MIM EXPLORATION PTY. LTD.

HALO PROJECT

(1990 - 1991)

Tech Memo 1991/008

GENERALISED AND IDEALISED LONG AND CROSS SECTIONAL SUMMARIES OF MOUNT ISA MINE

& associated technical memoranda

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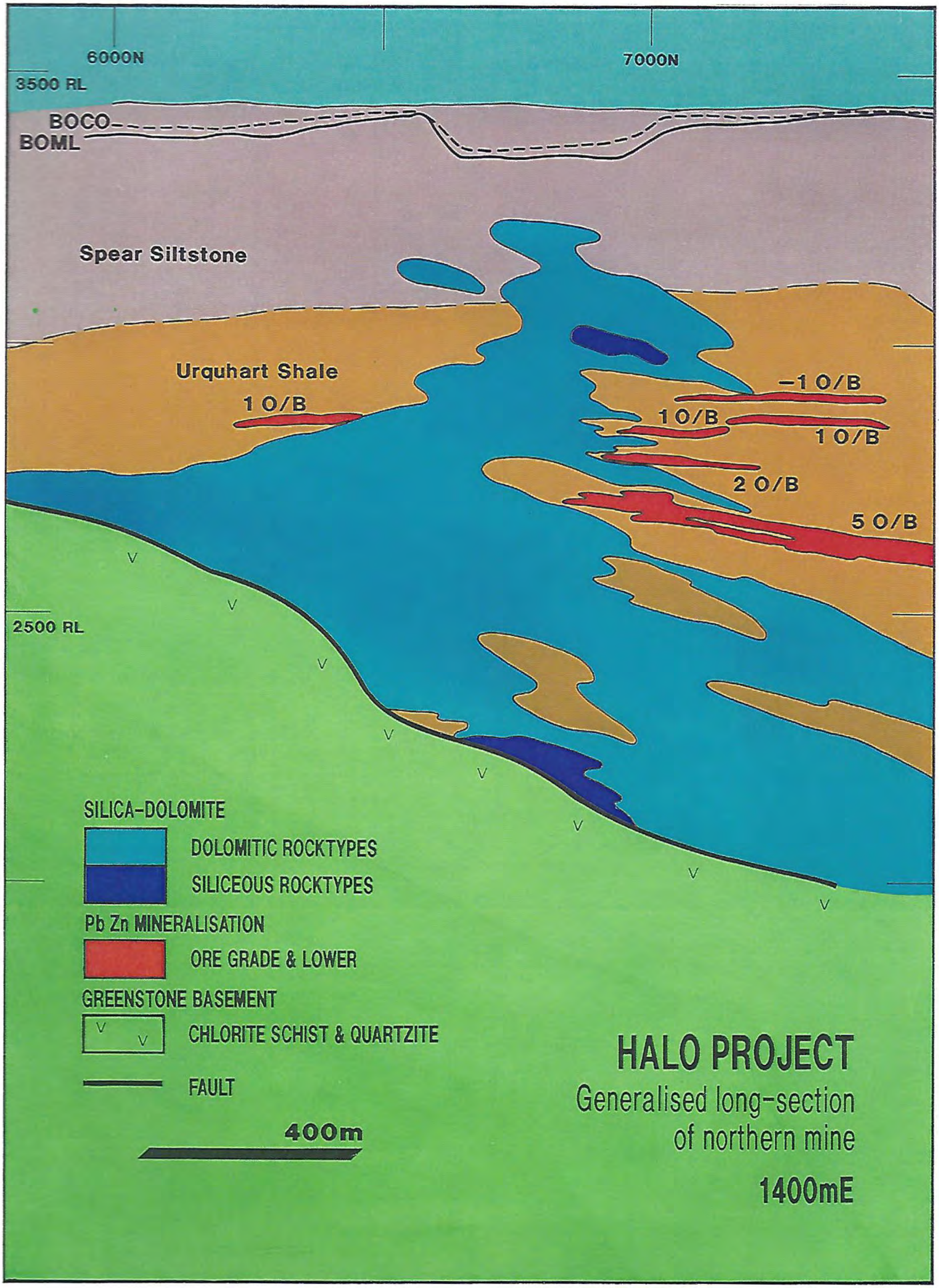
D.J. Hutton
W.G. Perkins

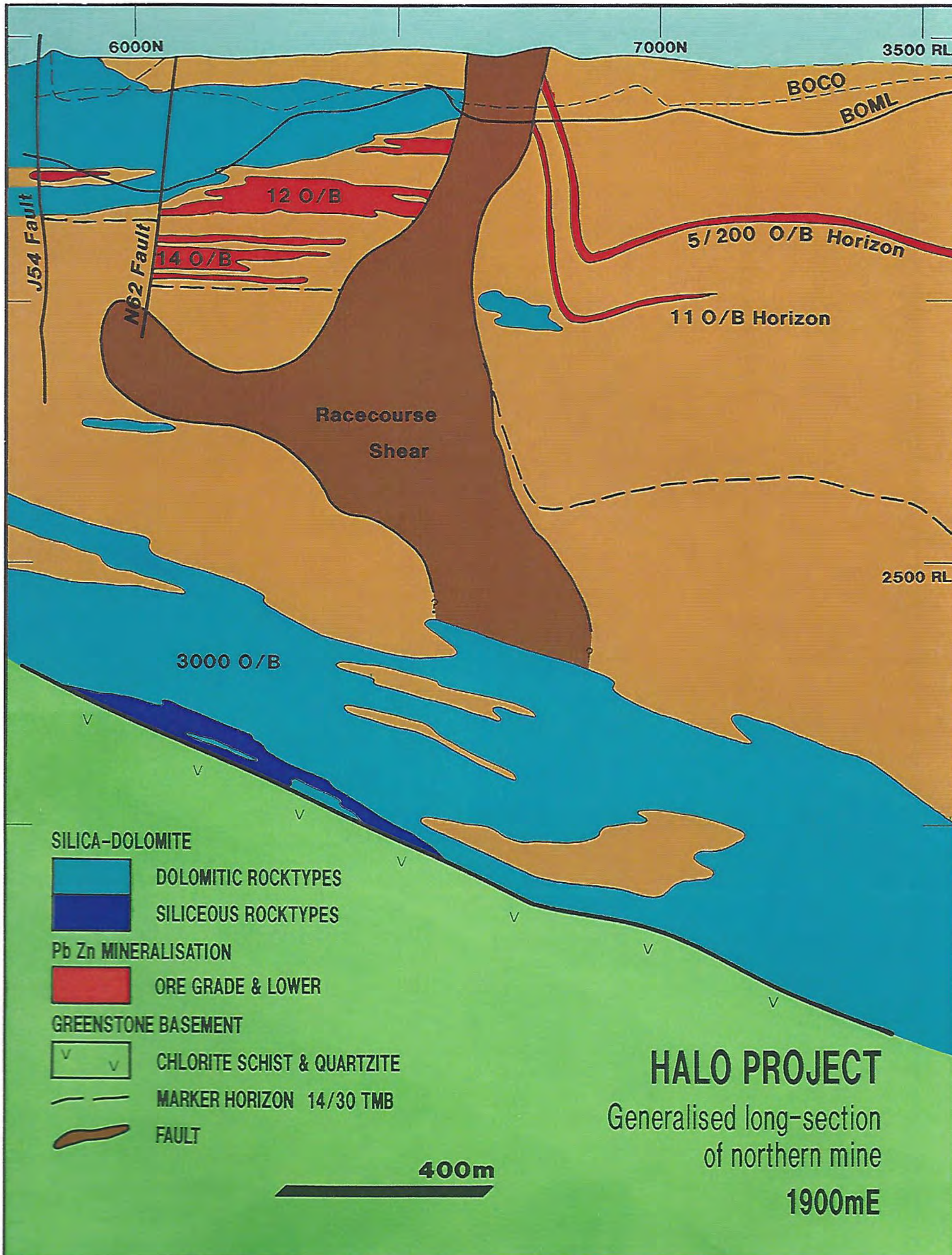
Contents:–

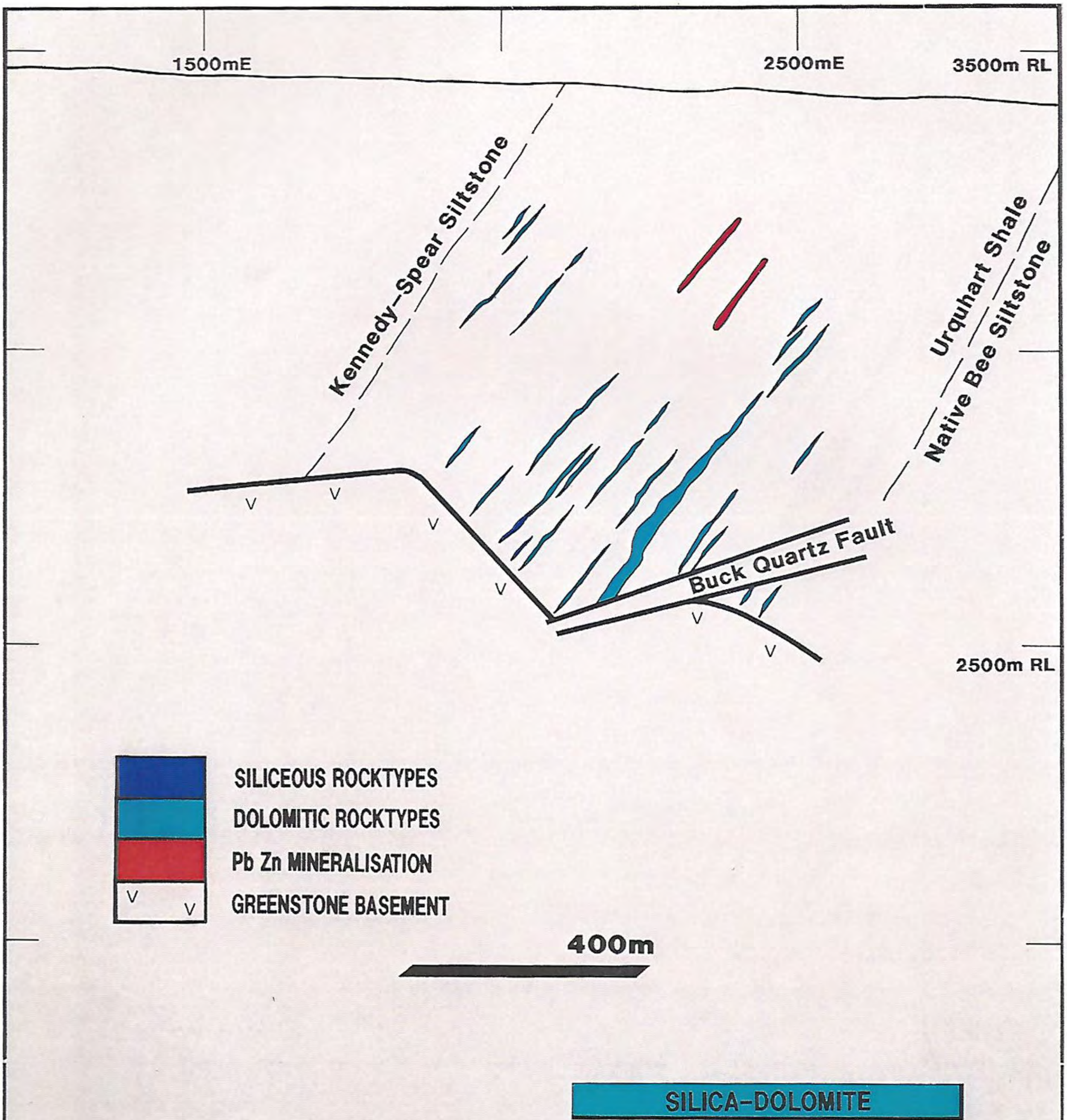
Note:–

- These summaries do not attempt to portray timing relationships between the different halo elements, or between halo elements and the Pb–Zn and Cu orebodies.

- The angular relationships between bedding and some elements of the halo may be distorted in places; these are artifacts introduced during compilation by the use of off–section drill holes (e.g. fine–grained pyrite horizons do not *actually* transgress the Urquhart Shale/Spear Siltstone contact at 4200mN)

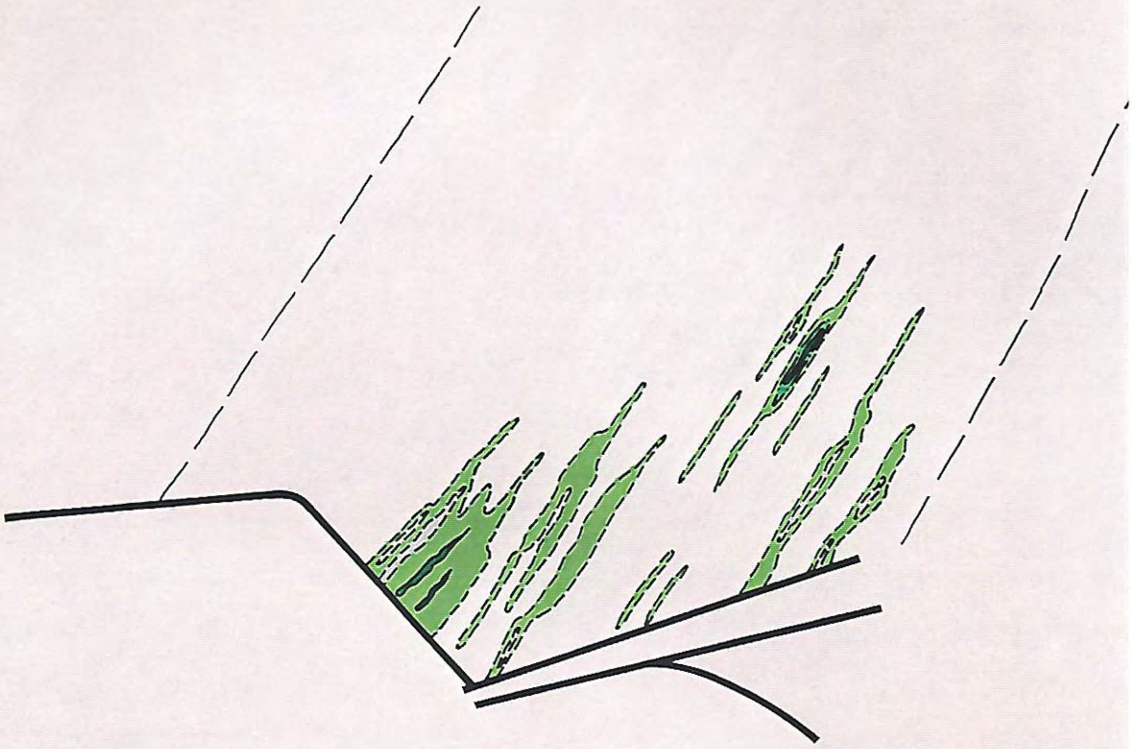

6000N
7000N
3500 RL
BOCO
BOML
Spear Siltstone
Urquhart Shale
1 O/B
-1 O/B
1 O/B
1 O/B
2 O/B
5 O/B
2500 RL
SILICA-DOLOMITE
DOLOMITIC ROCKTYPES
SILICEOUS ROCKTYPES
Pb Zn MINERALISATION
ORE GRADE & LOWER
GREENSTONE BASEMENT
CHLORITE SCHIST & QUARTZITE
FAULT
400m
HALO PROJECT
Generalised long-section
of northern mine
1400mE


6000N
7000N
3500 RL
BOCO
BOML
12 O/B
14 O/B
J54 Fault
N62 Fault
5/200 O/B Horizon
11 O/B Horizon
Racecourse
Shear
2500 RL
3000 O/B
SILICA-DOLOMITE
DOLOMITIC ROCKTYPES
SILICEOUS ROCKTYPES
Pb Zn MINERALISATION
ORE GRADE & LOWER
GREENSTONE BASEMENT
CHLORITE SCHIST & QUARTZITE
MARKER HORIZON 14/30 TMB
FAULT
400m
HALO PROJECT
Generalised long-section
of northern mine
1900mE

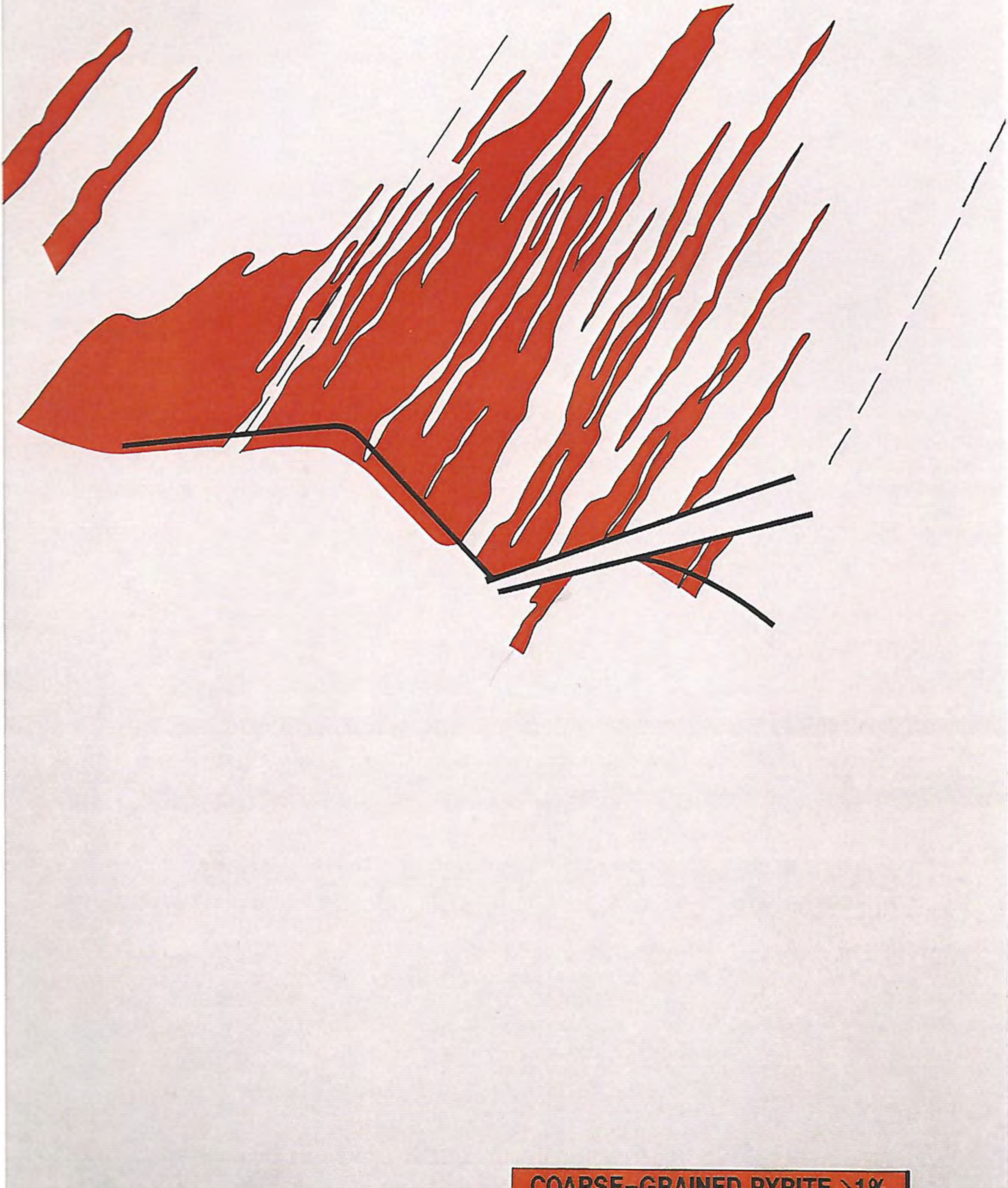


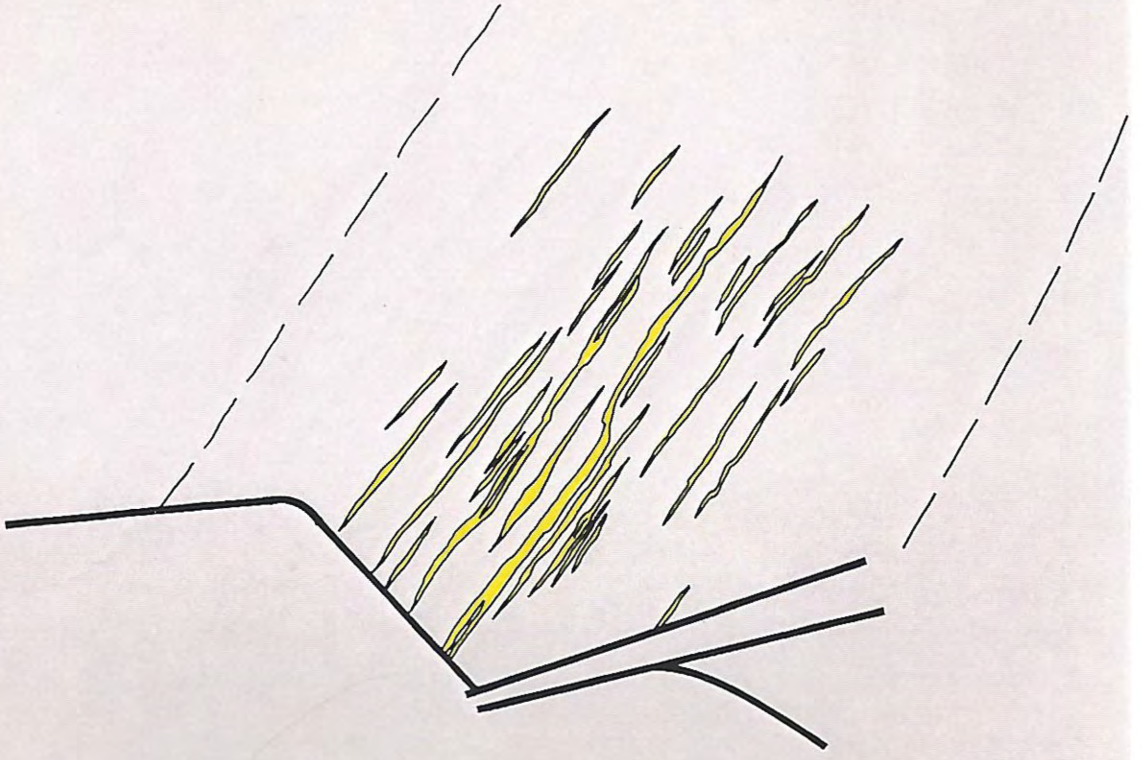
HALO PROJECT

Idealised section ~2500N

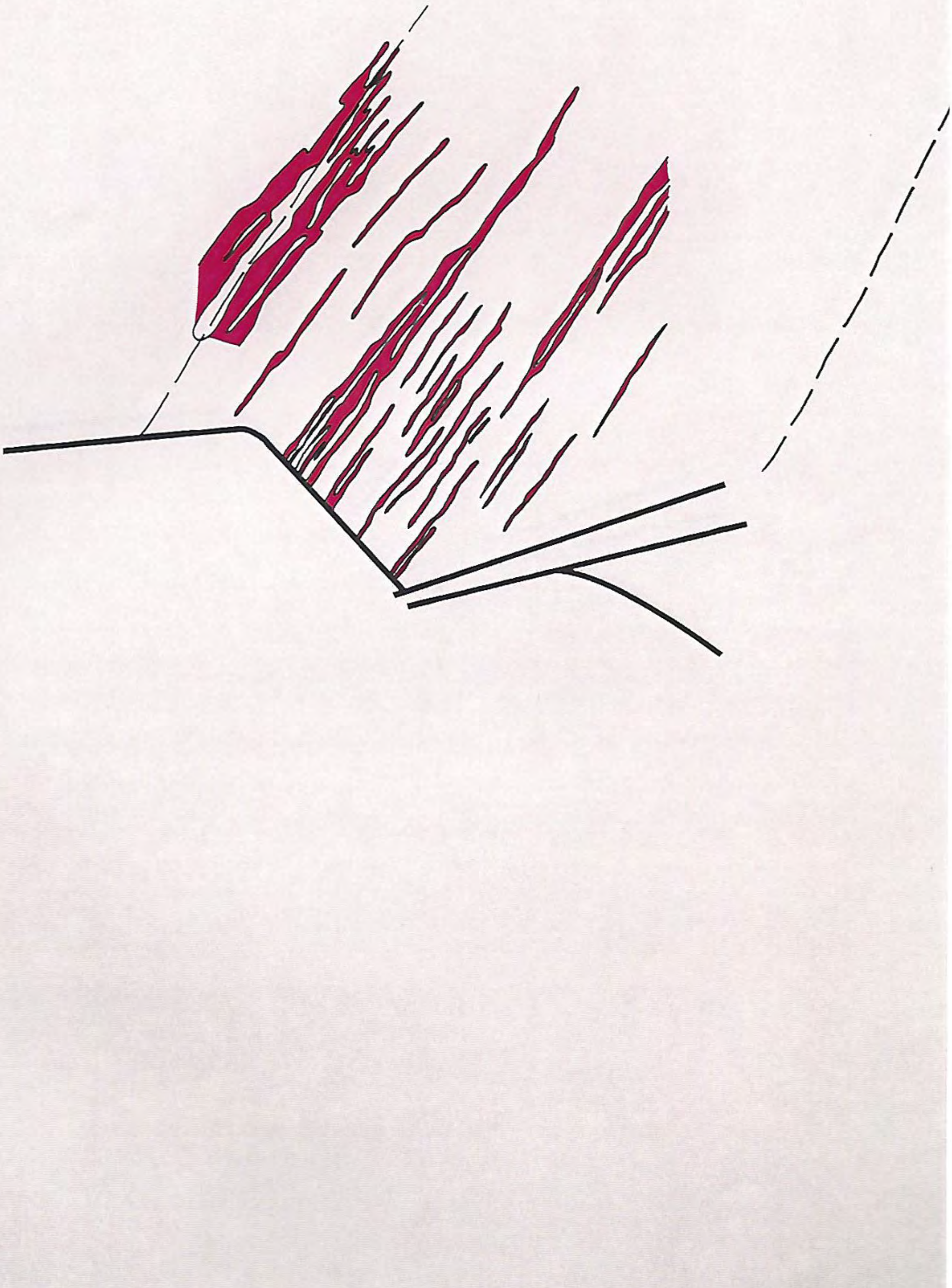


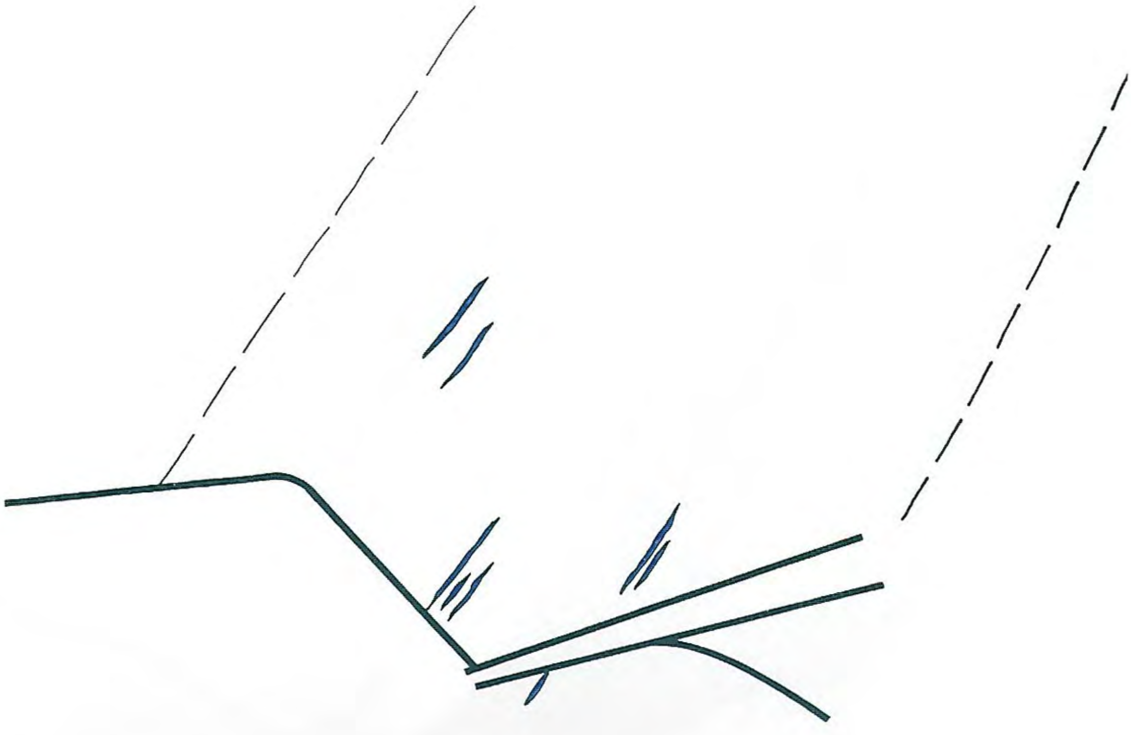
COPPER CONTOURS


COARSE–GRAINED PYRITE >1%

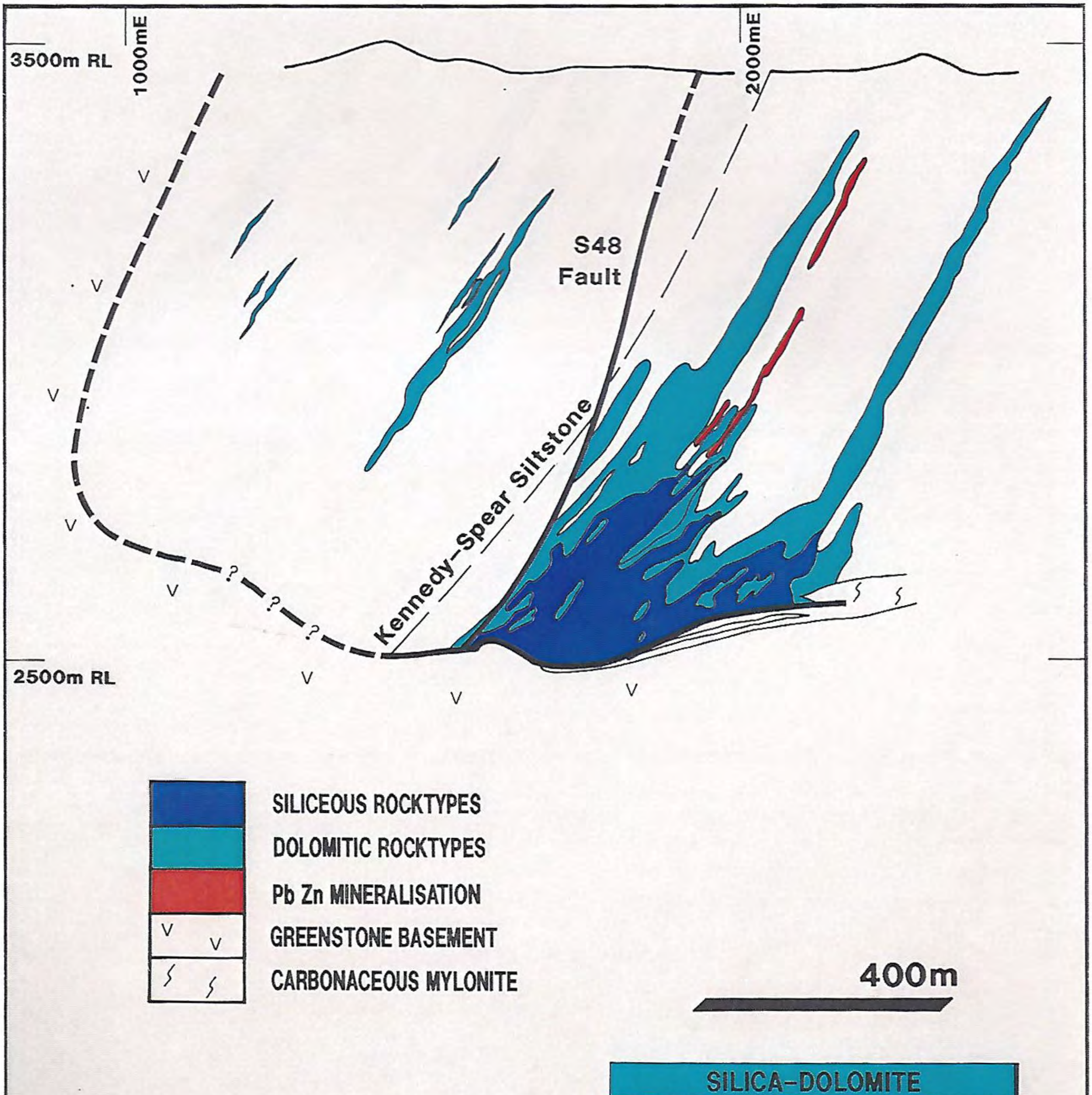


FINE-GRAINED PYRITE ≫20%


PYRRHOTITE

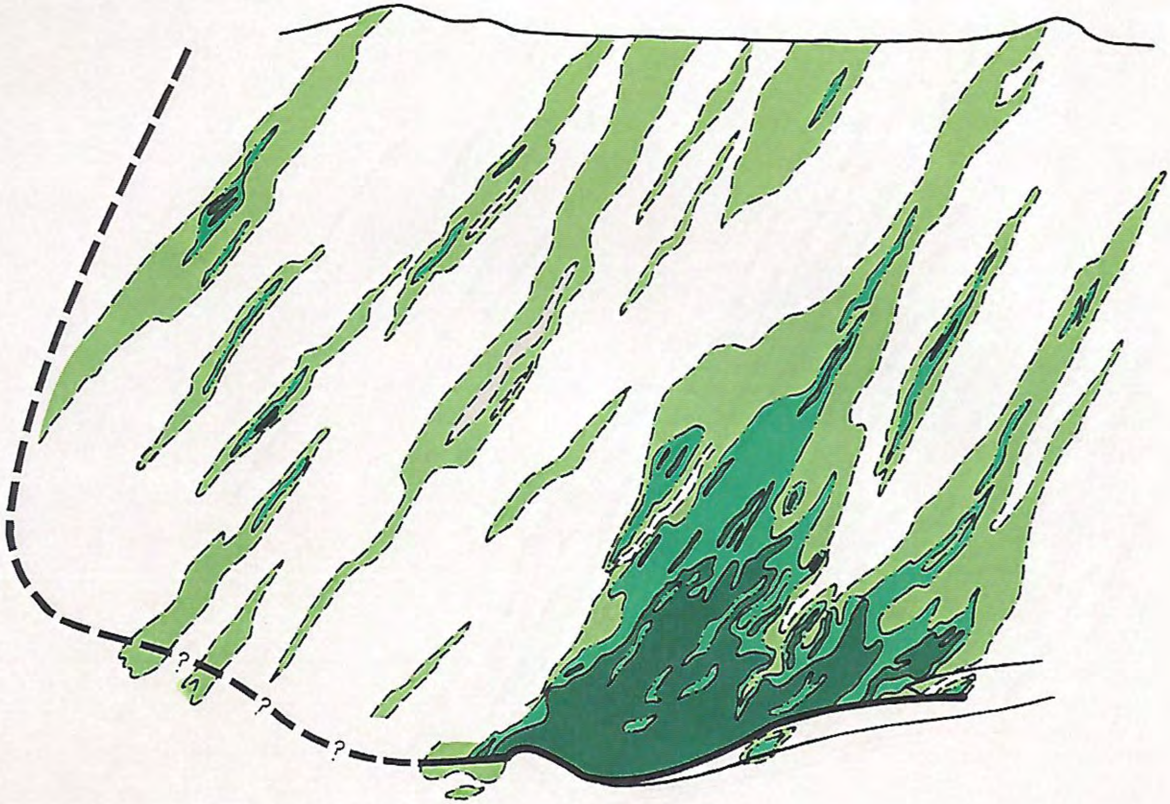


TALC



HALO PROJECT

Idealised section 4200N

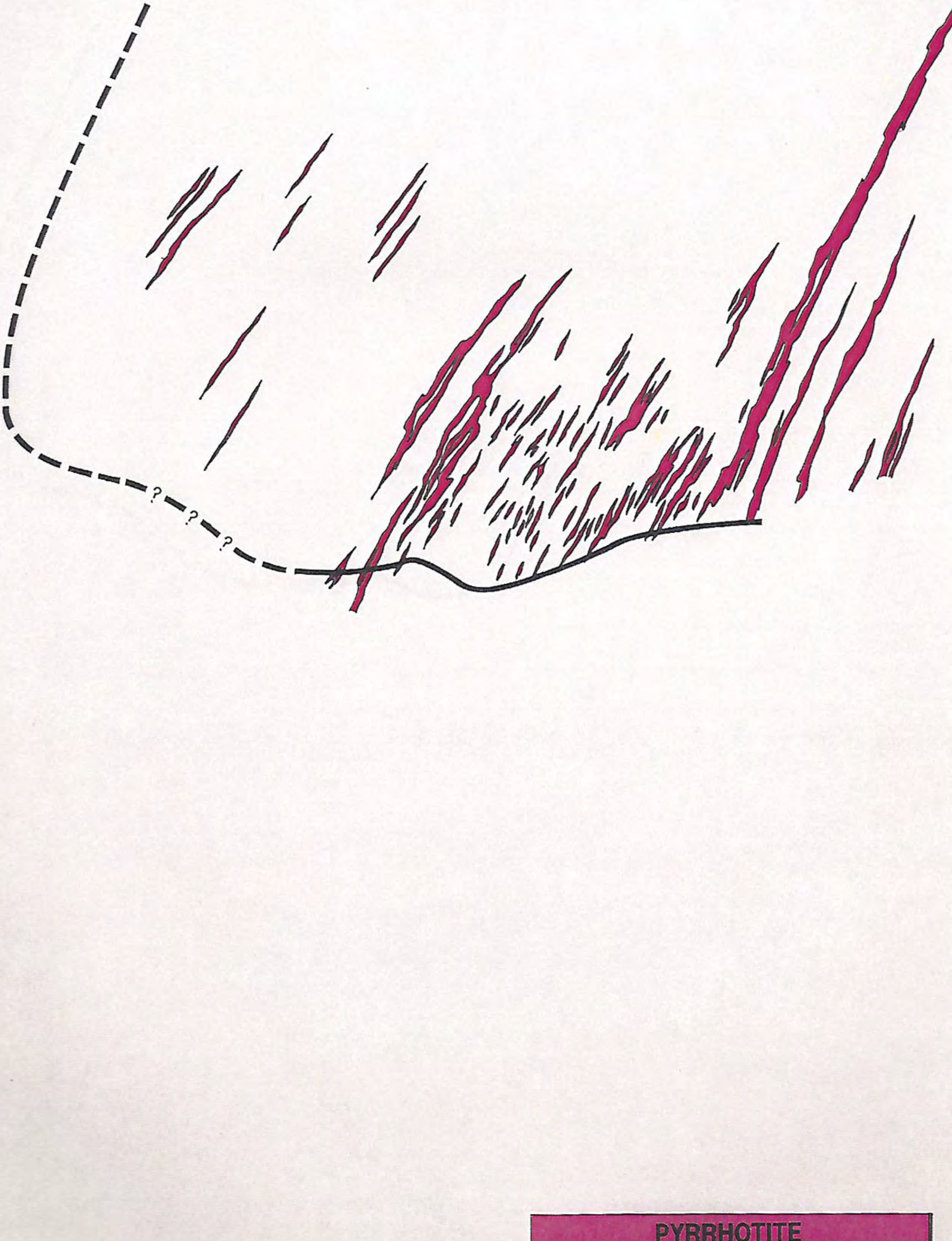


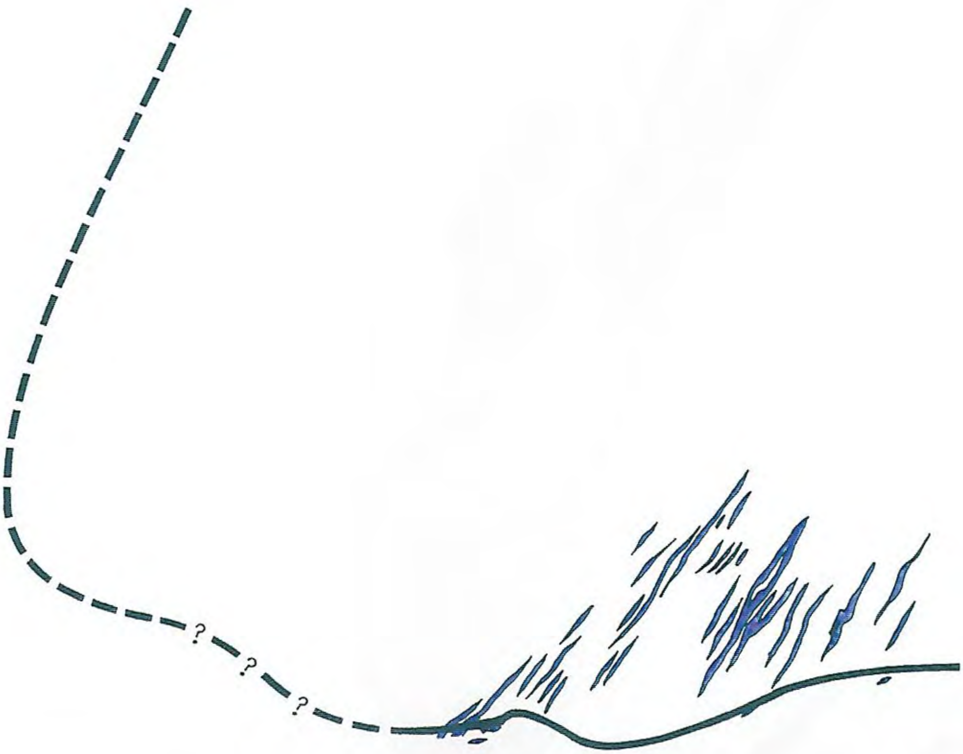
COPPER CONTOURS

0·1
0·5
1·0%

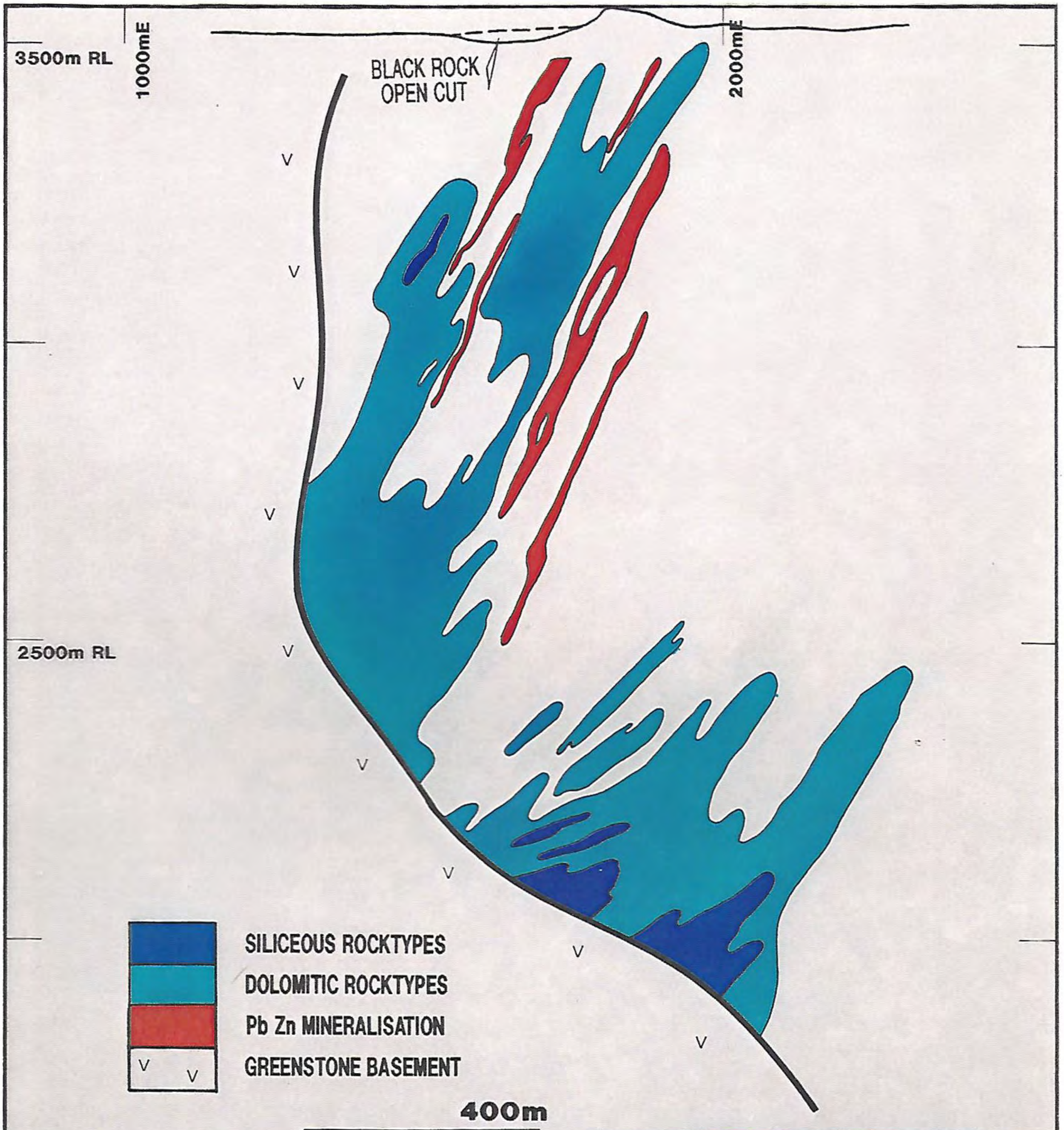

COARSE-GRAINED PYRITE >1%

?
?
?
FINE-GRAINED PYRITE ≥20%


PYRRHOTITE



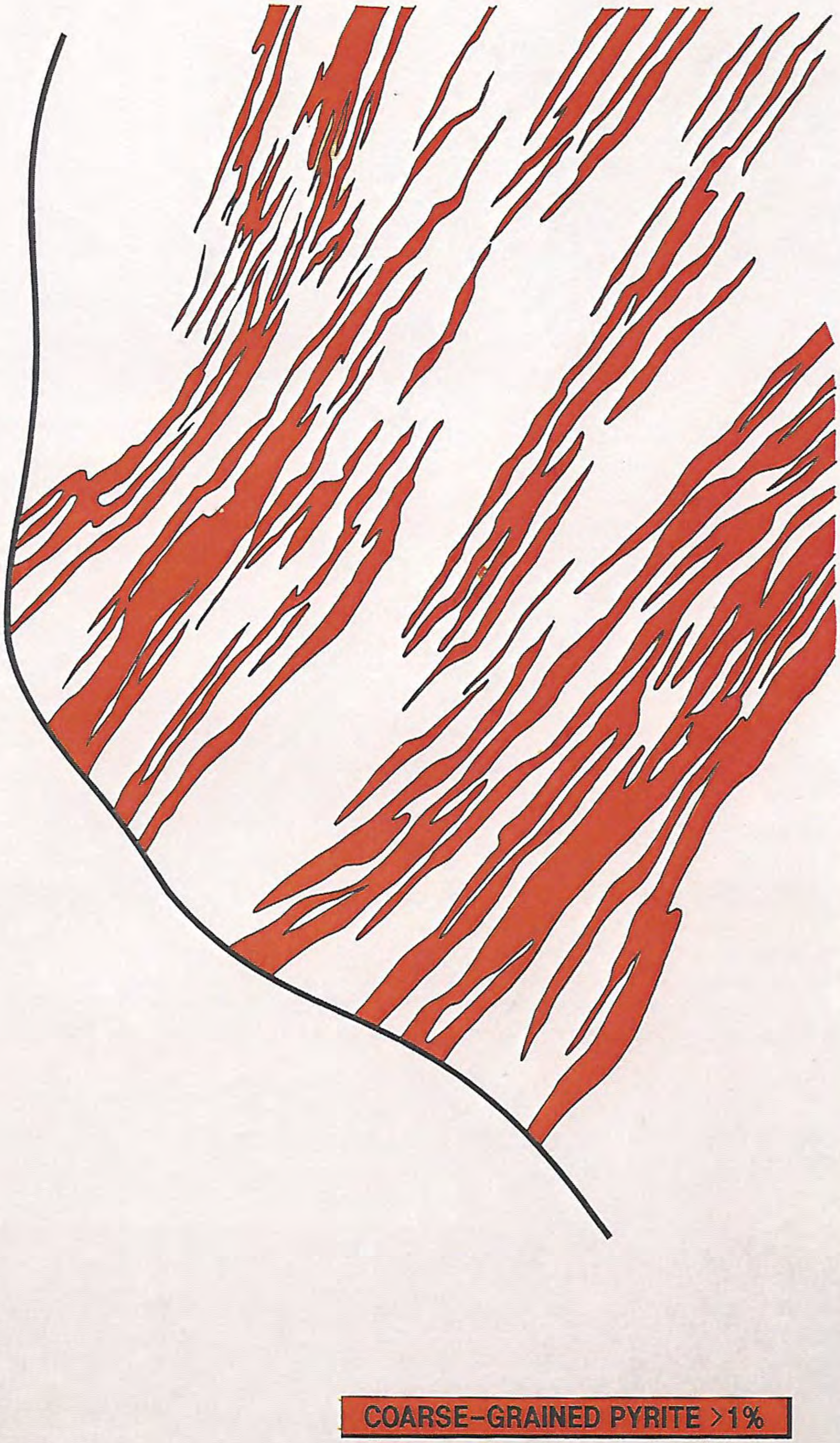
TALC



HALO PROJECT

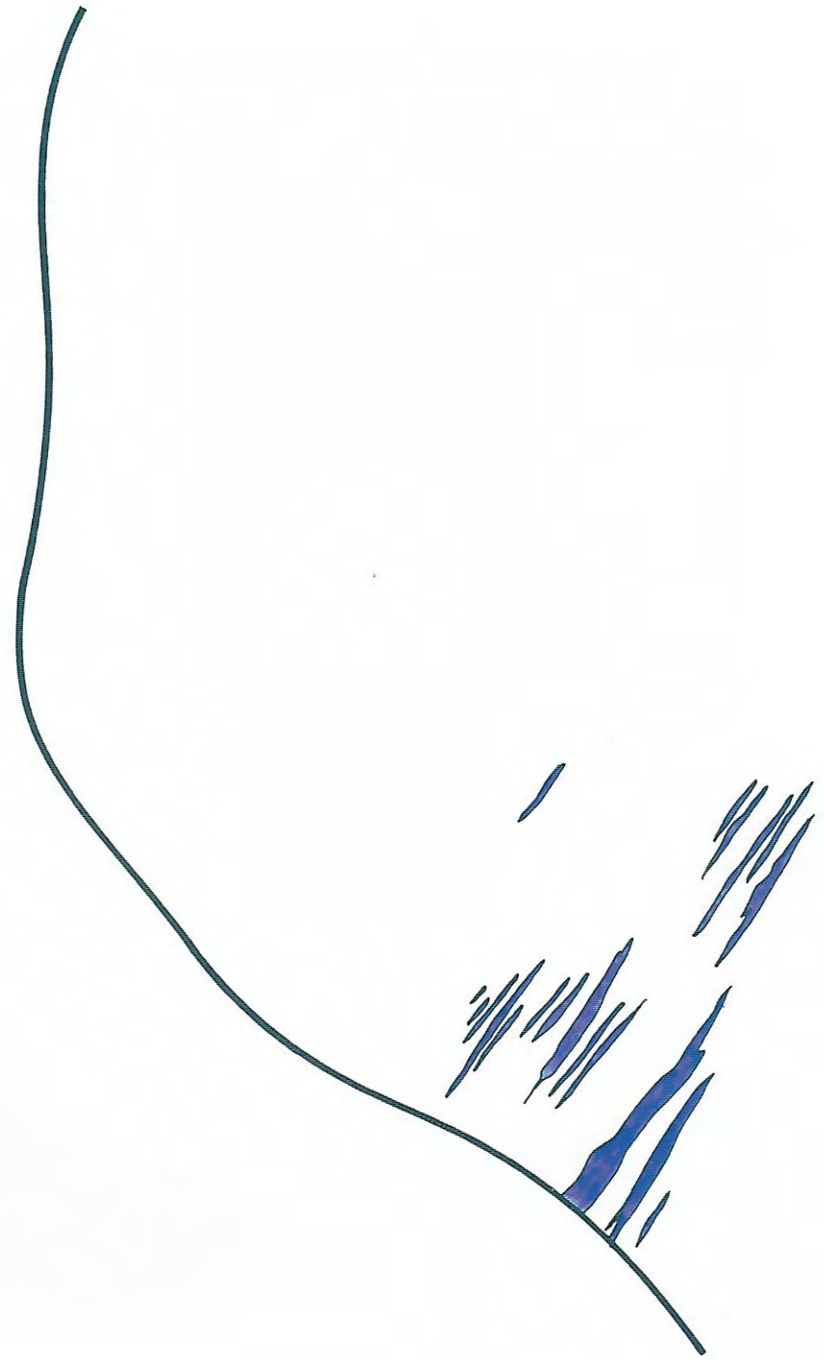
Generalised northern mine section

COPPER CONTOURS


COARSE-GRAINED PYRITE >1%

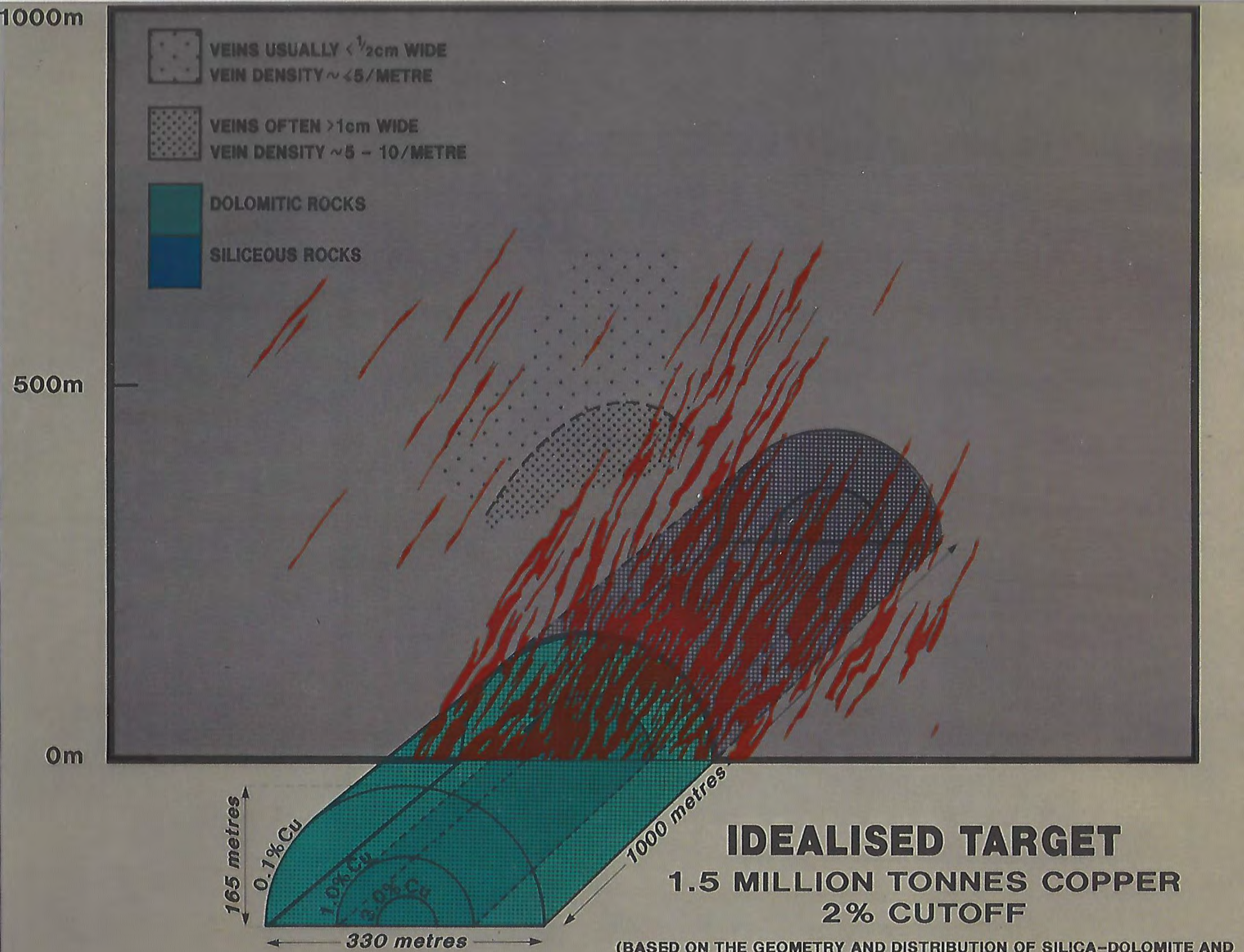

FINE-GRAINED PYRITE >20%

PYRRHOTITE



TALC

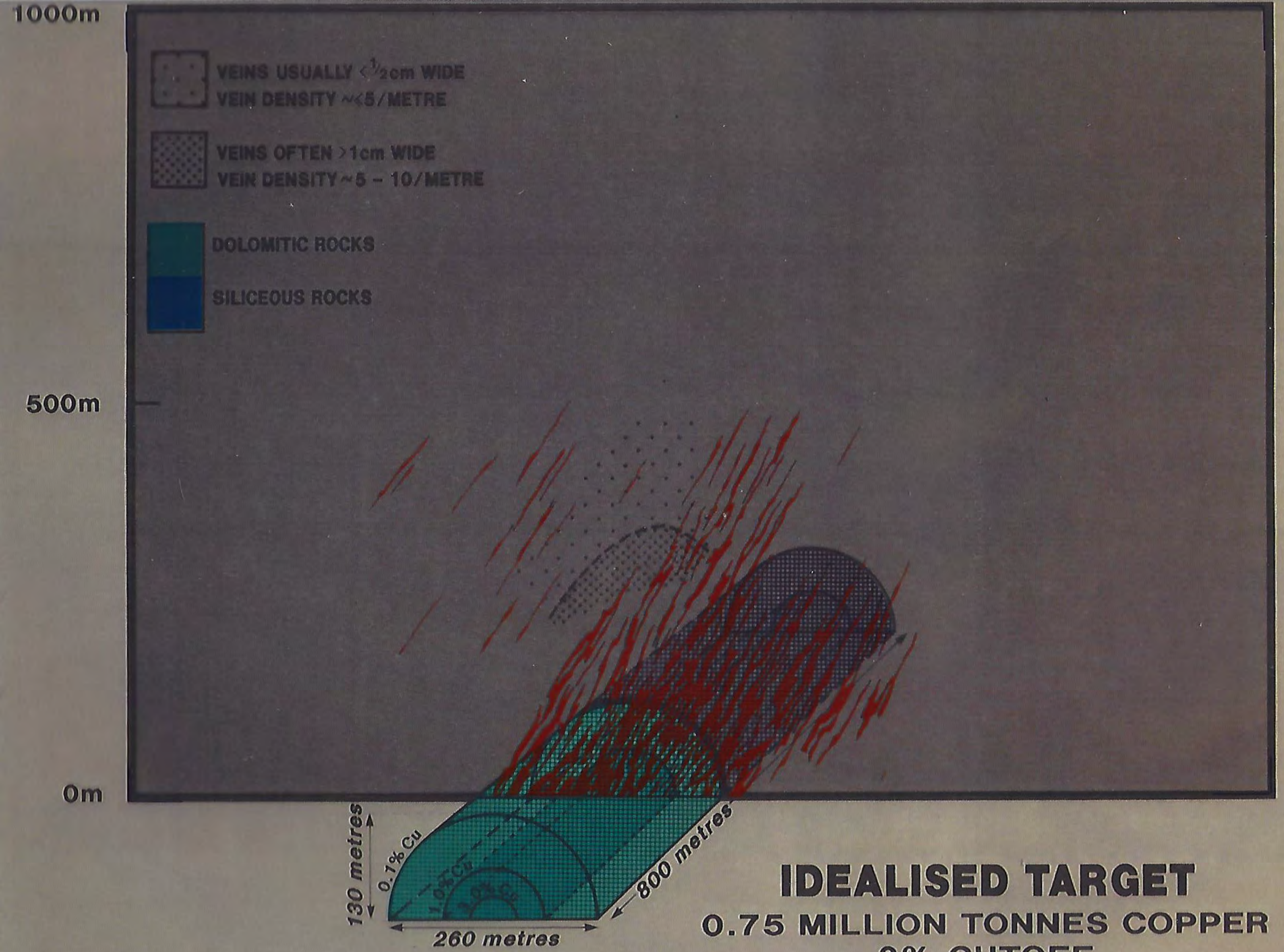

1000m
500m
0m
VEINS USUALLY < 1/2cm WIDE
VEIN DENSITY
~ ≤5/METRE
VEINS OFTEN >1cm WIDE
VEIN DENSITY
~ 5 - 10/METRE
DOLOMITIC ROCKS
SILICEOUS ROCKS
250 metres
1500 metres
0.1% Cu
1.0% Cu
3.0% Cu
IDEALISED TARGET
5.2 MILLION TONNES COPPER
2% CUTOFF
(BASED ON THE GEOMETRY AND DISTRIBUTION OF SILICA-DOLOMITE AND
COPPER ASSOCIATED WITH THE MOUNT ISA 1100 OREBODY)



IDEALISED TARGET

1.5 MILLION TONNES COPPER
2% CUTOFF

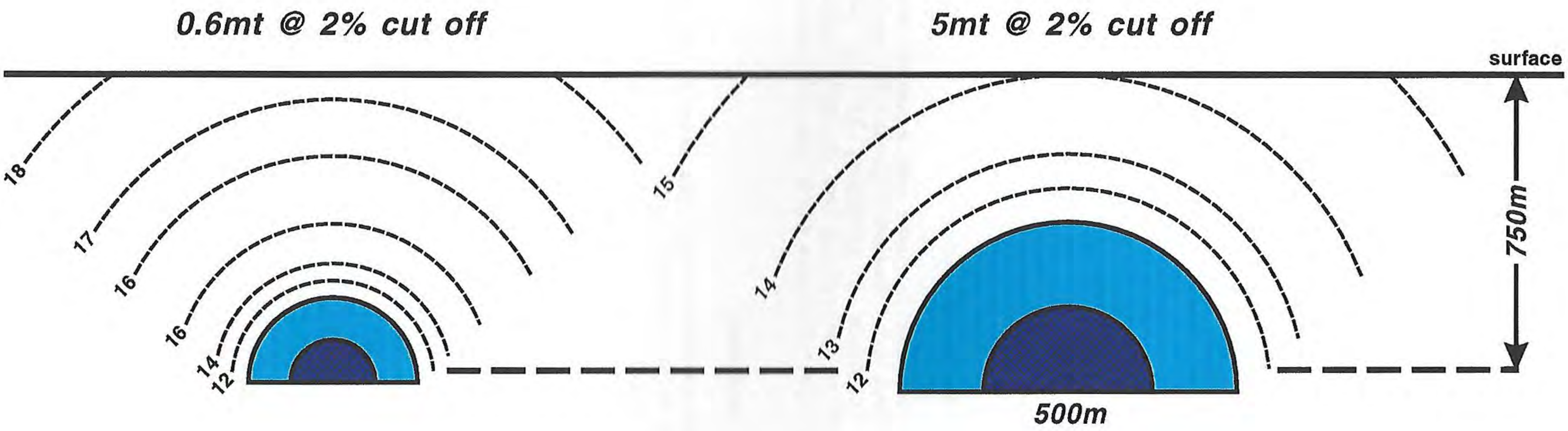
(BASED ON THE GEOMETRY AND DISTRIBUTION OF SILICA–DOLOMITE AND COPPER ASSOCIATED WITH THE MOUNT ISA 1100 OREBODY)



IDEALISED TARGET

0.75 MILLION TONNES COPPER 2% CUTOFF

(BASED ON THE GEOMETRY AND DISTRIBUTION OF SILICA–DOLOMITE AND COPPER ASSOCIATED WITH THE MOUNT ISA 1100 OREBODY)



IDEALISED CROSS-SECTIONAL VIEW OF $\delta^{18}O$ CONTOURS ABOUT TWO MOUNT ISA STYLE Cu OREBODIES

M.I.M. Exploration Pty. Ltd.

FILE NOTE

FROM : PROJECT GEOLOGIST-TARGET GENERATION REFERENCE : KWH/5.4/EXP1.0
TO : PRINCIPAL GEOLOGIST-TARGET GENERATION DATE : June 27, 1991

TITLE : PICTORIAL REPRESENTATION OF THE MOUNT ISA CU-ORE HALO
SUBJECT : SUMMARY OF THE HALO PROJECT

Introduction

This note presents the results, conclusions and brief discussion, where appropriate, of the Halo Project. The project was initiated in early 1990, with the aim of producing a pictorial description of the textural, mineralogic, chemical and geophysical attributes of the silica-dolomite *and its environs*, for use in the search for more Mount Isa-style copper resources.

Results

The description takes the form of a series of manually and computer-generated, *semi-interpretative*, cross-sections which depict the spatial relationships between mineralogic, textural, rocktype, and, to some extent, chemical features beyond areas of high-grade copper mineralisation.

Components of the description include:

(i) an idealised northern Mine cross section, at 1:2500, which is a summarisation of sections, at 8 northings between 5800 and 7200mN, compiled by Dave Hutton during 1990;

(ii) a generalised cross section at 4200mN (± 200m) which corresponds, approximately, to the high-grade 'centre' of the 1100 orebody;

(iii) a generalised cross section at 2500mN (± 500m) which corresponds to the southern periphery of the 1100 orebody;

(iv) two long sections through the northern Mine at 1400mE and 1900mE (1:2500);

(v) a 2D projection of an idealised 1100 orebody, with Cu contours, Fe-sulphide halo and vein intensities, at 3 scales corresponding to resources of 5, 1.5 and 0.75 million tonnes of Cu at 2% cutoff; and

(vi) dolomite $\delta^{18}O$ contours as overlays for the 4200mN and 2500mN sections (produced, in a preliminary format, by Chris Waring).

Incomplete, but 'in progress' aspects of the project include:

(a) a geophysical/rock property depiction (*e.g.*, magnetic susceptibility, conductivity, density); and

(b) a depiction of lithochemical zonations (work on this may proceed later in 1991, also refer to Hannan, 1991a).

Conclusions

(1) The Mount Isa base-metal ore system seems to be surrounded by a large 'halo' of anomalous Fe-sulphide (coarse-grained pyrite at >1% and/or pyrrhotite at >1%). However, like anomalous Tl and K distributions, the extent of, and controls on, the Fe-sulphide anomaly are not yet fully understood.

(2) As a corollary to conclusion 1, anomalous Fe-sulphide, Tl, and K, and ferroan dolomite, constitute a set of halo attributes which may be more useful for the assessment of poorly explored ground at a sub-basin to basin scale rather than for the assessment of prospects *within* a previously identified anomalous area.

(3) There seems to be non-systematic changes in the relative proportions of coarse-grained pyrite and pyrrhotite, and non-systematic changes in the absolute abundances of these sulphides, from south to north, in the hangingwall of the ore system; this observation illustrates the schematic nature of the halo depiction, the limitations of the database used to construct the generalised cross sections, and therefore the limitations of the model as a predictive tool.

(4) As a corollary to conclusion 3, it is not possible to relate single components of the halo, on the basis of variations in spatial distribution at the Mine scale, to distinct features of the ore system (*e.g.*, pyrrhotite distributions and abundances relative to the volume of silica-dolomite; or volume of pyritic shale relative to silica-dolomite at a given northing).

(5) It is possible, either in the halo, or within massive hydrothermal dolomite associated with a Mount Isa-style Cu resource, to drill hundreds of metres at less than 0.5 wt% Cu.

(6) Fine-grained pyritic shale 'ribs' were not selectively 'avoided', or left unaffected, by the silica-dolomitisation process.

(7) Continual up-grading of our knowledge of the halo will help us refine exploration models, particularly for Mount Isa-style copper resources. Upgrading will require *halo-style* logging of district and regional, as well as Mine exploration drill core.

Recommendations

(1) There is a gap in the set of halo cross sections between 4200mN and 5700mN which could be filled to provide more information about pyrrhotite, fine-grained pyrite and talc distributions and abundances throughout the Mine. Sections at 5353mN (already started) and about 4700mN are recommended, and could be compiled by Mine geologists.

(2) Some attempt must be made to define the limits (or gradient) of the *interpreted* Fe-sulphide halo. To this end, diamond drill core from between Lena and Crystallena in the south, and between Leichhardt King and Hilton in the north, should be examined for Fe-sulphide abundances and distributions, and perhaps other halo attributes (*e.g.*, vein intensities, fine-grained pyrite, Tl and K abundances). The question is whether the problem should be tackled fulltime or piecemeal by Company personnel, or, handed over to a post-graduate student as part of a larger project to, say, assess and integrate the findings of research projects in the last ten years.

(3) As a general comment, the Mine logging system was satisfactory for the Halo Project. It is recommended, however, that Mine geologists continue to note carefully the abundances of the different Fe-sulphides outside areas of silica-dolomite. It is also suggested that more use be made of columns 68 and 69 (veins) of the logging sheets, particularly for core distal to silica-dolomite. Weak, moderate, and strong veining (column 68), for example, should be *formally* associated with definite intensities (*e.g.*, <2/metre, 2-10/metre, >10/metre).

Discussion

Fe-sulphide

Mine sequence rocks peripheral to the silica-dolomite system seem to contain anomalous quantities of Fe-sulphide, either as coarse-grained pyrite (>1%) and/or pyrrhotite (>1%). In detail, Fe-sulphide-anomalous rock occurs as broadly stratabound, bifurcating and interdigitating lenses. Throughout the Mine, the coarse-grained pyrite component of the sulphide halo generally extends to the surface, as does the pyrrhotite component except in the southern part of the Mine, where it terminates 100-250m below the surface (2500mN section).

The across-strike extent of the pyrrhotite and coarse-grained pyrite halo components are almost identical and almost coincide with the outer limit of the silica-dolomite mass (>1100m northern Mine and ≈750m southern Mine). Thus, the Fe-sulphide halo appears to contract slightly in the southern part of the Mine, althought it persists at proportionately larger volumes than silica-dolomite at 2500mN.

In the southern part of the Mine, inferred anomalous coarse-grained pyrite (*i.e.*, >1%) extends both to the east and west of the copper ore system, *viz.*, the Kennedy-Spear Siltstone and Native Bee Siltstone, respectively. To the east, the Kennedy-Spear siltstone also features, in contrast to the Native Bee Siltstone, considerable volumes of rock which has been defined as pyrrhotite-anomalous (*i.e.*, po>1%). There also seems to be variations in the size of the pyrrhotite halo along strike. For example, the Hutton sections show a distinct southward decrease in the volume of pyrrhotite-anomalous rock between 6500 and 6200mN. This decrease seems to coincide with a shrinking volume of Pb-Zn mineralised rock. However, the pyrrhotite abundances increase again further south (refer 4200mN section).

Finally, it is stressed that the Fe-sulphide halo has not been `closed off´ in the north-south direction, particularly the coarse-grained pyrite component, and that Urquhart Shale may be similarly sulphidised for kilometres, along strike, beyond the ore system (see recommendations).

Fine-grained (bedded) pyrite

See also Hutton (1991), and note that fine-grained pyritic shale is treated in this project as intervals of cored shale containing bands of visibly massive fine-grained pyrite that constitute, by area, ≥20% of that interval.

The so-called `pyrite rib´ extends well into the silica-dolomite mass and, indeed, its siliceous core at 4200mN. That is, fine-grained pyritic shale and silica-dolomite are not mutually exclusive in space. This fact. and the abundant evidence of dolomitisation (*i.e.*, replacement) of pyritic shale throughout the Mine. and also the presence of pyritic shale remnants in the siliceous core contradicts the notion that the silica-dolomitisation process somehow avoided, or left unaffected, earlier-formed pyritic shale 'ribs'.

Although the total volume of fine-grained pyritic shale decreases southward, the decrease is proportionately much less than the southward decrease in silica-dolomite volumes (compare the 4200mN and 2500mN sections). That is, there is not a simple *proportionate* correlation between presently observed volumes of pyritic shale and silica-dolomite and, therefore, Cu mineralisation.

Silica-dolomite

The silica-dolomite system extends for up to 4 km along strike, as much as 1 km up-dip, and is up to 1 km wide in places. It is essentially a zoned-replacement and vein-network system that consists of a high-grade copper and siliceous core surrounded by grossly stratabound lobes of dolomite-replaced, brecciated and veined Urquhart Shale (see also Perkins, 1984).

The shape of the silica-dolomite mass is highly variable (compare the northern and 4200mN sections) and its outer boundary with metasediment can be sharp (*e.g.*, footwall of the 3500 Cu orebody) or transitional, as it is in the hangingwall of the 1100 orebody where sporadic dolomitisation and low-grade Cu mineralisation occurs in the Kennedy-Spear Siltstone (*e.g.*, 4200mN section).

It seems that it may be possible, in the search for Mount Isa-style Cu resources, to drill from visibly unmineralised and poorly veined metasediment into massive hydrothermal dolomite adjacent to high-grade Cu mineralisation, without passing through a transitional zone of low intensity dolomitisation, or veining, and associated low-grade Cu mineralisation. Thus, the presence or not of anomalous Fe-sulphide (as coarse-grained pyrite and/or pyrrhotite) may be a better halo discriminant than vein intensities for ground assessment in new areas.

Copper contours

The 0.1% Cu contour often closely follows the outer boundary of the dolomitic group of rocktypes of the silica-dolomite mass (see also Hutton, 1991). However, 0.1-0.5% Cu grades are commonly encountered outside the silica-dolomite envelope, where chalcopyrite occurs in sporadic zones of dolomite veining (see also Hannan, 1991b)**. Therefore, persistent intersections along a drill hole (*i.e.*, hundreds of metres) of patchey, low-grade mineralisation, in metasediment or massive hydrothermal dolomite, should not be dismissed as the expression of an 'unfocussed' alteration system.

Persistent intersections of hydrothermal dolomite with more than 0.5% Cu are likely to be within 100m, across-strike or along-dip, of silica-dolomite carrying >1% Cu.

** This sentence originally read, *incorrectly*, "However, some broadly stratabound lobes of dolomitic rocktypes can extend 200-300m beyond the 0.1% contour in an up-dip direction; and 0.1-0.5% grades are commonly....". (File Note to senior geological staff late June, 1991). This incorrect statement was based on a single cross-section with complete drill hole logs but poor analytical coverage.

Talc

On the scale of the Mine, and ignoring possible differences in talc chemistry associated with the Pb-Zn and Cu orebodies, the proportion of talc to silica-dolomite does not change systematically along the Mount Isa base-metal ore system. For example, talc is present at 2500mN in approximately the same proportion to the total volume of siliceous and dolomitic rocktypes as that further north in the 1100 orebody. However, talc is clearly associated with the 3000 and 3500 orebody silica-dolomite lobes and not the 500-650 lobes in the northern Mine (see also Hutton, 1991): and there is a southward increase in the volume of talc, coincident with increasing volumes of siliceous rocktypes, in the 1100 orebody between 5500mN and 4000mN (Waring, 1990).

Although talc is spatially associated with the silica-dolomite mass, the detailed nature of its relationship to dolomitic and siliceous rocktypes is not clear from the Halo Project cross sections (*e.g.*, some talc `stringers' seem to cross-cut siliceous/dolomitic rocktype boundaries and also the outer dolomitic rocktype boundary with shale.

In conclusion, the complex relationship of talc to the silica-dolomite mass, and the apparent lack of gross systematic trends in its distribution throughout the Mine suggest that talc is unlikely to be of much use as a halo discriminant.

Vein intensities

The idealised templates for 1100 orebody-style copper resources attempt to predict dolomite vein thicknesses and intensities (or frequencies) outside the silica-dolomite mass for a given tonnage of included copper metal. This vein `shell' is based on a *summary* of observations of a single drill hole in the hangingwall of the 1100 orebody at 3340mN (Hannan, 1991b). As such, it is highly schematic and should be applied accordingly.

Some chemical attributes of the halo

The DDH V334 study (Hannan, 1991b), and a brief review of Tl and K distributions in the Mount Isa Mine area (Hannan, 1991a) indicate that dolomite Fe/Mn ratios, and Tl and K abundances are anomalously high for kilometres, along strike, beyond the Mount Isa base-metal ore system.

References

Hannan, K.W., 1991a, Review of Thallium-Potassium distributions, Mount Isa Mine: File Note to Principal Geologist (KJM), June 25, 1991, 3pp. plus table and diagrams.

Hannan, K.W., 1991b, A study of DDH V334 as part of the Halo Project: Technical Report 1573, C.E.C. pty. Ltd., 29pp. plus diagrams, tables and appendices.

Hutton, D.J., 1991, Graphical portrayal of the Isa silica-dolomite system: File Note to Exploration Manager (PJF), March 29, 1991, 9pp.

Perkins, W.G., 1984, Mount Isa silica dolomite and copper orebodies: the result of a syntectonic hydrothermal alteration system: Economic Geology, v. 79, p. 601-637.

Waring, C.L., 1990, Genesis of the Mount Isa Cu Ore system: unpublished Ph.D. Thesis, Monash University.

K.W. Hannan

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Senior Geologist (Research) - W. Perkins
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CARPENTARIA EXPLORATION COMPANY PTY LTD

FILE NOTE

FROM : GEOLOGIST - PROJECT GENERATION

TO : EXPLORATION MANAGER - NW QUEENSLAND

DATE : MARCH 29 1991

REF : DJH/5.4/EXP/1.0

TITLE : GRAPHICAL PORTRAYAL OF THE ISA SILICA - DOLOMITE SYSTEM

SUBJECT : LITHOLOGY SECTION DESCRIPTIONS, 35750mN TO 37240mN ISA MINE

1. OBJECT

The comprehensive graphical portrayal of ISA silica-dolomite systems on serial sections at 1:2500 scale.

2. INTRODUCTION AND AIMS

Following a review by Hunt et al (1989), Wall et al (1989) proposed a programme of 'halo' investigations. Several projects were proposed that were designed to document the nature of; lithological and mineralogical distribution, trace element distribution and stable isotope data, for the Isa copper "halo".

The aim of this project was "to utilise existing mine database of drill core data and to build on the sections compiled by C. Waring. Serial sections to show copper grades, mineralogical and textural data for alteration types, sulphide types and modes, etc. Relogging of one section may be needed for control.

The proposed programme should provide an adequate documentation of the silica-dolomite systems, for both mine and regional exploration, as well as highlighting needs for additional data/relogging" (Wall et al 1989).

Sections at eight northings were compiled; 35750, 36207, 36329, 36512, 36634, 36816, 36999, 37240mn. All sections were compiled at 1:2500 scale and can be used in conjunction with Isa mine 1:2500 cross-sections. Sections are kept at the Duchess Road Office, Mount Isa.

3. EXPLORATION IMPLICATIONS

1. The observed distribution of copper suggest that it is possible to drill a hole into massive coarse grained dolomite and hit no copper. Yet down dip it is possible to intersect 0.1%, 0.5% copper contours as this study has established significant down dip variations in copper mineralisation within coarse grained dolomitic lobes.

2. However once 0.1% copper contours are intersected, the 0.5% copper contour should be intersected within 30 to 100 metres. This is the case both up dip and across bedding.

3. The study has established that lobes of Mt Isa style coarse grained dolomite exist with a close spatial association to stratabound occurrences of coarse and fine grained pyrite together with pyrrhotite. However this study has not been able to eliminate non-sulphidic and non-mineralised (< 0.1% copper) coarse grained dolomite as a prospective host to copper mineralisation at depth.

4. RECOMMENDATIONS

1. Reconcile old logging and examine old core for the distribution of pyrrhotite and coarse grained pyrite in the upper level holes.

2. Some sections (37240 mN) highlight inconsistencies in the logging of adjacent holes. Production logging must endeavour to systematically record all sulphide occurrences.

3. Scan or digitise all sections onto computer to enable 3 - dimensional modelling of the Isa silica - dolomite system.

4. Construction of appropriate scaled plans as a continuation of recommendation 3. These would also document the Isa silica - dolomite system.

5. PREVIOUS WORK [Waring's section described in Waring (1990)]

The current work was a continuation of the earlier work of Chris Waring and R.C. Downs, who compiled a series of lithology/mineralogy sections at 1:1000 scale for the southern half of the mine. Waring's sections were from 34200mN to 35553mN. Three sections, compiled by R.C. Downs were compiled from 34080mN to 34160mN.

Waring's (and Downs') sections detailed the distribution of; collective siliceous rock types and coarse grained dolomitic rock types, talc, total pyrite and pyrrhotite. All elements were portrayed on the same section. A hierarchal scheme for plotting the elements was used. Collective silica-dolomite rock types were plotted first. Talc (when noted to be present) was plotted next, which was followed by total pyrite content greater than 15%. The final parameter plotted was pyrrhotite greater than 1%.

While the system showed the distribution of mineralogy and rock types, it gave a false impression of the distribution of respective elements, especially if two were occurring in the same location. In that case only one would be plotted.

6. LITHOLOGY SECTION CONSTRUCTION

6.1 Elements Chosen

For this study, Waring's categories were used, but with several modifications. To overcome problems associated with the hierarchal system of depiction, this study adopted the format of a lithological base plot, with mineralogical plus mineralisation overlays. This enables the depiction of other elements at a later date.

The collective siliceous and coarse grained dolomitic, lithological assemblages used by Waring were retained. Collective siliceous rock types comprised the Isa mine rock types of brecciaed siliceous shale and siliceous shale. The coarse grained dolomite rock types comprised the Isa mine rock types of recrystallised dolomitic shale, irregularly brecciaed and recrystallised shale and crystalline dolomite.

Copper mineralisation was contoured at 0.1%, 0.5% and 1.0% in an effort to examine the peripheral coper halo and its relationship to other factors.

The mineralogies depicted where; talc, pyrrhotite, coarse and fine-grained pyrite. Talc was plotted wherever it was present in the log data. Pyrrhotite greater than 1% was plotted. Coarse grained pyrite greater than 1% was plotted along with fine grained pyrite greater than 20%.

6.2 Construction Methods

6.2.1 Lithologies

Manual plotting of collective siliceous and coarse grain dolomite rock types was initially done at 1:500. Isa mine 1:500 cross-sections were interpreted and then resealed to 1:2500. Additional plotting and interpretation was also carried out at 1:2500 scale.

The transition into Urquhart Shale from silica-dolomite alteration is often a gradual one, characterised by a lessening in vein intensity. The plotting of the actual boundary between silica-dolomite and Urquhart Shale is often open to interpretation when using the Isa mine log data.

For example, the logged "major" rock type may change from recrystallised shale (R) to shale (S) but the logged "minor" rock type may remain "R" for several splits;

	MJR RT	MNR RT
536 - 537	R	I (irreg.)
537 - 538	R	S
538 - 539	R	R
539 - 541	S	R
541 - 542	S	R
542 - 545	S	S

In this example, the coarse grained dolomite-shale contact would be put around the 541 - 542m interval. If strong silica-dolomite veining was recorded for several splits past the contact then the boundary may have to be moved to accommodate some degree of strong veining. However, veining densities or occurrences, generally were not depicted as that was beyond the scope of the project.

6.2.2 Copper Contouring

Raw data was obtained by computer extracting production copper assay results on a 40 metre wide search width, 20 metres either side of the section. The search width allowed for drill holes that went a long way off section (below 2500mRL) and completeness of data in the upper levels.

Extracted data was composited into 10 metre splits before plotting. The program starts compositing data at the top/start of each hole until it reaches the end of the hole. If less than 10 metres of data is left over but more than the specified minimum (5 metres specified) then a final split is given. If the remaining data is less than the specified minimum then it is overlooked.

Composited data was plotted for each section northing at 1:2500 scale and manually contoured for 0.1%, 0.5% and 1.0% copper.

6.2.3 Mineralogy and Sulphides

Raw data for the talc, pyrrhotite, coarse and fine grained pyrite was obtained from computer extractions of logged data. Search widths were a total of 10 metres wide, although on most sections it was necessary to increase the search width to accommodate deep holes below 2500mRL that had gone off-section. The narrower search width enables a better resolution for the mineralogical elements.

Pyrrhotite content greater than 1% was extracted although it was necessary to extract at greater than 2% in order to obtain a clearer account of pyrrhotite distribution. 1% pyrrhotite tends to be a default value for traces of pyrrhotite during production core logging. The higher values of >1% and >2% gave a less clouded account of pyrrhotite distribution.

Talc whenever noted in logging was extracted. Coarse grained pyrite content greater than 1% was extracted, however like pyrrhotite, "default" values of 1% also proved a problem, so it was necessary to increase the extraction level to greater than 2%.

Fine grained pyrite greater than 20% was extracted by computer. In addition, development data on 1:500 sections and plans was interpretated and resealed to 1:2500.

All raw data plots at 1:2500 scale were interpreted using Isa mine 1:2500 cross-sections as geological bases. When interpreting, splits less than and up to 2-4 metres were not transferred.

Systematic recording of pyrrhotite, coarse and fine grained pyrite corresponded with the adoption of the currently-used logging system. Computer extraction of earlier data is haphazard and unreliable so for all sections it was necessary to manually plot data from old Imperial log data. Pyrrhotite in particular may not be systematically logged in the upper old parts of the mine.

Coarse grained pyrite was rarely recognised in the older data, therefore all coarse grain pyrite sections are very data-poor above 13/L.

7. OBSERVATIONS FOR 35750mN TO 37240mN

Several observations have been made from the sections. Although some have been made previously, they will be made again by way of completeness.

7.1 Lithology and Mineralogy

7.1.1 Silica-Dolomite

Collective siliceous rock types occur immediately adjacent the basement contact in remnants of the 1100/1900 orebody and 3000/3500 orebody systems. Their orientation in the 3000/3500 orebodies is more bedding parallel then in the 1100/1900 orebodies.

Coarse grain dolomite lithologies are bedding parallel especially up-dip of the basement contact zone. This morphology becomes better developed northwards.

The hanging wall development of coarse grained dolomite is best developed at the northern end of the mine in particular 36512mN to 36999mN. The 650 and 500 orebodies have a grossly stratabound morphology with their footwall margins interdigitating with pyritic shale and Pb-Zn-Ag mineralisation of the Black Star orebodies.

7.1.2 Copper Mineralisation

The 0.1% copper contour often closely follows the outer boundary of the "coarse - grained dolomitic" rock types; however some lobes of coarse - grained dolomite extend well beyond (200-300m) the 0.1% contour in an up dip direction.

Highest grades (>1.0% Cu) are generally associated with siliceous lithologies proximal to the basement however such grades do also occur in coarse grained dolomites (i.e. 650 orebody). Moderate values of 0.5% copper are restricted to coarse grained dolomites.

The gradation from 0.1% to 0.5% copper is generally 30 to 50 metres apart both up dip and across bedding especially for the upper hangingwall orebodies (650, 500, 200) perhaps reflecting the more tightly, stratabound nature of these orebodies. The quick change of values from 0.1% to 0.5% is also apparent to a lesser degree for the 3500 orebody.

7.1.3 Talc

Talc only occurs at one stratigraphic position in the lithology sections. It occurs on the footwall of the 3500 orebody in "coarse grained dolomitic" rocks both away from and adjacent the siliceous rock types. It doesn't continue into or occur with siliceous rock types.

On the footwall of the 3500 orebody, talc occurs with pyrrhotite, fine and coarse grained pyrite (36329mN, 37240mN).

From examining the Waring southern sections, talc occurs in coarse grained dolomitic rocks, especially at siliceous-dolomitic interfaces. Where talc occurs within siliceous lithologies, coarse grained dolomitic rocks are always present (34080mN, 34548mN).

Talc distribution is noticeably stratified and commonly in proximity to Pb-Zn mineralisation at the northern end of the mine. While it still occurs within coarse grained dolomitic rocks (i.e. 3500 orebody 36329mN), the talc seems to have less of an intimate relationship with copper than it does at the southern end of the mine.

7.1.4 Pyrrhotite

With a few exceptions the distribution of pyrrhotite is very much like that for coarse grained pyrite. Pyrrhotite occurs with coarse grained dolomite and adjacent to, but not in fine grained pyrite ribs (>20%). Its maximum occurrence is throughout the Racecourse Pb-Zn orebodies but it is also well distributed through 3500 orebody horizon.

The logged occurrence of pyrrhotite decreases down-dip immediately adjacent to the basement, although evidence from the southern end of the mine (Perkins pers. comm. 1991), is that it is present on the basement contact. The pyrrhotite occurrences appear to die out up-dip (towards upper levels and surface) as well (may be geological or artificial).

Pyrrhotite is minimal in siliceous lithologies and best developed in the coarse grained dolomite rock type. In the 3500 orebody (36329mN), pyrrhotite decreases down-dip immediately adjacent to the siliceous core of the orebody. Pyrrhotite and course grained pyrite (36329, 36816) have similar distributions to that for coarse grained dolomitic rocks.

Similar to talc, pyrrhotite at the northern end of the mine is more stratified compared to the southern end of the mine.

7.1.5 Coarse Grained Pyrite

Occurs throughout the sequence with a concentration in two major zones, 3500 orebody and Racecourse lead areas with a possible maximum development in the Lower Racecourse stratigraphy. It has a strong bedding preferred orientation on layers and appears to be continuous down dip to the basement, especially in the 3500 orebody.

Most areas of the fine grained pyrite also feature coarse grained pyrite occurrences however, coarse grained pyrite commonly occurs as stratabound lobes within the silica-dolomite envelope which are not always obviously down dip extensions of fine grained pyrite ribs. (i.e. 6634mN. 3000 orebody stratigraphy, 12-14 orebody stratigraphy, 37240mN 3500 orebody stratigraphy).

The latter observation may be due to a lack of information such as the lack of systematic recognition of coarse grained pyrite.

7.1.6 Fine Grained Pyrite (>20%)

Three pyrite ribs have been documented; 5 orebody Pb-Zn, 14/30 orebody footwall, and 3500 orebody footwall. The logged occurrences of fine grained pyrite decrease approaching the siliceous zone adjacent to the basement contact. The 14/3 footwall and 3500 orebody footwall pyrite ribs are in particular well developed north of the Black Rock open cut.

There is an overall tendency for fine grained pyrite "ribs" to occur either up dip or between the major lobes of silica-dolomite. Copper mineralisation does occur within silica-dolomite downdip from fine grained pyrite ribs, an example being 5 orebody pyrite ribs at 36816mN and 37240mN.

7.2 Lateral Variations

Distribution of silica-dolomite lithologies becomes more continuous and sheetlike at the northern end of the mine. Coarse grain dolomite in particular develops parallel to bedding with less podding. The hanging wall copper orebodies (650, 500) exhibit a rapid transition from logged silica-dolomite lithologies to logged barren shale lithologies.

8. DISCUSSION

The majority of the project's goals were met with the sections documenting copper grades, mineralogy, sulphide types and modes. Two diamond drill cores on the 36999mN section were relogged.

The sections do not document textural data. The only textural data available from the mine drill core database is veining mineralogy and intensity. No attempt was made to systematically portray this data on sections as a separate veining project was proposed by Wall et al (1989).

The project has highlighted the old upper levels of the mine and possibly the extreme footwall stratigraphy east of the Racecourse Shear as areas where there is a need for additional data and relogging. Apparent truncation of horizons in these areas shown on the sections are probably an artificial rather than geological product.

9. REFERENCES

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