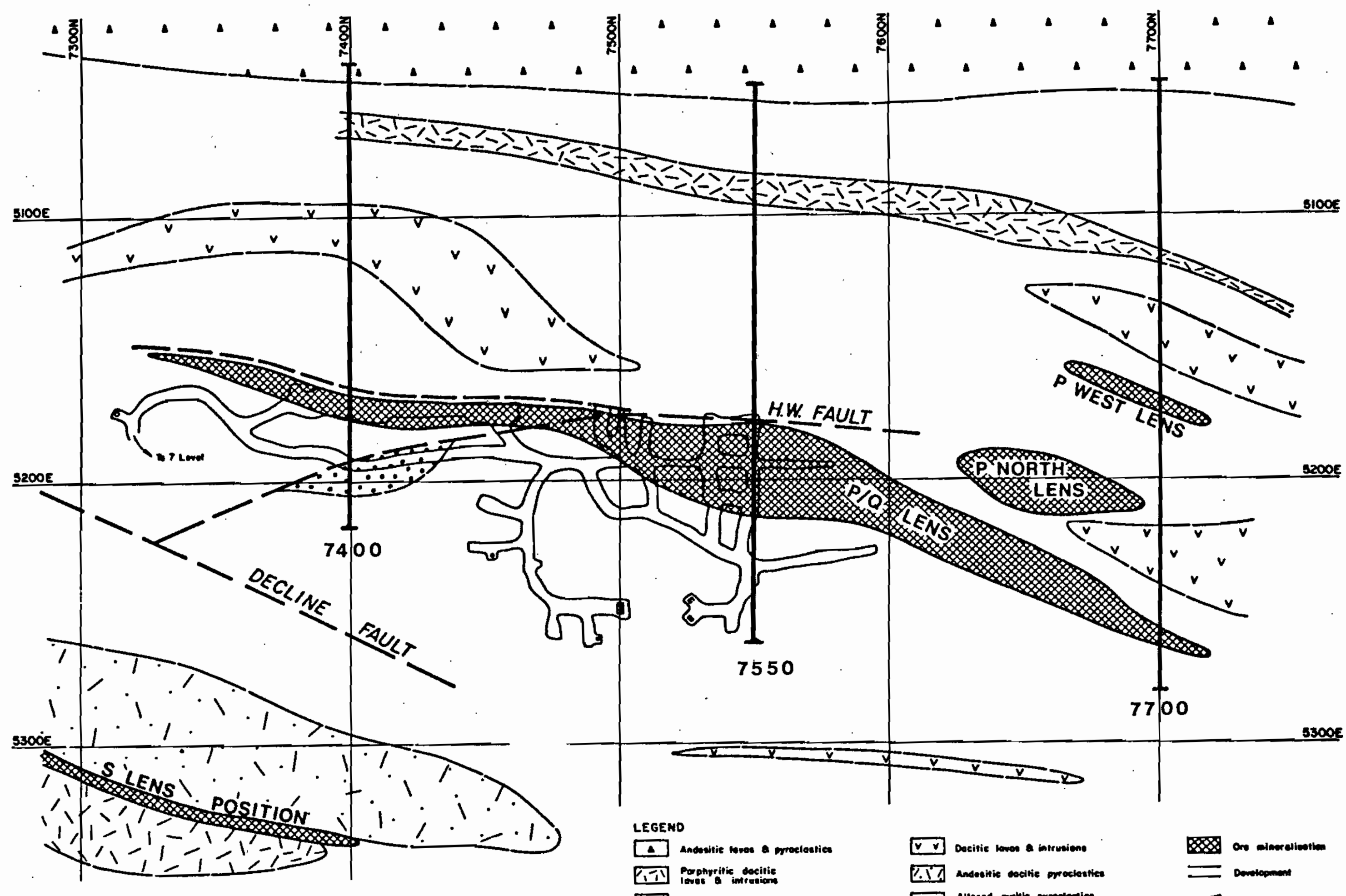
Descriptions of the mine geology at Que River are given by Wallace (1982 and 1984). The Volcanic sequence consists of lavas, pyroclastics and sub volcanic intrusives of andesite and dacite composition. A simplified geological plan (Wallace, 1982) is given in figure 1. The three major ore lenses are;

PQ Lens : the major lead zinc lens with a strike length of at least 400 m.

P North lens : a smaller lead-zinc lens adjacent to, and on the western side of the northern end of PQ lens.

S Lens : a copper-rich lens 120 m east of PQ lens.

A poorly defined zone of stringer style mineralisation known as P West lens occurs about 30 m west of the P North position.



GEOLOGICAL PLAN 5 LEVEL

Fig. 1

Structural Problems

Following discussions with David Wallace and Rod Patterson from Aberfoyle, it became apparent that before a detailed study of metal distribution could commence at Que River, the vexing problem of the geological structure of the mine area required serious attention. Two alternative structural interpretations had been suggested by previous workers.

1) The andesite-dacite volcanic pile and associated ore lenses represent a simple west facing sequence [Young (1977) and supported by Cox (1981), Wallace (1982), Whitford et. al. (1982) and Whitford and Craven (1983)].

2) The ore lenses are folded about a major synclinal structure with the P north lens representing the western limb and the PQ lens the eastern limb (Young, 1980).

The supporting evidence for each interpretation is given below in Table 1.

Studies to Date

To enable a study of the relative position of precious metals in and around the orebody, resolution of the geological structure became our first priority. Three cross sections through the PQ - P north lens system were selected for detailed study; 7400 N, 7550 N and 7700 N (Figs 1 & 2). These were chosen as representative sections because; 7750N is thickest and most copper-rich; 7400N is typical of the sheet-like massive sulphide and 7700N because it included the gold zone in the footwall of PQ lens. The following work has been carried out on each section.

1) Study of geological structure - thirty five drill holes were laid out and logged in a summary format. Holes on each section were laid side by side for ease of correlation.
2) Study of ore types and distribution of stringer mineralisation (in the 35 drill holes).
3) Contouring of drill hole metal values (Cu, Pb, Zn, Ag and Au) on the three cross sections.

The data from all sections was plotted at 1:250 scale and reduced to A4 size for presentation in this report (figs 3, 4, and 5).

Table 1 : Structural interpretations at Que River

Author	Evidence
a) <u>Simple West facing sequence</u>	
Cox (1981)	- Vergence relationships between cleavage and host rocks - Sedimentary structures in massive ore
Whitford et. al. (1982)	- Progressive increase in $\partial^{34}S$ value of pyrite in ore lenses passing east to west; S lens - PQ - P north- P west due to a gradually evolving source of sulphur.
Whitford and Craven (1983) Whitford (1984)	- Volcanics to the west of PQ and P north are less altered typical of a hanging wall sequence compared to those east of PQ which show typical footwall alteration chemistry.
b) <u>Syncline Interpretation</u>	- The ore type and metal values of PQ and P north drill intersection are very similar, suggesting the same ore lens folded around a dacite wedge.

Que River Long Projection Looking West

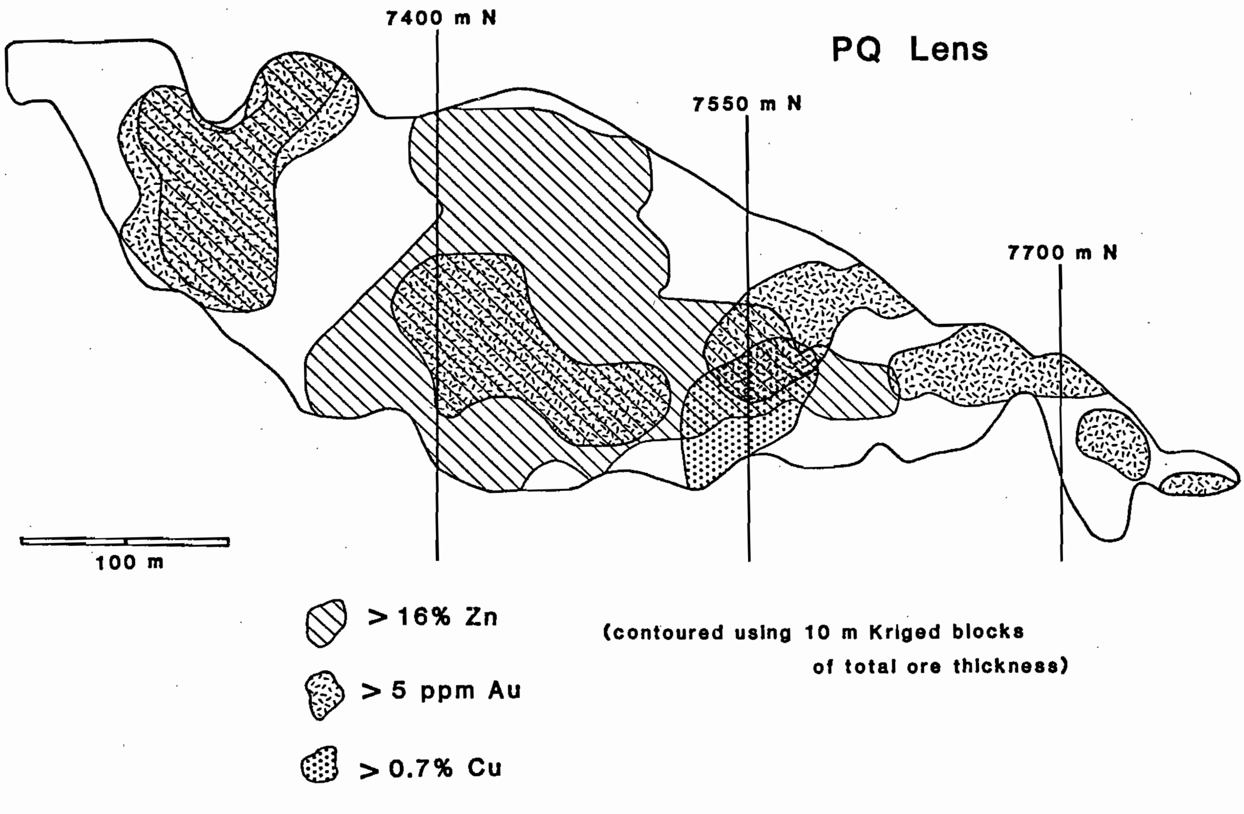


Fig. 2

RESULTS

Section 7550 N (centre of the PQ lens.)

Geology (figure 3a) : The PQ lens is considerably thickened below a major dacite wedge on this section. The structure is best interpreted as a complex fold as outlined below.

1) The massive sulphide PQ lens wraps around and under the dacite wedge, is thickened in the fold axis, and reappears as a faulted slice on the western side of the dacite as P north lens.

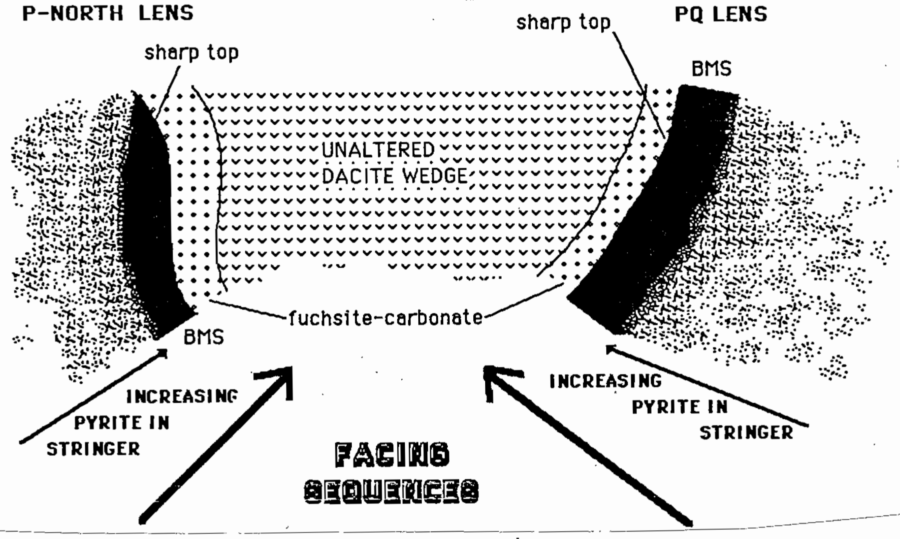
2) The inferred hanging wall rocks (the dacite wedge) consist of relatively unaltered and non pyritic flow banded and brecciated lavas, whilst the footwall volcaniclastics to both the east of PQ and the west of P north are highly altered (silicified and sericitised) and strongly pyritic indicative of typical footwall alteration.

3) Below the massive sulphide body in the keel of the fold is a zone of strongly pyritic volcaniclastics cut by intense stringer pyrite mineralisation. This area is interpreted to be a major feeder pyrite stringer to the PQ massive sulphide lens.

4) Immediately above the pyrite stringer keel is a zone of massive pyrite with minor chalcopyrite very similar to the massive pyrite-chalcopyrite lenses in he footwall to the Rosebery lead-zinc ore. This pyrite-rich zone extends up hrough the centre of the PQ lens outlining an isoclinal W-fold structure.

5) On the eastern and western flanks of the folded massive sulphide, stringer pyrite and stringer galena-sphalerite-pyrite extends laterally into the volcaniclastics. On both sides of the dacite wedge, facing sequences in the

sulphides are well developed, and support the fold interpretation (see sketch below).



Basal stringer zones increase in intensity and merge upwards with massive sulphides. Sharp tops on the massive sulphide are followed by a fuchsite-rich horizon.

6) An horizon of breccia (or volcaniclastic) with strong fuchsite and carbonate alteration is developed immediately above the massive sulphides, and is overlain in turn by dacite. The fuchsite breccia horizon is folded around the dacite and forms a narrow tongue extending into the massive sulphide along the major synclinal fold hinge. The western margin of the fuchsite breccia is faulted, resulting in high angle thrust displacement of the P north lens along the western limb. The fuchsite breccia contains clasts of altered basalt (?) and dacite and is interpreted to represent a primary chromium-rich volcanic breccia (possibly a basaltic epiclastic) which was deposited immediately following the cessation of massive sulphide formation. On-going hydrothermal alteration probably released chromium from minerals such as pyroxene and chromite in the breccia to give rise to the fuchsite development in this horizon. Scattered minor fuchsite is also present as spots in some sections of the base of the dacite wedge. No significant amounts of fuchsite have been observed footwall to the PQ - P north lenses, although isolated minor disseminations do occur.

7) Fragments of massive sulphide occur in the fuchsite breccia overlying PQ lens in DDH 438. These appear to be rip-up clasts from the underlying massive sulphide, and confirm a west facing in this eastern limb.

8) Elongate pods of chlorite carbonate alteration generally with associated disseminated and stringer pyrite are developed in the footwall on the western side of the ore lenses. These pods are interpreted to be a footwall alteration facies similar to intense chlorite zones developed in the immediate footwall of other massive sulphides (eg. Hellyer, Rosebery, Mt. Chalmers and Woodlawn).

Four textural varieties of base metal massive sulphide (bms) have been logged on section 7550 N.

a)Laminated bms : finely layered, strongly suggestive of original sedimentary layering.

b)Layered bms : generally coarser layering which may be caused by deformation.

c) Fragmental bms : clastic fragments of sulphide in a recrystallised sulphide matrix. The fragmentation appears to be related to primary deposition and this texture is assumed to be similar to that of the clastic ores in Kuroko deposits.

d) Disturbed bms : disrupted bands often with cross cutting sulphide veins indicating a later sulphide paragenesis. This texture is commonly developed in the pyrite-rich bms.

Layered and fragmental bms are the two most commonly developed varieties although all types occur interbedded in the PQ lens. Fragmental types are more abundant in the periphery of the lenses. It was not possible to obtain unequivocal facing evidence from the sulphide textures (eg. grading, flames and compaction features). Although considerable effort was put into the search for such evidence, conflicting facings were often interpreted in the same metre of core.

A prefolding reconstruction of the geology on section 7550 N is attempted in figure 6.

Metal Distribution on 7550 N

Copper (figure 3b) is concentrated in the base of the section overlying the main pyrite stringer zone. Values greater than one percent copper outline the W-fold structure in the lower portion of the ore lens and extending down into the massive pyrite zone. No significant copper occurs in the pyrite stringer, which is atypical for this style of mineralisation. Note that this section contains above average copper grades, compared with all other sections through PQ lens (see figure 2), due to the proximity to the central feeder system.

Zinc (figure 3c) outlines the isoclinal nature of the fold structure. High grade zinc greater than twenty percent occurs in a narrow band overlying the high grade copper, and folded in a very tight W structure.

Gold (figure 3d) is concentrated in PQ lens in two major bands, outlined by the 5 ppm contour, which join at the top of the lens below the dacite wedge. These two bands approximate to the trace of the two synclinal fold axes. This gold concentration is not considered to be caused by remobilisation. There is probably a primary concentration of gold in the top part of the massive sulphide lens similar to that shown in the Rosebery north orebody (Huston and Large, 1986). Subsequent folding has led to the present configuration of gold along the syncline axes. This interpretation is supported by the gold distribution on sections 7400 N and 7700 N.

Lead (figure 3e) shows a similar distribution to zinc.

Silver (figure 3f) is similar to lead, but the high grade silver occurs in the more distal parts of the lens away from the central feeder and high copper zone.

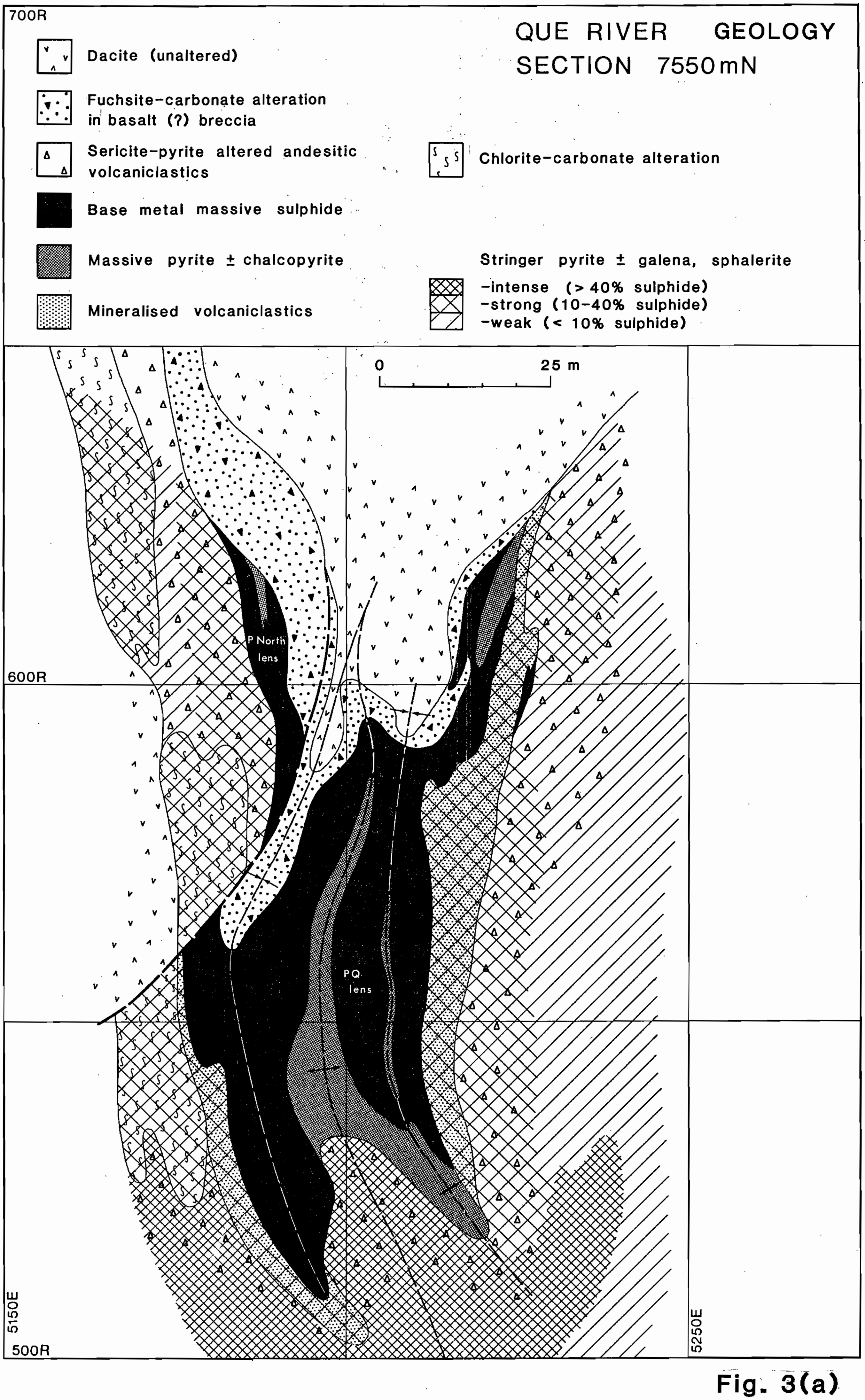

QUE RIVER GEOLOGY
SECTION 7550mN
Dacite (unaltered)
Fuchsite-carbonate alteration in basalt (?) breccia
Sericite-pyrite altered andesitic volcaniclastics
Base metal massive sulphide
Massive pyrite ± chalcopyrite
Mineralised volcaniclastics
Chlorite-carbonate alteration
Stringer pyrite ± galena, sphalerite
-intense (> 40% sulphide)
-strong (10-40% sulphide)
-weak (< 10% sulphide)
700R
600R
500R
5150E
5250E
0
25 m
P North lens
PQ lens

Fig. 3(a)

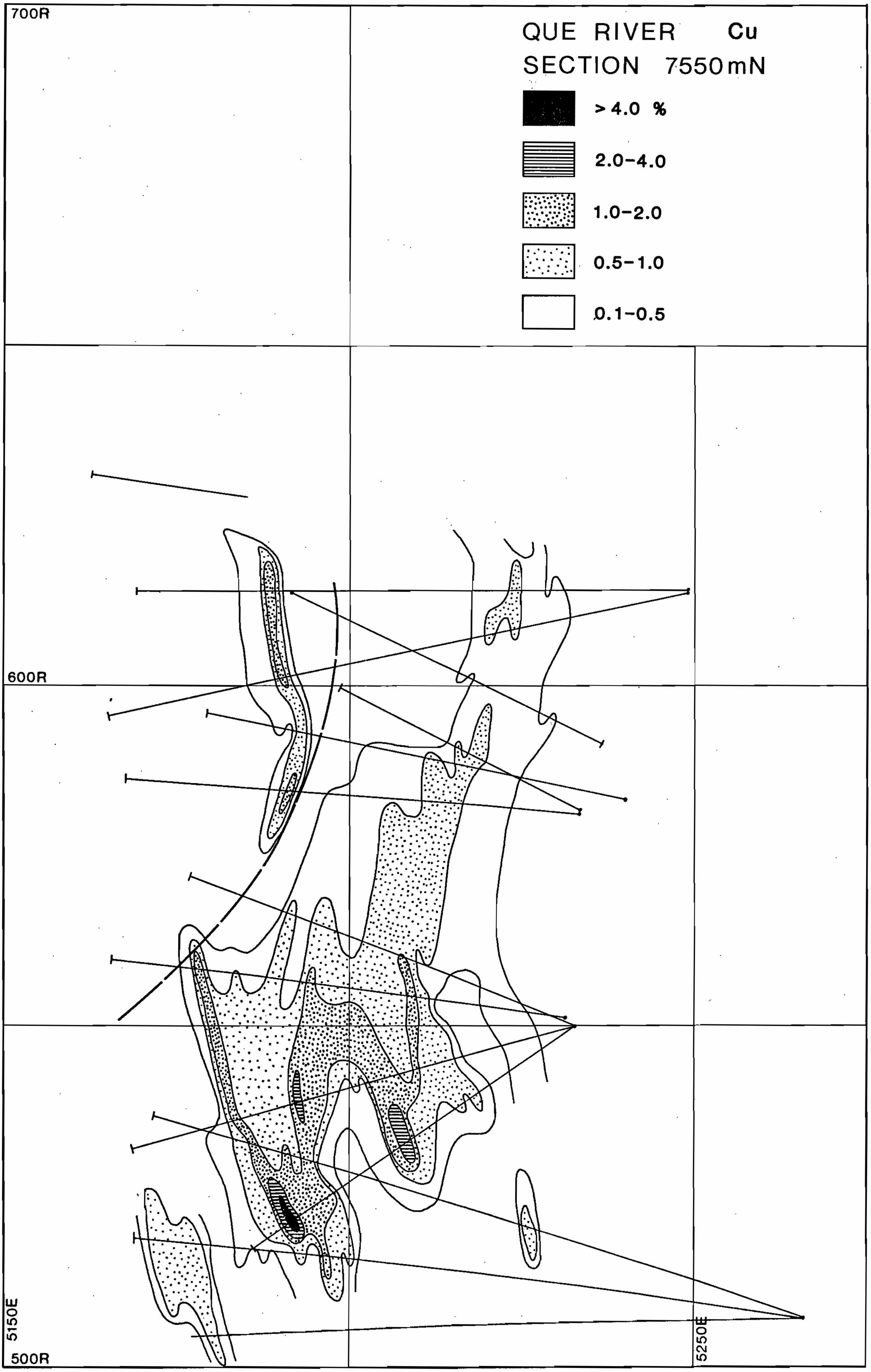

QUE RIVER Cu
SECTION 7550mN
> 4.0 %
2.0-4.0
1.0-2.0
0.5-1.0
0.1-0.5
700R
600R
500R
5150E
5250E

Fig. 3(b)

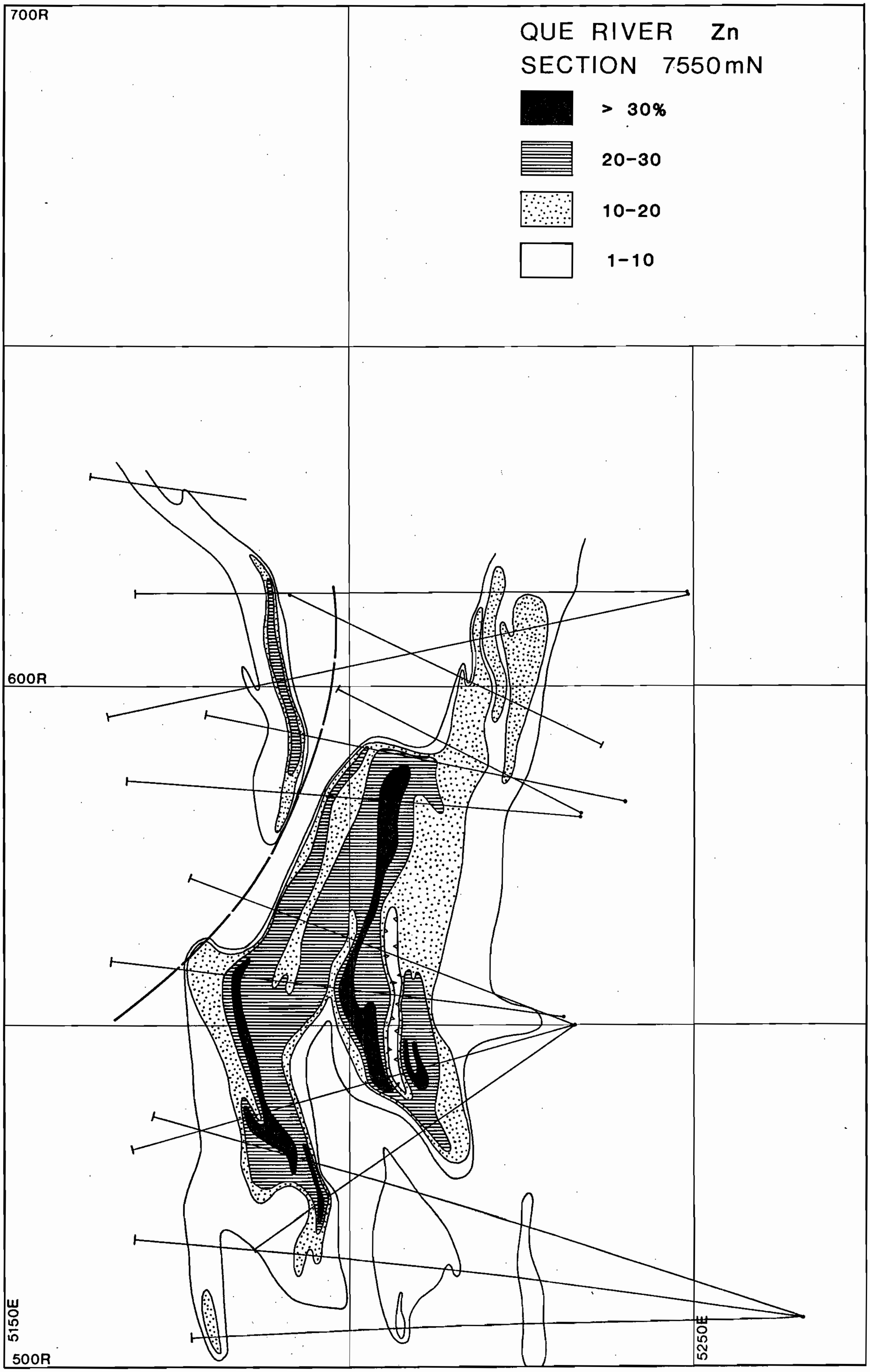
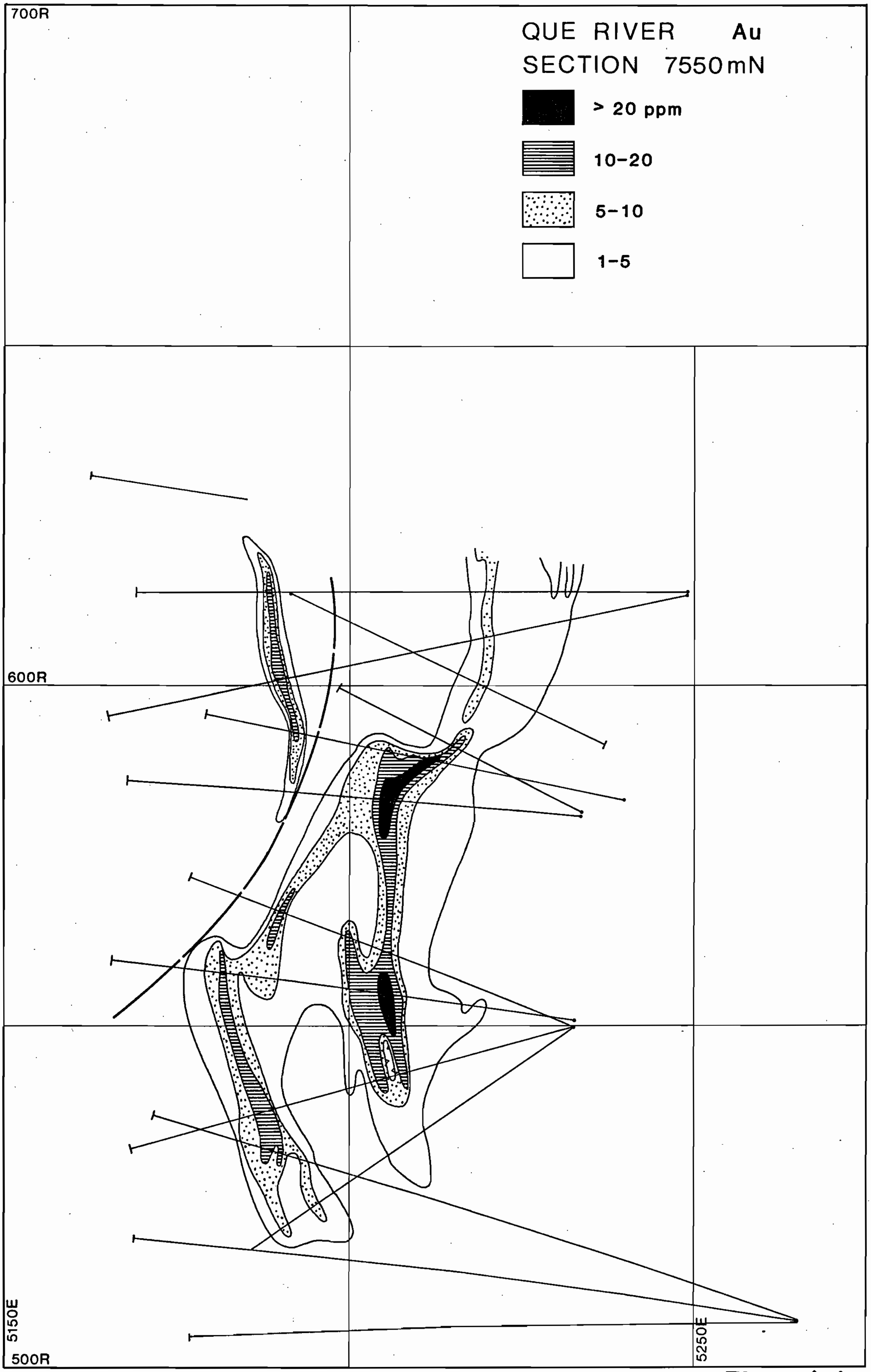

QUE RIVER Zn
SECTION 7550mN
> 30%
20-30
10-20
1-10
700R
600R
500R
5150E
5250E

Fig. 3(c)



QUE RIVER Au
SECTION 7550mN
> 20 ppm
10-20
5-10
1-5
700R
600R
500R
5150E
5250E

Fig. 3(d)

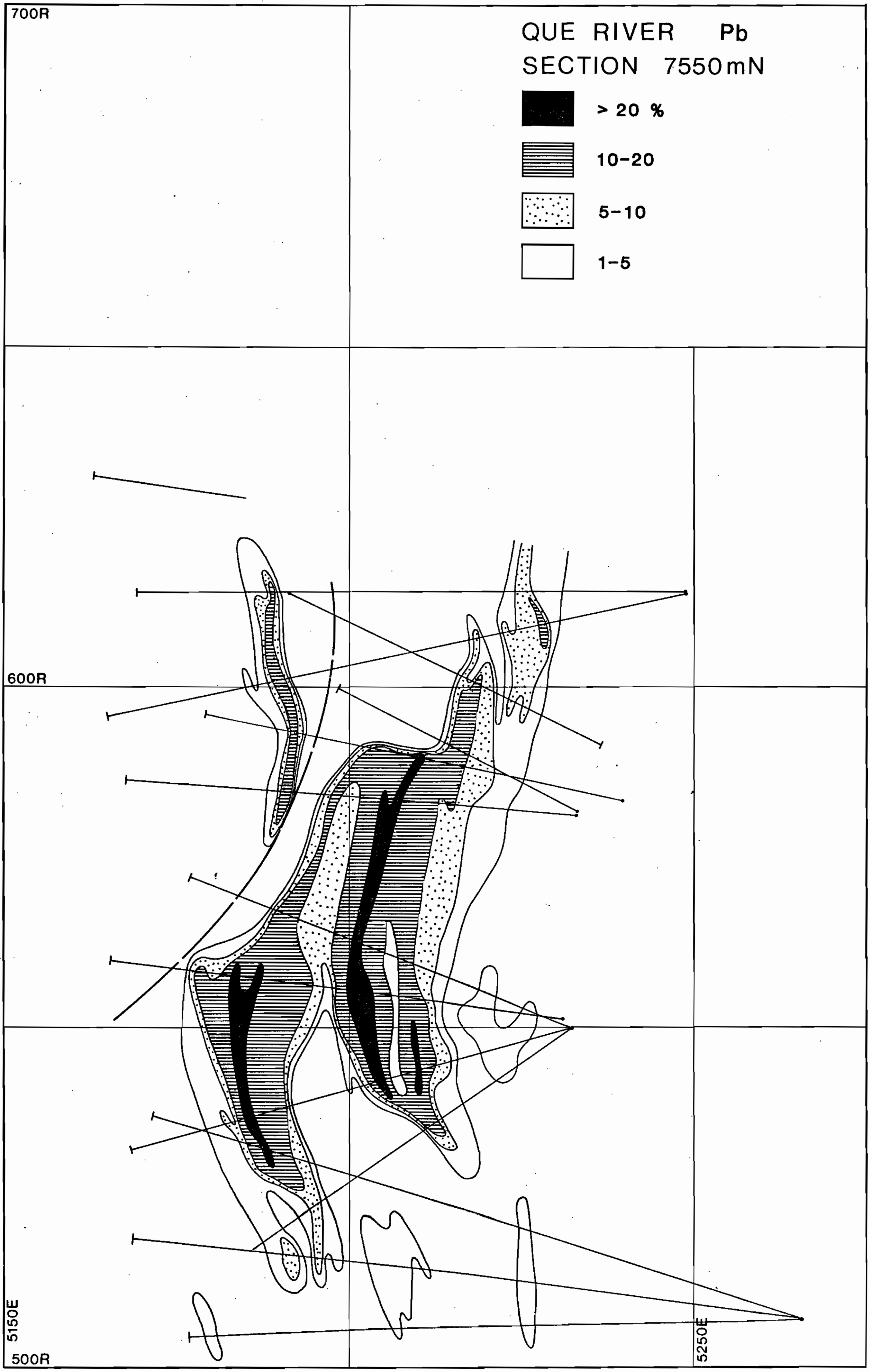
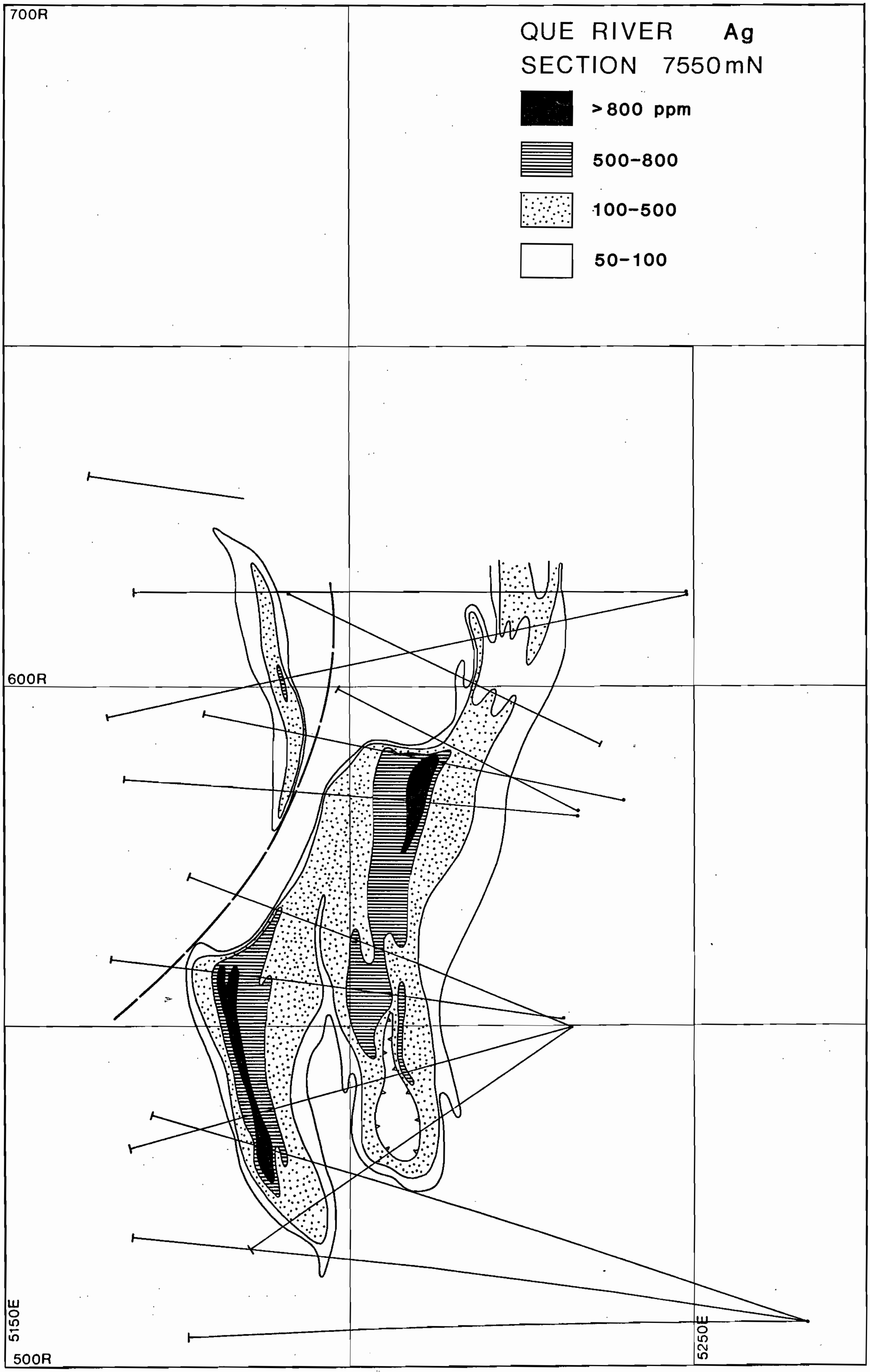

QUE RIVER Pb
SECTION 7550mN
> 20 %
10-20
5-10
1-5
700R
600R
500R
5150E
5250E

Fig. 3(e)



QUE RIVER Ag
SECTION 7550mN
>800 ppm
500-800
100-500
50-100
700R
600R
500R
5150E
5250E

Fig. 3(f)

Section 7400 N

This section is through the southern part of the PQ lens, where the massive sulphide has an elongate vertical attitude (figure 4a). The dacite wedge is much narrower than on section 7550 N and occurs above a zone of fuchsite breccia overlying the massive sulphide body. The syncline structure is not as obvious on this section. Two possible interpretations are suggested;

a) the PQ lens represents a simple west facing bed on one limb of the fold,

b) the PQ lens is tightly folded about the same isoclinal syncline axis as that forming the western part of the W fold structure on section 7550 N.

The latter interpretation is supported by the following evidence.

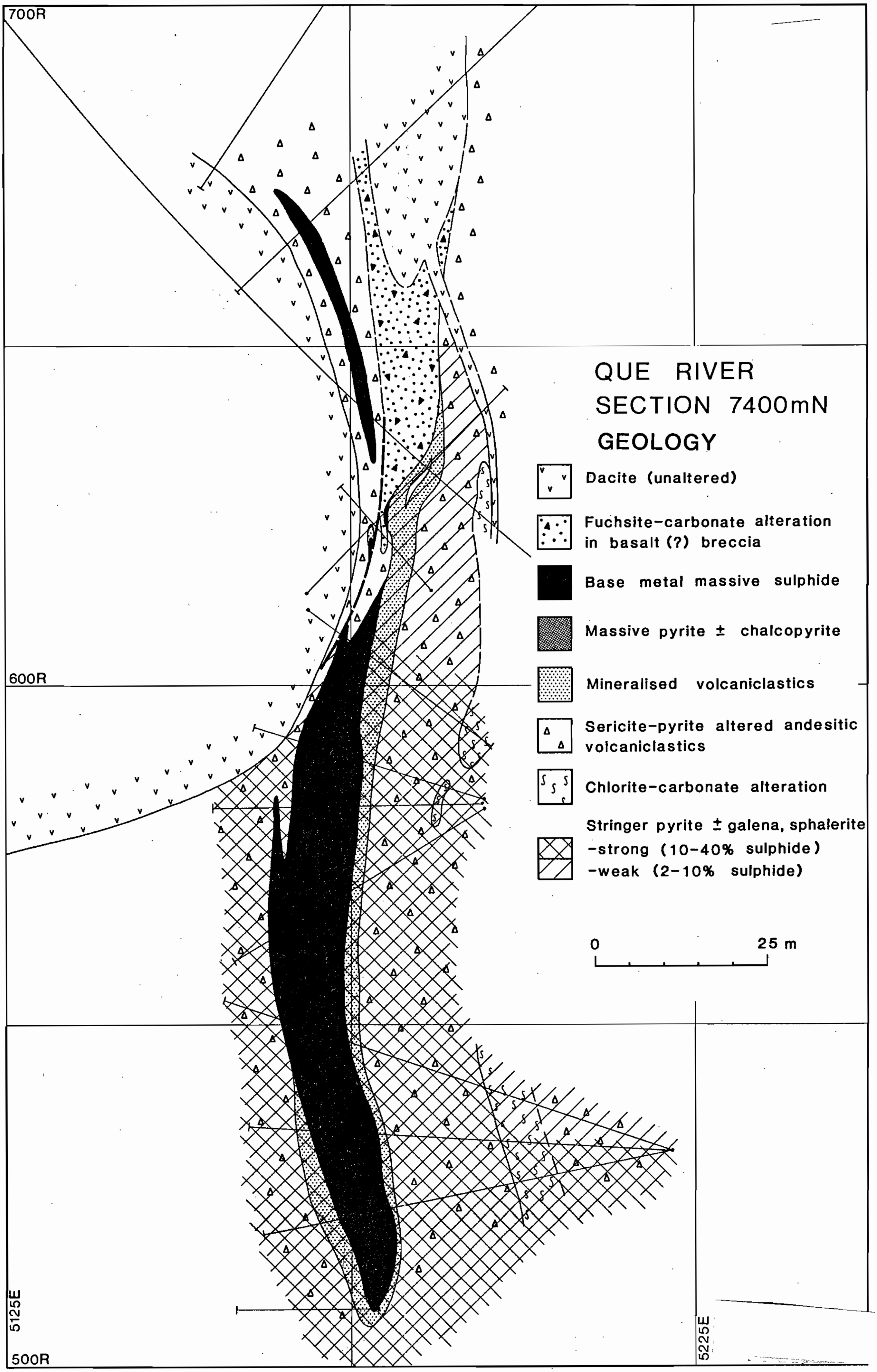
1) Intense alteration and stringer pyrite (increasing in intensity towards the bms lens) occurs on both sides of the lens.

2) The fuchsite breccia zone outlines the axis of the syncline below the dacite wedge.

3) Contours of zinc and lead on this section (see figures 4b and 4e) indicate high grade bands on both sides of the bms lens, strongly suggesting a fold axis down the centre of the lens.

4) Contours of gold (figure 4c) indicate that this metal is concentrated in the centre of the lens and following the syncline axis as demonstrated for section 7550 N (figure 3c).

A separate high grade lens of massive sulphide occurs on the western side of the fuchsite breccia. This probably represents the southern extension of the P north lens on the western limb of the fold. To the west of P north and PQ lenses is a large body of unaltered dacite interpreted to be a post mineralisation subvolcanic body intruded into the footwall mineralisation and possibly time equivalent to extrusion of the hanging wall dacite wedge lavas.



QUE RIVER
SECTION 7400mN
GEOLOGY
Dacite (unaltered)
Fuchsite-carbonate alteration in basalt (?) breccia
Base metal massive sulphide
Massive pyrite ± chalcopyrite
Mineralised volcaniclastics
Sericite-pyrite altered andesitic volcaniclastics
Chlorite-carbonate alteration
Stringer pyrite ± galena, sphalerite
-strong (10-40% sulphide)
-weak (2-10% sulphide)
0
25 m
700R
600R
500R
5125E
5225E

Fig. 4(a)

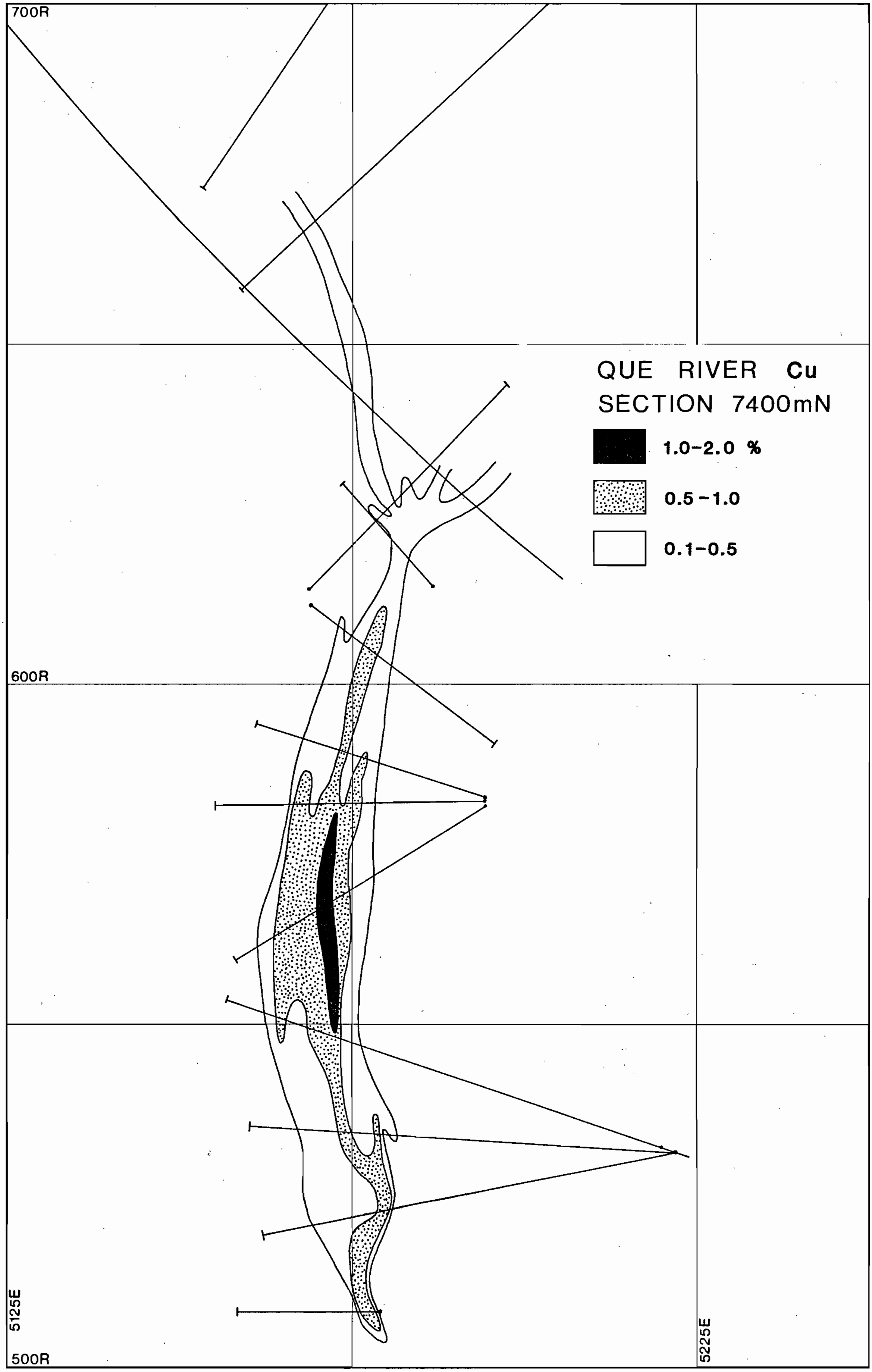
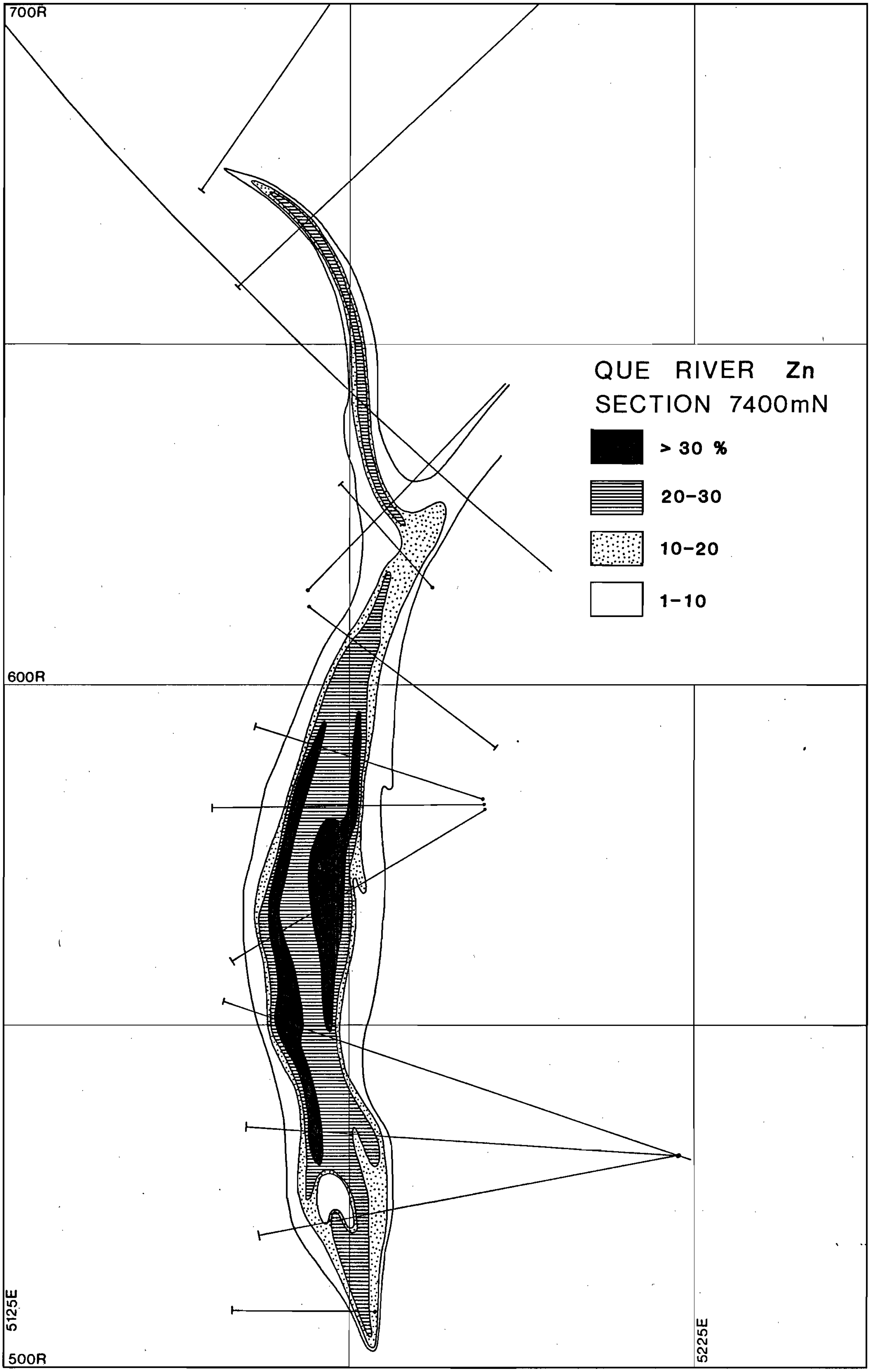

700R
QUE RIVER Cu
SECTION 7400mN
1.0-2.0 %
0.5-1.0
0.1-0.5
600R
5125E
500R
5225E

Fig. 4(b)



700R
QUE RIVER Zn
SECTION 7400mN
> 30 %
20-30
10-20
1-10
600R
5125E
5225E
500R

Fig. 4(c)

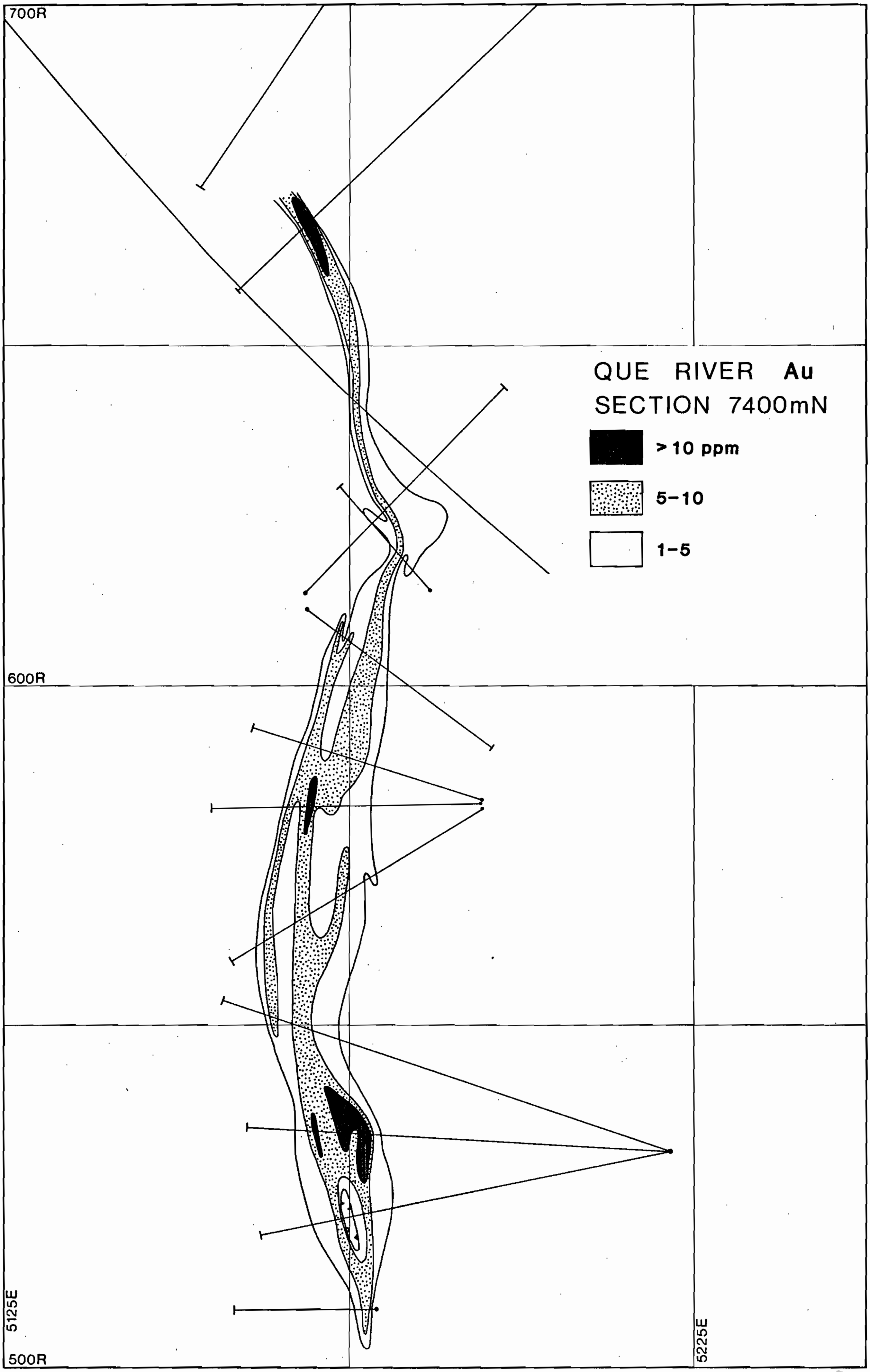

QUE RIVER Au
SECTION 7400mN
> 10 ppm
5-10
1-5
700R
600R
500R
5125E
5225E

Fig. 4(d)

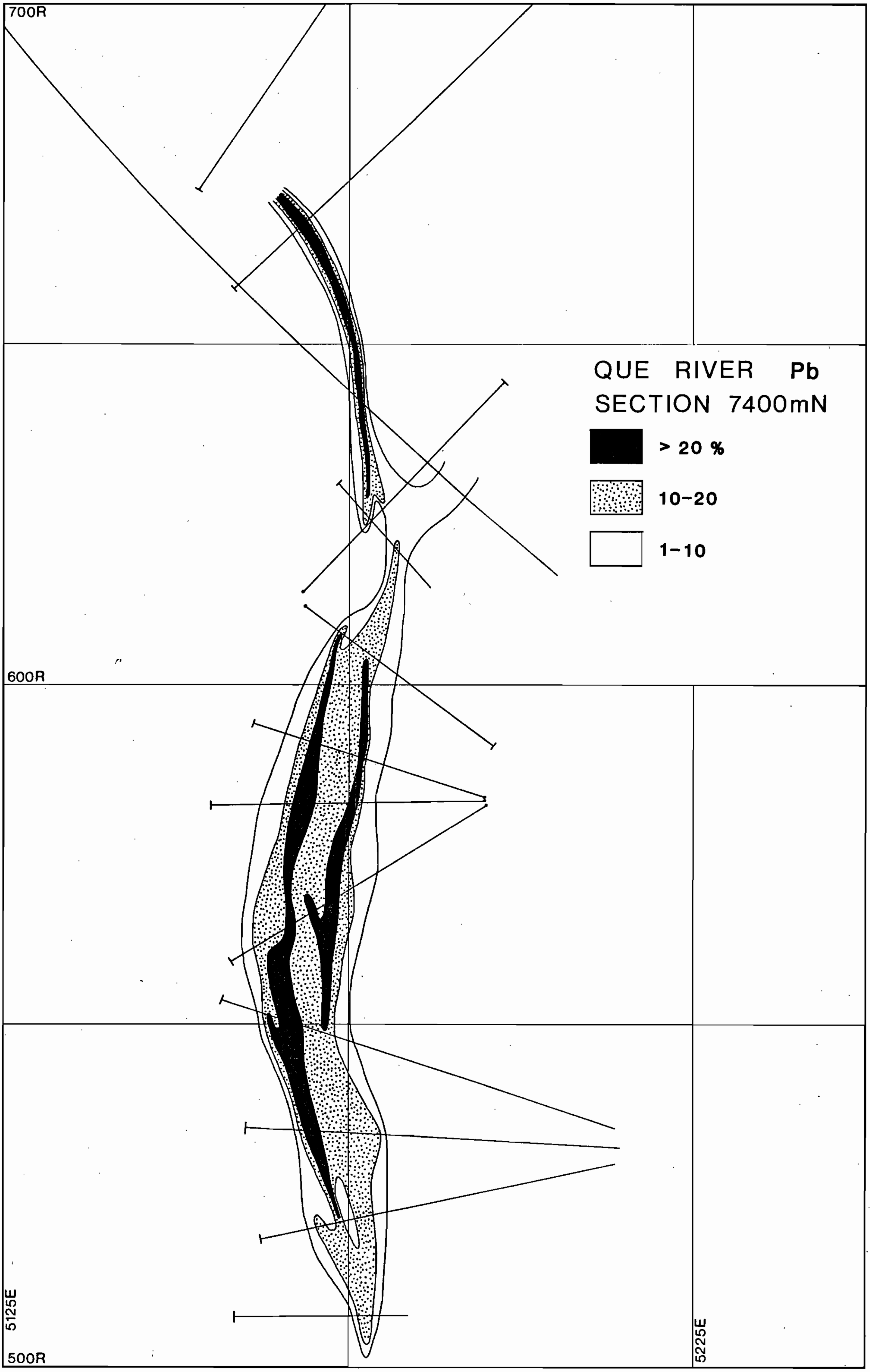
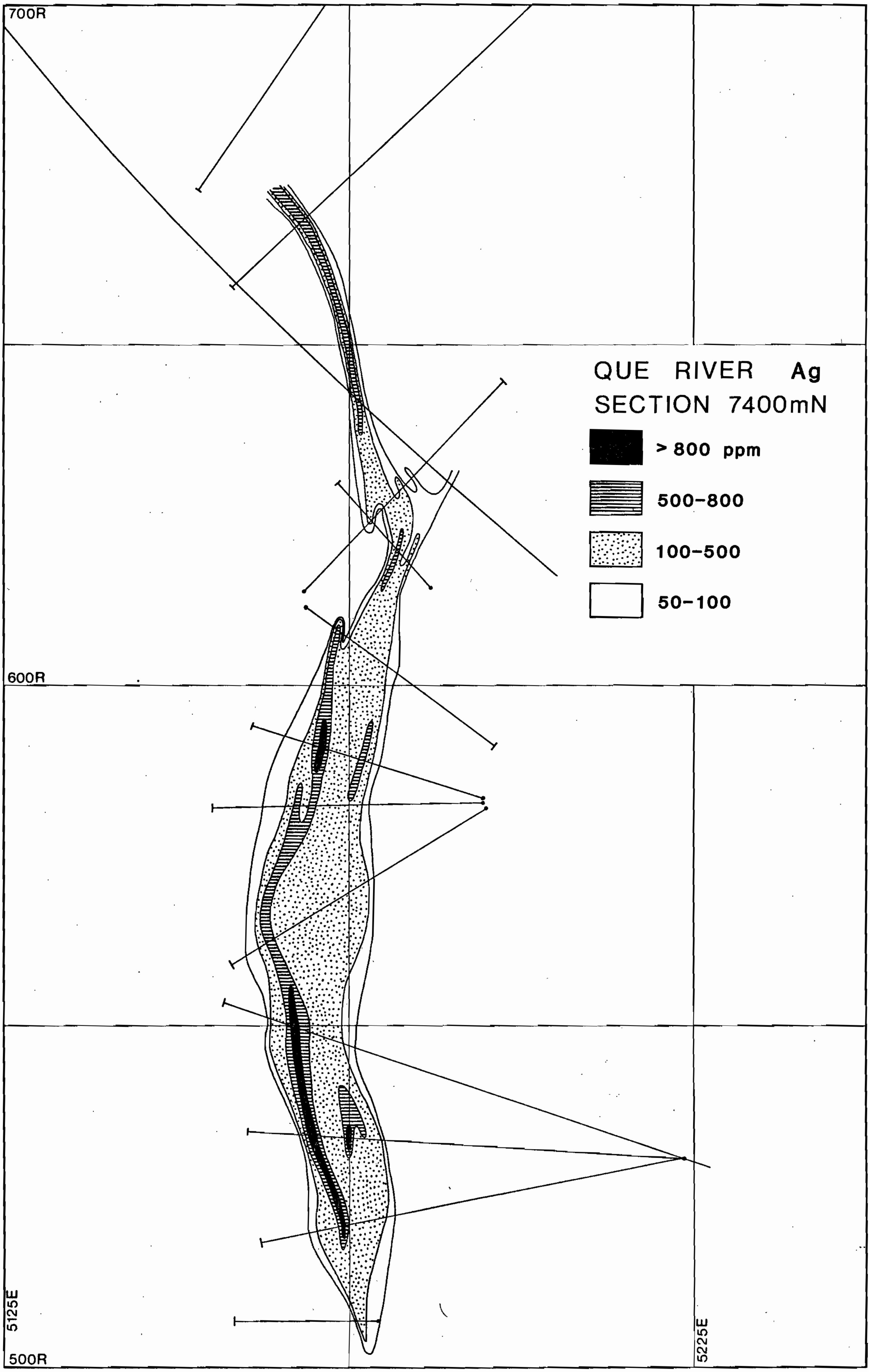

700R
600R
500R
5125E
5225E
QUE RIVER Pb
SECTION 7400mN
> 20 %
10-20
1-10

Fig. 4(e)



700R
QUE RIVER Ag
SECTION 7400mN
> 800 ppm
500-800
100-500
50-100
600R
5125E
5225E
500R

Fig. 4(f)

Section 7700 N

This section is through the northern portion of the PQ - P north lens system. Due to the shallow northerly plunge of the syncline, the dacite wedge is prominent on this section (figure 5a). Two blobs of massive sulphide are developed; one immediately below the dacite wedge and thickened in the fold nose, and a second on the western limb in the P north position. The main blob of PQ lens bms is interpreted to face west. This is indicated by - development of fuchsite breccia on the western side,

- east to west metal zonation of copper (footwall)---lead/zinc -- silver/gold (hanging wall).

On the other hand the P north lens faces east, with overlying fuchsite breccia on the eastern side and a reverse sequence of metal zonation to that shown in PQ lens.

The most important feature of this section is the large area of disseminated and stringer pyrite and stringer galena-sphalerite developed in the footwall volcaniclatics. This zone of mineralisation varies from 2 to 10 percent combined Pb + Zn with 0.5 to 2 ppm Au, and occurs beneath the PQ lens (in the syncline axis), and on the eastern footwall side. The development of significant tonnages of stringer Pb-Zn-Au mineralisation is rare in other massive sulphide provinces. This zone will be studied in considerable detail over the next twelve months in order to elucidate it's relationship to the massive sulphide ore lenses and it's overall genesis. A number of important questions need to be addressed in this work. Could this stringer zone relate to incipient solution boiling below the sea floor, or be due to variations in the chemistry of the ore-bearing solutions along the PQ structure? Do zones of this type represent a worthwhile exploration target elsewhere in the Mt Read volcanics?

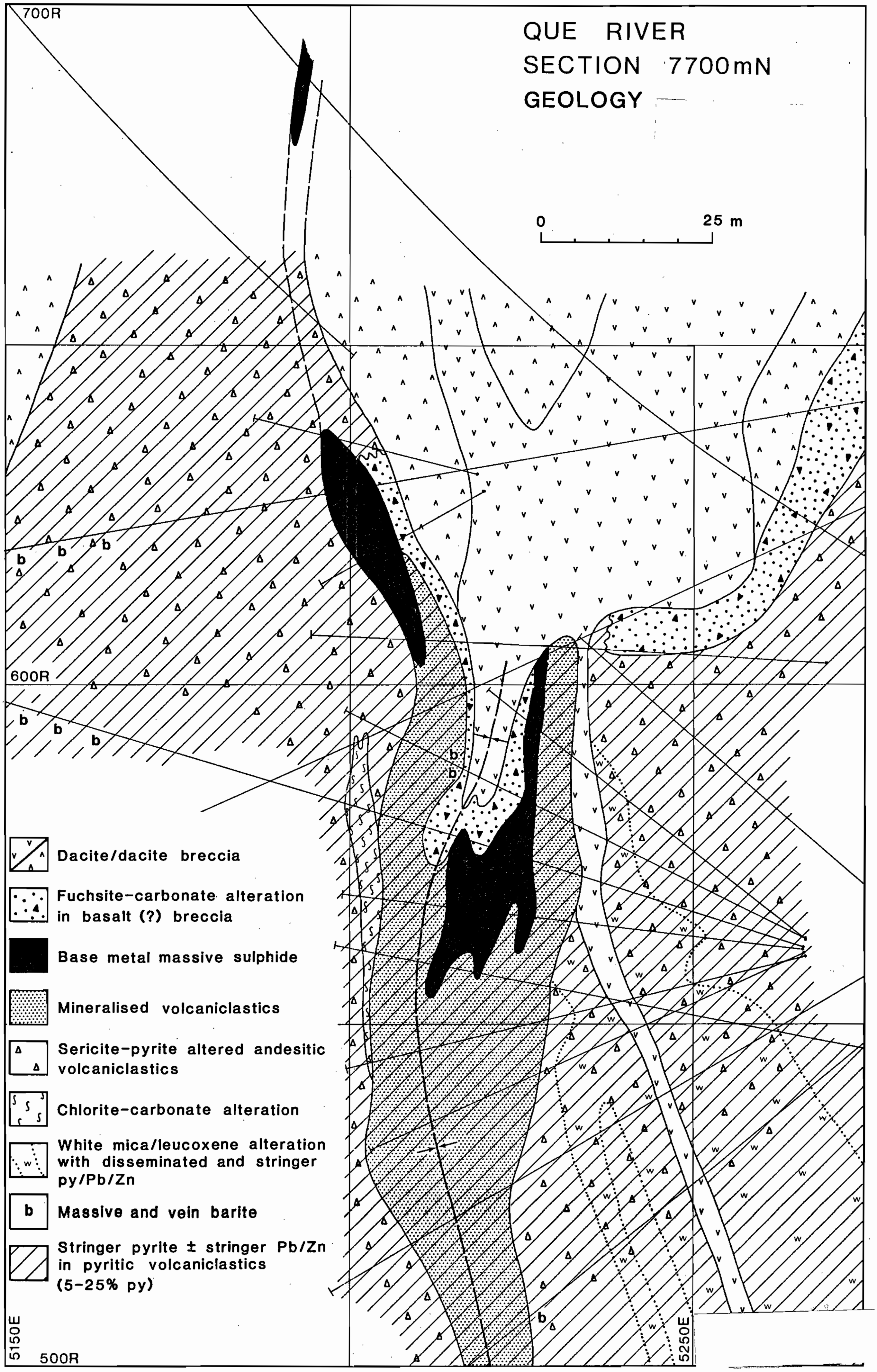
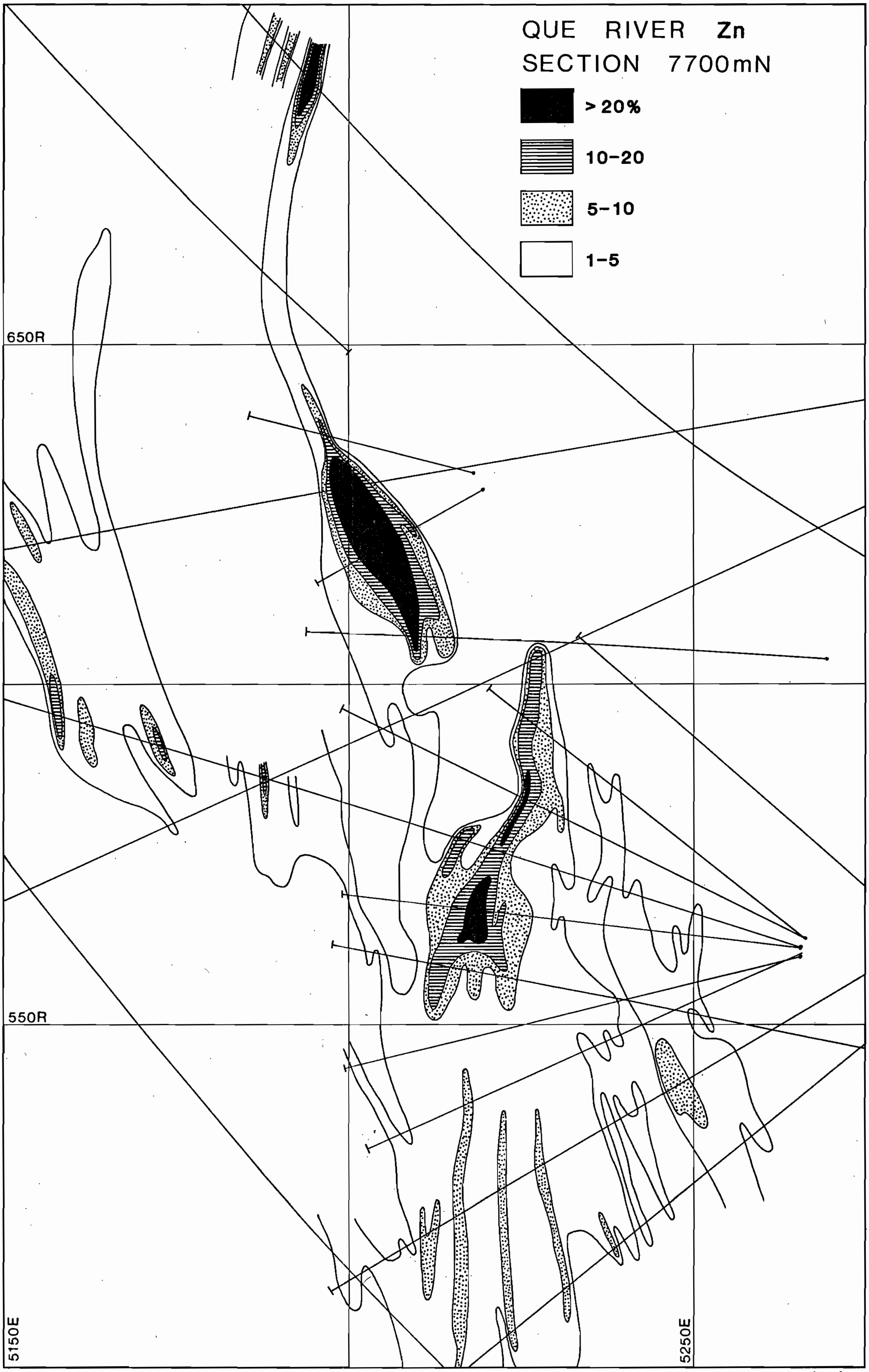
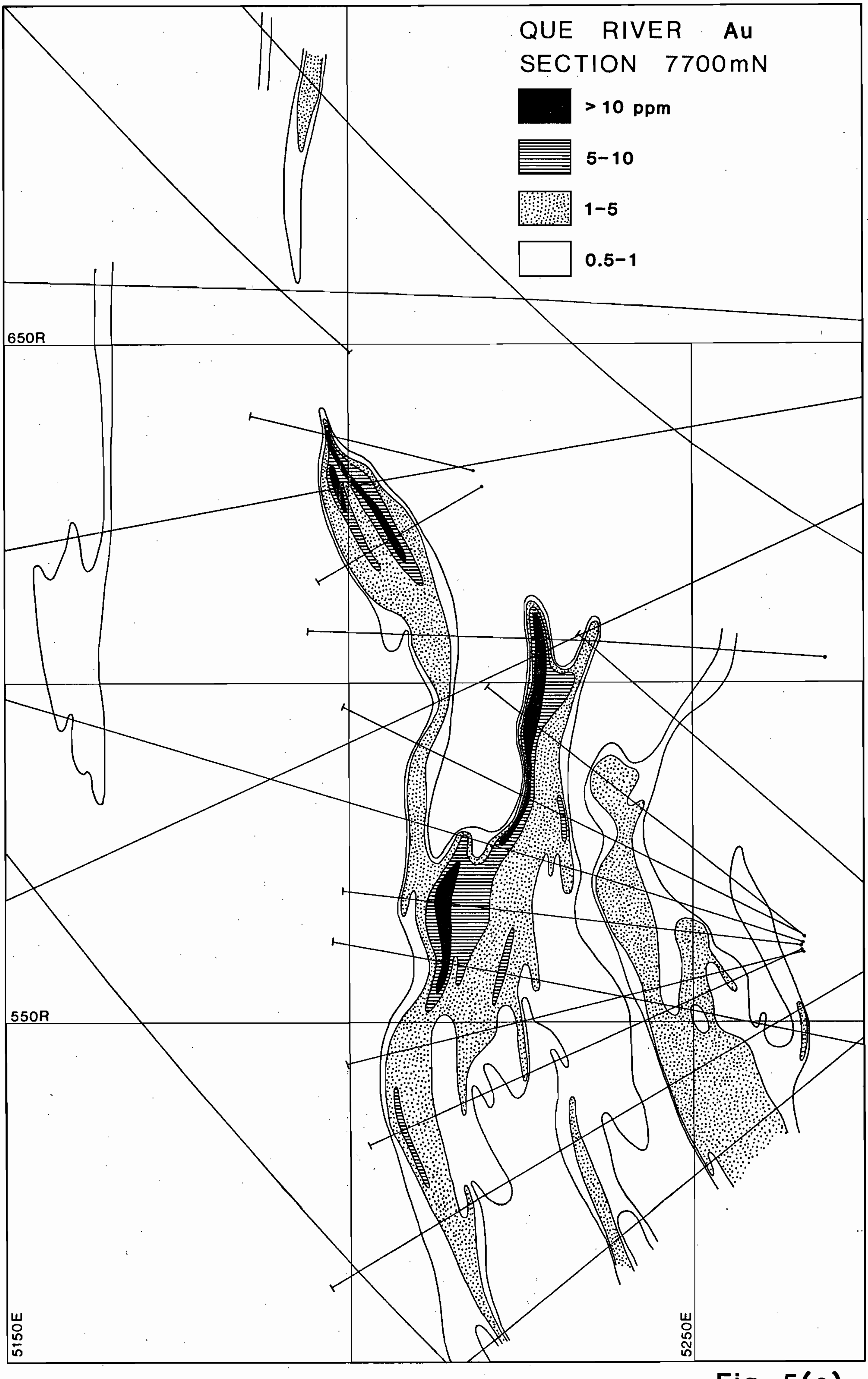

QUE RIVER
SECTION 7700mN
GEOLOGY
700R
600R
500R
5150E
5250E
0
25 m
b
Dacite/dacite breccia
Fuchsite-carbonate alteration in basalt (?) breccia
Base metal massive sulphide
Mineralised volcaniclastics
Sericite-pyrite altered andesitic volcaniclastics
Chlorite-carbonate alteration
White mica/leucoxene alteration with disseminated and stringer py/Pb/Zn
Massive and vein barite
Stringer pyrite ± stringer Pb/Zn in pyritic volcaniclastics (5-25% py)

Fig. 5(a)



QUE RIVER Zn
SECTION 7700mN
> 20%
10-20
5-10
1-5
650R
550R
5150E
5250E

Fig. 5(b)



QUE RIVER Au
SECTION 7700mN
> 10 ppm
5-10
1-5
0.5-1
650R
550R
5150E
5250E

Fig. 5(c)

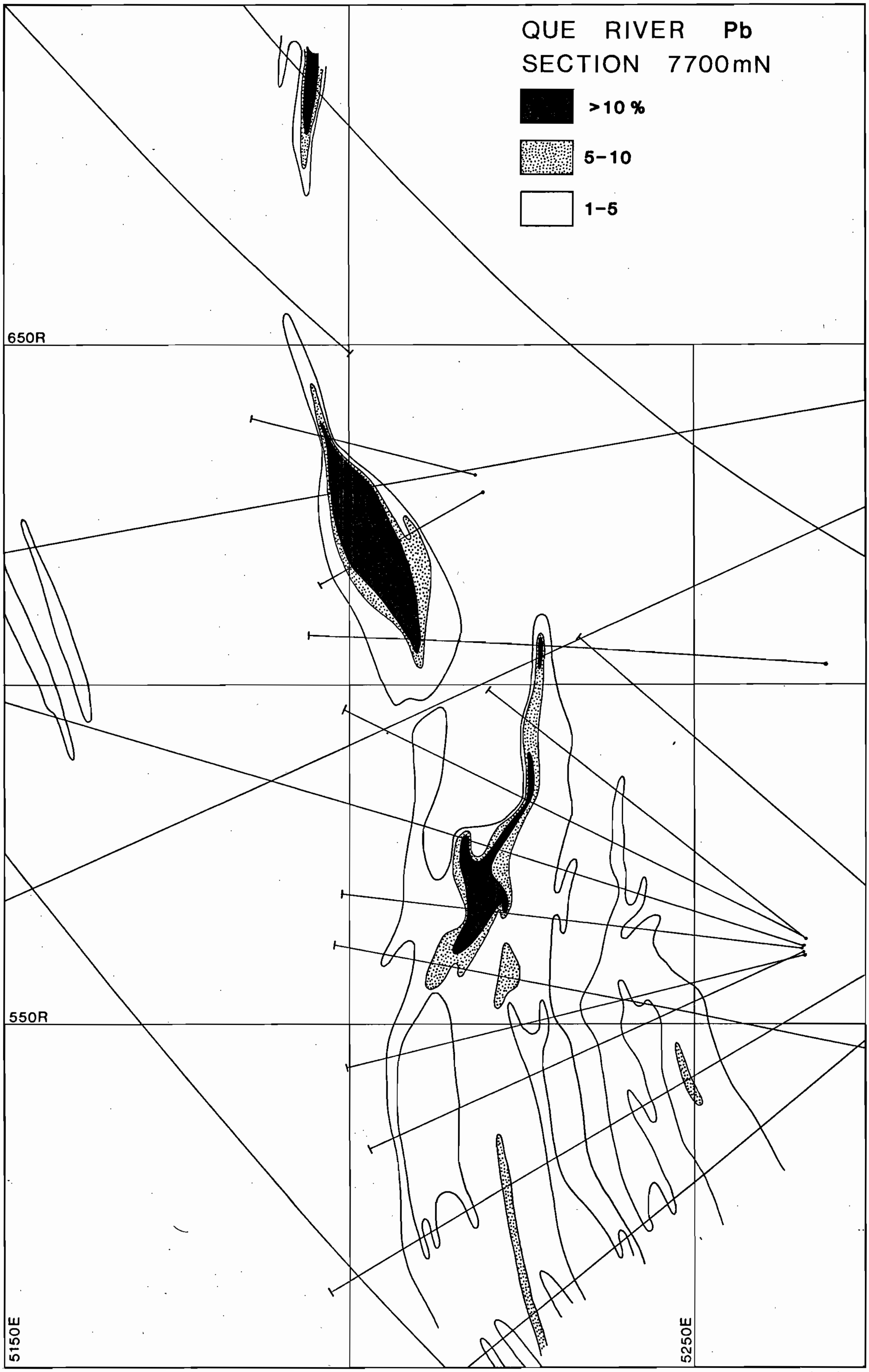


Fig. 5(d)

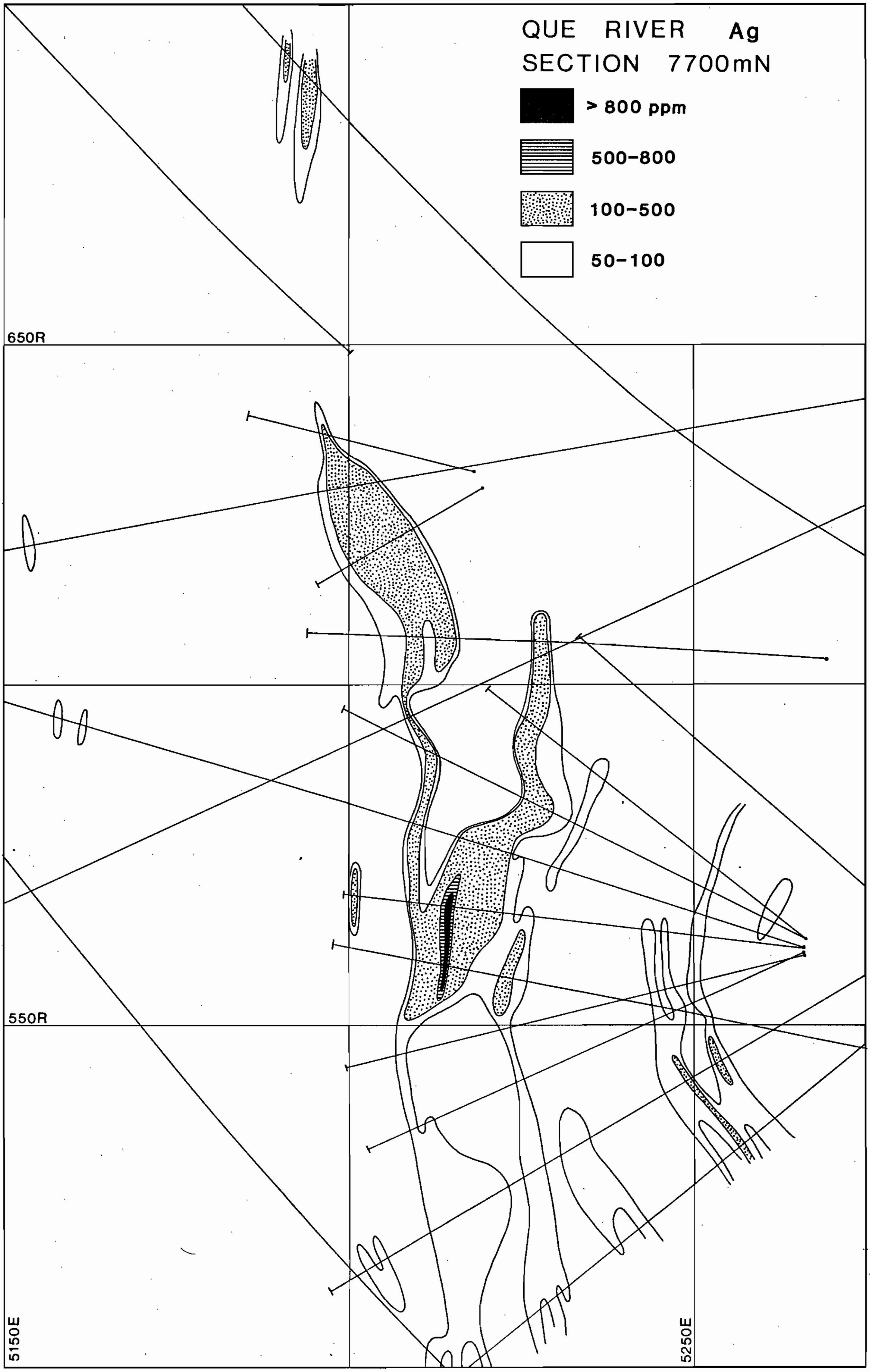
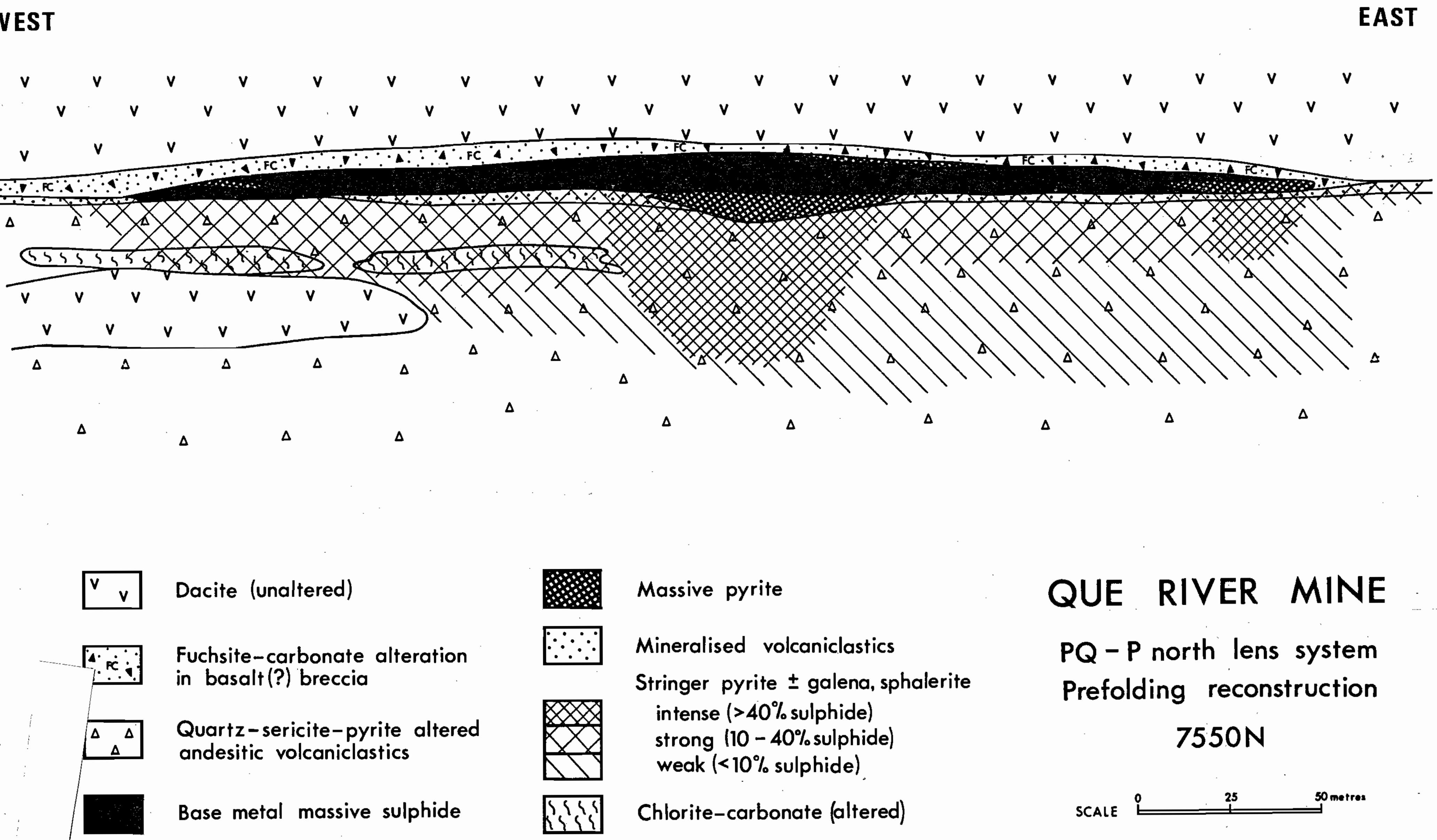

QUE RIVER Ag
SECTION 7700mN
> 800 ppm
500-800
100-500
50-100
650R
550R
5150E
5250E

Fig. 5(e)



WEST
EAST
FC
Dacite (unaltered)
Fuchsite-carbonate alteration in basalt(?) breccia
Quartz-sericite-pyrite altered andesitic volcaniclastics
Base metal massive sulphide
Massive pyrite
Mineralised volcaniclastics
Stringer pyrite ± galena, sphalerite
intense (>40% sulphide)
strong (10 - 40% sulphide)
weak (<10% sulphide)
Chlorite-carbonate (altered)
QUE RIVER MINE
PQ - P north lens system
Prefolding reconstruction
7550N
SCALE
0
25
50 metres

Fig. 6

FORWARD PROGRAMME FOR NEXT 12 MONTHS

1) Complete logging and fill-in geology on section 7700 N.

2) Study the full extent and nature of the Pb-Zn-Au stringer zone at the northern end of PQ lens.

3) Study the Au-Ag zone at the southern end of PQ lens.

4) Initial paragenetic and fluid inclusion studies of the major ore types, concentrating on the stringer type.

5) Include silicate analyses of unaltered and altered host rocks from Que River in the Mt Read analytical data base.

ACKNOWLEDGEMENTS

We wish to thank Aberfoyle Limited for providing complete access to all geological and assay data throughout this study. Geological discussions with David Wallace, Rod Patterson, Gary McArthur and Peter Bertram have considerably enhanced our understanding of the ore deposit and their generous assistance and time is very much appreciated. Thanks also to June Pongratz for drafting and Marlene Large for typing.

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STERLING VALLEY PROJECT

Ian Gordon

AIMS OF THE STUDY:

To examine the occurrence of gold along the Henty Fault Zone. Initially this study will be centred on the Sterling Valley, with possible extensions of the study to the south (Red Hills and Moxson Saddle area) and/or to the north (Farrell Leases).

Specific aims within the project are to understand the genesis and age of the gold mineralisation, and to study the chemistry of the veins and the various component phases with a view to identifying possible indicator elements, alteration zones etc, which can then be applied to exploration.

BACKGROUND:

The Sterling Valley is located south of Tullah on the north-west slopes of Mt. Murchison, Western Tasmania. The valley floor is largely covered by glacial till, often tens of metres thick. Under the glacial cover the Henty Fault Zone, a major meridional structure, separates the predominantly intermediate volcanics of the Central Belt (Mt Read Volcanics) from a sequence of meta-sediments called the Farrell Slates (Fig. 1). The fault is exposed to the south, towards the top of the valley.

Known mineralisation in the area includes several Pb/Zn and Cu prospects which were worked around the turn of the century. The largest of these is the Sterling Valley Mine. These shows appear to be structurally controlled veins, subjected to varying degrees of deformation and recrystallisation. Polya (1981) among others has suggested that at least some of the Farrell Deposits are remobilised massive sulphides. The deposits are hosted by the Farrell Slates. Gold was not a recorded product from these shows.

Other known mineralisation includes several sulphide rich vein systems immediately to the west of the Henty Fault, in the central belt volcanics. Some of these veins contain significant gold values. Sulphide phases present include pyrite, pyrrhotite, arsenopyrite and chalcopyrite. Several veins also show elevated tin values.

PREVIOUS WORK:

The Sterling Valley, covered by EL 4/73 has been the subject of exploration by the Electrolytic Zinc Co. in various joint ventures over the past few years. Their work includes grid mapping of outcrop and float, soil geochemistry, geophysical surveys and diamond drilling. The core from the EZ holes has kindly been made available for this study. Due to the poor outcrop over the zone of interest these holes are the major source of data and samples at this stage.

METHODS:

-Mapping: some structural mapping in the Sterling Valley will be carried out. Rock types have been mapped in detail by EZ geologists, along grid lines which are now largely obscured by regrowth.

-Sampling: mainly from drill core, but also during surface mapping. Country rocks and different styles of mineralisation will be sampled.

-Petrography: examination of polished thin sections to characterise alteration events and define a paragenetic sequence.

-Analyses: to catagorise rocks, define trace element variations around mineralisation, and examine economic metal values.

-Comparison of the mafic rocks along the Henty Fault Zone with the petrology and geochemistry of volcanics in the remainder of the Mt. Read Volcanics.

-Other Techniques: fluid inclusions, stable isotopes and electron probe analyses to determine aspects of the conditions prevailing during the various mineralising events, including the nature and possible origin of the fluids.

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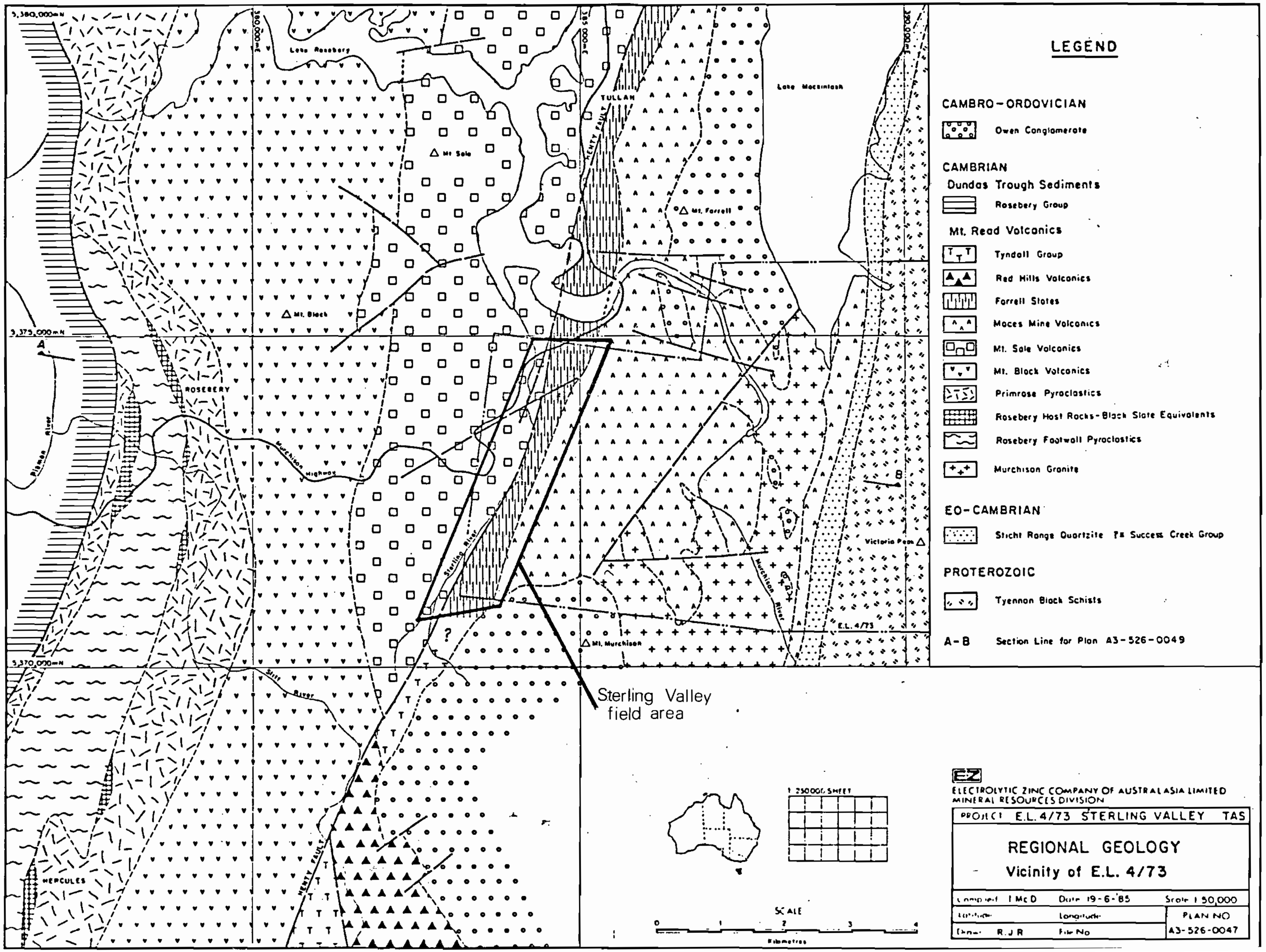

LEGEND
CAMBRO-ORDOVICIAN
Owen Conglomerate
CAMBRIAN
Dundas Trough Sediments
Rosebery Group
Mt. Read Volcanics
Tyndall Group
Red Hills Volcanics
Farrell Slates
Maces Mine Volcanics
Mt. Sale Volcanics
Mt. Black Volcanics
Primrose Pyroclastics
Rosebery Host Rocks-Black Slate Equivalents
Rosebery Footwall Pyroclastics
Murchison Granite
EO-CAMBRIAN
Sticht Range Quartzite ?= Success Creek Group
PROTEROZOIC
Tyennan Black Schists
A-B Section Line for Plan A3-526-0049
Lake Rosebery
Lake Mackintosh
TULLAH
HENTY FAULT
Mt. Farrell
Mt. Sale
Mt. Black
ROSEBERY
Murchison Highway
Pieman River
Sterling River
Mt. Murchison
Murchison River
Victoria Pass
E.L. 4/73
Stitt River
HERCULES
5,380,000mN
5,375,000mN
5,370,000mN
380,000mE
385,000mE
390,000mE
Sterling Valley field area
1:250000 SHEET
SCALE
0 1 2 3 4
Kilometres
EZ
ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED
MINERAL RESOURCES DIVISION
PROJECT E.L. 4/73 STERLING VALLEY TAS
REGIONAL GEOLOGY
Vicinity of E.L. 4/73
Compiled I McD
Date 19-6-85
Scale 1:50,000
Latitude
Longitude
Drawn R.J.R
File No
PLAN NO
A3-526-0047

FIG.1

LAKE SELINA PROJECT OUTLINE

Steven Hunns

AIM :

To study the "barren" pyrite deposit at Lake Selina and compare and contrast it with other ore bearing pyrite systems in the Mt. Read Volcanics.

SIGNIFICANCE :

In order to develop effective exploration models for precious metal bearing volcanogenic deposits, an understanding of barren volcanogenic sulphide systems is required. What are the major geological and geochemical criteria that distinguish mineralised systems from barren systems ?

BACKGROUND :

The Lake Selina field area lies on the eastern margin of the Mt. Read Volcanics approximately 12 - 13 km south east of Rosebery. The area extends northwards from Lake Rollerston to the southern foothills of Mt. Murchison (Fig. 1). The southern region of the field area is covered by glacial till, tens of metres thick.

The field area is bounded to the east by the Sticht Range Beds, a Cambrian sedimentary sequence of quartz sandstones, pebble conglomerates, siltstones and black shales. This unit unconformably overlies the Precambrian quartzite basement.

To the west are the Selina Volcanics which form part of the Tyndal Group of Corbett (1984) and have been sub-divided into two units by Goldfields geologists.

a) Dacitic Lavas : These are pink to red-brown, very fine grained, quartz and quartz-feldspar phyric dacitic lavas forming an elongate

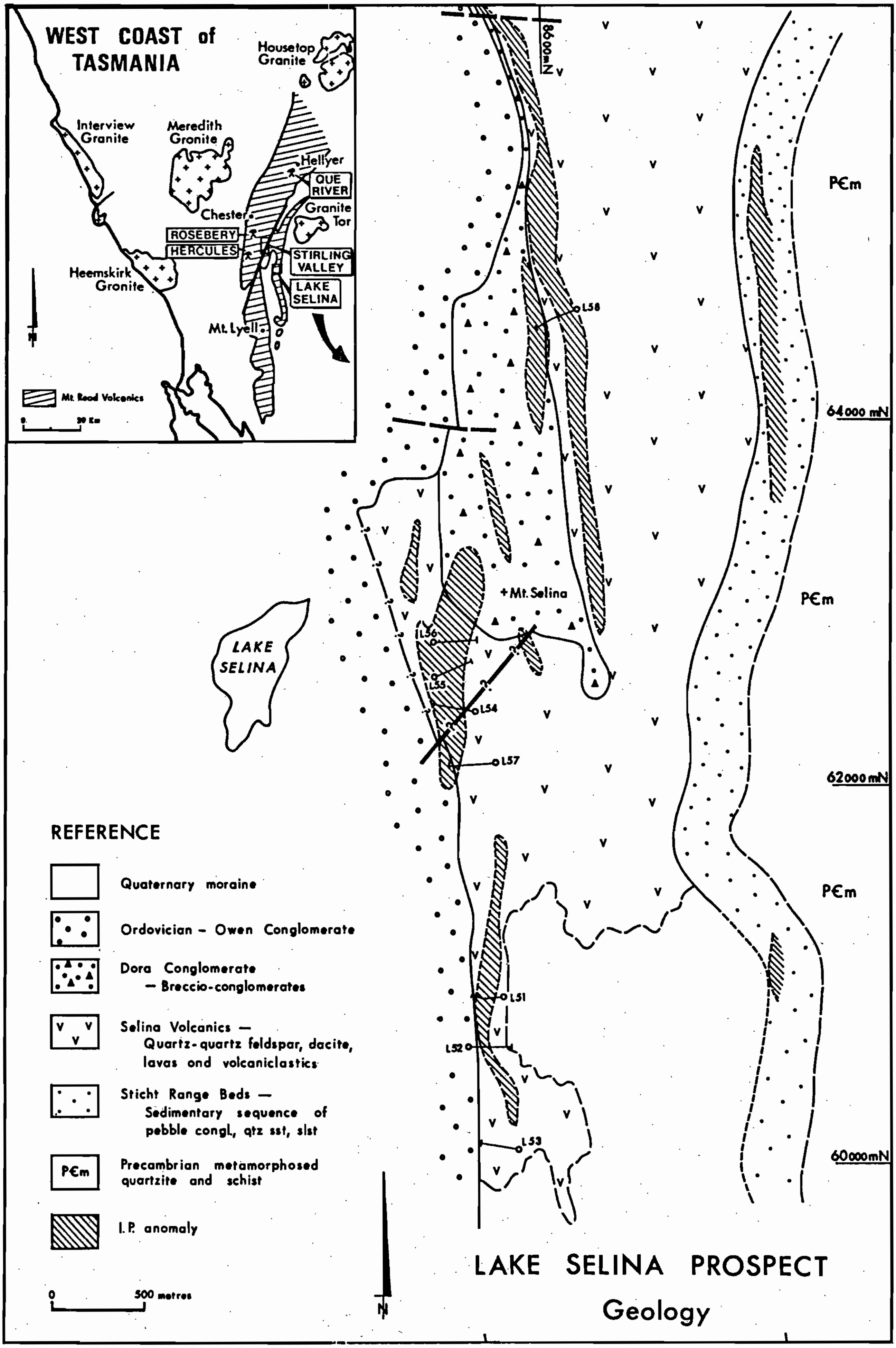

WEST COAST of TASMANIA
Housetop Granite
Interview Granite
Meredith Granite
Hellyer
QUE RIVER
Chester
Granite Tor
ROSEBERY
HERCULES
STIRLING VALLEY
Heemskirk Granite
LAKE SELINA
Mt. Lyell
Mt. Read Volcanics
20 Km
8600mN
PЄm
64000 mN
62000 mN
60000 mN
L58
+Mt. Selina
LAKE SELINA
L56
L55
L54
L57
L51
L52
L53
REFERENCE
Quaternary moraine
Ordovician – Owen Conglomerate
Dora Conglomerate – Breccio-conglomerates
Selina Volcanics – Quartz-quartz feldspar, dacite, lavas and volcaniclastics
Sticht Range Beds – Sedimentary sequence of pebble congl., qtz sst, slst
PЄm Precambrian metamorphosed quartzite and schist
I.P. anomaly
0 500 metres
N
LAKE SELINA PROSPECT
Geology

Fig. 1

"dome-like" complex. The lavas are characterised by pervasive siliceous-chloritic-haematitic alteration with extensive quartz-chlorite-magnetite-haematite veining.

b) Volcaniclastics : These form linear belts along both the eastern and western margins of the dacitic lava dome complex. Generally the volcaniclastics grade outwards from coarse grained unsorted volcanic conglomerates and grits to fine grained tuffaceous siltstones and shales.

Unconformably overlying the Selina volcanics is a sequence of poorly sorted breccia conglomerates termed the Dora Conglomerates or Jukes Breccia. Clasts are composed predominantly of dacitic lavas, volcaniclastics, siltstones and quartzites. The matrix consists of tuffaceous grit.

The Lake Selina prospect was discovered early this century when several adits and trenches were excavated. An aeromagnetic survey was carried out in 1957, with ground surveys in 1969-1970. From 1970 onwards, investigations have centred around two extensive linear belts of strongly altered sulphidic volcanics outlined by I.P. surveys. To date, thirteen holes have been drilled but no prospective economic base metal zone have been intersected.

METHOD OF RESEARCH :

Initially field mapping of the area will be carried out, utilizing previous work done by Goldfields, with additional structural interpretations. The thirteen drill holes will be re-logged, with a view to relating them to the major rock units as defined by the field mapping.

Petrographic investigations of the rocks and XRF analyses for both major and trace elements will be carried out in order to elucidate the field mapping. Samples from the "mineralized" zones will be studied in both thin and polished sections to determine the mineralogy, alteration styles and textures.

XRF analyses will be done to document the geochemical alteration of the rocks as they pass from barren to altered to mineralized. Sulphur and oxygen isotope studies may be carried out, along with a fluid inclusion study, to better constrain the physico-chemical conditions of the alteration process.

Once a better understanding of the geological history of the Lake Selina prospect has been achieved a comparison of this barren system and nearby mineralized systems such as Red Hills will be attempted.

REFERENCES

Corbett, K.D., 1985, Unpubl. Report 1985/11; Notes to accompany the geological compilation map of the Mt. Read Volcanics, Que River to Mt. Darwin.

Goldfields Exploration Annual Reports

WORLD WIDE DATA BASE FOR VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS

Peter Ruxton

Introduction

A literature search of VMS deposits throughout the world has been initiated to broaden our understanding of Au/Ag distribution in these ores.

Preliminary work has defined two principle deposit types in volcanic rocks:

1) Volcanogenic Cu/Au - gold occurring with copper in siliceous stockwork deposits. eg. Mt. Morgan, Mt. Lyell, Mt. Chalmers.
2) Volcanogenic Polymetallic - gold occurring in the upper most parts or spacially related to VMS deposits, associated with galena/sphalerite, fahlerz minerals and baryte. eg. Rosebery, Kuroko deposits.

From detailed studies in Australia, particularly the west coast of Tasmania, and a literature review of world VMS deposits, it is hoped to confirm or extend these two categories.

Aims of the world literature review are similar to the more detailed studies :

a) to define Au/Ag distribution in VMS deposits,
b) elucidate geological/geochemical controls on ore deposition and Au/Ag distribution,
c) to establish if relationships exist between Au/Ag and specific geological provinces/environments, volcanic composition, particular metal associations, and physiochemical conditions during ore formation.

Scope of Study

As much information as possible will gathered on individual VMS deposits and VMS provinces. Particular emphasis will be placed on : -

1) the distribution of Au/Ag,

2) the host rock sequence,

3) types and distribution of ore,

4) structural setting/controls on ore,

5) alteration styles,

6) geochemistry of ores and host rocks,

7) physicochemical conditions of ore formation.

Data will be presented in the following format :

PROVINCE - summary

Geology/Stratigraphy (+ map with deposits shown).

Structure/Metamorphism.

Regional VMS deposit distribution + controls.

Regional Au/Ag distribution + controls.

Summary of Deposit types (cartoons of the various styles).

Exploration Signature of deposits (case histories where warranted).

Tonnage v Grade (tables/plots).

Physicochemical controls.

Ore Genesis.

INDIVIDUAL DEPOSITS

Data Sheet - to enable rapid assessment (format attached).

Local geology map + cross-sections.

Computerisation of the Data Sheet will be made at a later stage to aid in correlation of the data on individual deposits.

Work to Date

Approximately two weeks has been spent studying the Kuroko deposits of Japan.

Data has been compiled on twenty five of the major individual deposits and deposit groups in the Kuroko Belt. More detailed work on the Hokuroku District reported in "The Kuroko and Related Volcanogenic Massive Sulphide Depsoits" Economic Geology Monograph 5 is being assessed.

The Kuroko district was chosen to initiate the literature search because of the high level of understanding and documentation of the ores, and to rapidly familiarize the Group with information from these classic deposits.

Preliminary data compilation has begun in the Mt. Read Volcanics.

Due to the short time span of work on this aspect of the project, a written report on results is delayed.

VOLCANOGENIC MASSIVE SULPHIDE – DATA SHEET.

DEPOSIT. name
style(s)

OWNER/OPERATOR(S).

LOCATION.

MODE OF DISCOVERY.

REFERENCES

TONNAGE / GRADES	TONNES	Zn	Pb	Cu	Ag	Au		References
Date PRODUCTION								
PROD+ RESERVES								

CURRENT STATUS

RATIOS	Zn No.	100Ag / Ag+100Au	Zn/Cu	Cu/Au	Zn/Au	

REGIONAL TECTONIC SETTING.

GEOLOGICAL PROVINCE
- Environment –
- Lithologies –
- Intrusives. –
- Structure / Metamorphism –

GEOGRAPHICALLY ASSOCIATED DEPOSITS

REGIONAL ORE CONTROLS

SIGNATURE OF ORE HORIZON

LOCAL GEOLOGY

HOST ROCKS. name age thickness.

A). FOOTWALL
- Rock types/variation :
- Characteristic features :
- Depositional Environment :

B). HANGING WALL
- Rock types / variation :
- Characteristic features :
- Depositional Environment :

C). ORE HORIZON
- Rock types / variation :
- Characteristic features :
- Depositional Environment :

ALTERATION.

Ore Horizon
Footwall
Hangingwall

MINERAL DEPOSIT(S)

ORE TYPE	MINERALOGY ORE	MINERALOGY GANGUE.	STRUCTURE	TEXTURE	ASSOC. METALS	GEOPHYSICS.	COMMENTS.
MASSIVE							
STRINGER.							
OTHER.							

DISTRIBUTION OF Au/Ag.

CONDITIONS OF ORE FORMATION.

	Fluid Inclusions T°C	Fluid Inclusions % NaCl	Fluid Inclusions Other	$\delta^{34}S$ Range	$\delta^{34}S$ mean	$\delta^{18}O$ Range	$\delta^{18}O$ Mean	Interpretation and Conclusions
MS								
Stg								
other								
Refs								

COMMENTS ON ORIGIN.

WESTERN AUSTRALIAN ARCHAEAN VMS DEPOSITS: PROJECT OUTLINE

Peter Ruxton

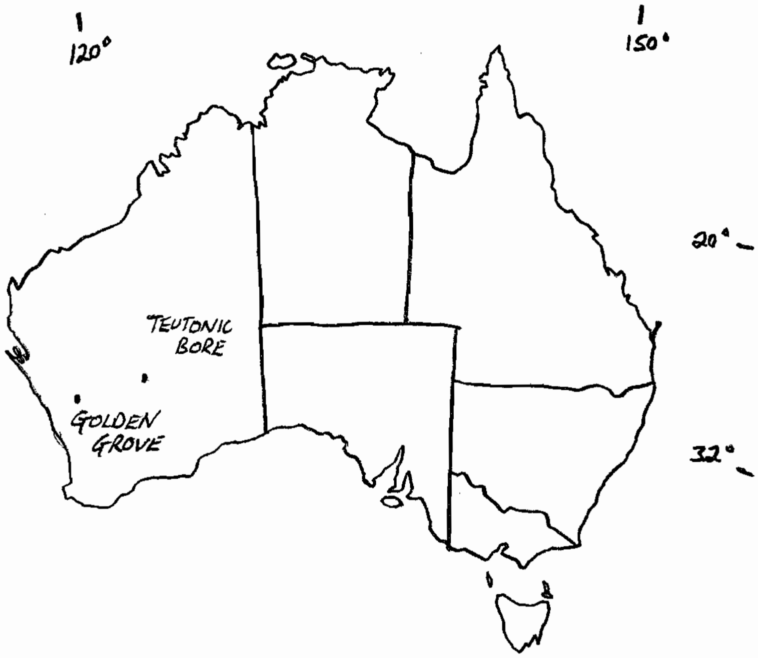
GOLDEN GROVE - Scuddles + Gossan Hill.
TEUTONIC BORE.

The aim of this study is to define the distribution and genesis of gold, silver and base metals in the three deposits. Comparison between these Archaean and the Palaeozoic Volcanogenic Massive Sulphide deposits of Tasmania will be made.

Work will include :

a) utilizing assay data, drill sections and plans to plot and study metal distribution and zonation in each deposit,
b) investigate gold/silver mineralogy and metal association,
c) study alteration and gangue mineral variations relative to gold/silver distribution,
d) analyse sulphur isotopic variations through each deposit,
e) utilize other techniques as appropriate (fluid inclusions and oxygen/hydrogen isotopes) to try and understand the ore fluid chemistry,
f) and develop geological and geochemical models to account for metal transport and deposition in each deposit.

Fieldwork in Western Australia is planned for the third quarter of 1986.



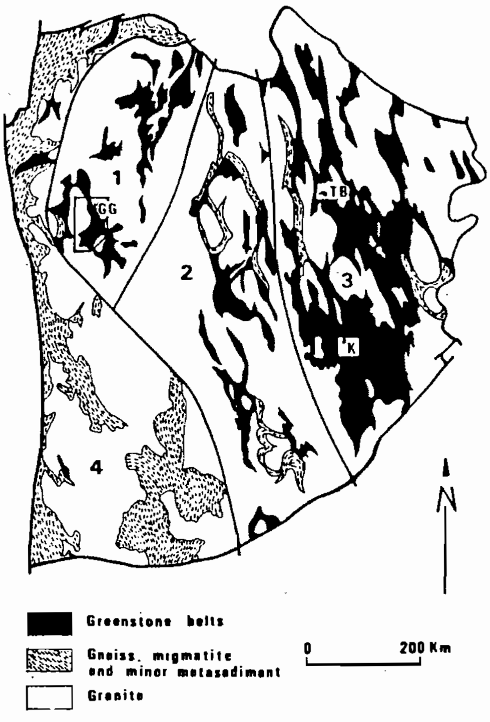
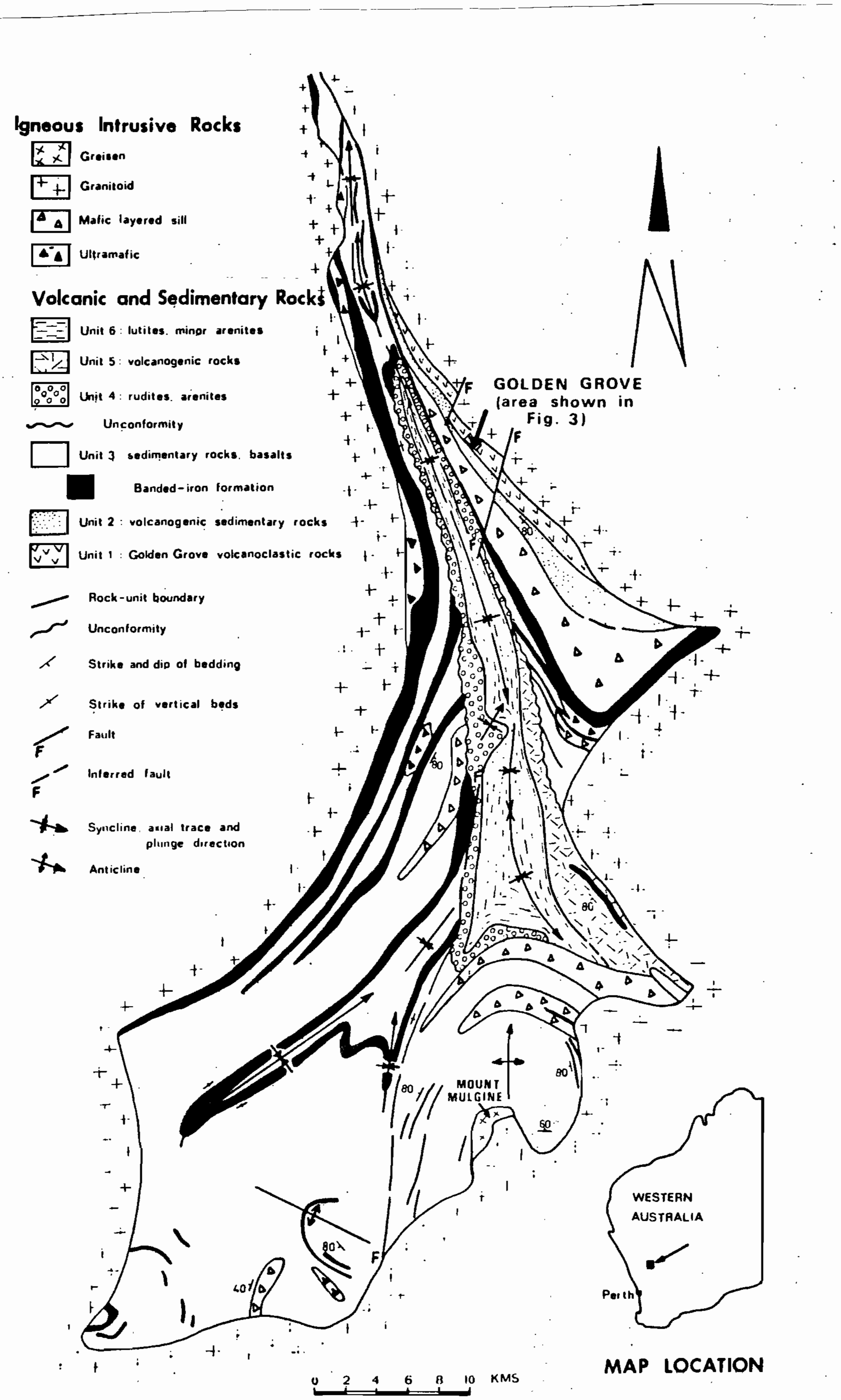
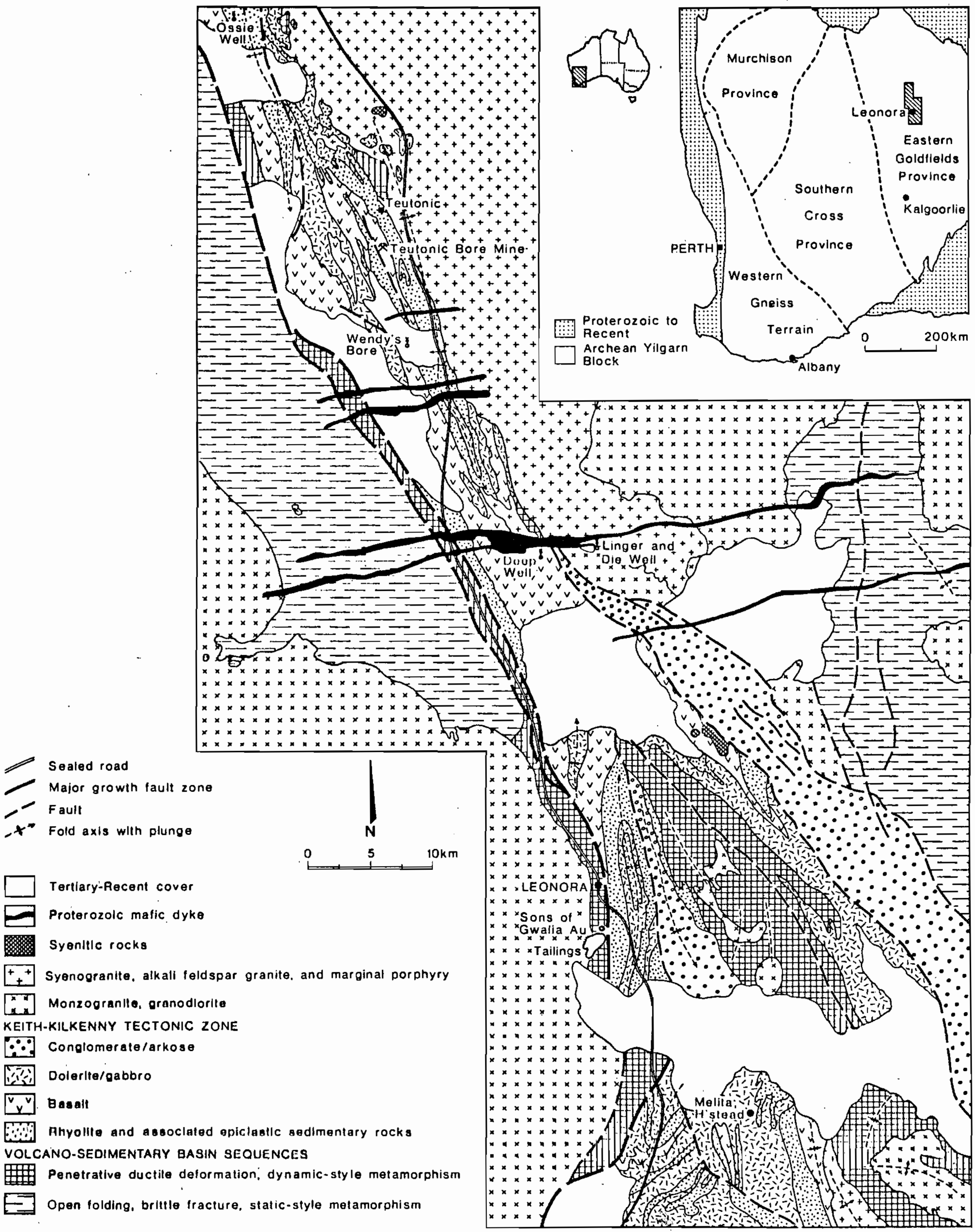


FIG. 1. Greenstone belts, gneissic terraines, and granitic rocks of the Yilgarn Block. Regional subdivisions are: 1. Murchison province. 2. Southern Cross province. 3. Eastern Goldfields province. 4. Western Gneiss terrain. Locations indicated: GG = Golden Grove (blocked area is the greenstone belt shown in Fig. 2); TB = Teutonic Bore; K = Kalgoorlie. Adapted from Gee et al., 1981.



Generalized regional geology of the greenstone belt in the vicinity of Golden Grove.

Fig. 2



Generalized geologic map of the area from Leonora to Teutonic, Western Australia.

Fig. 3

BALCOOMA AREA, QLD., PROJECT OUTLINE

David L. Huston

AIMS OF THE STUDY:

To describe the mineralization at the Balcooma massive sulphide prospect, to evaluate the effect of subsequent processes (metamorphism and gossan formation) on the mineralogy and textures of both mineralisation and alteration, and to develop a geologic/geochemical model to describe the formation of the mineral deposit.

BACKGROUND:

The Balcooma massive sulphide prospect is located in northern Queensland in the lower Palaeozoic Balcooma Metamorphics, which consist of metamorphosed volcanics of upper greenschist to lower amphibolite facies (Harvey, 1984). The Balcooma Metamorphics may be correlatives of the Mt. Windsor volcanics (Harvey, 1984) which host the massive sulphide deposits at Thalanga and Liontown.

Other known mineralization in the area includes the Surveyor zinc-lead-silver deposit which is held by Noranda, Lachlan Resources and Jones Mining, and a zinc-lead deposit recently found by Carpentaria Exploration Company.

The Balcooma deposit itself is largely massive pyrite, chalcopyrite and pyrrhotite, although significant semi-massive to massive sphalerite does exist. The deposit is precious-metal poor, which will provide a good contrast to the precious metal-rich deposits currently being studied in this project. It also provides a chance to study the mobility of all metals under medium to high grade metamorphic conditions.

PREVIOUS WORK:

The deposit and surrounding rocks have been an area of intense interest over the past few years. Carpentaria Exploration Company and their joint venture partners have conducted and are continuing a program of geological mapping, geochemistry and geophysics in the area, as is Noranda; a large amount of company data exists on the deposit and the surrounding area.

K. Harvey recently completed a M.Sc. on the deposit in late 1984, and F. van der Hor has recently completed, or is writing up, a Ph.D. thesis on regional structure.

The author has completed two months field work at the deposit, logging core and beginning field mapping. Figure 1 shows his interpretation of the local structure as determined from drill core logging. This interpretation broadly agrees with the current interpretation of the company geologists. The most significant aspect of the interpretation is the possibility that two ore horizons may exist.

METHODS:

-Detailed field mapping and core logging to ascertain the structure of the deposit.

-Mineragraphy to describe ore mineralogy and textures.

-Petrography to describe the host rocks, country rocks and alteration.

-Geochemical analyses to describe mineralisation and country rocks.

-Detailing metal zonation through the body of mineralisation.

REFERENCES:

Harvey, K. J., 1984, The geology of the Balcooma massive sulphide deposit, north-east Queensland: Unpub. M.Sc. thesis, James Cook Univ., 92 p.

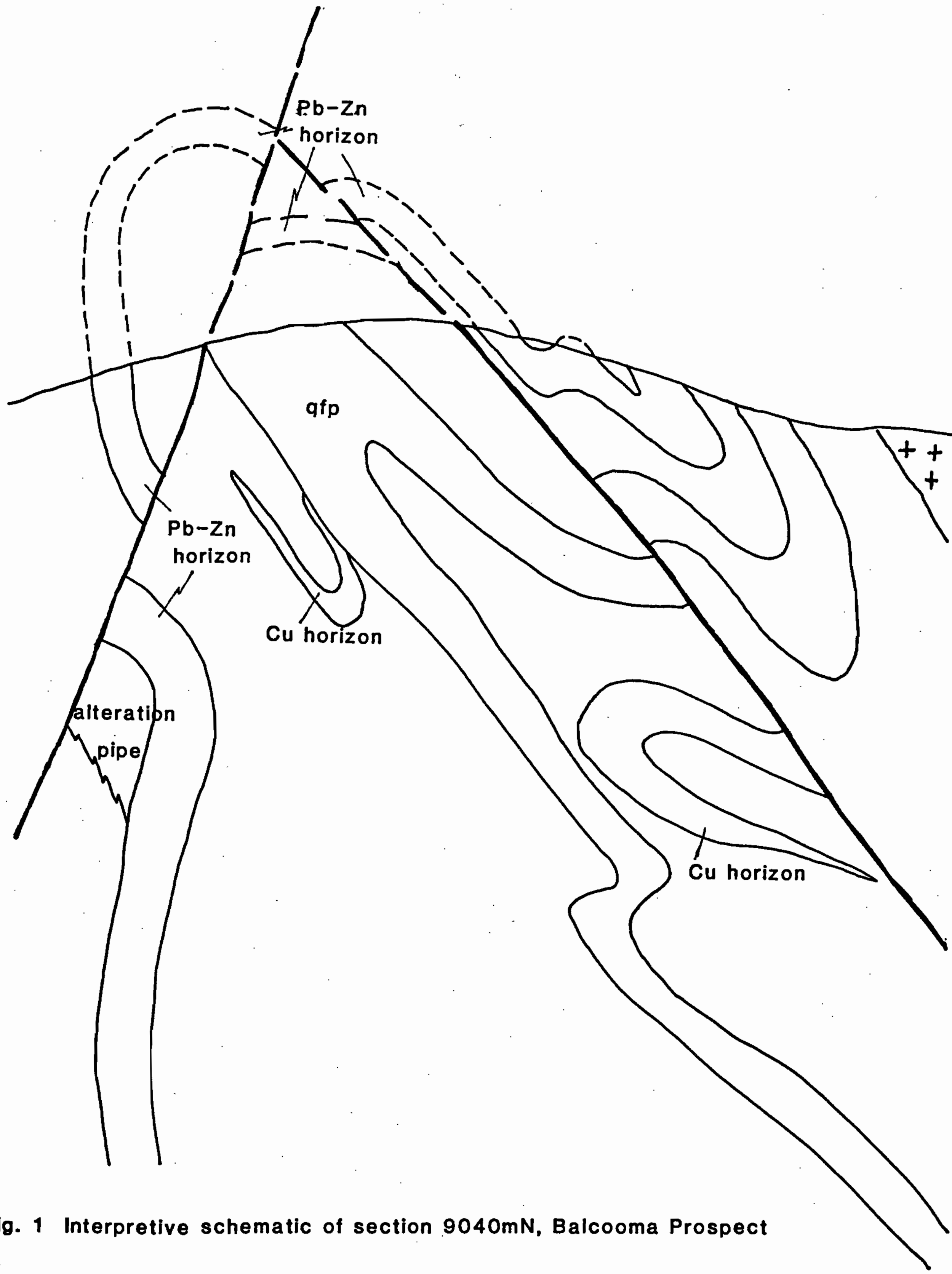


Fig. 1 Interpretive schematic of section 9040mN, Balcooma Prospect

CHEMISTRY OF VOLCANICS IN THE MT. READ ARC

A Preliminary Report

Anthony J. Crawford

Geology Department
University of Tasmania

April 28th, 1986

INTRODUCTION

In 1985, the author initiated a project with Drs. K.D. Corbett and G.R. Green and Mr. J. Everard (Tasmanian Mines Dept.), Dr. D.J. Whitford (CSIRO) and Dr. M. McCulloch (RSES, ANU) to investigate in detail the petrology and geochemistry of the Cambrian Mount Read Volcanics in western Tasmania. The first phase of this project was to collect a suite of least altered lavas thought to be representative of the petrographic (basalt to rhyolite) and geographic (Elliot Bay to Sheffield) spread of the Mount Read Volcanics. Following selection of 125 samples according to criteria described below, the samples were pulverized and analyzed for major and trace elements in the Geology Department, University of Tasmania, using an automated Phillips XRF. Further analytical work later this year will determine rare earth element (REE) abundances and Nd and Sr isotopes on selected samples and mineral separates. In this preliminary report, I present a list of analyses for 128 Mount Read Volcanics lavas and shallow intrusives, with abbreviated petrographic descriptions, a locality map, a series of Harker (element-SiO_2) diagrams showing the compositional range of the suite, and a brief discussion of the significance of the data at hand. It is envisaged that a follow-up report, incorporating all analytical data (including isotopes and REE,) and a detailed discussion of the petrogenesis of the Mount Read Volcanics will be completed in late 1986. The data, which should be useful as a reference database for assessing element mobility around mineralization, has been stored on the Macintosh microcomputer system in the AMIRA room in the Geology Dept., University of Tasmania.

SAMPLE SELECTION

As the aim of this project was to determine as closely as possible the ***primary*** compositional range of the Mount Read Volcanics, sample selection rationale involved avoiding obviously altered samples rather than monitoring chemical changes during various processes of intense alteration in shearzones and zones of mineralization. From well over one thousand samples available in various collections (see below), one hundred and thirty samples were selected for detailed study. Wherever possible, hand specimens showing penetrative deformation, veining, or domains of localized development of secondary minerals (eg. epidote clots) were avoided. Selection also entailed careful microscopic examination of all samples available, involving more than one thousand thin sections. Any sample showing in thin section a cleavage, more than a few modal percent calcite, or significant textural modification was rejected. The sample set eventually selected, therefore, is considered to be representative of the least altered Mount Read Volcanics; this is well shown by the fact that the great majority of these samples have retained fresh primary mafic minerals, including clinopyroxene, hornblende, and, in some dacites and rhyolites, biotite. It must be borne in mind, however, that even these least altered samples are all now metamorphic rocks, with low-grade burial metamorphic mineral assemblages; as such, they must necessarily have undergone some degree of element mobility and chemical alteration during burial metamorphic degradation.

SAMPLE COLLECTIONS INVOLVED, AND ACKNOWLEDGEMENTS

The available sample suites from which the 130 least altered rocks were selected included those made by Honours and post-graduate students in the Geology Department, University of Tasmania and the collections of the Geological Survey (Tasmanian Mines Dept.). In addition, several companies provided drillhole material or samples from inaccessible areas collected during helicopter or line-cutting investigations. I thank John Everard and Keith Corbett for samples from the Queenstown-Rosebery area, Rod Sainty (EZ) for drillhole material from Stirling Valley and Mount Black, Peter Ellis and Rod Williams (CSR) for Boco Prospect drillhole material, and especially, Phil Jones and Grag Carey from AMOCO for providing all the samples from the Sorrell Peninsula. I am particularly grateful to Ross Large, Keith Corbett, Geoff Green, Peter Baillie, Peter Ellis, Rod Williams, Marcus McClenaghan and Phil Jones for many stimulating discussions on Mount Read arc geology, and to Phil Robinson for maintaining the XRF laboratory and assisting in every way in analysing these rocks. Finally, I thank Ross Large and AMIRA for financial assistance to carry out this project.

GEOCHEMISTRY OF MOUNT READ VOLCANICS: DISCUSSION

The Mount Read Volcanics range petrographically from basalts to rhyolites, and show a complete spectrum of compositions between these extremes. This may be seen on the Harker diagrams (element-SiO_2), which show a continuum of compositions from 47% to 77% SiO_2; the SiO_2 minimum at around 56-62% typical of stratovolcanoes in oceanic island arcs (Wheller and Varne, in press) is absent, and in this respect, the Mount Read Volcanics (herein abbreviated to MRV) show closer affinities with calc-alkaline basalt-andesite-dacite-rhyolite suites from active continental margins such as occur along Western USA, Central America and the Andes. These arcs are constructed on essentially continental-type crust, and have in general, higher abundances of large ion lithophile elements (LILE) such as K, Ba, Rb and La than equivalent lavas built on oceanic crust.

From the following chemical and petrographic features, and reference to the accompanying Harker plots, it is concluded that the MRV were erupted in a continental margin arc, and probably had closest affinities with modern continental margin high-K_2O suites, such as those erupted in the northern and central Andes.

1. The accompanying K_2O-SiO_2 diagram shows that the MRV display a compositional field notable for two main features. Firstly, there is a well-defined magmatic trend of increasing K_2O with increasing SiO_2, even though K is often considered to be a highly mobile element during burial metamorphism; secondly, the average trend defined by the MRV data falls within the high-K calc-alkaline field of Ewart (1982).

2. The compositional fields of both Ba (considered very mobile during metamorphism) and Zr (immobile during any alteration) are most similar to high-K calc-alkaline suites, and both elements are notably enriched in MRV samples relative to oceanic arc lavas at similar SiO2 levels.

3. The relative abundance of hornblende in the MRV is also characteristic of calc-alkaline suites from continental margin arcs.

It is expected that rare earth element (REE) and isotopic studies will confirm this conclusion; REE are insensitive to low grade metamorphism and high-K calc-alkaline lavas are notably enriched in light REE relative to medium-K calc-alkaline or tholeiitic arc lavas, so these should prove a diagnostic test of affinities for the Mount Read Volcanics. Similarly, proposed isotopic studies of MRV lavas and mineral separates should support the foregoing conclusion, as high-K arc lavas have significantly more radiogenic Sr and less radiogenic Nd than other subalkaline arc lavas.

GEOCHEMISTRY AS AN AID TO CORRELATION IN THE MT READ ARC

In addition to its usefulness in providing information about the affinities of MRV lavas, the geochemical study in progress may yield important information pertinent to regional stratigraphic correlation and subdivision within the MRV. From the data in hand, the following observations are made:

1. The MRV lavas occurring on the Sorrell Peninsula, south of Macquarie Harbour, are petrographically and geochemically identical to the MRV from the main belt north of Macquarie Harbour, and are undoubtedly part of the same, once-continuous belt.
2. The relatively abundant hornblende-bearing lavas and shallow intrusives within the MRV appear on available evidence to be comagmatic with the hornblende-free MRV. Hornblende does not appear until lavas are andesitic in composition.
3. There is a larger than expected spread in TiO_2 contents across the basalt to basaltic andesite range. Unambiguous Central Belt lavas (eg. Y408, 462A, 31767A and Hellyer basalt 334162) always have less than 0.8% TiO_2; however, basaltic and doleritic dykes in Central Belt lavas at Boco and Sterling Valley, and along Howards Rd. have higher TiO_2 and lower Sc contents than the lavas, and may represent a

slightly later, magmatically distinct suite of basalts.

4. A number of samples from the University collections from the Beaconsfield area have striking petrographic and geochemical similarities to MRV. Other samples from the same area are identical petrographically and chemically to Crimson Creek Fmn. basalts and dolerites. It is possible that the mafic-ultramafic sequence at Beaconsfield may be a thrust slice of the same sequence exposed further west in Tasmania. This possibility, which will be investigated in more detail with REE, has important implications for base and precious metal exploration in the Beaconsfield area.
5. Corbett (1979) recorded a distinctive suite of ophitic textured basaltic lavas and breccias from Miners Ridge, near the western margin of the Central Belt of the MRV. These rocks outcrop in the core of an anticlinorium, and may represent an early or precursor phase of the MRV. Unfortunately, only one sample (W64) from this sequence was analyzed in the present study; however, McClenaghan and Corbett (1985) report that seven samples analyzed from the Miners Ridge sequence appear to have tholeiitic affinities. Further work will clarify the relationships and affinities of these rocks.
6. Although few examples were analyzed for the present study, large volumes of the MRV are composed of pink rhyolites and crystal tuffs which have generally 6-9% K_2O. By comparison with modern, fresh arc suites from continental margins and oceanic arcs, it is concluded that these high K_2O contents are not primary, but are due to enrichment of K_2O. Modern rhyolites in arc suites never have more than 6% K_2O.

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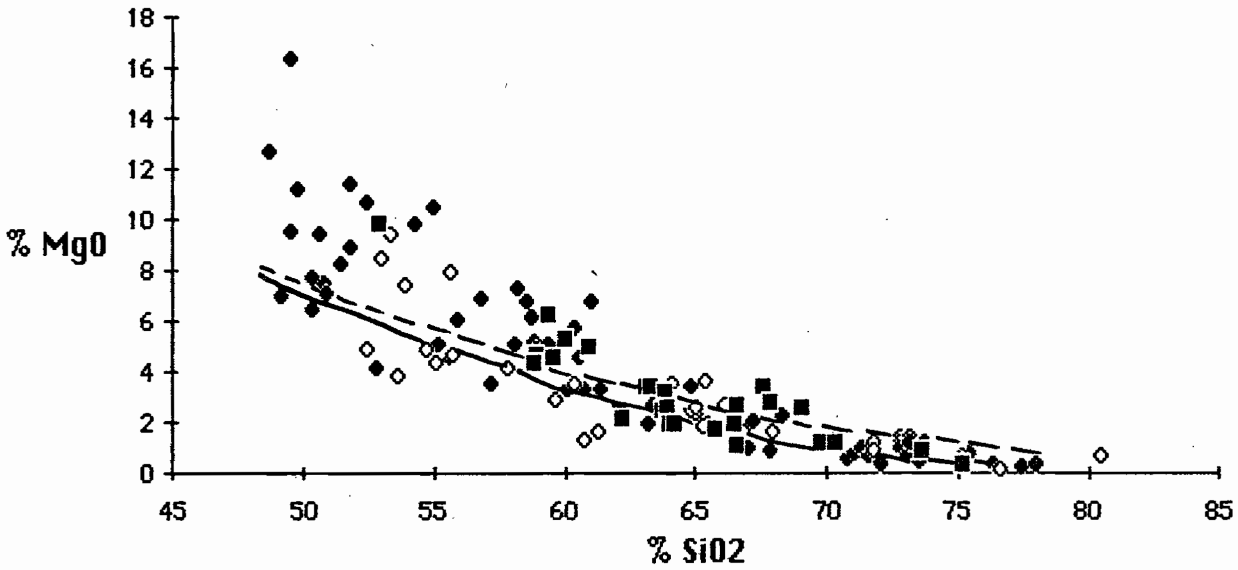
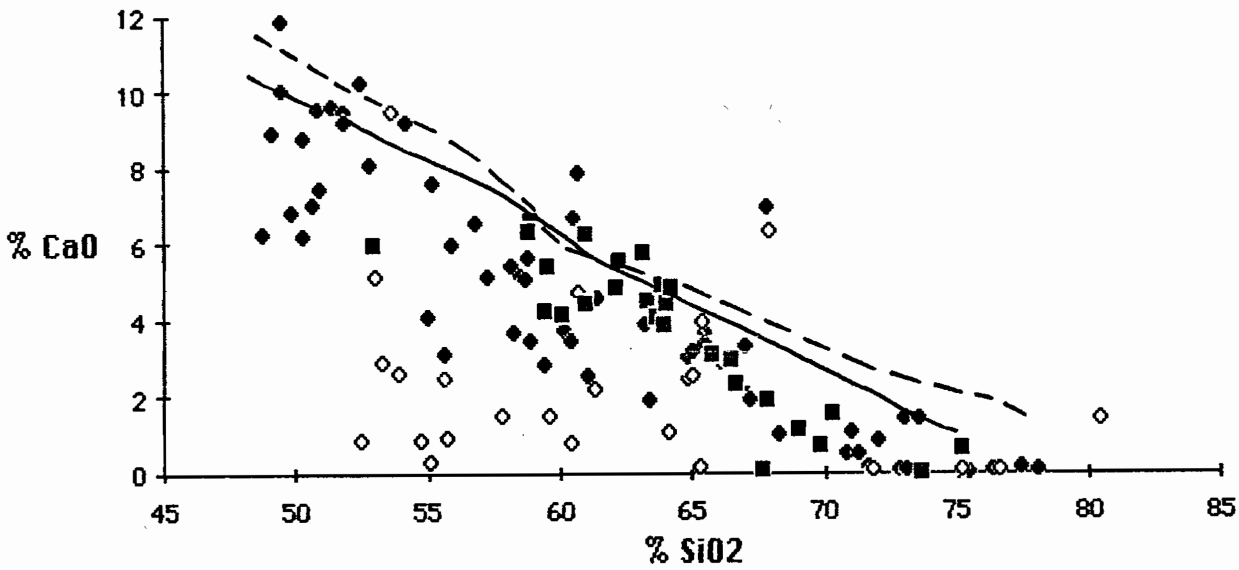
GEOCHEMICAL DATABASE FOR MOUNT READ VOLCANICS

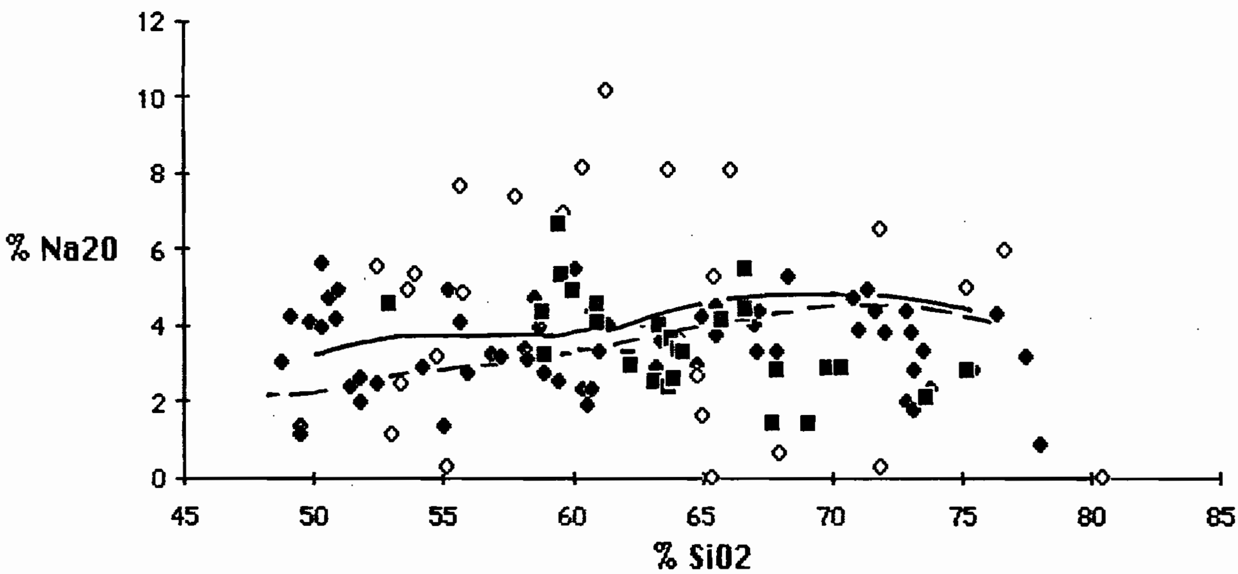
In the following pages, a tabulated list of major and trace element analyses of volcanics and associated shallow intrusives from the Mount Read Volcanics is presented. The list is divided into two sections. The first list of 91 analyses is for the least altered rocks selected for the study. The other list, containing 27 analyses, is for rocks showing slightly more alteration of plagioclase and mafics, but no significant carbonate development. In most cases, these samples plot slightly or significantly away from the fresher lavas on Harker diagrams of the most mobile elements, such as Na, Ba, Ca, Sr and K.

A series of Harker diagrams following the tables of analyses show the MRV subdivided into three groups marked by different symbols. Samples from the least altered group are designated by a solid diamond if they are hornblende-free, and by a solid square if the are hornblende-bearing. Rocks from the more altered group are plotted using an open diamond symbol. On these Harker diagrams are also marked two, or in some cases three trends for modern, fresh arc volcanics from the Cascades arc (solid line), the oceanic arcs of the SW Pacific (average of Fiji, Vanuatu, Solomons, New Britain, from Ewart, 1982) (dashed line) and the Andean arc (dotted line).

MOUNT READ VOLCANICS







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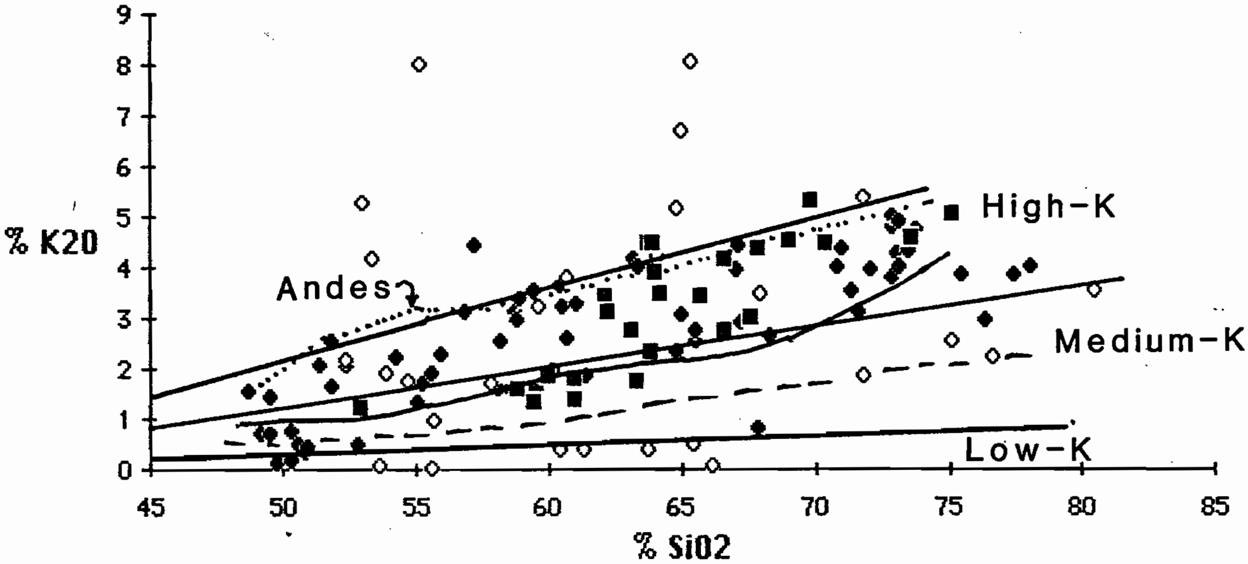

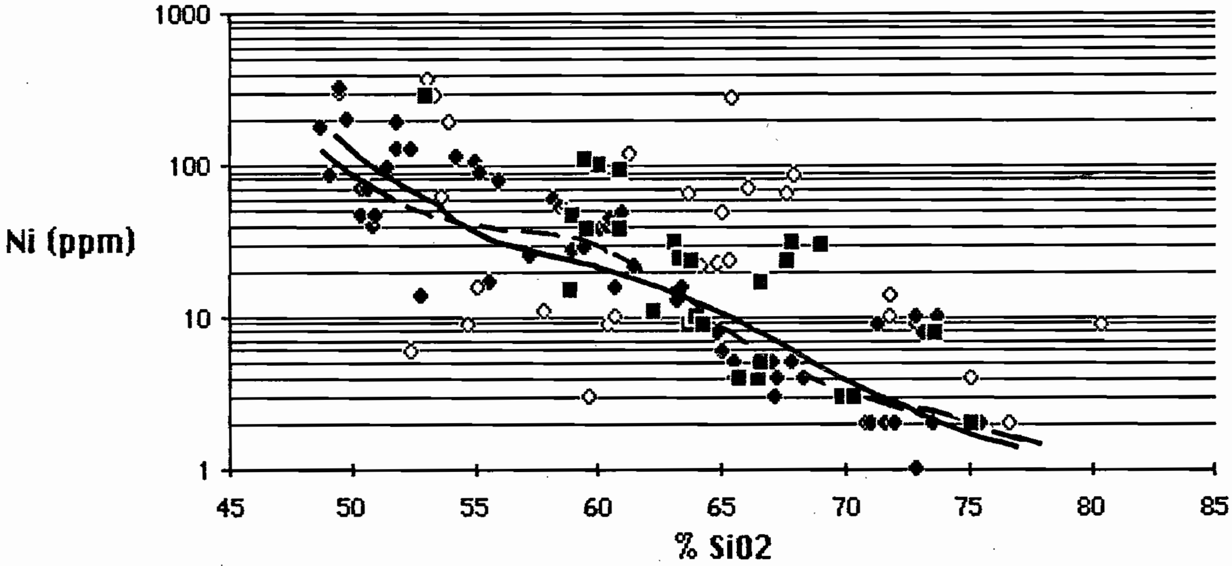

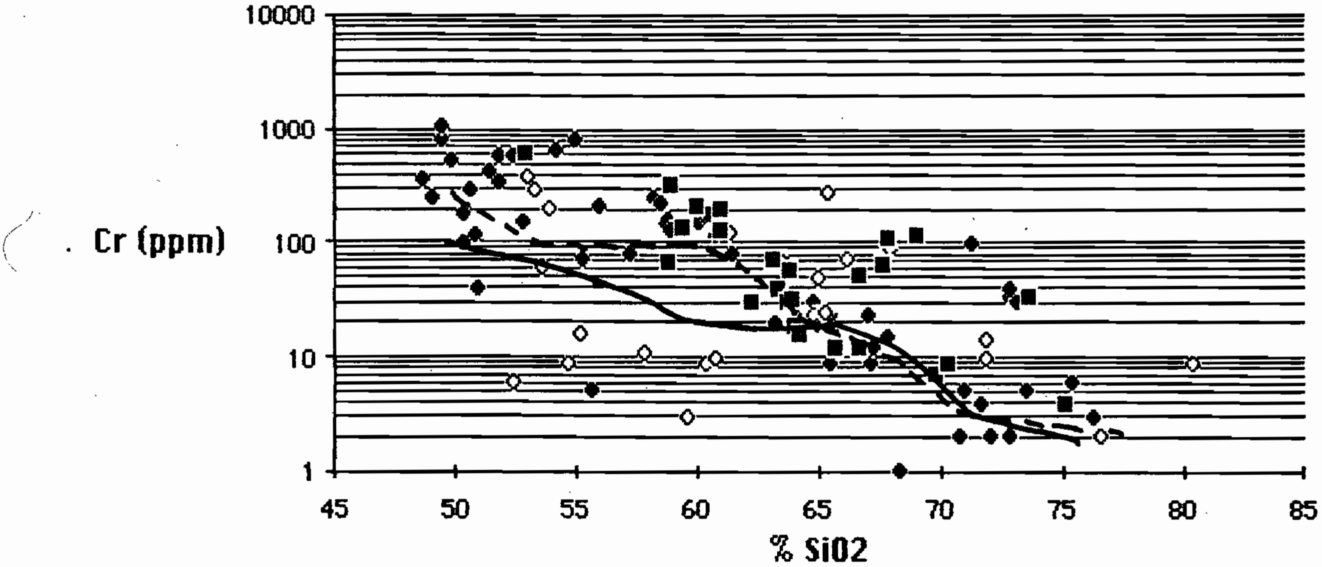

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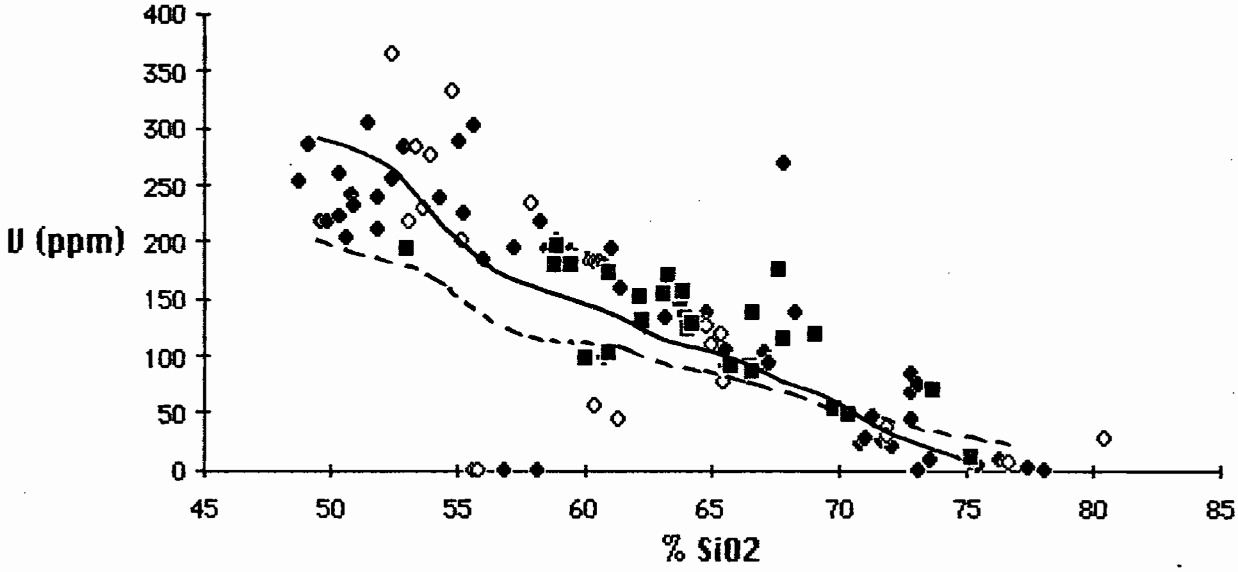

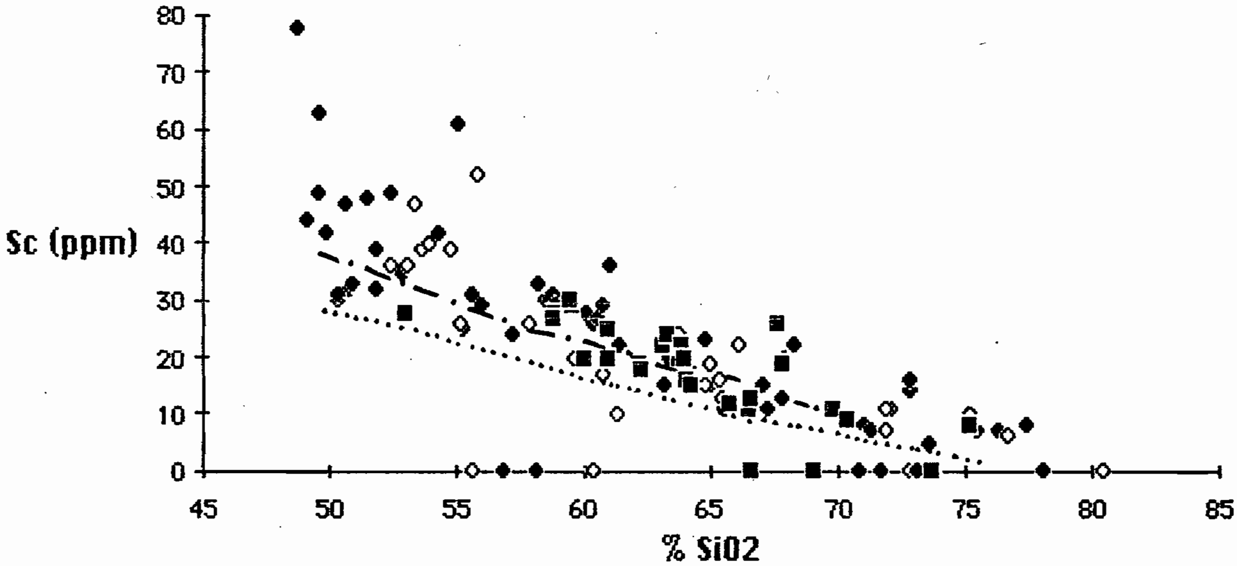

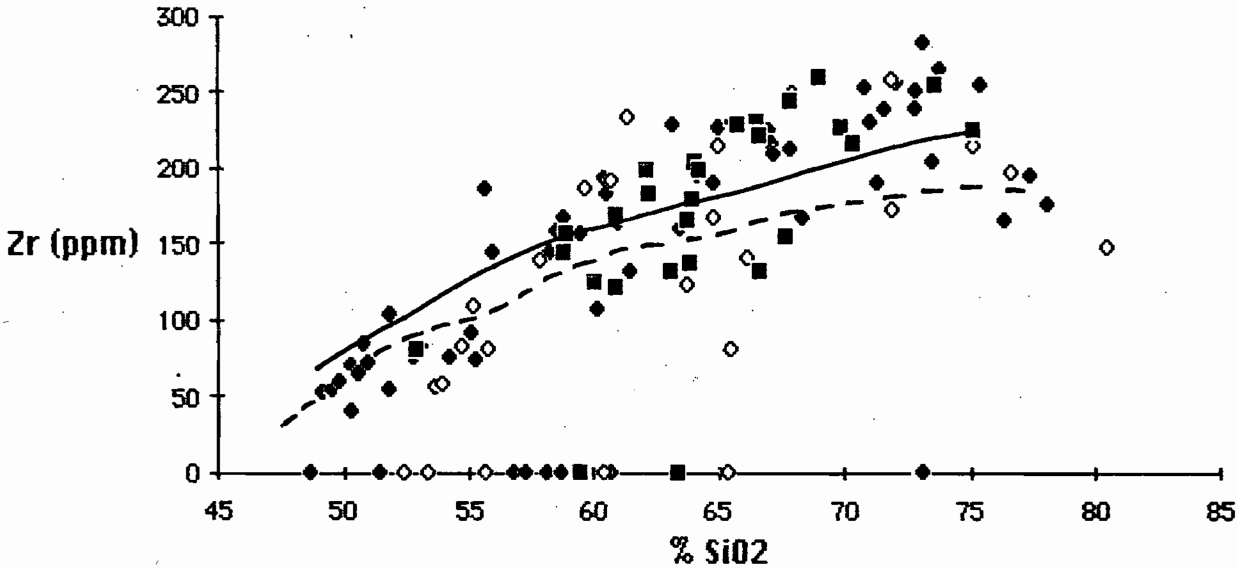

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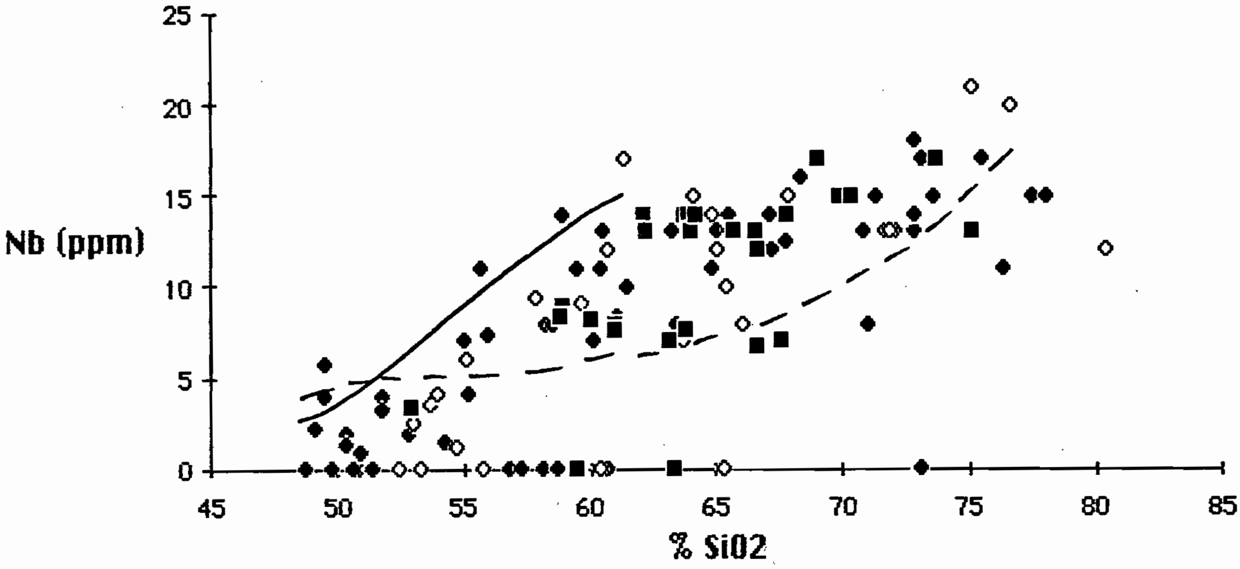

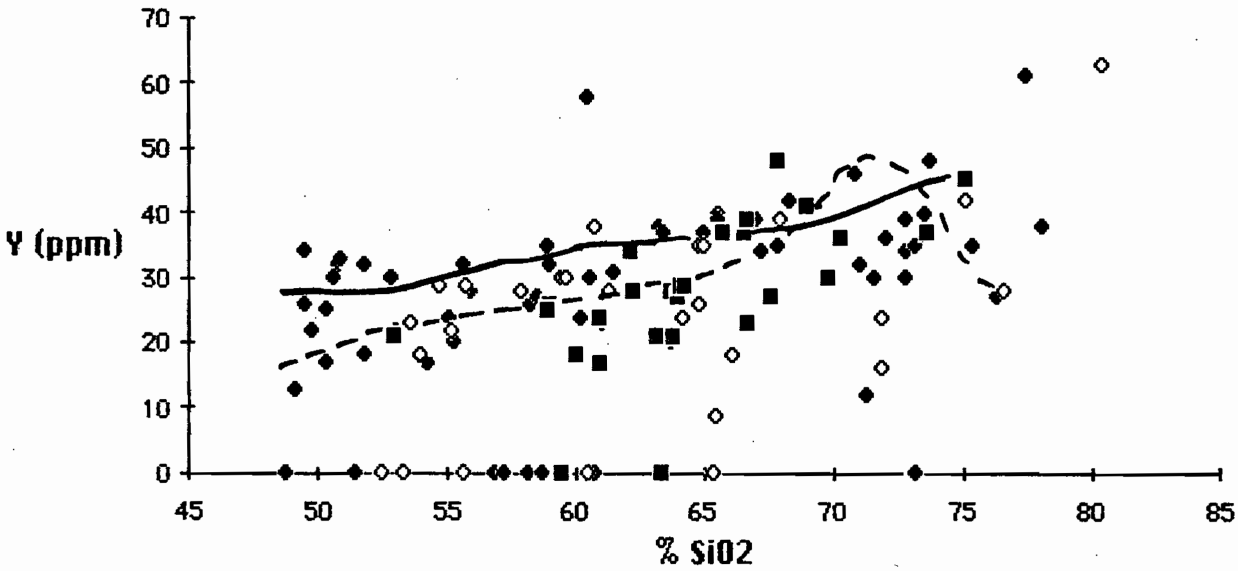

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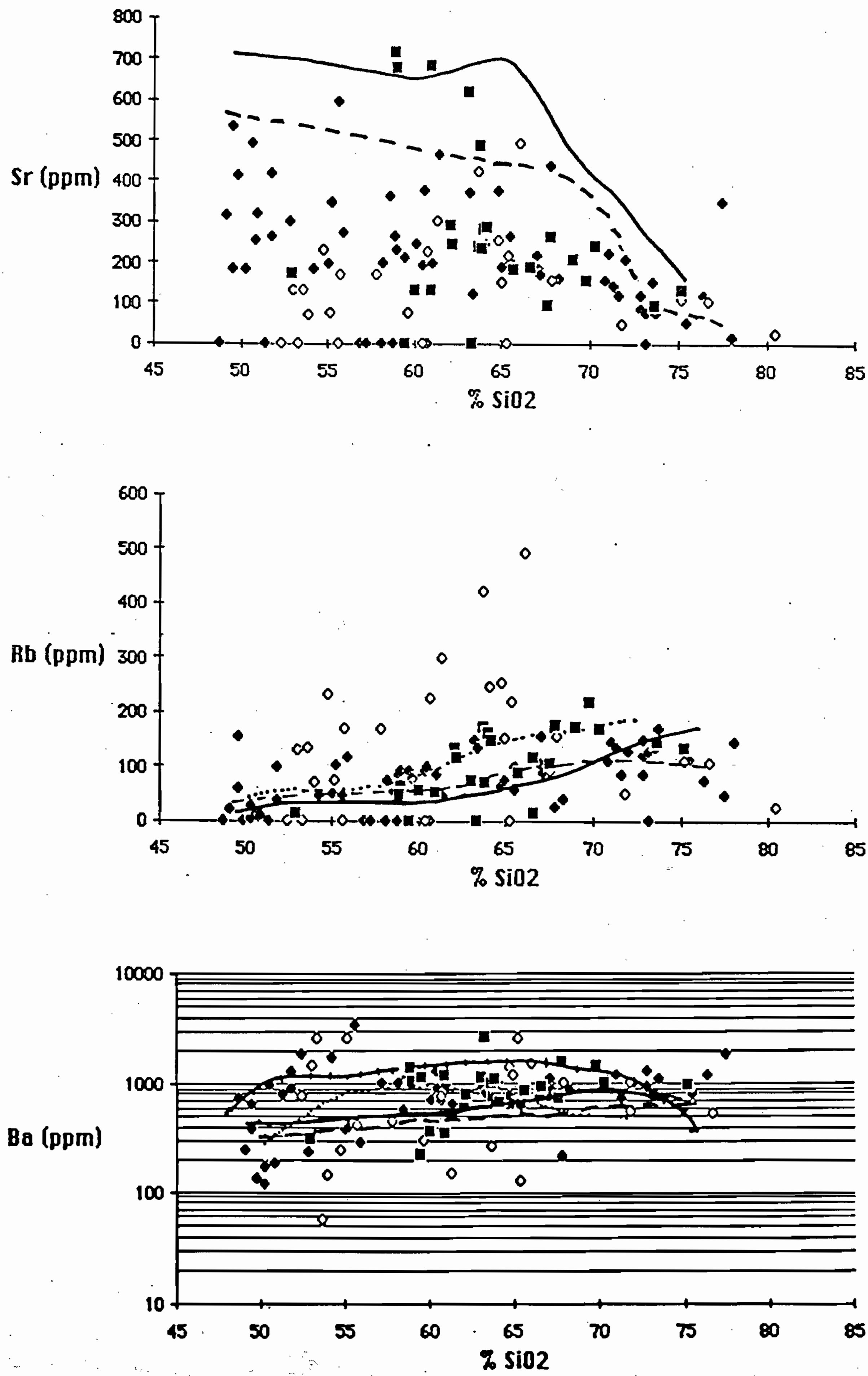

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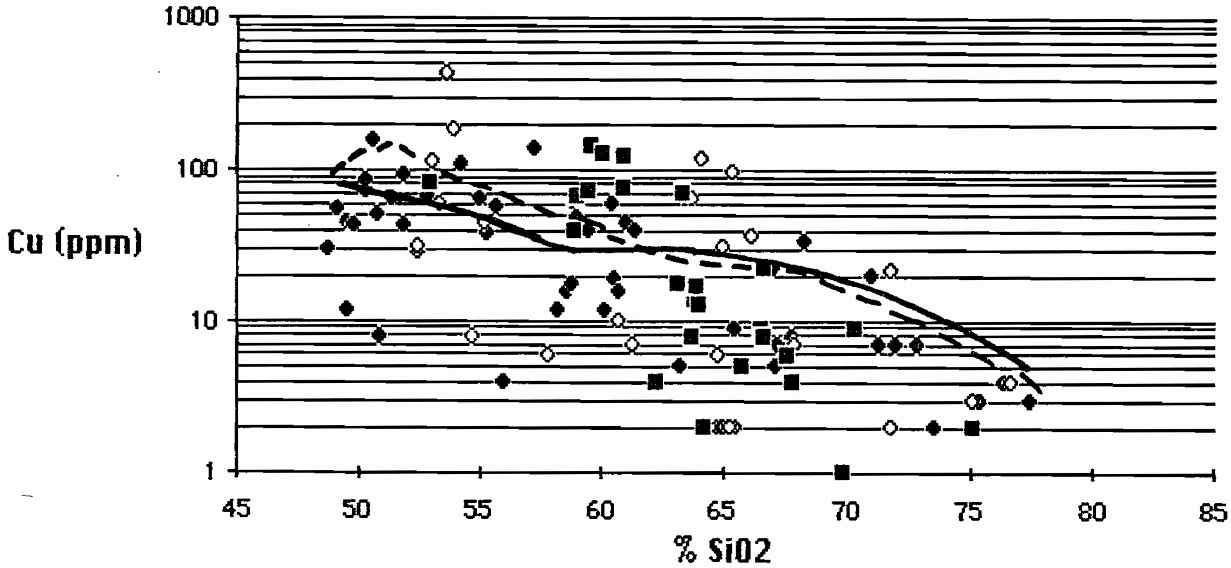

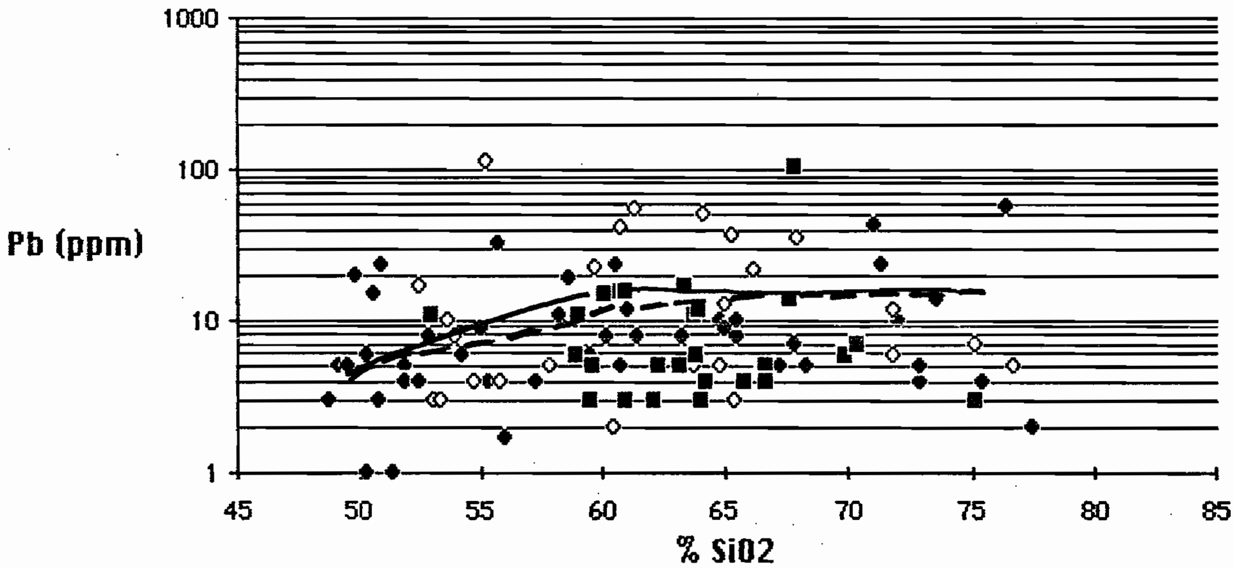

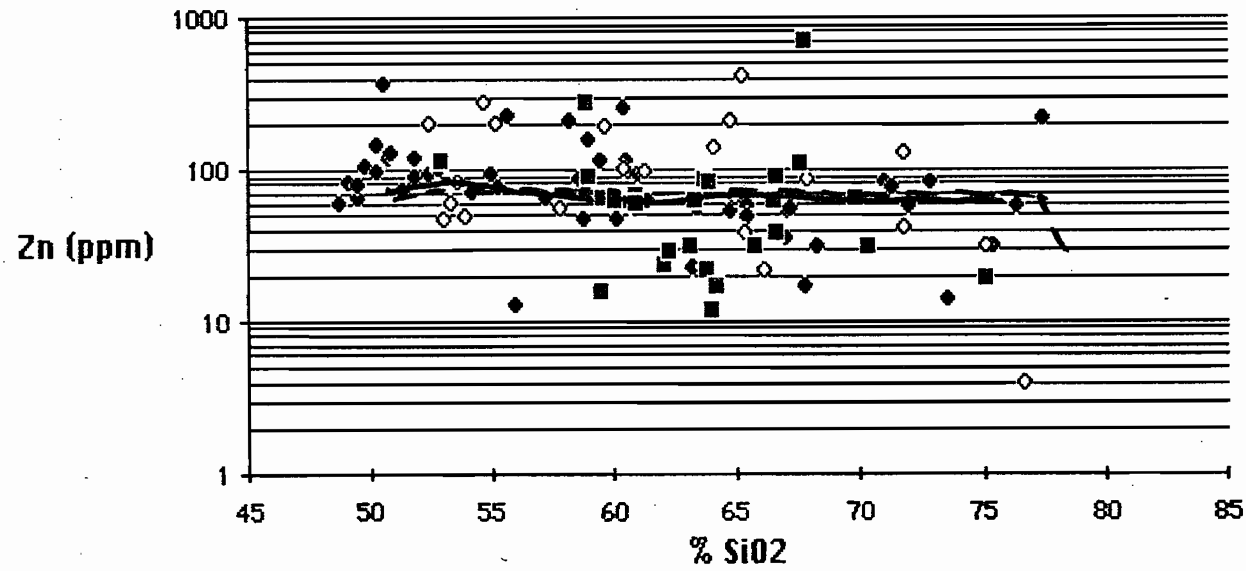

MOUNT READ VOLCANICS: LIST 1 LEAST ALTERED ROCKS

SAMPLE	W64	8150	Z627	31980	R8	R14	STP234	8151	R195	R227	5033
ANALYSIS No	1	2	3	4	5	6	7	8	9	10	11
SiO2	48.7	49.1	49.5	49.5	49.8	50.8	50.3	50.3	50.6	50.9	51.4
TiO2	0.71	0.8	0.32	0.42	1.02	1.32	1.13	0.89	0.99	0.88	0.76
Al2O3	15.3	17.5	8.94	16.5	16.7	15.9	17.1	18.4	17	17.7	15
Fe2O3	11.4	11.4	10.5	11	10.5	10.1	9.83	11.6	9.1	10.3	10.2
MnO	0.2	0.14	0.2	0.29	0.19	0.19	0.24	0.15	0.48	0.17	0.2
MgO	12.7	6.94	16.4	9.48	11.25	7.47	7.73	6.51	9.42	7.08	8.23
CaO	6.28	8.92	11.9	10.1	6.84	9.59	8.81	6.2	7.04	7.44	9.65
Na2O	3.07	4.26	1.35	1.12	4.09	4.16	3.94	5.61	4.76	4.93	2.4
K2O	1.56	0.68	0.7	1.45	0.1	0.33	0.73	0.17	0.5	0.43	2.08
P2O5	0.06	0.2	0.17	0.1	0.07	0.13	0.15	0.16	0.07	0.12	0.12
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	4.3	3.56	3.28	1.39	4.3	2.64	7.98	3.39	4.24	3.29	3.53
Ni	177	88	303	335	202	40	70	48	72	47	97
Cr	365	252	819	1049	528	118	175	99	293	39	418
Y	254	287	221	219	218	241	223	260	205	233	306
Sc	78	44	49	63	42	32	30	31	47	33	48
Zr		53	53	55	61	84	71	41	66	73	
Nb		2.2	4	5.8	0	0	2	1.4	0	0.9	
Y		13	34	26	22	32	25	17	30	33	
Sr		316	182	534	415	255	184	182	495	320	
Rb		21	155	59	2.5	9	30	5	13	13	
Ba	730	248	382	649	132	188	173	120	960	185	811
Cu	30	55	12	45	43	51	75	85	156	8	65
Pb	3	5	5	5	20	3	6	1	15	24	1
Zn	60	82	64	81	105	118	148	98	375	131	74
Zn No.	95	94	93	94	84	98	96	99	96	85	99

SAMPLE	Y408	462A	31767A	34519	925	Z102	LPD11C	462	334162	385A
ANALYSIS No.	12	13	14	15	16	17	18	19	20	21
SiO2	51.8	51.8	52.4	52.8	52.9	54.2	55	55.2	55.6	55.9
TiO2	0.41	0.59	0.42	1.03	0.56	0.38	0.68	0.55	0.77	0.61
Al2O3	12.5	13.9	11.9	17.4	14.4	12	15.7	15.5	18.6	14.9
Fe2O3	10	10	9.44	11.2	10.3	9.1	11.1	9.06	10.5	10
MnO	0.18	0.28	0.16	0.16	0.18	0.14	0.15	0.21	0.23	0.07
MgO	11.4	8.9	10.7	4.13	9.78	9.84	10.5	5.05	4.6	6.06
CaO	9.48	9.24	10.3	8.07	6.01	9.2	4.08	7.58	3.08	5.97
Na2O	2.02	2.64	2.46	4.6	4.58	2.92	1.34	4.93	4.12	2.79
K2O	1.66	2.56	2.08	0.51	1.24	2.21	1.33	1.72	1.93	2.26
P2O5	0.48	0.1	0.19	0.12	0.08	0.28	0.19	0.11	0.57	0.11
TOTAL	100	100	100	100	100	100	100	100	100	100
LOI	4.07	2.37	2.43	2.24	3.79	2.87	5.22	1.15	3.99	1.45
Ni	130	198	132	14	291	115	107	91	17	81
Cr	580	342	601	157	638	640	825	70	5	213
Y	240	211	255	285	196	240	288	225	302	185
Sc	39	32	49	35	28	42	61	25	31	29
Zr	105	55		76	81	76	92	74	187	145
Nb	4	3.2		2	3.4	1.5	7	4.1	11	7.3
Y	32	18		30	21	17	24	20	32	28
Sr	420	262		302	177	185	199	350	595	271
Rb	41	101		12	15	45	51	104	46	116
Ba	1300	919	1869	239	310	1750	380	403	3407	288
Cu	94	44	29	67	84	110	65	39	58	4
Pb	5	4	4	8	11	6	9	4	33	1.7
Zn	90	122	92	102	115	72	92	76	224	13
ZN NO.	95	97	96	93	91	92	91	95	87	88

MOUNT READ VOLCANICS ... FRESH LAVAS

SAMPLE	Z96	123	385	52	39233	W93	39232	M189	5010	32522	977
ANALYSIS No.	22	23	24	25	26	27	28	29	30	31	32
SiO2	56.8	57.2	58.1	58.2	58.5	58.7	58.8	58.8	58.9	58.9	59.4
TiO2	0.47	0.67	0.61	0.57	0.56	0.55	0.57	0.48	0.83	0.53	0.48
Al2O3	13.7	16.4	16.4	14.6	14.2	14.2	14.4	15.9	15.9	15	14.1
Fe2O3	8.82	9.03	9.14	9.44	8.11	7.9	7.83	7.65	9.49	8.99	7.35
MnO	0.17	0.13	0.12	0.27	0.13	0.12	0.12	0.21	0.17	0.14	0.08
MgO	6.91	3.5	5.1	7.27	6.75	6.19	5.24	4.37	4.92	4.62	6.27
CaO	6.55	5.13	5.43	3.66	5.18	5.05	5.62	6.35	3.43	6.62	4.26
Na2O	3.23	3.21	3.36	3.11	4.76	3.97	4.24	4.4	2.79	3.24	6.67
K2O	3.11	4.45	1.59	2.56	1.61	3.15	2.97	1.59	3.36	1.57	1.33
P2O5	0.23	0.24	0.16	0.14	0.2	0.2	0.22	0.21	0.19	0.34	0.07
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	2.59	2.1	2.96	3.27	2.11	1.65	1.85	1.81	3.33	1.81	1.73
Ni		26		61	53	52	49	15	28	47	112
Cr		82		250	224	157	160	68	128	321	134
Y		195		218	196	188	201	181	202	198	182
Sc		24		33	30	30	31	27	29	28	30
Zr				145	159		167	144	155	157	
Nb				8	8		9	8.4	14	9	
Y				26	27		35	25	32	26	
Sr				200	363		262	716	231	682	
Rb				76	53		85	49	91	65	
Ba		1019		1032	572	1160	1068	1403	1105	1067	226
Cu		139		12	16	18	60	40	50	67	75
Pb		4		11	19	6	10	6	6	11	3
Zn		66		214	86	48	71	277	159	90	16
ZN NO.	0	94	0	95	82	89	88	98	96	89	84

SAMPLE	5016	3399	5008	47	HR24	HR23	X	5009	Z632	39235	44078
ANALYSIS No.	33	34	35	36	37	38	39	40	41	42	43
SiO2	59.4	59.5	60	60.1	60.4	60.5	60.7	60.9	60.9	61	61.4
TiO2	0.83	0.45	0.45	0.68	0.75	0.76	0.62	0.42	0.49	0.56	0.68
Al2O3	16.1	15.5	16.8	14.7	14.7	14.7	14.9	16.6	14.3	14.3	16.3
Fe2O3	9.25	7.26	6.25	9.72	8.72	7.42	7.44	6.07	7.29	7.88	7.37
MnO	0.16	0.13	0.11	0.1	0.1	0.1	0.1	0.1	0.13	0.09	0.13
MgO	5.11	4.53	5.25	3.27	5.72	4.53	3.3	5	4.84	6.81	3.35
CaO	2.86	5.45	4.19	3.73	3.46	6.68	7.91	4.47	6.29	2.58	4.61
Na2O	2.58	5.36	4.96	5.53	2.36	1.95	2.37	4.59	4.07	3.31	4.03
K2O	3.55	1.56	1.87	1.99	3.67	3.24	2.59	1.81	1.39	3.29	1.88
P2O5	0.18	0.25	0.11	0.14	0.13	0.12	0.13	0.12	0.32	0.21	0.15
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	3.28	2.03	2.81	1.33	3.24	2.71	2.93	2.79	1.94	2.73	2.42
Ni	29	38	101	38	40	45	16	95	39	49	22
Cr	130	139	208	151	166	182	116	198	130	168	81
Y	192	184	99	186	183	184	182	103	175	194	161
Sc	29	29	20	28	26	27	29	20	25	36	22
Zr	156		125	107	194	183		122	169	163	133
Nb	11		8.2	7	11	13		7.7	8	8.4	10
Y	30		18	24	58	30		17	24	23	31
Sr	210		132	243	192	375		131	683	199	465
Rb	93		56	61	93	100		54	42	84	48
Ba	1235	1143	365	695	1316	901	702	353	1184	994	664
Cu	40	144	132	12	60	19	16	124	77	46	40
Pb	6	5	15	8	16	24	5	16	3	12	8
Zn	115	66	62	48	260	115	58	61	69	94	62
ZN NO.	95	93	81	86	94	83	92	79	96	89	89

MOUNT READ VOLCANICS ... FRESH LAVAS

SAMPLE	58	85	3402	413	M235	150	3403	HR71	3398	65	98
ANALYSIS No.	44	45	46	47	48	49	50	51	52	53	54
SiO2	62.1	62.2	63.1	63.2	63.3	63.4	63.7	63.8	63.9	64	64.2
TiO2	0.66	0.66	0.42	0.72	0.42	0.55	0.66	0.4	0.64	0.54	0.53
Al203	16.6	16.9	14.9	16.5	14.7	15.6	15.2	15	14.9	15.8	16.2
Fe203	6.5	6.2	6.79	6.41	7.42	8.03	6.5	6.38	6.59	5.78	5.18
MnO	0.08	0.11	0.11	0.11	0.16	0.07	0.24	0.07	0.23	0.06	0.07
MgO	2.45	2.1	3.39	1.94	3.45	2.71	2.5	3.2	2.56	1.9	1.97
CaO	4.86	5.54	5.75	3.89	4.51	1.89	4.06	4.96	3.9	4.47	4.87
Na20	3.21	2.94	2.55	2.87	4.05	3.6	2.39	3.64	2.6	3.38	3.35
K20	3.43	3.15	2.77	4.16	1.77	4.04	4.51	2.32	4.48	3.9	3.48
P205	0.15	0.16	0.17	0.17	0.19	0.12	0.17	0.2	0.16	0.16	0.13
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	1.7	2.44	3.62	1.6	2.96	2.56	4.54	1.72	4.66	1.49	1.6
Ni	11	11	32	13	25	16	9	24	10	10	9
Cr	29	30	72	20	40	39	31	59	32	19	16
V	152	132	155	135	172	169	151	157	134	125	130
Sc	19	18	22	15	24	20	20	22	20	16	15
Zr	199	184	133	228		161	166	138	179	204	199
Nb	14	13	7	13		8	14	7.6	14	13	14
Y	34	28	21	38		37	28	21	27	29	29
Sr	292	247	620	371		123	241	488	237	281	285
Rb	135	117	74	148		136	173	70	164	161	148
Ba	667	793	1148	927	2720	839	1023	773	1087	721	692
Cu	0	4	18	5	70	65	8	14	17	13	2
Pb	3	5	5	8	17	5	11	6	12	3	4
Zn	24	29	31	23	62	55	88	22	82	12	17
ZN NO.	89	85	86	74	78	92	89	79	87	80	81

SAMPLE	48378	36113	40141A	44063	40140	44041	HR65	30039A	44067	LPD11A	44045
ANALYSIS No.	55	56	57	58	59	60	61	62	63	64	65
SiO2	64.8	65	65.5	65.5	65.7	66.5	66.6	66.6	67	67.1	67.2
TiO2	0.61	0.67	0.62	0.68	0.66	0.68	0.36	0.62	0.67	0.68	0.67
Al203	15.3	15.3	15.8	15.4	15.4	14.9	14.6	15.5	15.1	15	15
Fe203	7.21	6	5.92	5.83	5.57	5.72	4.98	5.11	4.84	5.24	5.52
MnO	0.12	0.08	0.1	0.07	0.07	0.11	0.11	0.09	0.08	0.1	0.09
MgO	3.43	2.37	1.94	1.74	1.71	1.88	2.66	1.08	0.94	1.98	2.01
CaO	3.04	3.17	3.71	3.36	3.12	2.96	2.3	2.33	3.29	2.04	1.91
Na20	2.97	4.25	3.74	4.5	4.2	4.31	5.53	4.43	4.04	3.33	4.35
K20	2.31	3.05	2.53	2.78	3.43	2.83	2.74	4.18	3.97	4.45	2.92
P205	0.12	0.13	0.12	0.12	0.14	0.14	0.19	0.12	0.13	0.13	0.27
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	2.79	2.3	2.23	1.67	1.52	1.44	1.26	0.95	1.89	1.28	1.49
Ni	8	6	4	5	4	4	17	5	5	3	4
Cr	31	23	9	23	12	13	52	12	23	9	12
V	139	111	92	107	91	92	140	88	104	92	94
Sc	23	15	11	13	12	11		13	15	11	11
Zr	191	227	228	231	228	231	132	221	226	216	209
Nb	11	13	14	13	13	13	6.8	12	12	14	12
Y	35	37	40	39	37	37	23	39	39	34	34
Sr	378	191	204	264	182	184	1004	188	218	182	172
Rb	64	75	101	58	88	119	16	118	105	155	89
Ba	754	658	696	620	882	764	0	927	819	1099	860
Cu	2	2	2	9	5	9	23	8	23	5	7
Pb	10	9	8	10	4	5	5	4	5	5	5
Zn	53	69	57	49	32	63	89	39	35	53	55
ZN NO.	84	88	88	83	89	93	95	91	88	91	92

MOUNT READ VOLCANICS ... FRESH LAVAS

SAMPLE	HR70	2488	30039B	5017	Y249	30050	30051A	Y318	Y549	38927	Y324
ANALYSIS No.	66	67	68	69	70	71	72	73	74	75	76
SiO2	67.6	67.8	67.8	68.3	69	69.8	70.3	70.8	71	71.3	71.6
TiO2	0.44	0.62	0.6	0.78	0.74	0.46	0.45	0.4	0.33	0.31	0.38
Al2O3	16.9	14.4	14.5	15.2	15.1	15.6	15.2	14.7	14.3	15.1	14.6
Fe2O3	6.76	4.99	4.85	4.23	5.37	3.86	3.67	4.06	4.51	3.08	4.89
MnO	0.02	0.19	0.07	0.17	0.11	0.04	0.07	0.06	0.09	0.11	0.05
MgO	3.43	2.76	0.88	2.26	2.52	1.23	1.16	0.56	0.73	0.96	0.66
CaO	0.1	1.89	6.99	1.01	1.11	0.69	1.54	0.5	1.1	0.52	0.19
Na2O	1.44	2.83	3.34	5.28	1.42	2.87	2.93	4.72	3.92	4.93	4.37
K2O	3.02	4.39	0.82	2.65	4.56	5.36	4.52	4.04	4.4	3.54	3.13
P2O5	0.23	0.13	0.13	0.17	0.13	0.1	0.1	0.17	0.11	0.08	0.07
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	4.28	1.82	1.56	1.9	3.88	1.44	1.22	1.14	1.72	1.84	1.34
Ni	24	31	5	4	30	3	3	2	2	9	2
Cr	64	113	15	1	118	7	9	2	5	102	4
V	177	115	269	138	121	55	51	24	29	48	26
Sc	26	19	13	22		11	9		8	7	
Zr	155	245	213	167	260	227	216	254	230	190	240
Nb	7.1	14	12.5	16	17	15	15	13	8	15	13
Y	27	48	35	42	41	30	36	46	32	12	30
Sr	94	265	435	161	208	156	238	158	220	143	120
Rb	105	176	25	38	173	218	169	109	145	136	84
Ba	747	1614	218	859		1463	1033		1200	725	
Cu	6	4	8	34		1	9		20	7	
Pb	14	104	7	5		6	7		44	24	
Zn	112	706	17	32		65	31		84	76	
ZN NO.	89	87	71	86	0	92	82	0	66	76	0

SAMPLE	Y311	Y5	Y821	Z221	40136A	Y4	Y74	40136	Y75	Y472	36117
ANALYSIS No.	77	78	79	80	81	82	83	84	85	86	87
SiO2	72	72.8	72.8	72.8	73	73.1	73.1	73.5	73.6	73.7	75.1
TiO2	0.41	0.49	0.48	0.52	0.28	0.48	0.49	0.27	0.51	0.48	0.29
Al2O3	14.8	14.8	15.4	14.3	13.9	14.7	14.4	13.9	14.7	14.8	12.9
Fe2O3	3.64	3.44	3.1	3.07	2.67	3.51	3.83	2.73	3.42	2.83	2.8
MnO	0.06	0.05	0.02	0.01	0.05	0.04	0.03	0.04	0.03	0.03	0.05
MgO	0.38	1.42	1.16	0.96	0.66	1.36	1.21	0.46	0.89	1.19	0.32
CaO	0.88	0.03	0.06	0.07	1.39	0.03	0.06	1.39	0.04	0.06	0.64
Na2O	3.8	2.07	1.98	4.36	3.78	1.76	2.81	3.29	2.16	2.34	2.82
K2O	3.96	4.8	5	3.81	4.29	4.92	4.04	4.34	4.62	4.77	5.05
P2O5	0.06	0.05	0.04	0.05	0.05	0.07	0.05	0.06	0.05	0.03	0.04
TOTAL	100	100	100	100	100	100	100	100	100	100	100
LOI	2.02	2.58	3.51	1.49	1.66	2.52	2.45	1.66	2.86	2.5	0.83
Ni	2	9	1	10			8	2	8	10	2
Cr	2	33	2	39			30	5	33	34	4
V	21	69	46	84			75	11	70	69	12
Sc	11		14	16				5			8
Zr	257	240	251	251			283	205	256	266	225
Nb	13	13	18	14			17	15	17	17	13
Y	36	30	39	34			35	40	37	48	45
Sr	208	120	84	86			76	153	97	75	134
Rb	129	84	150	120			129	134	146	169	133
Ba	1032		1275	946				1093			987
Cu	7			7				2			2
Pb	10		4	5				14			3
Zn	57			84				14			19
ZN NO.	85	0	0	94	0	0	0	50	0	0	86

MOUNT READ VOLCANICS ... FRESH LAVAS

SAMPLE	LPD6	42610	COL	Y760
ANALYSIS No.	88	89	90	91
SiO2	75.4	76.3	77.4	78
TiO2	0.23	0.23	0.19	0.29
Al2O3	14.5	13.8	12.2	13.3
Fe2O3	2.37	1.82	2.58	2.96
MnO	0.02	0.04	0.07	0.12
MgO	0.76	0.3	0.26	0.35
CaO	0.03	0.1	0.18	0.1
Na2O	2.81	4.32	3.17	0.86
K2O	3.87	2.99	3.87	4.01
P2O5	0.01	0.01	0.03	0.06
TOTAL	100	100	100	100
LOI	1.74	1.35	1.22	2.51
Ni	2	0	0	0
Cr	6	3	0	0
V	6	10	4	5
Sc	7	7	8	1
Zr	256	165	195	176
Nb	17	11	15	15
Y	35	27	61	38
Sr	52	120	347	15
Rb	114	76	47	146
Ba	808	1189	1881	0.00
Cu	3	4	3	
Pb	4	57	2	
Zn	31	57	220	
ZN NO.	89	50	99	0

SAMPLE LOCATIONS AND PETROGRAPHY

1	W64	Miners Ridge
		Subophitic-textured basalt, serp. ol phenos, ser. plag phenos
2	8150	Beaconsfield
		Intersertal-textured basalt, sparse albitized plag phenos
3	Z627	Howards Plains Franklin 1:100,000 7837 4247
		Ankaramite; fresh cpx phenos, chloritized ol phenos
4	31980	300m NW of Remine near mouth of Montagu Ck.
		Basalt with abundant cpx phenos and altered ol phenos
5	R8	Howards Rd.
		Dyke: porphyritic basalt; plag phenos in altd. glassy gmass
6	R14	Howards Rd.
		Fine-gr. dolerite dyke; sparse albitized plag phenos
7	STP234	EZ Stirling Valley Drillhole 234 at 86m
		Dyke:
8	8151	Beaconsfield
		Porphyritic basalt;abundant plag phenos, sparse cpx phenos
9	R195	Howards Rd.
		Dolerite dyke; albitized plag phenos
10	R227	Howards Rd.
		Aphyric, coarse-gr., intersertal textured basalt
11	5033	Beaconsfield
		Basalt with 15% sericitized plag phenos, chlor. cpx phenos
12	Y408	Swan Ck. Franklin 1:100,000 7830 4730
		Cpx pheno-rich basalt with sparse plag phenos
13	462A	Sorrell Peninsula AMOCO Hibbs Rv. traverse
		Cpx- + plag- + ol-phyric basalt
14	31767A	Red Hills bore 95 at 619 ft.
		Cpx pheno-rich basalt; small chloritized opx phenos
15	34519	NE of Hercules
		Aphyric, intersertal textured basalt
16	925	Sorrell Peninsula Macquarie Harbour 1:250,000 6775 9715
		Fine-gr. hornblende diorite
17	Z102	Lyell Hwy at Madame Howard Plains Franklin 1:100,000 7915 4250
		Ankaramite with abundant small fresh cpx phenos
18	LPD11C	Cutting where Macintosh Rv crosses Murchison Hwy
		Cpx+plag-phyric basalt
19	462	Sorrell Peninsula; AMOCO Hibbs River traverse

Cpx+plag-phyric basalt; fresh cpx

20	334162	Hellyer Drillhole HL6 at 208.4m
		Fine-gr basalt; plag altered
21	385A	Sorrell Peninsula ; Macquarie Harbour 1;250,000 703 870
		Basaltic andesite with fresh cpx and albitized plag phenos
22	Z96	Lyell Hwy at Madame Howard Plains; Franklin 1:100,000 7908 4244
		Basaltic andesite with 10% large, fresh cpx phenos, seric. plag phenos
23	123	Sorrell Peninsula ; Macquarie Harbour 1:250,000 681 876
		Cpx + plag-phyric andesite; cpx actinolitized, plag sausseritized
24	385	Sorrell Peninsula Macquarie Harbour 1:250,000 703 870
		Andesite with cpx phenos (fresh) and abundant plag phenos
25	052	Sorrell Peninsula Macquarie Harbour 1:250,000 683 000
		Plag +cpx-phyric andesitic agglomerate
26	39233	Mount Lyell Mine Grid 4180'W 11450'S
		Cpx + opx +plag-phyric andesite with fresh cpx phenos
27	W93	Queenstown Reservoir
		Cpx +plag-phyric andesite; 8% fresh cpx phenos; plag phenos sericitized
28	39232	Mount Lyell Mine Grid 4040'W 12480'S
		Cpx + opx +plag-phyric andesite; 10% fresh cpx; 15% altd. plag phenos
29	M189	Crown Hill
		Plag +cpx-phyric andesite; 5% small cpx phenos; plag sericitized
30	5010	Leven Gorge
		Plag-phyric andesite with sparse albitized plag phenos
31	32522	Near South Darwin (?)
		Hbd + cpx- +plag-phyric andesite
32	977	Sorrell Peninsula AMOCO from Helipad 00 at 300m
		Hornblende diorite
33	5016	Leven Gorge
		Almost aphyric andesite ; sparse albitized plag phenos
34	3399	HT lines 1.5km N of Boulder Hill
		Hbd +plag-phyric andesite
35	5008	Golden Valley, Quamby Brook
		Andesite with 1% fresh cpx, 20% albitized plag phenos
36	47	Sorrell Peninsula Macquarie Harbour 1:250,000 689 000
		Andesite with 5% cpx phenos, 40% albitized plag phenos
37	HR24	Halls Rivulat, S of Howards Rd.
		Cpx + opx +plag-phyric andesite; fresh cpx; chloritized opx

38	HR23	Halls Rivulet, S of Howards Rd
		Cpx+plag-phyric andesite; 5% fresh cpx, 10% plag phenos
39	X	Sorrell Peninsula AMOCO Hibbs Rv traverse
		Cpx+plag-phyric andesite
40	5009	Golden Valley, Quamby Brook
		Plag-phyric andesite with 15% albitized plag phenos
41	Z632	Crown Hill
		Hbd +cpx +plag-phyric andesite; fresh hbd and cpx phenos; altd. plag
42	39235	Mount Lyell Mine Grid 4790'W 10710'S
		Plag+cpx-phyric andesite
43	44078	Tullah; Rosebery Metric Grid 3876E 53840N
		Plag+cpx-phyric andesite; cpx actinolitized; plag albitized
44	58	Sorrell Peninsula AMOCO Hibbs Rv. traverse
		Hornblende diorite with fresh hbd and minor fresh biotite
45	85	Sorrell Peninsula AMOCO Hibbs Rv traverse
		Hornblende diorite with mafics more altered than #58
46	3402	North of Boulder Hill on track to Lake Julia
		Hbd+plag-phyric andesite
47	413	Sorrell Peninsula AMOCO Hibbs Rv traverse
		Cpx+opx+plag-phyric andesite
48	M235	Crown Hill
		Cpx+plag+hbd-phyric andesite breccia
49	150	Sorrell Peninsula AMOCO Hibbs Rv traverse
		Plag-phyric andesite
50	3403	Head of canal leading into W side of Lake Dora (?)
		Hbd+plag-phyric andesite
51	HR71	Bradshaws Rd, SW of Leach Hill
		Plag+hbd+qtz-phyric dacite; fresh hbd
52	3398	1.4 km N of Boulder Hill on Lake Julia track
		Plag+qtz+biotite-phyric dacite; biotite slightly altered
53	65	Sorrell Peninsula; AMOCO Hibbs Rv traverse
		V. fine-gr. diorite with fresh biotite and hbd
54	98	Sorrell Peninsula; AMOCO Hibbs Rv traverse
		Hbd+cpx+biotite-phyric dacite; fresh mafics
55	48378	Smiths Plains; Forth 1:100,000 4180E 4094S
		Plag+qtz-phyric dacite
56	36113	Confluence of Murchison and Macintosh Rivers

		Plag-phyric dacite
57	40141A	Tullah; Rosebery Metric Grid 3462E 8610N
		Aphyric dacite
58	44063	Tullah; Rosebery Metric Grid 3845E 5379N
		Vesicular plag-phyric dacite with sparse altered hbd phenos
59	40140	Tullah; Rosebery Metric Grid 3629E 8615N
		Plag+hbd-phyric dacite; hbd altered
60	44041	Tullah; Rosebery Metric Grid 3840E 5382N
		Sparsely plag-phyric dacite
61	HR65	Bradshaws Rd SW of Leach Hill
		Hbd+qtz+plag-phyric dacite; 8% fresh hbd
62	30039A	Tullah; Rosebery Metric Grid 3656E 8625N
		Plag+hbd-phyric dacite; 1% brown hbd phenos
63	44067	Tullah; Rosebery Metric Grid 3845E 5380N
		Plag-phyric dacite
64	LPD11a	Macintosh Rv. bridge over Murchison Hwy
		Plag-phyric dacite
65	44045	Tullah; Rosebery Metric Grid 3851E 5380N
		Plag-phyric dacite
66	HR70	Bradshaws Rd SW of Leach Hill
		Plag+hbd+qtz-phyric dacite; hbd totally chloritized
67	Z488	Zeehan Hwy Franklin 1:100,000 7756E 4451N
		Plag+qtz+biotite-phyric dacite ; mica chloritized
68	30039B	Tullah; Rosebery Metric Grid 3656E 8628N
		Plag+opx-phyric dacite; opx chloritized
69	5017	Leven Gorge
		Spherulitic-textured dacite with sparse plag phenos
70	Y249	Lower Zeehan Hwy; Franklin 1:100,000 7760 4456
		Plag+biotite+qtz+hbd-phyric dacite; mafics altered
71	30050	Tullah; Rosebery Metric Grid 3647E 8567N
		Qtz+plag+biotite-phyric dacite; mica altered
72	30051A	Tullah; Rosebery Metric Grid 3476E 8573N
		Qtz-plag-biotite-phyric dacite
73	Y318	Mid Yolande River; Franklin 1:100,000 7778 4725
		Plag+qtz+biotite-phyric dacite
74	Y549	Davies Hill; Franklin 1:100,000 7784 4695
		Plag+qtz+biotite-phyric dacite

75	38927	Sorrell Peninsula ; Timbertops area Plag-phyric rhyolite
76	Y234	Mid Yolande Rv; Franklin 1:100,000 7752 4725 Plag+qtz+biotite-phyric dacite
77	Y311	Western peak of Davies Hill; Franklin 1:100,000 7846 4531 Plag+qtz+biotite-phyric dacite
78	Y5	Powerhouse track SW of Lake Margaret; Franklin 1:100,000 7863 4755 Plag+qtz+biotite-phyric dacite
79	Y821	Upper Leach Ck. ; Franklin 1:100,000 7820 4886 Plag+qtz+biotite-phyric dacite
80	Z221	Penghana Hill; Franklin 1:100,000 7935 4237 Plag-phyric dacite
81	40136A	Tullah; Rosebery Metric Grid 3595E 8553N Plag+qtz-phyric rhyolite
82	Y4	Powerhouse Track SW of Lake Margaret; Franklin 1:100,000 7872 4759 Plag+qtz+biotite-phyric dacite
83	Y74	Upper Yolande Rv; Franklin 1:100,000 7855 4759 Plag+qtz+biotite-phyric dacite
84	40136	Tullah; Rosebery Metric Grid 3595E 8553N Plag+qtz-phyric rhyolite
85	Y75	Upper Yolande Rv. ; Franklin 1:100,000 7850 4780 Qtz+plag+biotite-phyric dacite
86	Y472	Upper Swan Creek; Franklin 1:100,000 7868 4699 Plag+qtz+biotite-phyric dacite
87	36117	Macintosh River bridge over Murchison Hwy Plag+qtz+biotite-phyric rhyolite
88	LPD6	Lower Pieman Dam Rd. at 33km Plag+qtz-phyric rhyolite
89	42610	Main track at Chester Mine Qtz+plag-phyric rhyolite
90	COL1	Union Track near Mt. Roland Qtz+plag-phyric rhyolite
91	Y354	Yolande Rv tributary; Franklin 1:100,000 7686 4694 Qtz+plag-phyric rhyolite

ALTERED MT. READ VOLCS.

SAMPLE	31733A	540	RM49	5717	922	40758	86	J121	40758A	907
SiO2	52.4	53	53.3	53.6	53.9	54.7	55.1	55.6	55.7	57.8
TiO2	1.2	0.57	0.6	0.55	0.62	1.13	0.74	0.46	1.09	0.66
Al2O3	17.4	13.7	16.6	16.7	15.4	19.8	19.1	17.3	19.2	17.4
Fe2O3	15.2	12.5	10.1	10.4	12.6	13.1	11.4	8.25	12.1	9.2
MnO	0.14	0.12	0.09	0.19	0.09	0.31	0.58	0.15	0.3	0.09
MgO	4.87	8.45	9.37	3.85	7.37	4.83	4.3	7.89	4.67	4.12
CaO	0.87	5.16	2.92	9.53	2.59	0.88	0.29	2.51	0.92	1.51
Na2O	5.57	1.13	2.5	4.96	5.34	3.18	0.31	7.7	4.89	7.39
K2O	2.2	5.31	4.19	0.06	1.89	1.78	8.03	0.02	0.97	1.71
P2O5	0.18	0.08	0.31	0.11	0.17	0.15	0.17	0.06	0.13	0.14
TOTAL	100	100	100	100	100	100	100	100	100	100
LOI	3.17	2.45	4.44	2.03	3.09	4.21	4.54	2.94	3.61	2.58
Ni	17	95	125	35	71	11	20			13
Cr	6	378	295	62	196	9	16			11
V	365	219	284	231	277	334	203			234
Sc	36	36	47	39	40	39	26		52	26
Zr		83		57	59	83	109		81	140
Nb		2.6		3.5	4.2	1.2	6.1		<1	9.4
Y		22		23	18	29	22		29	28
Sr		132		133	73	232	74		170	171
Rb		142		3.1	22	39	259		63	21
Ba	773	1492	2599	57	149	251	2588		423	448
Cu	31	116	59	435	184	8	45			6
Pb	17	3	3	10	8	4	116		4	5
Zn	199	47	61	83	50	284	199			56

SAMPLE	815	5714	DH278.221	34496	3429	31793	3481	40141	3404	5715
SiO2	59.6	60.4	60.7	61.3	63.7	64.1	64.8	65	65.3	65.4
TiO2	0.71	0.62	0.62	0.79	0.37	0.68	0.61	0.69	0.6	0.37
Al2O3	17.1	17.8	17.9	20	15.5	15.6	15.3	15	14.6	15
Fe2O3	7.62	8.13	6.25	3.26	4.92	6.81	6.03	5.58	8.78	5.72
MnO	0.23	0.11	0.18	0.08	0.08	0.18	0.22	0.09	0.5	0.06
MgO	2.88	3.47	1.31	1.59	2.69	3.56	2.48	2.57	1.79	3.61
CaO	1.5	0.83	4.72	2.21	4.09	1.09	2.45	2.58	0.15	3.93
Na2O	6.98	8.14	4.38	10.2	8.09	3.57	2.7	1.62	0	5.27
K2O	3.23	0.38	3.79	0.39	0.38	4.25	5.18	6.69	8.07	0.49
P2O5	0.14	0.13	0.14	0.17	0.17	0.16	0.18	0.11	0.15	0.1
TOTAL	100	100	100	100	100	100	100	100	100	100
LOI	1.79	3.4	5.71	1.31	1.5	2.27	3	1.46	2.24	2.17
Ni	8	4	5	6	18	10	8	9	13	164
Cr	3	9	10	120	64	22	23	49	24	277
V	188	56	99	45	152	131	127	110	120	77
Sc	20		17	10	24	18	15	19	16	13
Zr	186		192	234	124	196	168	215		81
Nb	9.1		12	17	7	15	14	12		10
Y	30		38	28	20	24	26	35		8.6
Sr	77		226	300	423	246	255	151		219
Rb	30		173	9	8	159	182	188		15
Ba	301		755	154	267	1029	1385	1172	2588	130
Cu	<1	<2	10	7	65	119	6	31	2	99
Pb	23	2	42	55	5	51	5	13	37	3
Zn	192	100	64	96	23	140	207	65	425	39

ALTERED MT. READ VOLCS.

SAMPLE	3407	HR70	33527	915	Y788	3527	3504	Y354
SiO2	66.1	67.6	67.9	71.8	71.8	75.1	76.6	80.4
TiO2	0.43	0.44	0.64	0.3	0.34	0.22	0.19	0.21
Al2O3	15.3	16.9	14	14.7	17.2	13	13.5	11.6
Fe2O3	4.22	6.76	5.04	3.34	3.77	3.35	1.2	1.91
MnO	0.07	0.02	0.13	0.09	0.11	0.02	0.02	0.11
MgO	2.68	3.43	1.6	1.14	0.89	0.67	0.18	0.71
CaO	2.88	0.1	6.37	0.12	0.12	0.07	0.06	1.45
Na2O	8.07	1.44	0.64	6.58	0.28	5.01	6	0
K2O	0.07	3.02	3.52	1.88	5.39	2.55	2.25	3.53
P2O5	0.18	0.23	0.15	0.08	0.05	0.02	0.02	0.05
TOTAL	100	100	100	100	100	100	100	100
LOI	0.41	4.28	0.89	1.56	3.5	1.61	0.59	3.59
Ni	20	24	20	10	5	<1	<1	3
Cr	70	64	87	10	14	4	2	9
V	95	177	112	39	32	8	8	29
Sc	22	26	20	7	11	10	6	
Zr	141	155	250	172	259	215	198	148
Nb	8	7.1	15	13	61	21	20	12
Y	18	27	39	16	24	42	28	63
Sr	493	94	157	49	1002	110	105	27
Rb	<1	105	185	51	16	52	47	162
Ba	1513	747	1005	563	1012	962	525	
Cu	37	6	7	22	2	3	4	
Pb	22	14	35	12	6	7	5	
Zn	22	112	88	129	41	31	4	

ALTERED MOUNT READ VOLCANICS: LOCATIONS AND PETROGRAPHY

31733A	Great Lyell area
	Basalt with altd. plag
540	Sorrell Peninsula; AMOCO traverse 800m S of Warrens Helipad
	Cpx+plag-phyric basaltic andesite; plag totally seicitized
RM49	Lynch Ck., S of Queenstown
	Slightly sheared basaltic andesite with fresh cpx phenos, seric. plag phenos
5717	Quamby Brook
	Basaltic andesite with 5% fresh cpx phenos and 20% albitized plag phenos
922	Sorrell Peninsula; Timbertops area
	Hbd diorite; albitized plag and altered hbd
40758	Dallwitz Prospect
	Aphyric, quench-textured lava with albitized plagioclase
86	Sorrell Peninsula; AMOCO Hibbs Rv. traverse
	Aphyric andesite; sericitized glassy gmass
J121	Coast N of Elliot Bay near Veridian Point
	Slightly sheared andesite with albitized plag and gmass glass
40758A	Dallwitz Prospect
	Aphyric, quench-textured andesite
907	Sorrell Peninsula; Macquarie Harbour 1:250,000 6806 9600
	Pilotaxitic textuerd aphyric andesite with albitized plag
815	Sorrell Peninsula; Macquarie Harbour 1:250,000 667 950
	Pilotaxitic-textured hbd andesite with albitized plag phenos
5714	Deloraine-Quamby Brook area
	Plag+qtz-phyric andesite with albitized plag phenos and gmass
DH278.221	CSR Boco Prospect Drillhole 278 at 221m
	Andesite with seric. alteration of plag
34496	Hercules Drillhole 710 ; depth unknown
	Plag pheno rich andesite; all plag albitized
3429	1.5km N of Boulder Hill
	Hbd+plag-phyric andesite with sparse cpx phenos; albitized plag
31793	RB Road, Williamsford (?)
	Plag+biotite+hbd-phyric dacite; plag sericitized, mafics altered
3481	W of Lake Dora (?)
	Plag+biotite+qtz-phyric dacite; plag and mica sericitized

40141	Tullah; Rosebery Metric Grid 3480E 5382N Sparsely plag-phyric dacite; all plag albitize
3404	Lake Dora, S end , W side (?) Plag+hbd-phyric dacite; all plag albitized
5715	Quamby Brook Slightly sheared plag-phyric dacite
3407	1km N of Boulder Hill Plag+hbd-phyric dacite; all plag albitized; hbd altered
HR70	Bradshaws Rd SW of Leach Hill Plag+hbd+qtz-phyric dacite; hbd altered; plag albitized
33527	Bull Ck. Volcanics; Lorinna Rd. Qtz+plag-phyric rhyolite
915	Sorrell Peninsula ; Macquarie Harbour 6792 9610 Qtz+plag+biotite-phyric dacite; plag all albitized
Y788	Truscott Ck., Franklin 1:100,000 7756 4451 Qtz+plag+hbd-phyric dacite; plag and mica sericitized
3527	Red Hills Plag+qtz-phyric rhyolite; all plag albitized
3504	1.5km W of Lake Julia Qtz+plag-phyric rhyolite; all plag albitized
Y354	Lower Yolande Rv; Franklin 1:100,000 7686 4694 Qtz+plag-phyric rhyolite; silicified gmass