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# Copper and molybdenum distribution at Shap, Cumbria

K E Beer and G S Kimbell

BRITISH GEOLOGICAL SURVEY

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# Copper and molybdenum distribution at Shap, Cumbria

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*Cover illustration*

A banded carbonate/sphalerite/marcasite/galena vein from the Gwynfynydd Gold Mine, near Dolgellau in North Wales

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## SUMMARY

Examination of rock outcrops in and around the Shap Granite and percussion drilling behind the Pink Granite Quarry have confirmed that both copper and molybdenum are present over a wide area, though in amounts which everywhere are sub-economic. Surprisingly, chemical analytical results show a lack of strong correlation between these two metals. Induced polarisation surveys did not provide any evidence of anomalously high concentrations of sulphide mineralisation, although a VLF-EM anomaly indicates a possible northward extension of a fracture zone which is mineralised where exposed in the quarry face. A model suggesting a more deeply buried porphyry-type deposit is not wholly disproved but the evidence obtained from drillholes and geophysical surveys is far from encouraging.


## INTRODUCTION

The occurrence of molybdenite and chalcopyrite as scattered coatings on many joints in the Pink Granite Quarry [NY 558 084]* at the foot of Shap Fell (Figure 1) has long been known to students of geology (see Harker and Marr, 1891). In the aureole rocks which surround the granite these minerals are found only at widely scattered localities and, even then, in only minor amounts. Rather less well publicised is the presence of accessory scheelite within the granite.

Little serious academic attention had been paid to the Shap mineralisation until it was examined by Kim (1973). From personal knowledge he drew favourable comparisons with the Climax porphyry molybdenum deposit in Colorado, U.S.A. Prior to this work, in 1970, Riofinex Ltd. carried out an augered soil geochemical survey over all the area underlain by granite and a sizeable tract of the northern and western aureole; their work failed to encourage further exploration.

MRP studies of the Shap Granite were proposed in late 1973 but were not begun until 1980.

Most of the granite is covered by bouldery glacial clay topped by a thick layer of wet peat and its agricultural value is restricted mainly to coarse summer grazing for hill stock. There are no all-weather tracks across the fell and in the depths of winter it commonly is totally cut off by deep snow. Immediately above the quarry a tall radio/television transmission mast forms a prominent landmark and is approached by a rough track starting from the quarry floor. This provides the most convenient access to the fell area, though vehicular right of way is reserved. The quarry is served by road connections to the M6 motorway and the granite works, on the A6 road towards Shap village [562 152], has its own rail freight sidings.

The area behind the Pink Granite Quarry belongs to the Shap Granite Company (Thos. W. Ward (Roadstone) Ltd.) and most of the surrounding land forms part of the Lowther Estate. Almost all of the

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* All the localities mentioned in this report lie within the Ordnance Survey National Grid square designated by the letters NY.

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study area lies within the Lake District National Park (Fig. 1).

## GEOLOGY AND MINERALISATION

The Shap Granite has a mapped surface outcrop of some 8 $km^2$ and a crudely oval outline (Fig. 2). It is very poorly exposed and most of the published descriptions apply to material from the Pink Granite Quarry. Although not seen, the southern contact can be placed with some precision a short distance north of the derelict Wasdale Head farm buildings [550 082]. The northern contact, however, is exposed in a stream section [562 101] south of the so-called Blue Rock Quarry [564 106] and shows several tongues and veins of pink granite penetrating hornfelsed vesicular andesite. At neither locality is there any clear indication of the slope of the contact but the northern one may dip gently outwards.

The intrusion is emplaced at the junction of regionally metamorphosed Ordovician and Silurian successions. All of the northern half of the contact abuts against andesitic lavas and agglomerates of the Borrowdale Volcanic sequence. In its southwest quadrant the granite cuts across the ENE strike of the volcanic rocks, slates and limestones of the Coniston Limestone Group at the top of the Ordovician. Silurian slates and grits are in contact with the granite only along its extreme southern margin, between Wasdale Head and the A6 road.

Gravity modelling by Bott (1974) and Lee (1986) indicates that the Shap pluton is but one high-level expression of an underlying Lake District batholith. There are, however, significant density variations within this composite body; Lee (1986) assumes mean densities of 2.66 Mg $m^{-3}$ in the Shap region and 2.63 Mg $m^{-3}$ further west, for example around Skiddaw. Geochemically the Shap Granite differs in several significant respects from the Grainsgill Granite, one of the Skiddaw plutonic cusps (Beer et al., 1987): in particular its rare earth element profile suggests it to be a distinctly less evolved intrusion. These authors show that its apparent similarity to many of the Cornish granites is also somewhat illusory.

Universally the granite is both pink and coarsely porphyritic, the orthoclase phenocrysts commonly being more than 3cm in length. Around some of the joints the colour locally intensifies to a redder variant. The K-feldspar is set in a moderately coarse granular aggregate of oligoclase (mainly white), quartz and biotite. Accessory minerals include apatite, zircon, sphene, magnetite and scheelite, locally with fluorite. Its petrographic features have been reported in detail by Grantham (1928).

The plagioclase is preferentially altered to a mixture of quartz and sericite , and the biotite is commonly partially chloritised. Pyrite is unevenly distributed, being more abundant in proximity to biotite chloritisation.

Two conspicuous joint sets are seen in the granite quarry, both carry scattered mineralisation. A vertical, usually N-S trending set tends to be lined by a thin coating of chlorite and/or quartz and, in some parts of the quarry, develops into well defined shatter zones and faults. This seems to be the more general plane for mineralisation and commonly bears molybdenite, chalcopyrite and abundant pyrite, sometimes with much fluorite (purple, green and colourless) or a little white barite. Traces of galena, sphalerite and bismuthinite are also found. The other joint direction has an E-W strike with a dip which may vary from 60N to 60S but is commonly near-vertical. Only some of this set are lined with chlorite-quartz layers, and these may be mineralised.

Sulphide veining is most prominently seen (in 1989) in the modern eastern bay of the quarry, particularly near its centre (Fig. 3), and is less conspicuously developed elsewhere. Kim (1973) describes five types of molybdenum mineralisation. He also recognises a series of hydrothermal alteration within the length of the quarry faces and heequates these to the standard model for porphyry deposits as defined by Lowell and Guilbert (1970).

## RIOFINEX GEOCHEMISTRY

The soil geochemical survey carried out by this company in 1970 was based on 13 N-S traverses 300m apart extending from the latitude of the Pink Granite Quarry northwards to Wet Sleddale Reservoir [550 114] and westwards and northwestwards to the Sleddale Beck and River Lowther; an area around the quarry was excepted (Fig. 6). The total area involved was 10.5 $km^2$. Along each traverse samples were taken at 60m intervals.

Collection is presumed to have been made by auger sampling on foot - the only possible method in such terrain - but this raises doubts about its reliability. BGS attempts to auger to any depth in the boulder clay have proved totally unsuccessful and it seems likely that the Riofinex samples may have been derived from a wide variety of depths and that many may have contained large proportions of peaty material. As organic matter is an efficient scavenger of secondary molybdenum, there is a clear danger of outlining spurious anomalies.

In all, 635 samples were collected, and these were analysed for Cu, Pb, Zn and Mo. Presumably the first three were determined by Atomic Absorption Spectrometry (AAS), but the analytical method for Mo is not known. A summary of the analytical results is given in Table 1 and log-probability plots for the four metals comprise Figures 4 and 5.

Table 1. Riofinex analytical summary (in ppm)

| Element | Range | Mean | S.D. | Median | Anomalous values* |
|---|---|---|---|---|---|
| Cu | 4-140 | 24.72 | 16.84 | 20 | > 58 (5.5%) |
| Pb | 10-500 | 71.47 | 51.43 | 60 | > 140 (8.5%) |
| Zn | 10-455 | 86.50 | 63.42 | 70 | > 140 (14%) |
| Mo | <2-460 | 6.97 | 19.87 | 4 | > 12.5 (8%) |

* Derived from log-probability plots; figures in parentheses indicate proportion of total samples.

Figures 6-9 show the locations of soils containing anomalous amounts of each of the four metals. In none of the plots is there any distinctive or meaningful distribution pattern. Although copper and molybdenum are closely associated in the visible mineralisation, there is no direct correlation in the distribution of these metals. Indeed, they seem almost to be antipathetic. Not unexpectedly, there is some degree of correlation between lead and zinc, but it is very limited. Copper and zinc correlate only poorly.

Many of the small groupings of anomalous metal values lie close to the drainage channels and may reflect deposition of these metals on emergence into an oxidising and iron-rich environment after movement through an acidic and organic reducing medium. Perhaps the most interesting grouping is a rather scattered concentration of anomalous Mo values the N and NE slopes of Wasdale Pike. Although the sampling did not closely approach the margins of the Pink Granite Quarry, it appears that there are no concentrations of Cu, Pb or Mo near the quarry top. However, Zn shows a cluster of anomalies immediately north of the face.

Because of the mobility of these four metals and the nature of the local surface media, the absolute elemental values are of little real significance but it must be noted that the anomalous Mo values all tend to be disappointingly low.

## PERCUSSION DRILLING

The detailed studies by Kim (1973) suggested a more extensive mineralisation than was immediately evident in the granite quarry exposures, despite the somewhat unpromising anomaly levels determined by Riofinex. Unsupported by other evidence, such a concept was too uncertain to justify immediate deep drilling and, furthermore, failed to define a target. To remedy this situation a programme of base of drift and of outcrop sampling was proposed.

Attempts to penetrate the drift by hand auger and by Minuteman auger drill proved to be both laborious and commonly ineffectual. In consequence this approach was abandoned in favour of percussive air flush drilling which could penetrate the solid rock. Most of the holes were inclined at about 45 degrees but their azimuths varied; details are given in Table 2 and sites are plotted in Figure 3. Two different types of rig were employed. The Halco drill is a small rig mounted on a self propelling caterpillar tracked body and capable of at least 120 ft of inclined drilling, but the machine proved to be too heavy to successfully traverse the soft peat and underlying saturated boulder clay. It proved impossible to operate this equipment at any distance from the track edge. The larger Hymac rig was mounted on a lorry chassis and was equally unable to cross the soft peat but, being equipped with a jointed and extendable boom, it was able to reach out laterally for several feet. With its greater power the Hymac rig was capable of drilling to greater depths, though no hole exceeded 177 ft in length.

Samples were collected over lengths of 5 ft and each of these was submitted to a private analyst, Mather Research Ltd. of Rothbury, for determination of Cu and Mo by XRF. One small batch of samples was analysed again by the Analytical Chemistry Unit of BGS, also using the XRF method but for a range of elements.

Table 2. Percussion drillhole data

| Percussion Hole No. | Collar Grid Ref. | Azimuth degrees M | Inclination degrees | Length ft. |
|---|---|---|---|---|
| Halco H-1 | 55787 08542 | 007 | vertical | 120 |
| 2 | 55787 08566 | 007 | vertical | 140 |
| 3 | 55787 08592 | 007 | vertical | 70 |
| 4 | Not drilled, replaced by HY-21 | | | |
| 5 | 55787 08620 | 007 | vertical | 40 |
| 6 | 55787 08628 | 007 | vertical | 125 |
| 7 | 55787 08654 | 007 | vertical | 130 |
| 8 | 55787 08680 | 007 | vertical | 40 |
| 9 | 55787 08689 | 007 | vertical | 30 |
| 10 | 55787 08695 | 007 | vertical | 20 |
| 11 | 55787 08692 | 007 | vertical | 110 |
| 12 | 55787 08706 | 007 | vertical | ??? |
| 13 | 55787 08716 | 007 | vertical | 50 |
| 14 | 55787 08726 | 007 | vertical | 70 |
| Halco HA-1 | 55588 08593 | 007 | -45 | 100 |
| 2 | 55588 08614 | 007 | -45 | 100 |
| 3 | 55588 08634 | 007 | -45 | 75 |
| Hymac HY-1 | 55565 08404 | 275 | -46 | 147 |
| 2 | 55565 08404 | 304 | -44 | 177 |
| 3 | 55565 08404 | 001 | -45 | 177 |
| 4 | 55587 08453 | 359 | -47 | 177 |
| 5 | 55620 08488 | 012 | -47 | 177 |
| 6 | 55671 08506 | 357 | -44 | 177 |
| 7 | 55633 08522 | 007 | -45 | 177 |
| 8 | 55633 08557 | 008 | -45 | 177 |
| 9 | 55635 08592 | 007 | -47 | 157 |
| 10 | 55588 08488 | 007 | -45 | 177 |
| 11 | 55588 08523 | 007 | -46 | 177 |
| 12 | 55588 08558 | 007 | -46 | 177 |
| 13 | 55671 08541 | 007 | -45 | 177 |
| 14 | 55671 08577 | 005 | -45 | 177 |
| 15 | 55671 08611 | 007 | -46 | 177 |
| 16 | 55677 08647 | 007 | -45 | 177 |
| 17 | 55721 08508 | 007 | -45 | 177 |
| 18 | 55720 08544 | 007 | -45 | 177 |
| 19 | 55707 08578 | 007 | -45 | 177 |
| 20 | 55707 08614 | 010 | -45 | 177 |
| 21 | 55787 08605 | 007 | -45 | 177 |
| 22 | 55850 08570 | 007 | -46 | 137 |
| 23 | 55847 08546 | --- | vertical | 57 |
| 24 | 55836 08542 | --- | vertical | 177 |
| 25 | 55899 08568 | 000 | -45 | 177 |

DRILLHOLE GEOCHEMISTRY

A fully listed set of Cu and Mo contents determined by Mather is given in Appendix 1 and the statistical summary in Table 3. A rapid visual scan of the appendix shows that the majority of the Mo contents are less than the detectable level of 5ppm. It is apparent that the higher Mo values are only occasionally clustered and, therefore, that the mineralisation is in fact extremely scattered and tenuous.

Table 3. Statistical summary of Cu and Mo in drill pulps (in ppm)

| Element | Range | Mean | St.Dev. | Median | Anomalous values |
|---|---|---|---|---|---|
| Mo | 0*-120 | 3.05 | 13.12 | 0 | > or = 12 (2%) |
| Cu | 4-1000 | 58.42 | 63.79 | 40 | > or = 185 (4%) |

Analyses by Mather Research Ltd.
* = Below detectable limit (5ppm); N = 999.

Table 4. Listing of metalliferous zones in percussion drillholes

| Drill No. | Depth ft. | Samples XHM | ppm/length Cu or Mo | Drill No. | Depth ft. | Samples XHM | ppm/length Cu or Mo |
|---|---|---|---|---|---|---|---|
| H-2 | 95-100 | 38 | 370Cu/5 | HY-13 | 37-42 | 792 | 200Cu/5 |
| | 115-125 | 42-43 | 16Mo/10 | | 97-107 | 804-805 | 240Cu/10 |
| H-6 | 20-30 | 111-112 | 16Mo/10 | | 152-157 | 815 | 210Cu/5 |
| | 95-100 | 126 | 24Mo/5 | | 172-177 | 819 | 80Mo/5 |
| H-14 | 10-25 | 204-206 | 67Mo/15 | | | | 380Cu/5 |
| | 65-70 | 215 | 12Mo/5 | HY-16 | 107-112 | 906 | 310Cu/5 |
| HY-1 | 120-135 | 422-424 | 15Mo/15 | HY-17 | 92-97 | 937 | 15M0/5 |
| HY-2 | 172-177 | 457 | 44Mo/5 | HY-18 | 62-67 | 965 | 220Cu/5 |
| HY-3 | 62-67 | 468 | 12Mo/5 | HY-19 | 162-172 | 1017-1018 | 730Cu/10 |
| HY-7 | 82-87 | 605 | 32M0/5 | HY-20 | 12-17 | 1020 | 15Mo/5 |
| | 97-102 | 608 | 40Mo/5 | HY-21 | 57-82 | 1062-1066 | 248Cu/25 |
| HY-8 | 102-112 | 642-643 | 30Mo/10 | HY-23 | 42-47 | 1117 | 15Mo/5 |
| | 107-112 | 643 | 240Cu/5 | HY-24 | 27-32 | 1124 | 15Mo/5 |
| | 122-127 | 646 | 24Mo/5 | | 137-147 | 1146-1147 | 220Cu/10 |
| | 122-132 | 646-647 | 305Cu/10 | | 162-167 | 1151 | 200Cu/5 |
| | 162-167 | 654 | 12Mo/5 | HY-25 | 17-22 | 1155 | 20Mo/5 |
| | 172-177 | 656 | 12Mo/5 | | | | 200Cu/5 |
| HY-12 | 17-22 | 755 | 190Cu/5 | | 27-32 | 1157 | 250Cu/5 |
| | 37-42 | 759 | 220Cu/5 | | 32-37 | 1158 | 20Mo/5 |
| | 47-72 | 761-765 | 204Cu/25 | | 122-127 | 1176 | 15Mo/5 |
| | 77-82 | 767 | 12Mo/5 | HAL-3 | 35-40 | 2044 | 20Mo/5 |
| | 77-127 | 767-776 | 262Cu/50 | | | | |
| | 147-152 | 781 | 250Cu/5 | | | | |
| | 162-167 | 784 | 200Cu/5 | | | | |

Log-probability distribution plots have been prepared for both metals (Figure 10) and these clearly define sets of anomalously high values as indicated in Table 3. When applied to the results quoted in Appendix 1 it is possible to recognise the zones of metalliferous concentration listed drillhole by drillhole in Table 4 below.

No attempt has been made to quantify any correlation between these two metals; it is apparent from a cursory examination that it must be extremely poor.

A random group of samples taken from Hymac drillholes 23 and 24 was sent to the BGS laboratories for XRF analysis in order to establish a correlation between the Mather results and other Cu and Mo data held in BGS files. A full multi-element list of analytical results is given in Appendix 2, and is summarised in Table 5. Comparison between the Mather and BGS results is tabulated in Appendix 3 and presented graphically in Figures 11 and 12. The Mo plot is biased by so many contents below the Mather detectable limit.

Table 5. Multi-element statistical summary for drill pulps (in ppm)

| Element | Range | Mean | St. Dev. | Median |
|---|---|---|---|---|
| Ba | 529-647 | 591.81 | 22.46 | 592 |
| Ca | 6390-9900 | 8200 | 868.2 | 8460 |
| Ce | 99-149 | 123.19 | 12.61 | 122 |
| Cu | 4-202 | 71.12 | 52.71 | 57 |
| Fe | 19880-24520 | 21964 | 1111 | 21630 |
| Mn | 180-310 | 239.28 | 26.31 | 240 |
| Mo | 1-48 | 10.50 | 10.19 | 7 |
| Nb | 15-25 | 19.86 | 2.43 | 20 |
| Ni | 13-22 | 15.21 | 1.79 | 15 |
| Pb | 50-253 | 73.43 | 32.58 | 66 |
| Rb | 293-332 | 313.05 | 9.36 | 312 |
| Sn | 3-16 | 8.76 | 3.30 | 8 |
| Sr | 322-390 | 343.88 | 13.58 | 341 |
| Th | 31-69 | 45.02 | 7.81 | 43 |
| Ti | 2960-3330 | 3238 | 162.6 | 3220 |
| U | 1-17 | 10.40 | 3.84 | 10 |
| Y | 16-25 | 20.50 | 1.87 | 19 |
| Zn | 20-121 | 36.33 | 17.82 | 31 |
| Zr | 268-447 | 371.33 | 38.71 | 368 |

Analysis by BGS Analytical Chemistry Unit

Because these samples were not selected as a representative set no attempt has been made to prepare log-distribution plots. Results are quoted here solely to provide a guide to the trace element composition of the granite.

## OUTCROP LITHOGEOCHEMISTRY

Samples were collected from a broad selection of stream outcrops in the aureole around the Shap Granite; their descriptions are given in Appendix 4. These were submitted for multi-element XRF analysis by the BGS laboratories; the results are listed in Appendix 5 and a statistical summary is provided in Table 6.

Table 6. Geochemical statistics for the Shap rocks (in ppm)*

| Element | Range | Mean | S.D. | Median | Anomalous values |
|---|---|---|---|---|---|
| Ag | 0-5 | 1.04 | 1.22 | 1 | > 3 (4%) |
| Ba | 26-1783 | 600.9 | 342.9 | 533 | > 1200 (4.5%) |
| Ce | 9-104 | 53.01 | 19.62 | 54 | > 75 (9%);> 100 (3%) |
| Cu | 0-259 | 43.99 | 48.62 | 29 | > 115 (8%) |
| Fe | 4630-108600 | 52793 | 22196 | 53780 | > 87000 (5%) |
| Mo | 0-46 | 3.13 | 5.59 | 2 | > 7 (3%) |
| Pb | 4-721 | 38.72 | 86.54 | 21 | > 54 (9%) |
| Sn | 0-15 | 2.75 | 2.98 | 2 | > 11.5 (3.5%) |
| Sr | 48-762 | 250.2 | 129.0 | 219 | > 380 (7.5%) |
| U | 0-9 | 2.84 | 2.04 | 2 | > 7.5 (3.5%) |
| Zn | 5-773 | 88.32 | 91.87 | 77 | > 155 (6%) |
| Zr | 26-457 | 216.8 | 78.62 | 215 | > 390 (4.5%) |

* XHR 324 omitted throughout

Further comparison can be made with the detailed analyses for the Shap Granite and its aureole rocks given in Beer et al. (1987).

## GEOPHYSICAL INVESTIGATIONS

Reconnaissance Very Low Frequency electromagnetic (VLF-EM), magnetic, induced polarisation (IP) and resistivity surveys were undertaken on Long Fell. Only IP has the capability of detecting disseminated mineralisation, but the other methods were included for the additional structural information they can provide, and in particular for the identification of fracture zones. The base point of the survey grid (Figure 13) was at the centre of the smaller of the two radio masts above the Pink Granite Quarry.

VLF surveys. VLF-EM measurements were made at 10m intervals along the survey traverses using Geonics FM16 equipment tuned to the Rugby transmitter (GBR, 16.0 kHz). The in-phase VLF-EM data have been filtered by the method of Fraser (1969), which converts downward inflections across conductors to maxima, and the positive values plotted on the survey lines (Figure 13). The plot reveals four principal conductive zones which trend broadly north-south. The strongest anomalies occur towards the western and eastern ends of the traverses; the trend ofthe western feature is slightly east of north and that of the eastern feature is slightly west of north. Topographic correlations indicate that these anomalies are caused by a thickening of the conductive peat and drift layer on the flanks of Long Fell.

A linear conductive feature extends due north from the vicinity of the zone of Cu-Mo veining exposed in the eastern bay of the quarry. It appears likely, therefore, that a geophysical response has been detected over the northward extension of the quarry vein zone. If this is the case, the conductive nature of the zone is more likely to be due to the fracturing and the higher water content than to the (low) concentrations of mineralisation present. It is possible that the anomaly is due to a local thickening of drift, although it could still provide an indirect indication of the fracture zone since the latter may control the position of a sub-drift gully.

A somewhat sinuous VLF-EM conductor crosses the base line around 350N (Fig. 13). In-fill traverses were carried out at 40N, 200N and 400N to confirm the course of this feature, which could be due either to a zone of fracturing within the granite or a sub-drift gully. The latter is perhaps more likely since extrapolation of this feature does not coincide with any of the main fracture zones observed in the quarry. Its course passes close to drillholes HY 13, 14, 15 and 16, and probably also HY 6, but these do not show any correlated zone of even minor metalliferous mineralisation.

Magnetic surveys. Total magnetic field measurements were made at 10m intervals along the principal traverses and the results are displayed in profile form in Figure 14. The data have been corrected for diurnal variation. The Shap Granite is moderately magnetic; the magnetisation is predominantly induced, with a susceptibility of the order of $10^{-2}$ SI units (Locke and Brown, 1978; M.K. Lee, pers. comm.). The observed profiles show a broad northward decrease in magnetic field, which is due to regional structures not directly relevant to this investigation, and short wavelength variations with amplitudesof up to about 100nT. The latter may arise because of variations in either the depth to granite (thickness of drift) or the magnetite content of the granite.

There is a clear correlation between magnetic lows and the conductive features defined by VLF-EM surveys. Simple modelling shows that a thickening of drift in a north-south orientated gully does give rise to a magnetic low, with flanking minor highs. For example, with a bedrock susceptibility of $10^{-2}$ SI units, a thickening of 10m will typically produce anomaly amplitudes of between 50 and 100nT. The magnetic and VLF-EM results are therefore compatible in those cases where drift thickening is inferred. Comparison of these two methods reveals that the eastern drift-filled trough is typically about 100m wide and also shows some local bedrock highs within the gully. The western zone of thickened drift is about 200m wide where it crosses the western end of line 300N, becoming broader to the north and apparently extending from just west of the base-line to around 300E on line 700N.

A magnetic low also occurs over the possible extension of the Cu-Mo veining. This may be due to alteration of magnetite within the zone of fracturing or to a thickening of the drift. There are slight differences between the shape of the theoretical magnetic anomaly due to superficial effects and that due to a zone in bedrock with greater vertical extent (there is a reduction in the magnitude of the flanking highs in the latter). Such distinctions are difficult to make with "noisy" profiles such as are observed here, although the anomaly associated with this feature on line 120N appears more characteristic of a source within bedrock.

IP/resistivity surveys. IP and resistivity data were collected along lines 35S, 120N and 300N using Huntec Mk III time domain equipment. A dipole-dipole array was used, with the dipole length set at 50m and dipole-centre separations between 100m and 300m (n = 2 to n = 6). Chargeabilities were calculated from the time integral of the voltage decay curve between 240ms and 1140ms after the termination of a 2s current pulse.

The resistivity pseudosections (Figs. 15, 16 and 17) reveal very high apparent resistivities (typically 5000-10000 ohm/m, but up to almost 30000 ohm/m) associated with the Shap Granite. This is in accord with the results from borehole electrical logs recorded by Lee (1986). The conductive zones at the eastern and western ends of the pseudosections for 120N and 300N correlate with drift-filled gullies identified by other geophysical methods and confirm the more limited extent of the eastern feature. The chargeability data from lines 120N and 300N show no evidence of any zones of increased pyrite concentration which might be expected to occur in association with a porphyry deposit. The results are thus negative down to the maximum depth explored with the array used; this is estimated to be about 75m (Edwards, 1977).

Slightly higher chargeabilities are found on line 35S (Fig. 15), but it is unlikely that these are due to porphyry style mineralisation. There is a clear positive correlation between resistivity and chargeability, suggesting that the higher chargeabilities may simply be due to a larger portion of the applied current passing through the rock (as opposed to the fluid it contains) in the less fractured parts of the granite. There are no anomalous zones in the pseudosection of the specific capacitance parameter, which makes allowance for such effects. There is also the possibility that man-made structures influence the results on this line, as it passes close to the transmission masts and associated structures.

## CONCLUSIONS

Kim (1973) reports that the vein zone in the centre of the eastern bay of the Pink Granite Quarry bears veinlets with 0.12-0.16% Mo, 0.1-0.2% Cu and 0.26-1.66% Bi. To the east of this zone the altered envelope contains 0.02% Mo and 0.02% Cu with narrow veinlets showing values up to 50% higher. Kim (op. cit.) summarises the tenors of other described deposits and, on the basis of that survey, suggests that the Shap Granite mineralised zone may be a low-grade hypogene indicator of richer ore at depth.

Although the drilling programme probably did not penetrate as deeply as would be needed to substantiate this proposition, it does show that the Cu and Mo mineralisation is much more patchy and of poorer tenor than in Kim's (1973) quarry model and on this basis it would seem to hold little promise for large tonnages of workable low-grade ore at acceptable sub-surface depths.

There is no direct correlation between the Cu and Mo contents of the bulk rock, even though they are obviously products of a single mineralising pulse. Because of analytical difficulties the samples were not determined for bismuth, which Kim (1973) shows to be ubiquitously present. It seems unlikely, however, that this metal would make any significant difference to the economic appeal of this area.


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APPENDIX 1. Cu and Mo analyses of drillhole pulps

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| H-1 | 0001 | 15-20 | 42 | 0 |
| | 0002 | 20-25 | 16 | 0 |
| | 0003 | 25-30 | 6 | 0 |
| | 0004 | 30-35 | 8 | 0 |
| | 0005 | 35-40 | 6 | 0 |
| | 0006 | 40-45 | 20 | 0 |
| | 0007 | 45-50 | 18 | 0 |
| | 0008 | 50-55 | 30 | 0 |
| | 0009 | 55-60 | 6 | 0 |
| | 0010 | 60-65 | 12 | 0 |
| | 0011 | 65-70 | 42 | 0 |
| | 0012 | 70-75 | 56 | 0 |
| | 0013 | 75-80 | 18 | 0 |
| | 0014 | 80-85 | 10 | 0 |
| | 0015 | 85-90 | 66 | 0 |
| | 0016 | 90-95 | 120 | 0 |
| | 0017 | 95-100 | 10 | 0 |
| | 0018 | 100-105 | 12 | 0 |
| | 0019 | 105-110 | 24 | 0 |
| | 0020 | 110-115 | 10 | 0 |
| | 0021 | 115-120 | 10 | 0 |
| H-2 | 0022 | 15-20 | 22 | 0 |
| | 0023 | 20-25 | 42 | 0 |
| | 0024 | 25-30 | 54 | 0 |
| | 0025 | 30-35 | 42 | 0 |
| | 0026 | 35-40 | 90 | 0 |
| | 0027 | 40-45 | 130 | 0 |
| | 0028 | 45-50 | 80 | 0 |
| | 0029 | 50-55 | 54 | 0 |
| | 0030 | 55-60 | 150 | 0 |
| | 0031 | 60-65 | 130 | 0 |
| | 0032 | 65-70 | 130 | 0 |
| | 0033 | 70-75 | 116 | 0 |
| | 0034 | 75-80 | 30 | 0 |
| | 0035 | 80-85 | 28 | 0 |
| | 0036 | 85-90 | 18 | 0 |
| | 0037 | 90-95 | 18 | 0 |
| | 0038 | 95-100 | 370 | 0 |
| | 0039 | 100-105 | 130 | 0 |
| | 0040 | 105-110 | 100 | 0 |
| | 0041 | 110-115 | 114 | 0 |
| | 0042 | 115-120 | 150 | 12 |
| | 0043 | 120-125 | 120 | 20 |
| | 0044 | 125-130 | 70 | 0 |
| | 0045 | 130-135 | 86 | 0 |
| | 0046 | 135-140 | 120 | 0 |
| | Encountered water | | | |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| H-3 | 0047 | 15-20 | 108 | 0 |
| | 0048 | 20-25 | 150 | 0 |
| | 0049 | 25-30 | 160 | 0 |
| | 0050 | 30-35 | 130 | 0 |
| | 0051 | 35-40 | 170 | 0 |
| | 0052 | 40-45 | 160 | 0 |
| | 0053 | 45-50 | 130 | 0 |
| | 0054 | 50-55 | 70 | 0 |
| | 0055 | 55-60 | 66 | 0 |
| | 0056 | 60-65 | 58 | 0 |
| | 0057 | 65-70 | 50 | 0 |
| H-4 | Not drilled | | | |
| H-5 | 0101 | 8-10 | 24 | 0 |
| | 0102 | 10-15 | 24 | 0 |
| | 0103 | 15-20 | 20 | 0 |
| | 0104 | 20-25 | 20 | 0 |
| | 0105 | 25-30 | 30 | 0 |
| | 0106 | 30-35 | 36 | 0 |
| | 0107 | 35-40 | 26 | 0 |
| | Encountered water | | | |
| H-6 | 0108 | 5-10 | 52 | 0 |
| | 0109 | 10-15 | 30 | 0 |
| | 0110 | 15-20 | 8 | 0 |
| | 0111 | 20-25 | 130 | 12 |
| | 0112 | 25-30 | 140 | 20 |
| | 0113 | 30-35 | 102 | 0 |
| | 0114 | 35-40 | 74 | 0 |
| | 0115 | 40-45 | 40 | 0 |
| | 0116 | 45-50 | 60 | 0 |
| | 0117 | 50-55 | 120 | 0 |
| | 0118 | 55-60 | 130 | 0 |
| | 0119 | 60-65 | 46 | 0 |
| | 0120 | 65-70 | 48 | 0 |
| | 0121 | 70-75 | 98 | 0 |
| | 0122 | 75-80 | 58 | 0 |
| | 0123 | 80-85 | 42 | 0 |
| | 0124 | 85-90 | 40 | 0 |
| | 0125 | 90-95 | 104 | 0 |
| | 0126 | 95-100 | 76 | 24 |
| | 0127 | 100-105 | 72 | 8 |
| | 0128 | 105-110 | 50 | 0 |
| | 0129 | 110-115 | 36 | 0 |
| | 0130 | 115-120 | 20 | 0 |
| | 0131 | 120-125 | 40 | 8 |
| | Rod jammed | | | |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| H-7 | 0132 | 5-10 | 14 | 0 |
| | 0133 | 10-15 | 4 | 0 |
| | 0134 | 15-20 | 6 | 0 |
| | 0135 | 20-25 | 6 | 0 |
| | 0136 | 25-30 | 6 | 0 |
| | 0137 | 30-35 | 64 | 0 |
| | 0138 | 35-40 | 18 | 0 |
| | 0139 | 40-45 | 12 | 0 |
| | 0140 | 45-50 | 12 | 0 |
| | 0141 | 50-55 | 14 | 0 |
| | 0142 | 55-60 | 18 | 0 |
| | 0143 | 60-65 | 12 | 0 |
| | 0144 | 65-70 | 8 | 0 |
| | 0145 | 70-75 | 8 | 0 |
| | 0146 | 75-80 | 16 | 0 |
| | 0147 | 80-85 | 36 | 0 |
| | 0148 | 85-90 | 18 | 0 |
| | 0149 | 90-95 | 30 | 0 |
| | 0150 | 95-100 | 50 | 0 |
| | 0151 | 100-105 | 24 | 0 |
| | 0152 | 105-110 | 24 | 0 |
| | 0153 | 110-115 | 12 | 0 |
| | 0154 | 115-120 | 8 | 0 |
| | 0155 | 120-125 | 14 | 0 |
| | 0156 | 125-130 | 8 | 0 |
| H-8 | 0157 | 10-15 | 10 | 0 |
| | 0158 | 15-20 | 34 | 0 |
| | 0159 | 20-25 | 24 | 0 |
| | 0160 | 25-30 | 18 | 0 |
| | 0161 | 30-35 | 6 | 0 |
| | 0162 | 35-40 | 12 | 0 |
| | Encountered water | | | |
| H-9 | 0163 | 5-10 | 6 | 0 |
| | 0164 | 10-15 | 6 | 0 |
| | 0165 | 15-20 | 6 | 0 |
| | 0166 | 20-25 | 14 | 0 |
| | 0167 | 25-30 | 6 | 0 |
| | Encountered water | | | |
| H-10 | 0168 | 5-10 | 20 | 0 |
| | 0169 | 10-15 | 20 | 0 |
| | 0170 | 15-20 | 20 | 0 |
| | Encountered water | | | |
| H-11 | 0171 | 0-5* | 12 | 0 |
| | 0172 | 5-10 | 6 | 0 |
| | 0173 | 10-15 | 4 | 0 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| H-11 (cont) | 0174 | 15-20 | 4 | 0 |
| | 0175 | 20-25 | 6 | 0 |
| | 0176 | 25-30 | 4 | 0 |
| | 0177 | 30-35 | 12 | 0 |
| | 0178 | 35-40 | 18 | 0 |
| | 0179 | 40-45 | 6 | 0 |
| | 0180 | 45-50 | 6 | 0 |
| | 0181 | 50-55 | 6 | 0 |
| | 0182 | 55-60 | 32 | 0 |
| | 0183 | 60-65 | 46 | 0 |
| | 0184 | 65-70 | 34 | 0 |
| | 0185 | 70-75 | 26 | 0 |
| | 0186 | 75-80 | 56 | 0 |
| | 0187 | 80-85 | 64 | 0 |
| | 0188 | 85-90 | 58 | 0 |
| | 0189 | 90-95 | 48 | 0 |
| | 0191 | 95-100 | 44 | 0 |
| | 0191 | 100-105 | 20 | 0 |
| | 0192 | 105-110 | 20 | 0 |
| | * = Overburden | | | |
| H-12 | Hole started but too wet and abandoned | | | |
| H-13 | 0193 | 5-10 | 18 | 0 |
| | 0194 | 10-15 | 24 | 0 |
| | 0195 | 15-20 | 28 | 0 |
| | 0196 | 20-25 | 40 | 0 |
| | 0197 | 25-30 | 78 | 0 |
| | 0198 | 30-35 | 50 | 0 |
| | 0199 | 35-40 | 34 | 0 |
| | 0200 | 40-45 | 24 | 8 |
| | 0201 | 45-50 | 20 | 0 |
| | Encountered water | | | |
| H-14 | 0202 | 2-5 | 8 | 0 |
| | 0203 | 5-10 | 28 | 0 |
| | 0204 | 10-15 | 10 | 120 |
| | 0205 | 15-20 | 12 | 32 |
| | 0206 | 20-25 | 10 | 48 |
| | 0207 | 25-30 | 6 | 0 |
| | 0208 | 30-35 | 4 | 0 |
| | 0209 | 35-40 | 6 | 0 |
| | 0210 | 40-45 | 6 | 8 |
| | 0211 | 45-50 | 24 | 0 |
| | 0212 | 50-55 | 8 | 0 |
| | 0213 | 55-60 | 78 | 0 |
| | 0214 | 60-65 | 82 | 8 |
| | 0215 | 65-70 | 14 | 12 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-1 | 0400 | 10-15* | 210 | 12 |
| | 0401 | 15-20 | 38 | 0 |
| | 0402 | 20-25 | 32 | 0 |
| | 0403 | 25-30 | 38 | 0 |
| | 0404 | 30-35 | 16 | 0 |
| | 0405 | 35-40 | 22 | 0 |
| | 0406 | 40-45 | 18 | 0 |
| | 0407 | 45-50 | 32 | 0 |
| | 0408 | 50-55 | 40 | 0 |
| | 0409 | 55-60 | 26 | 0 |
| | 0410 | 60-65 | 22 | 0 |
| | 0411 | 65-70 | 26 | 0 |
| | 0412 | 70-75 | 24 | 0 |
| | 0413 | 75-80 | 64 | 8 |
| | 0414 | 80-85 | 34 | 8 |
| | 0415 | 85-90 | 66 | 0 |
| | 0416 | 90-95 | 24 | 0 |
| | 0417 | 95-100 | 24 | 0 |
| | 0418 | 100-105 | 24 | 0 |
| | 0419 | 105-110 | 34 | 0 |
| | 0420 | 110-115 | 24 | 0 |
| | 0421 | 115-120 | 14 | 0 |
| | 0422 | 120-125 | 18 | 20 |
| | 0423 | 125-130 | 46 | 12 |
| | 0424 | 130-135 | 28 | 12 |
| | 0425 | 135-140 | 22 | 8 |
| | 0426 | 140-147 | 16 | 0 |
| | * = Overburden | | | |
| HY-2 | 0427 | 22-27 | 44 | 0 |
| | 0428 | 27-32 | 16 | 0 |
| | 0429 | 32-37 | 56 | 0 |
| | 0430 | 37-42 | 56 | 0 |
| | 0431 | 42-47 | 26 | 0 |
| | 0432 | 47-52 | 30 | 8 |
| | 0433 | 52-57 | 42 | 8 |
| | 0434 | 57-62 | 60 | 8 |
| | 0435 | 62-67 | 34 | 8 |
| | 0436 | 67-72 | 32 | 0 |
| | 0437 | 72-77 | 26 | 0 |
| | 0438 | 77-82 | 20 | 0 |
| | 0439 | 82-87 | 20 | 8 |
| | 0440 | 87-92 | 20 | 8 |
| | 0441 | 92-97 | 20 | 8 |
| | 0442 | 97-102 | 20 | 8 |
| | 0443 | 102-107 | 20 | 8 |
| | 0444 | 107-112 | 20 | 8 |
| | 0445 | 112-117 | 14 | 0 |
| | 0446 | 117-122 | 28 | 0 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-2 | 0447 | 122-127 | 18 | 0 |
| (cont) | 0448 | 127-132 | 14 | 0 |
| | 0449 | 132-137 | 8 | 0 |
| | 0450 | 137-142 | 74 | 8 |
| | 0451 | 142-147 | 10 | 0 |
| | 0452 | 147-152 | 10 | 0 |
| | 0453 | 152-157 | 14 | 0 |
| | 0454 | 157-162 | 140 | 0 |
| | 0455 | 162-167 | 50 | 0 |
| | 0456 | 167-172 | 34 | 0 |
| | 0457 | 172-177 | 42 | 44 |
| HY-3 | 0458 | 15-17 | 24 | 0 |
| | 0459 | 17-22 | 16 | 0 |
| | 0460 | 22-27 | 20 | 0 |
| | 0461 | 27-32 | 24 | 8 |
| | 0462 | 32-37 | 18 | 8 |
| | 0463 | 37-42 | 22 | 0 |
| | 0464 | 42-47 | 32 | 0 |
| | 0465 | 47-52 | 30 | 0 |
| | 0466 | 52-57 | 18 | 0 |
| | 0467 | 57-62 | 12 | 8 |
| | 0468 | 62-67 | 16 | 12 |
| | 0469 | 67-72 | 24 | 8 |
| | 0470 | 72-77 | 22 | 8 |
| | 0471 | 77-82 | 30 | 0 |
| | 0472 | 82-87 | 24 | 0 |
| | 0473 | 87-92 | 14 | 0 |
| | 0474 | 92-97 | 10 | 0 |
| | 0475 | 97-102 | 20 | 0 |
| | 0476 | 102-107 | 8 | 0 |
| | 0477 | 107-112 | 10 | 0 |
| | 0478 | 112-117 | 12 | 0 |
| | 0479 | 117-122 | 18 | 0 |
| | 0480 | 122-127 | 12 | 0 |
| | 0481 | 127-132 | 16 | 0 |
| | 0482 | 132-137 | 56 | 0 |
| | 0483 | 137-142 | 20 | 8 |
| | 0484 | 142-147 | 32 | 0 |
| | 0485 | 147-152 | 40 | 0 |
| | 0486 | 152-157 | 24 | 0 |
| | 0487 | 157-162 | 24 | 0 |
| | 0488 | 162-167 | 14 | 0 |
| | 0489 | 167-172 | 12 | 8 |
| | 0490 | 172-177 | 18 | 8 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-4 | 0491 | 0-17* | 32 | 0 |
| | 0492 | 17-22 | 36 | 0 |
| | 0493 | 22-27 | 50 | 0 |
| | 0494 | 27-32 | 54 | 0 |
| | 0495 | 32-37 | 48 | 0 |
| | 0496 | 37-42 | 26 | 0 |
| | 0497 | 42-47 | 10 | 0 |
| | 0498 | 47-52 | 12 | 0 |
| | 0499 | 52-57 | 26 | 0 |
| | 0500 | 57-62 | 30 | 0 |
| | 0501 | 62-67 | 10 | 0 |
| | 0502 | 67-72 | 18 | 0 |
| | 0503 | 72-77 | 14 | 0 |
| | 0504 | 77-82 | 26 | 0 |
| | 0505 | 82-87 | 18 | 0 |
| | 0506 | 87-92 | 14 | 0 |
| | 0507 | 92-97 | 26 | 0 |
| | 0508 | 97-102 | 10 | 0 |
| | 0509 | 102-107 | 12 | 0 |
| | 0510 | 107-112 | 8 | 0 |
| | 0511 | 112-117 | 8 | 0 |
| | 0512 | 117-122 | 6 | 0 |
| | 0513 | 122-127 | 6 | 0 |
| | 0514 | 127-132 | 6 | 0 |
| | 0515 | 132-137 | 8 | 0 |
| | 0516 | 137-142 | 8 | 0 |
| | 0517 | 142-147 | 10 | 0 |
| | 0518 | 147-152 | 6 | 0 |
| | 0519 | 152-157 | 8 | 0 |
| | 0520 | 157-162 | 10 | 0 |
| | 0521 | 162-167 | 12 | 0 |
| | 0522 | 167-172 | 14 | 0 |
| | * = Overburden | | | |
| HY-5 | 0525 | 0-17* | 26 | 0 |
| | 0526 | 17-22 | 24 | 0 |
| | 0527 | 22-27 | 32 | 0 |
| | 0528 | 27-32 | 32 | 0 |
| | 0529 | 32-37 | 26 | 0 |
| | 0530 | 37-42 | 16 | 0 |
| | 0531 | 42-47 | 30 | 0 |
| | 0532 | 47-52 | 14 | 0 |
| | 0533 | 52-57 | 24 | 0 |
| | 0534 | 57-62 | 26 | 0 |
| | 0535 | 62-67 | 34 | 0 |
| | 0536 | 67-72 | 20 | 0 |
| | 0537 | 72-77 | 14 | 0 |
| | 0538 | 77-82 | 32 | 0 |
| | 0539 | 82-87 | 34 | 0 |
| HY-5 (cont) | 0540 | 87-92 | 30 | 0 |
| | 0541 | 92-97 | 32 | 0 |
| | 0542 | 97-102 | 34 | 0 |
| | 0543 | 102-107 | 18 | 0 |
| | 0544 | 107-112 | 32 | 0 |
| | 0545 | 112-117 | 48 | 0 |
| | 0546 | 117-122 | 50 | 0 |
| | 0547 | 122-127 | 26 | 0 |
| | 0548 | 127-132 | 22 | 0 |
| | 0549 | 132-137 | 26 | 0 |
| | 0550 | 137-142 | 28 | 0 |
| | 0551 | 142-147 | 26 | 0 |
| | 0552 | 147-152 | 44 | 0 |
| | 0553 | 152-157 | 24 | 0 |
| | 0554 | 157-162 | 24 | 0 |
| | 0555 | 162-167 | 6 | 0 |
| | 0556 | 167-172 | 8 | 0 |
| | 0557 | 172-177 | 24 | 0 |
| | * = Overburden | | | |
| HY-6 | 0558 | 12-17 | 22 | 0 |
| | 0559 | 17-22 | 10 | 0 |
| | 0560 | 22-27 | 20 | 0 |
| | 0561 | 27-32 | 20 | 0 |
| | 0562 | 32-37 | 26 | 0 |
| | 0563 | 37-42 | 24 | 0 |
| | 0564 | 42-47 | 16 | 0 |
| | 0565 | 47-52 | 16 | 0 |
| | 0566 | 52-57 | 26 | 0 |
| | 0567 | 57-62 | 46 | 0 |
| | 0568 | 62-67 | 20 | 0 |
| | 0569 | 67-72 | 14 | 0 |
| | 0570 | 72-77 | 16 | 0 |
| | 0571 | 77-82 | 20 | 0 |
| | 0572 | 82-87 | 18 | 0 |
| | 0573 | 87-92 | 28 | 0 |
| | 0574 | 92-97 | 26 | 0 |
| | 0575 | 97-102 | 16 | 0 |
| | 0576 | 102-107 | 14 | 0 |
| | 0577 | 107-112 | 12 | 0 |
| | 0578 | 112-117 | 26 | 0 |
| | 0579 | 117-122 | 20 | 0 |
| | 0580 | 122-127 | 28 | 0 |
| | 0581 | 127-132 | 30 | 0 |
| | 0582 | 132-137 | 36 | 0 |
| | 0583 | 137-142 | 14 | 0 |
| | 0584 | 142-147 | 30 | 0 |
| | 0585 | 147-152 | 24 | 0 |
| | 0586 | 152-157 | 40 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-6 | 0587 | 157-162 | 20 | 0 |
| (cont) | 0588 | 162-167 | 12 | 0 |
| | 0589 | 167-172 | 8 | 0 |
| | 0590 | 172-177 | 10 | 0 |
| HY-7 | 0591 | 8-17 | 70 | 0 |
| | 0592 | 17-22 | 58 | 0 |
| | 0593 | 22-27 | 48 | 0 |
| | 0594 | 27-32 | 26 | 0 |
| | 0595 | 32-37 | 40 | 0 |
| | 0596 | 37-42 | 48 | 0 |
| | 0597 | 42-47 | 40 | 0 |
| | 0598 | 47-52 | 16 | 0 |
| | 0599 | 52-57 | 10 | 0 |
| | 0600 | 57-62 | 18 | 0 |
| | 0601 | 62-67 | 24 | 0 |
| | 0602 | 67-72 | 52 | 0 |
| | 0603 | 72-77 | 26 | 0 |
| | 0604 | 77-82 | 20 | 0 |
| | 0605 | 82-87 | 24 | 32 |
| | 0606 | 87-92 | 66 | 0 |
| | 0607 | 92-97 | 50 | 0 |
| | 0608 | 97-102 | 32 | 40 |
| | 0609 | 102-107 | 36 | 0 |
| | 0610 | 107-112 | 24 | 0 |
| | 0611 | 112-117 | 34 | 8 |
| | 0612 | 117-122 | 26 | 0 |
| | 0613 | 122-127 | 18 | 0 |
| | 0614 | 127-132 | 36 | 0 |
| | 0615 | 132-137 | 40 | 0 |
| | 0616 | 137-142 | 58 | 0 |
| | 0617 | 142-147 | 62 | 0 |
| | 0618 | 147-152 | 52 | 0 |
| | 0619 | 152-157 | 42 | 0 |
| | 0620 | 157-162 | 30 | 0 |
| | 0621 | 162-167 | 52 | 0 |
| | 0622 | 167-172 | 40 | 0 |
| | 0623 | 172-177 | 26 | 0 |
| HY-8 | 0624 | 11-17 | 56 | 0 |
| | 0625 | 17-22 | 36 | 0 |
| | 0626 | 22-27 | 50 | 0 |
| | 0627 | 27-32 | 38 | 0 |
| | 0628 | 32-37 | 58 | 12 |
| | 0629 | 37-42 | 72 | 0 |
| | 0630 | 42-47 | 82 | 0 |
| | 0631 | 47-52 | 84 | 0 |
| | 0632 | 52-57 | 98 | 0 |
| | 0633 | 57-62 | 70 | 0 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-8 | 0634 | 62-67 | 104 | 0 |
| (cont) | 0635 | 67-72 | 106 | 8 |
| | 0636 | 72-77 | 94 | 0 |
| | 0637 | 77-82 | 120 | 0 |
| | 0638 | 82-87 | 84 | 0 |
| | 0639 | 87-92 | 50 | 0 |
| | 0640 | 92-97 | 88 | 0 |
| | 0641 | 97-102 | 102 | 0 |
| | 0642 | 102-107 | 106 | 20 |
| | 0643 | 107-112 | 240 | 40 |
| | 0644 | 112-117 | 94 | 0 |
| | 0645 | 117-122 | 170 | 0 |
| | 0646 | 122-127 | 340 | 24 |
| | 0647 | 127-132 | 270 | 0 |
| | 0648 | 132-137 | 160 | 0 |
| | 0649 | 137-142 | 120 | 8 |
| | 0650 | 142-147 | 130 | 0 |
| | 0651 | 147-152 | 110 | 0 |
| | 0652 | 152-157 | 116 | 0 |
| | 0653 | 157-162 | 114 | 0 |
| | 0654 | 162-167 | 106 | 12 |
| | 0655 | 167-172 | 84 | 0 |
| | 0656 | 172-177 | 70 | 12 |
| HY-9 | 0657 | 0-7* | 76 | 0 |
| | 0658 | 7-12 | 100 | 0 |
| | 0659 | 12-17 | 70 | 0 |
| | 0660 | 17-22 | 100 | 0 |
| | 0661 | 22-27 | 76 | 0 |
| | 0662 | 27-32 | 120 | 0 |
| | 0663 | 32-37 | 98 | 0 |
| | 0664 | 37-42 | 94 | 8 |
| | 0665 | 42-47 | 56 | 0 |
| | 0666 | 47-52 | 40 | 0 |
| | 0667 | 52-57 | 30 | 0 |
| | 0668 | 57-62 | 30 | 8 |
| | 0669 | 62-67 | 32 | 0 |
| | 0670 | 67-72 | 68 | 0 |
| | 0671 | 72-77 | 60 | 0 |
| | 0672 | 77-82 | 46 | 8 |
| | 0673 | 82-87 | 50 | 0 |
| | 0674 | 87-92 | 64 | 0 |
| | 0675 | 92-97 | 44 | 0 |
| | 0676 | 97-102 | 74 | 0 |
| | 0677 | 102-107 | 46 | 0 |
| | 0678 | 107-112 | 58 | 0 |
| | 0679 | 112-117 | 56 | 0 |
| | 0680 | 117-122 | 28 | 0 |
| | 0681 | 122-127 | 58 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-9 (cont) | 0682 | 127-132 | 40 | 0 |
| | 0683 | 132-137 | 40 | 0 |
| | 0684 | 137-142 | 78 | 0 |
| | 0685 | 142-147 | 104 | 8 |
| | 0686 | 147-152 | 102 | 8 |
| | 0687 | 152-157 | 80 | 8 |
| | * = Overburden | | | |
| | Water encountered at 137′ | | | |
| HY-10 | 0688 | 0-17* | 26 | 0 |
| | 0689 | 17-22 | 10 | 0 |
| | 0690 | 22-27 | 14 | 0 |
| | 0691 | 27-32 | 12 | 0 |
| | 0692 | 32-37 | 10 | 0 |
| | 0693 | 37-42 | 16 | 0 |
| | 0694 | 42-47 | 20 | 0 |
| | 0695 | 47-52 | 14 | 0 |
| | 0696 | 52-57 | 8 | 0 |
| | 0697 | 57-62 | 8 | 0 |
| | 0698 | 62-67 | 8 | 0 |
| | 0699 | 67-72 | 6 | 0 |
| | 0700 | 72-77 | 8 | 0 |
| | 0701 | 77-82 | 36 | 0 |
| | 0702 | 82-87 | 28 | 0 |
| | 0703 | 87-92 | 18 | 0 |
| | 0704 | 92-97 | 26 | 0 |
| | 0705 | 97-102 | 12 | 0 |
| | 0706 | 102-107 | 24 | 0 |
| | 0707 | 107-112 | 20 | 0 |
| | 0708 | 112-117 | 26 | 0 |
| | 0709 | 117-122 | 10 | 0 |
| | 0710 | 122-127 | 10 | 0 |
| | 0711 | 127-132 | 26 | 0 |
| | 0712 | 132-137 | 22 | 0 |
| | 0713 | 137-142 | 24 | 0 |
| | 0714 | 142-147 | 20 | 0 |
| | 0715 | 147-152 | 78 | 0 |
| | 0716 | 152-157 | 30 | 0 |
| | 0717 | 157-162 | 12 | 0 |
| | 0718 | 162-167 | 14 | 0 |
| | 0719 | 167-172 | 10 | 0 |
| | 0720 | 172-177 | 24 | 0 |
| | * = Overburden | | | |
| HY-11 | 0721 | 12-17 | 24 | 0 |
| | 0722 | 17-22 | 30 | 0 |
| | 0723 | 22-27 | 30 | 0 |
| | 0724 | 27-32 | 16 | 0 |
| | 0725 | 32-37 | 18 | 0 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-11 (cont) | 0726 | 37-42 | 10 | 0 |
| | 0727 | 42-47 | 10 | 0 |
| | 0728 | 47-52 | 16 | 0 |
| | 0729 | 52-57 | 92 | 0 |
| | 0730 | 57-62 | 42 | 0 |
| | 0731 | 62-67 | 76 | 0 |
| | 0732 | 67-72 | 46 | 0 |
| | 0733 | 72-77 | 64 | 0 |
| | 0734 | 77-82 | 58 | 0 |
| | 0735 | 82-87 | 58 | 0 |
| | 0736 | 87-92 | 28 | 0 |
| | 0737 | 92-97 | 36 | 0 |
| | 0738 | 97-102 | 54 | 0 |
| | 0739 | 102-107 | 22 | 0 |
| | 0740 | 107-112 | 68 | 0 |
| | 0741 | 112-117 | 30 | 0 |
| | 0742 | 117-122 | 48 | 0 |
| | 0743 | 122-127 | 20 | 0 |
| | 0744 | 127-132 | 22 | 0 |
| | 0745 | 132-137 | 26 | 0 |
| | 0746 | 137-142 | 26 | 0 |
| | 0747 | 142-147 | 34 | 0 |
| | 0748 | 147-152 | 28 | 0 |
| | 0749 | 152-157 | 22 | 0 |
| | 0750 | 157-162 | 24 | 0 |
| | 0751 | 162-167 | 30 | 0 |
| | 0752 | 167-172 | 58 | 0 |
| | 0753 | 172-177 | 56 | 0 |
| HY-12 | 0754 | 12-17 | 160 | 0 |
| | 0755 | 17-22 | 190 | 0 |
| | 0756 | 22-27 | 180 | 0 |
| | 0757 | 27-32 | 118 | 0 |
| | 0758 | 32-37 | 170 | 0 |
| | 0759 | 37-42 | 220 | 0 |
| | 0760 | 42-47 | 96 | 0 |
| | 0761 | 47-52 | 200 | 0 |
| | 0762 | 52-57 | 240 | 0 |
| | 0763 | 57-62 | 200 | 0 |
| | 0764 | 62-67 | 190 | 0 |
| | 0765 | 67-72 | 190 | 0 |
| | 0766 | 72-77 | 160 | 0 |
| | 0767 | 77-82 | 370 | 12 |
| | 0768 | 82-87 | 190 | 0 |
| | 0769 | 87-92 | 220 | 0 |
| | 0770 | 92-97 | 230 | 0 |
| | 0771 | 97-102 | 270 | 0 |
| | 0772 | 102-107 | 340 | 0 |
| | 0773 | 107-112 | 280 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-12 | 0774 | 112-117 | 240 | 0 |
| (cont) | 0775 | 117-122 | 250 | 0 |
| | 0776 | 122-127 | 230 | 0 |
| | 0777 | 127-132 | 84 | 0 |
| | 0778 | 132-137 | 88 | 0 |
| | 0779 | 137-142 | 120 | 0 |
| | 0780 | 142-147 | 90 | 0 |
| | 0781 | 147-152 | 250 | 0 |
| | 0782 | 152-157 | 140 | 0 |
| | 0783 | 157-162 | 180 | 0 |
| | 0784 | 162-167 | 200 | 0 |
| | 0785 | 167-172 | 104 | 0 |
| | 0786 | 172-177 | 104 | 0 |
| HY-13 | 0787 | 10-17 | 26 | 0 |
| | 0788 | 17-22 | 34 | 0 |
| | 0789 | 22-27 | 34 | 0 |
| | 0790 | 27-32 | 16 | 0 |
| | 0791 | 32-37 | 32 | 0 |
| | 0792 | 37-42 | 200 | 0 |
| | 0793 | 42-47 | 44 | 0 |
| | 0794 | 47-52 | 66 | 0 |
| | 0795 | 52-57 | 68 | 0 |
| | 0796 | 57-62 | 30 | 0 |
| | 0797 | 62-67 | 30 | 0 |
| | 0798 | 67-72 | 22 | 0 |
| | 0799 | 72-77 | 40 | 0 |
| | 0800 | 77-82 | 52 | 0 |
| | 0801 | 82-87 | 68 | 0 |
| | 0802 | 87-92 | 52 | 0 |
| | 0803 | 92-97 | 114 | 0 |
| | 0804 | 97-102 | 190 | 0 |
| | 0805 | 102-107 | 290 | 0 |
| | | 107-112 | No sample | |
| | | 112-117 | No sample | |
| | 0808 | 117-122 | 76 | 0 |
| | 0809 | 122-127 | 86 | 0 |
| | 0810 | 127-132 | 74 | 0 |
| | 0811 | 132-137 | 64 | 0 |
| | 0812 | 137-142 | 114 | 0 |
| | 0813 | 142-147 | 120 | 0 |
| | 0814 | 147-152 | 106 | 0 |
| | 0815 | 152-157 | 250 | 0 |
| | 0816 | 157-162 | 210 | 0 |
| | 0817 | 162-167 | 106 | 0 |
| | 0818 | 167-172 | 112 | 0 |
| | 0819 | 172-177 | 380 | 80 |
| | Encountered water at 107 | | | |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-14 | 0820 | 12-17 | 84 | 5 |
| | 0821 | 17-22 | 160 | 0 |
| | 0822 | 22-27 | 78 | 0 |
| | 0823 | 27-32 | 74 | 0 |
| | 0824 | 32-37 | 80 | 0 |
| | 0825 | 37-42 | 60 | 0 |
| | 0826 | 42-47 | 34 | 0 |
| | 0827 | 47-52 | 46 | 10 |
| | 0828 | 52-57 | 34 | 0 |
| | 0829 | 57-62 | 70 | 0 |
| | 0830 | 62-67 | 64 | 0 |
| | 0831 | 67-72 | 44 | 0 |
| | 0832 | 72-77 | 52 | 5 |
| | 0833 | 77-82 | 52 | 0 |
| | 0834 | 82-87 | 72 | 0 |
| | 0835 | 87-92 | 44 | 0 |
| | 0836 | 92-97 | 54 | 0 |
| | 0837 | 97-102 | 70 | 0 |
| | 0838 | 102-107 | 84 | 0 |
| | 0839 | 107-112 | 50 | 0 |
| | 0840 | 112-117 | 64 | 0 |
| | 0841 | 117-122 | 72 | 0 |
| | 0842 | 122-127 | 76 | 0 |
| | 0843 | 127-132 | 68 | 0 |
| | 0844 | 132-137 | 62 | 5 |
| | 0845 | 137-142 | 66 | 0 |
| | 0846 | 142-147 | 58 | 0 |
| | 0847 | 147-152 | 64 | 10 |
| | 0848 | 152-157 | 52 | 5 |
| | 0849 | 157-162 | 56 | 5 |
| | 0850 | 162-167 | 66 | 0 |
| | 0851 | 167-172 | 80 | 0 |
| | 0852 | 172-177 | 130 | 0 |
| HY-15 | 0853 | 12-17 | 74 | 0 |
| | 0854 | 17-22 | 58 | 0 |
| | 0855 | 22-27 | 60 | 10 |
| | 0856 | 27-32 | 32 | 0 |
| | 0857 | 32-37 | 28 | 0 |
| | 0858 | 37-42 | 22 | 0 |
| | 0859 | 42-47 | 30 | 0 |
| | 0860 | 47-52 | 32 | 0 |
| | 0861 | 52-57 | 88 | 0 |
| | 0862 | 57-62 | 28 | 5 |
| | 0863 | 62-67 | 18 | 0 |
| | 0864 | 67-72 | 60 | 0 |
| | 0865 | 72-77 | 40 | 5 |
| | 0866 | 77-82 | 38 | 0 |
| | 0867 | 82-87 | 50 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-15 (cont) | 0868 | 87-92 | 64 | 0 |
| | 0869 | 92-97 | 38 | 0 |
| | 0870 | 97-102 | 130 | 0 |
| | 0871 | 102-107 | 80 | 0 |
| | 0872 | 107-112 | 54 | 0 |
| | 0873 | 112-117 | 56 | 0 |
| | 0874 | 117-122 | 18 | 0 |
| | 0875 | 122-127 | 14 | 0 |
| | 0876 | 127-132 | 52 | 5 |
| | 0877 | 132-137 | 58 | 5 |
| | 0878 | 137-142 | 28 | 0 |
| | 0879 | 142-147 | 28 | 0 |
| | 0880 | 147-152 | 14 | 0 |
| | 0881 | 152-157 | 22 | 0 |
| | 0882 | 157-162 | 30 | 5 |
| | 0883 | 162-167 | 34 | 0 |
| | 0884 | 167-172 | 100 | 0 |
| | 0885 | 172-177 | 80 | 0 |
| HY-16 | 0887 | 12-17 | 30 | 0 |
| | 0888 | 17-22 | 26 | 5 |
| | 0889 | 22-27 | 16 | 0 |
| | 0890 | 27-32 | 22 | 0 |
| | 0891 | 32-37 | 64 | 0 |
| | 0892 | 37-42 | 66 | 0 |
| | 0893 | 42-47 | 48 | 0 |
| | 0894 | 47-52 | 40 | 5 |
| | 0895 | 52-57 | 44 | 0 |
| | 0896 | 57-62 | 14 | 5 |
| | 0897 | 62-67 | 16 | 0 |
| | 0898 | 67-72 | 14 | 0 |
| | 0899 | 72-77 | 20 | 0 |
| | 0900 | 77-82 | 10 | 0 |
| | 0901 | 82-87 | 18 | 5 |
| | 0902 | 87-92 | 24 | 0 |
| | 0903 | 92-97 | 32 | 5 |
| | 0904 | 97-102 | 22 | 5 |
| | 0905 | 102-107 | 22 | 5 |
| | 0906 | 107-112 | 310 | 10 |
| | 0907 | 112-117 | 16 | 5 |
| | 0908 | 117-122 | 12 | 5 |
| | 0909 | 122-127 | 18 | 5 |
| | 0910 | 127-132 | 14 | 0 |
| | 0911 | 132-137 | 26 | 0 |
| | 0912 | 137-142 | 10 | 0 |
| | 0913 | 142-147 | 18 | 5 |
| | 0914 | 147-152 | 12 | 5 |
| | 0915 | 152-157 | 24 | 5 |
| | 0916 | 157-162 | 40 | 0 |
| HY-16 (cont) | 0917 | 162-167 | 40 | 10 |
| | 0918 | 167-172 | 42 | 10 |
| | 0919 | 172-177 | 32 | 0 |
| HY-17 | 0920 | 7-12 | 10 | 0 |
| | 0921 | 12-17 | 24 | 0 |
| | 0922 | 17-22 | 36 | 0 |
| | 0923 | 22-27 | 12 | 0 |
| | 0924 | 27-32 | 12 | 0 |
| | 0925 | 32-37 | 20 | 0 |
| | 0926 | 37-42 | 18 | 5 |
| | 0927 | 42-47 | 26 | 5 |
| | 0928 | 47-52 | 26 | 0 |
| | 0929 | 52-57 | 20 | 0 |
| | 0930 | 57-62 | 10 | 0 |
| | 0931 | 62-67 | 6 | 5 |
| | 0932 | 67-72 | 6 | 0 |
| | 0933 | 72-77 | 38 | 0 |
| | 0934 | 77-82 | 78 | 0 |
| | 0935 | 82-87 | 22 | 0 |
| | 0936 | 87-92 | 46 | 0 |
| | 0937 | 92-97 | 66 | 15 |
| | 0938 | 97-102 | 58 | 5 |
| | 0939 | 102-107 | 40 | 5 |
| | 0940 | 107-112 | 58 | 0 |
| | 0941 | 112-117 | 62 | 0 |
| | 0942 | 117-122 | 68 | 5 |
| | 0943 | 122-127 | 90 | 5 |
| | 0944 | 127-132 | 56 | 0 |
| | 0945 | 132-137 | 130 | 0 |
| | 0946 | 137-142 | 180 | 0 |
| | 0947 | 142-147 | 90 | 0 |
| | 0948 | 147-152 | 84 | 0 |
| | 0949 | 152-157 | 88 | 5 |
| | 0950 | 157-162 | 100 | 0 |
| | 0951 | 162-167 | 88 | 0 |
| | 0952 | 167-172 | 36 | 0 |
| | 0953 | 172-177 | 74 | 5 |
| HY-18 | 0955 | 12-17 | 90 | 0 |
| | 0956 | 17-22 | 86 | 0 |
| | 0957 | 22-27 | 58 | 0 |
| | 0958 | 27-32 | 68 | 0 |
| | 0959 | 32-37 | 86 | 0 |
| | 0960 | 37-42 | 100 | 0 |
| | 0961 | 42-47 | 88 | 0 |
| | 0962 | 47-52 | 170 | 0 |
| | 0963 | 52-57 | 116 | 0 |
| | 0964 | 57-62 | 140 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-18 (cont) | 0965 | 62-67 | 220 | 0 |
| | 0966 | 67-72 | 98 | 0 |
| | 0967 | 72-77 | 96 | 5 |
| | 0968 | 77-82 | 130 | 10 |
| | 0969 | 82-87 | 88 | 10 |
| | 0970 | 87-92 | 82 | 5 |
| | 0971 | 92-97 | 54 | 5 |
| | | 97-102 | No sample | |
| | | 102-107 | No sample | |
| | 0974 | 107-112 | 60 | 5 |
| | 0975 | 112-117 | 84 | 5 |
| | 0976 | 117-122 | 54 | 0 |
| | 0977 | 122-127 | 36 | 0 |
| | 0978 | 127-132 | 42 | 0 |
| | 0979 | 132-137 | 46 | 0 |
| | 0980 | 137-142 | 62 | 0 |
| | 0981 | 142-147 | 92 | 0 |
| | 0982 | 147-152 | 56 | 0 |
| | 0983 | 152-157 | 44 | 5 |
| | 0984 | 157-162 | 30 | 5 |
| | | 162-167 | No sample | |
| | 0986 | 167-172 | 48 | 5 |
| | 0987 | 172-177 | 36 | 5 |
| | Encountered water at 97 | | | |
| HY-19 | 0333 | 12-17 | 160 | 0 |
| | 0988 | 17-22 | 120 | 0 |
| | 0989 | 22-27 | 72 | 0 |
| | 0990 | 27-32 | 72 | 0 |
| | 0991 | 32-37 | 60 | 0 |
| | 0992 | 37-42 | 66 | 0 |
| | 0993 | 42-47 | 38 | 0 |
| | 0994 | 47-52 | 34 | 0 |
| | 0995 | 52-57 | 36 | 0 |
| | 0996 | 57-62 | 38 | 0 |
| | 0997 | 62-67 | 54 | 0 |
| | 0998 | 67-72 | 48 | 0 |
| | 0999 | 72-77 | 62 | 0 |
| | 1000 | 77-82 | 44 | 0 |
| | 1001 | 82-87 | 38 | 0 |
| | 1002 | 87-92 | 34 | 5 |
| | 1003 | 92-97 | 60 | 5 |
| | 1004 | 97-102 | 30 | 0 |
| | 1005 | 102-107 | 14 | 0 |
| | 1006 | 107-112 | 16 | 0 |
| | 1007 | 112-117 | 36 | 5 |
| | 1008 | 117-122 | 32 | 0 |
| | 1009 | 122-127 | 24 | 0 |
| | 1010 | 127-132 | 28 | 5 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-19 (cont) | 1011 | 132-137 | 38 | 0 |
| | 1012 | 137-142 | 28 | 0 |
| | 1013 | 142-147 | 34 | 0 |
| | 1014 | 147-152 | 100 | 0 |
| | 1015 | 152-157 | 68 | 0 |
| | 1016 | 157-162 | 110 | 0 |
| | 1017 | 162-167 | 1000 | 0 |
| | 1018 | 167-172 | 460 | 10 |
| | 1019 | 172-177 | 110 | 5 |
| HY-20 | 1020 | 12-17 | 150 | 15 |
| | 1021 | 17-22 | 180 | 5 |
| | 1022 | 22-27 | 44 | 0 |
| | 1023 | 27-32 | 28 | 0 |
| | 1024 | 32-37 | 32 | 0 |
| | 1025 | 37-42 | 58 | 0 |
| | 1026 | 42-47 | 44 | 0 |
| | 1027 | 47-52 | 44 | 5 |
| | 1028 | 52-57 | 34 | 5 |
| | 1029 | 57-62 | 22 | 0 |
| | 1030 | 62-67 | 34 | 0 |
| | 1031 | 67-72 | 48 | 5 |
| | 1032 | 72-77 | 18 | 10 |
| | 1033 | 77-82 | 16 | 5 |
| | 1034 | 82-87 | 14 | 0 |
| | 1035 | 87-92 | 30 | 0 |
| | 1036 | 92-97 | 22 | 0 |
| | 1037 | 97-102 | 14 | 0 |
| | 1038 | 102-107 | 68 | 0 |
| | 1039 | 107-112 | 52 | 5 |
| | 1040 | 112-117 | 52 | 5 |
| | 1041 | 117-122 | 38 | 5 |
| | 1042 | 122-127 | 40 | 5 |
| | 1043 | 127-132 | 66 | 10 |
| | 1044 | 132-137 | 84 | 5 |
| | 1045 | 137-142 | 54 | 5 |
| | 1046 | 142-147 | 36 | 10 |
| | 1047 | 147-152 | 38 | 5 |
| | 1048 | 152-157 | 26 | 5 |
| | 1049 | 157-162 | 26 | 0 |
| | 1050 | 162-167 | 24 | 0 |
| | 1051 | 167-172 | 12 | 0 |
| | 1052 | 172-177 | 18 | 5 |
| HY-21 | 1053 | 12-17 | 38 | 5 |
| | 1054 | 17-22 | 118 | 0 |
| | 1055 | 22-27 | 68 | 0 |
| | 1056 | 27-32 | 108 | 5 |
| | 1057 | 32-37 | 54 | 0 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-21 | 1058 | 37-42 | 160 | 0 |
| (cont) | 1059 | 42-47 | 74 | 0 |
| | 1060 | 47-52 | 66 | 0 |
| | 1061 | 52-57 | 82 | 0 |
| | 1062 | 57-62 | 220 | 0 |
| | 1063 | 62-67 | 240 | 0 |
| | 1064 | 67-72 | 280 | 5 |
| | 1065 | 72-77 | 200 | 0 |
| | 1066 | 77-82 | 300 | 0 |
| | 1067 | 82-87 | 140 | 0 |
| | 1068 | 87-92 | 68 | 0 |
| | 1069 | 92-97 | 180 | 5 |
| | 1070 | 97-102 | 100 | 0 |
| | 1071 | 102-107 | 30 | 0 |
| | 1072 | 107-112 | 26 | 0 |
| | 1073 | 112-117 | 34 | 0 |
| | 1074 | 117-122 | 26 | 0 |
| | 1075 | 122-127 | 68 | 0 |
| | 1076 | 127-132 | 62 | 0 |
| | 1077 | 132-137 | 118 | 0 |
| | 1078 | 137-142 | 50 | 0 |
| | | 142-147 | No sample | |
| | 1080 | 147-152 | 110 | 0 |
| | 1081 | 152-157 | 42 | 0 |
| | 1082 | 157-162 | 66 | 0 |
| | 1083 | 162-167 | 76 | 0 |
| | 1084 | 167-172 | 170 | 0 |
| | 1085 | 172-177 | 64 | 0 |
| HY-22 | 1086 | 12-17 | 28 | 5 |
| | 1087 | 17-22 | 64 | 0 |
| | 1088 | 22-27 | 90 | 0 |
| | 1089 | 27-32 | 78 | 10 |
| | 1090 | 32-37 | 78 | 5 |
| | 1091 | 37-42 | 68 | 0 |
| | 1092 | 42-47 | 90 | 0 |
| | 1093 | 47-52 | 70 | 0 |
| | 1094 | 52-57 | 64 | 0 |
| | 1095 | 57-62 | 54 | 0 |
| | 1096 | 62-67 | 66 | 5 |
| | 1097 | 67-72 | 70 | 0 |
| | 1098 | 72-77 | 66 | 0 |
| | 1099 | 77-82 | 68 | 0 |
| | 1100 | 82-87 | 28 | 0 |
| | 1101 | 87-92 | 42 | 5 |
| | 1102 | 92-97 | 68 | 0 |
| | 1103 | 97-102 | 108 | 5 |
| | 1104 | 102-107 | 108 | 5 |
| | 1105 | 107-112 | 80 | 5 |

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-22 | 1106 | 112-117 | 100 | 10 |
| (cont) | 1107 | 117-122 | 108 | 5 |
| | 1108 | 122-127 | 90 | 0 |
| | 1109 | 127-132 | 86 | 0 |
| | 1110 | 132-137 | 84 | 10 |
| | Encountered water | | | |
| HY-23 | 1111 | 0-17* | 16 | 0 |
| | 1112 | 17-22 | 18 | 0 |
| | 1113 | 22-27 | 36 | 0 |
| | 1114 | 27-32 | 24 | 0 |
| | 1115 | 32-37 | 46 | 0 |
| | 1116 | 37-42 | 36 | 0 |
| | 1117 | 42-47 | 38 | 15 |
| | 1118 | 47-52 | 90 | 0 |
| | 1119 | 52-57 | 86 | 10 |
| | Encountered water | | | |
| | * = Overburden | | | |
| HY-24 | 1120 | 0-10* | 12 | 0 |
| | 1121 | 10-17 | 6 | 0 |
| | 1122 | 17-22 | 6 | 0 |
| | 1123 | 22-27 | 6 | 0 |
| | 1124 | 27-32 | 52 | 15 |
| | 1125 | 32-37 | 32 | 0 |
| | 1126 | 37-42 | 12 | 0 |
| | 1127 | 42-47 | 8 | 0 |
| | 1128 | 47-52 | 64 | 0 |
| | 1129 | 52-57 | 28 | 0 |
| | 1130 | 57-62 | 106 | 5 |
| | 1131 | 62-67 | 140 | 0 |
| | 1132 | 67-72 | 70 | 0 |
| | 1133 | 72-77 | 40 | 5 |
| | 1134 | 77-82 | 70 | 5 |
| | 1135 | 82-87 | 48 | 10 |
| | 1136 | 87-92 | 82 | 10 |
| | 1137 | 92-97 | 60 | 10 |
| | 1138 | 97-102 | 84 | 10 |
| | 1139 | 102-107 | 150 | 5 |
| | 1140 | 107-112 | 140 | 5 |
| | 1141 | 112-117 | 68 | 10 |
| | 1142 | 117-122 | 56 | 0 |
| | 1143 | 122-127 | 96 | 0 |
| | 1144 | 127-132 | 150 | 0 |
| | 1145 | 132-137 | 160 | 5 |
| | 1146 | 137-142 | 210 | 10 |
| | 1147 | 142-147 | 230 | 10 |
| | 1148 | 147-152 | 108 | 0 |
| | 1149 | 152-157 | 88 | 5 |

Appendix 1 (cont.)

| Drill hole | Sample XHM | Depth ft. | Cu ppm | Mo ppm |
|---|---|---|---|---|
| HY-24 | 1150 | 157-162 | 94 | 10 |
| (cont) | 1151 | 162-167 | 200 | 10 |
| | 1152 | 167-172 | 160 | 0 |
| | 1153 | 172-177 | 170 | 10 |
| | * = Overburden | | | |
| HY-25 | 1154 | 12-17 | 114 | 10 |
| | 1155 | 17-22 | 200 | 20 |
| | 1156 | 22-27 | 106 | 10 |
| | 1157 | 27-32 | 250 | 10 |
| | 1158 | 32-37 | 118 | 20 |
| | 1159 | 37-42 | 34 | 0 |
| | 1160 | 42-47 | 44 | 5 |
| | 1161 | 47-52 | 50 | 5 |
| | 1162 | 52-57 | 54 | 5 |
| | 1163 | 57-62 | 72 | 0 |
| | 1164 | 62-67 | 108 | 0 |
| | 1165 | 67-72 | 26 | 0 |
| | 1166 | 72-77 | 50 | 0 |
| | 1167 | 77-82 | 114 | 0 |
| | 1168 | 82-87 | 108 | 0 |
| | 1169 | 87-92 | 60 | 0 |
| | 1170 | 92-97 | 40 | 0 |
| | 1171 | 97-102 | 38 | 0 |
| | 1172 | 102-107 | 30 | 0 |
| | 1173 | 107-112 | 16 | 0 |
| | 1174 | 112-117 | 42 | 5 |
| | 1175 | 117-122 | 58 | 5 |
| | 1176 | 122-127 | 54 | 15 |
| | 1177 | 127-132 | 34 | 10 |
| | 1178 | 132-137 | 42 | 0 |
| | 1179 | 137-142 | 34 | 0 |
| | 1180 | 142-147 | 60 | 5 |
| | 1181 | 147-152 | 34 | 5 |
| | 1182 | 152-157 | 66 | 5 |
| | 1183 | 157-162 | 104 | 5 |
| | 1184 | 162-167 | 104 | 0 |
| | 1185 | 167-172 | 104 | 5 |
| | 1186 | 172-177 | 102 | 5 |
| HA-1 | 2001 | 10-15 | 78 | 5 |
| | 2002 | 15-20 | 48 | 5 |
| | 2003 | 20-25 | 30 | 10 |
| | 2004 | 25-30 | 56 | 0 |
| | 2005 | 30-35 | 106 | 0 |
| | 2006 | 35-40 | 140 | 0 |
| HA-1 | 2007 | 40-45 | 80 | 0 |
| (cont) | 2008 | 45-50 | 86 | 5 |
| | 2009 | 50-55 | 64 | 0 |
| | 2010 | 55-60 | 42 | 0 |
| | 2011 | 60-65 | 104 | 5 |
| | 2012 | 65-70 | 114 | 5 |
| | 2013 | 70-75 | 94 | 5 |
| | 2014 | 75-80 | 60 | 0 |
| | 2015 | 80-85 | 80 | 0 |
| | 2016 | 85-90 | 96 | 0 |
| | | Encountered water | | |
| HA-2 | 2019 | 5-10 | 52 | 5 |
| | 2020 | 10-15 | 40 | 0 |
| | 2021 | 15-20 | 28 | 0 |
| | 2022 | 20-25 | 28 | 0 |
| | 2023 | 25-30 | 60 | 0 |
| | 2024 | 30-35 | 74 | 5 |
| | 2025 | 35-40 | 120 | 0 |
| | 2026 | 40-45 | 82 | 10 |
| | 2027 | 45-50 | 94 | 5 |
| | 2028 | 50-55 | 50 | 0 |
| | 2029 | 55-60 | 76 | 0 |
| | 2030 | 60-65 | 52 | 0 |
| | 2031 | 65-70 | 24 | 0 |
| | 2032 | 70-75 | 56 | 0 |
| | 2033 | 75-80 | 40 | 0 |
| | 2034 | 80-85 | 34 | 0 |
| | 2035 | 85-90 | 18 | 0 |
| | 2036 | 90-95 | 30 | 0 |
| | 2037 | 95-100 | 32 | 0 |
| HA-3 | 2038 | 5-10 | 22 | 0 |
| | 2039 | 10-15 | 30 | 0 |
| | 2040 | 15-20 | 10 | 5 |
| | 2041 | 20-25 | 22 | 0 |
| | 2042 | 25-30 | 28 | 0 |
| | 2043 | 30-35 | 44 | 5 |
| | 2044 | 35-40 | 24 | 20 |
| | 2045 | 40-45 | 34 | 5 |
| | 2046 | 45-50 | 18 | 0 |
| | 2047 | 50-55 | 16 | 0 |
| | 2048 | 55-60 | 40 | 5 |
| | 2049 | 60-65 | 16 | 0 |
| | 2050 | 65-70 | 12 | 5 |
| | 2051 | 70-75 | 20 | 5 |

APPENDIX 2. Multi-element XRF analyses of percussion drill samples

| XHR | Ce | Ba | Sn | Pb | Zn | Cu | Ca | Ni | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|
| 1112 | 134 | 625 | 6 | 68 | 36 | 18 | 6520 | 14 | 21900 | 250 |
| 1113 | 123 | 555 | 6 | 68 | 43 | 34 | 6580 | 14 | 21450 | 190 |
| 1114 | 113 | 601 | 10 | 64 | 27 | 18 | 7490 | 13 | 19880 | 210 |
| 1115 | 139 | 573 | 8 | 69 | 30 | 35 | 6740 | 15 | 21020 | 260 |
| 1116 | 138 | 604 | 15 | 75 | 34 | 35 | 7270 | 17 | 20830 | 260 |
| 1117 | 122 | 591 | 6 | 136 | 75 | 35 | 7520 | 16 | 21590 | 240 |
| 1118 | 118 | 581 | 11 | 108 | 60 | 77 | 7660 | 17 | 21680 | 250 |
| 1119 | 149 | 625 | 11 | 117 | 69 | 82 | 7910 | 22 | 24520 | 280 |
| 1120 | 99 | 554 | 13 | 70 | 45 | 11 | 6390 | 15 | 23420 | 240 |
| 1121 | 111 | 598 | 3 | 61 | 31 | 5 | 6980 | 13 | 23050 | 310 |
| 1122 | 146 | 586 | 8 | 61 | 26 | 4 | 7700 | 15 | 21100 | 280 |
| 1123 | 117 | 631 | 6 | 53 | 27 | 4 | 8020 | 14 | 21610 | 220 |
| 1124 | 105 | 569 | 8 | 253 | 121 | 52 | 6750 | 14 | 23100 | 180 |
| 1125 | 108 | 593 | 7 | 64 | 33 | 29 | 7440 | 13 | 19880 | 230 |
| 1126 | 115 | 647 | 9 | 70 | 32 | 12 | 8060 | 14 | 20270 | 270 |
| 1127 | 143 | 610 | 5 | 57 | 33 | 8 | 9690 | 17 | 23890 | 290 |
| 1128 | 105 | 529 | 5 | 78 | 41 | 58 | 7420 | 13 | 20960 | 260 |
| 1129 | 125 | 592 | 6 | 71 | 43 | 24 | 7780 | 15 | 20720 | 260 |
| 1130 | 135 | 608 | 7 | 79 | 39 | 78 | 8280 | 15 | 21200 | 260 |
| 1131 | 115 | 590 | 9 | 80 | 51 | 135 | 8570 | 16 | 21560 | 260 |
| 1132 | 136 | 590 | 6 | 72 | 53 | 77 | 8760 | 16 | 22150 | 260 |
| 1133 | 138 | 608 | 9 | 61 | 31 | 42 | 8610 | 15 | 22190 | 250 |
| 1134 | 110 | 571 | 12 | 72 | 32 | 62 | 8690 | 17 | 23600 | 250 |
| 1135 | 113 | 608 | 7 | 58 | 25 | 43 | 8490 | 15 | 22500 | 220 |
| 1136 | 138 | 578 | 8 | 66 | 26 | 80 | 8900 | 15 | 22850 | 230 |
| 1137 | 131 | 598 | 5 | 52 | 31 | 52 | 9900 | 17 | 23590 | 240 |
| 1138 | 118 | 584 | 13 | 62 | 33 | 53 | 9230 | 15 | 22970 | 240 |
| 1139 | 118 | 599 | 10 | 64 | 28 | 116 | 8680 | 16 | 22310 | 220 |
| 1140 | 123 | 584 | 4 | 81 | 34 | 113 | 9110 | 17 | 23580 | 230 |
| 1141 | 137 | 593 | 14 | 52 | 29 | 57 | 9110 | 16 | 23230 | 240 |
| 1142 | 125 | 600 | 15 | 61 | 30 | 47 | 8810 | 18 | 22210 | 240 |
| 1143 | 116 | 579 | 13 | 56 | 25 | 85 | 8290 | 16 | 21530 | 220 |
| 1144 | 136 | 576 | 8 | 50 | 20 | 114 | 8120 | 13 | 20620 | 200 |
| 1145 | 132 | 565 | 8 | 56 | 22 | 130 | 8840 | 13 | 20790 | 200 |
| 1146 | 107 | 577 | 5 | 69 | 28 | 192 | 8490 | 14 | 21630 | 220 |
| 1147 | 118 | 564 | 16 | 74 | 34 | 202 | 8900 | 15 | 22990 | 220 |
| 1148 | 125 | 596 | 13 | 58 | 25 | 96 | 8910 | 13 | 21550 | 230 |
| 1149 | 108 | 611 | 4 | 58 | 24 | 78 | 8540 | 13 | 21220 | 220 |
| 1150 | 127 | 583 | 8 | 58 | 24 | 100 | 8630 | 16 | 21390 | 220 |
| 1151 | 107 | 595 | 11 | 76 | 25 | 177 | 8950 | 15 | 22130 | 230 |
| 1152 | 134 | 632 | 9 | 66 | 24 | 167 | 8460 | 14 | 21170 | 220 |
| 1153 | 117 | 603 | 11 | 60 | 27 | 150 | 9200 | 18 | 22640 | 250 |

APPENDIX 2 (cont.)

| XHR | Ti | U | Rb | Th | Nb | Sr | Zr | Y | Mo |
|---|---|---|---|---|---|---|---|---|---|
| 1112 | 3380 | 6 | 330 | 42 | 19 | 343 | 343 | 21 | 3 |
| 1113 | 3380 | 10 | 328 | 43 | 20 | 337 | 268 | 17 | 4 |
| 1114 | 3000 | 9 | 324 | 38 | 16 | 347 | 299 | 19 | 6 |
| 1115 | 3220 | 14 | 312 | 37 | 18 | 325 | 307 | 19 | 2 |
| 1116 | 3190 | 17 | 325 | 46 | 20 | 330 | 320 | 20 | 3 |
| 1117 | 3330 | 15 | 311 | 42 | 19 | 334 | 310 | 16 | 16 |
| 1118 | 3260 | 14 | 321 | 52 | 21 | 330 | 306 | 21 | 7 |
| 1119 | 3620 | 17 | 326 | 59 | 25 | 341 | 355 | 20 | 21 |
| 1120 | 3500 | 12 | 323 | 45 | 20 | 344 | 398 | 20 | 3 |
| 1121 | 3370 | 5 | 307 | 49 | 20 | 354 | 447 | 20 | 4 |
| 1122 | 3190 | 6 | 332 | 44 | 20 | 361 | 410 | 21 | 3 |
| 1123 | 3170 | 7 | 306 | 41 | 20 | 384 | 401 | 19 | 5 |
| 1124 | 3250 | 16 | 307 | 45 | 16 | 322 | 351 | 16 | 25 |
| 1125 | 3090 | 6 | 312 | 44 | 19 | 353 | 381 | 23 | 3 |
| 1126 | 3170 | 7 | 302 | 36 | 19 | 370 | 375 | 21 | 1 |
| 1127 | 3600 | 4 | 293 | 31 | 21 | 390 | 390 | 22 | 3 |
| 1128 | 3090 | 6 | 314 | 33 | 20 | 327 | 380 | 19 | 3 |
| 1129 | 3130 | 7 | 319 | 38 | 18 | 342 | 345 | 20 | 4 |
| 1130 | 3120 | 1 | 322 | 40 | 20 | 334 | 361 | 22 | 8 |
| 1131 | 3240 | 10 | 321 | 47 | 19 | 332 | 391 | 23 | 14 |
| 1132 | 3300 | 14 | 311 | 41 | 23 | 338 | 410 | 23 | 13 |
| 1133 | 3260 | 10 | 316 | 38 | 20 | 344 | 366 | 20 | 8 |
| 1134 | 3390 | 12 | 320 | 60 | 24 | 341 | 369 | 22 | 6 |
| 1135 | 3190 | 12 | 312 | 41 | 15 | 335 | 371 | 20 | 9 |
| 1136 | 3440 | 7 | 295 | 43 | 24 | 337 | 444 | 25 | 10 |
| 1137 | 3460 | 15 | 305 | 43 | 21 | 336 | 401 | 21 | 48 |
| 1138 | 3370 | 9 | 303 | 42 | 21 | 344 | 364 | 24 | 47 |
| 1139 | 3280 | 11 | 306 | 48 | 22 | 349 | 412 | 21 | 11 |
| 1140 | 3330 | 13 | 298 | 63 | 23 | 341 | 398 | 21 | 16 |
| 1141 | 3400 | 11 | 295 | 41 | 24 | 349 | 422 | 23 | 6 |
| 1142 | 3360 | 15 | 310 | 44 | 19 | 351 | 363 | 20 | 5 |
| 1143 | 3190 | 9 | 317 | 39 | 20 | 338 | 345 | 21 | 3 |
| 1144 | 2960 | 13 | 320 | 37 | 18 | 347 | 368 | 21 | 1 |
| 1145 | 2980 | 4 | 308 | 46 | 17 | 344 | 401 | 20 | 12 |
| 1146 | 3040 | 10 | 308 | 69 | 21 | 342 | 362 | 19 | 23 |
| 1147 | 3110 | 10 | 306 | 55 | 22 | 330 | 367 | 19 | 13 |
| 1148 | 3150 | 11 | 313 | 42 | 22 | 350 | 386 | 20 | 7 |
| 1149 | 2990 | 10 | 319 | 46 | 16 | 355 | 356 | 20 | 14 |
| 1150 | 3070 | 11 | 316 | 45 | 16 | 347 | 350 | 23 | 11 |
| 1151 | 3060 | 11 | 311 | 56 | 16 | 338 | 410 | 19 | 12 |
| 1152 | 3060 | 16 | 312 | 47 | 22 | 352 | 429 | 21 | 10 |
| 1153 | 3320 | 14 | 312 | 53 | 18 | 335 | 364 | 19 | 18 |

APPENDIX 3. Comparison of BGS and Mather analyses

| Sample No. | Mo BGS | Mo Mather | Ratio BGS/Mather | Cu BGS | Cu Mather | Ratio Mather/BGS |
|---|---|---|---|---|---|---|
| XHM 1112 | 3 | 0 | ---- | 18 | 18 | 1.00 |
| 1113 | 4 | 0 | ---- | 34 | 36 | 1.06 |
| 1114 | 6 | 0 | ---- | 18 | 24 | 1.33 |
| 1115 | 2 | 0 | ---- | 35 | 46 | 1.31 |
| 1116 | 3 | 0 | ---- | 35 | 36 | 1.03 |
| 1117 | 16 | 15 | 1.07 | 35 | 38 | 1.09 |
| 1118 | 7 | 0 | ---- | 77 | 90 | 1.17 |
| 1119 | 21 | 10 | 2.10 | 82 | 86 | 1.05 |
| 1120 | 3 | 0 | ---- | 11 | 12 | 1.09 |
| 1121 | 4 | 0 | ---- | 5 | 6 | 1.20 |
| 1122 | 3 | 0 | ---- | 4 | 6 | 1.25 |
| 1123 | 5 | 0 | ---- | 4 | 6 | 1.25 |
| 1124 | 25 | 15 | 1.67 | 52 | 52 | 1.00 |
| 1125 | 3 | 0 | ---- | 29 | 32 | 1.10 |
| 1126 | 1 | 0 | ---- | 12 | 12 | 1.00 |
| 1127 | 3 | 0 | ---- | 8 | 8 | 1.00 |
| 1128 | 3 | 0 | ---- | 58 | 64 | 1.10 |
| 1129 | 4 | 0 | ---- | 24 | 28 | 1.17 |
| 1130 | 8 | 5 | 1.60 | 78 | 106 | 1.36 |
| 1131 | 14 | 0 | ---- | 135 | 140 | 1.04 |
| 1132 | 13 | 0 | ---- | 77 | 70 | 0.91 |
| 1133 | 8 | 5 | 1.60 | 42 | 40 | 0.95 |
| 1134 | 6 | 5 | 1.20 | 62 | 70 | 1.13 |
| 1135 | 9 | 10 | 0.90 | 43 | 48 | 1.12 |
| 1136 | 10 | 10 | 1.00 | 80 | 82 | 1.03 |
| 1137 | 48 | 10 | 4.80 | 52 | 60 | 1.15 |
| 1138 | 47 | 10 | 4.70 | 53 | 84 | 1.58 |
| 1139 | 11 | 5 | 2.20 | 116 | 150 | 1.29 |
| 1140 | 16 | 5 | 3.20 | 113 | 140 | 1.24 |
| 1141 | 6 | 10 | 0.60 | 57 | 68 | 1.19 |
| 1142 | 5 | 0 | ---- | 47 | 56 | 1.19 |
| 1143 | 3 | 0 | ---- | 85 | 96 | 1.13 |
| 1144 | 1 | 0 | ---- | 114 | 150 | 1.32 |
| 1145 | 12 | 5 | 2.40 | 130 | 160 | 1.23 |
| 1146 | 23 | 10 | 2.30 | 192 | 210 | 1.09 |
| 1147 | 13 | 10 | 1.30 | 202 | 230 | 1.14 |
| 1148 | 7 | 0 | ---- | 96 | 108 | 1.13 |
| 1149 | 14 | 5 | 2.80 | 78 | 88 | 1.13 |
| 1150 | 11 | 10 | 1.10 | 100 | 94 | 0.94 |
| 1151 | 12 | 10 | 1.20 | 177 | 200 | 1.13 |
| 1152 | 10 | 0 | ---- | 167 | 160 | 0.96 |
| 1153 | 18 | 10 | 1.80 | 150 | 170 | 1.13 |
| Mean | 10.5 | 4.166 | 1.98 | 70.69 | 80.48 | 1.14 |
| Correlation Coefficient | 0.639 | | | 0.986 | | |

APPENDIX 4. Rock samples analysed from Shap

| XHR | Description or Remarks |
| --- | --- |
| 301 | Slate hornfels, streaked with fine pyrite. |
| 302 | Black slate hornfels. |
| 303 | Slate hornfels with very finely disseminated mineralisation and occasional bands of tuff. Banding strikes 270, dips vertical. |
| 304 | Blue-black slate hornfels with weak foliation which strikes 085. Vertical veinlets strike 002. |
| 305 | Blue-black andesite with a little mineralisation and E-W banding. |
| 306 | Almost identical to XHR 305. |
| 307 | Black garnetiferous andesite with good foliation. |
| 308 | Almost identical to XHR 306. |
| 309 | Andesite heavily banded (strike 075) with chlorite and pyrite. |
| 310 | Andesite, banding strikes 075 and dips 70N. |
| 311 | Massive blue-grey andesite. Strike 070. |
| 312 | Andesite cut by large quartz vein with chlorite and sulphides. |
| 313 | Similar to XHR 311; strike 090. |
| 314 | Similar to XHR 311; strike 095. |
| 315 | Spotted grey andesite. Sulphides (mainly pyrite) associated with crosscutting interleaved intrusive contact between granite and andesite. |
| 316 | Blue-black andesite, strike 095. |
| 317 | As XHR 316. |
| 318 | Well foliated andesite; foliation strikes 080. |
| 319 | Massive greenish-grey andesite with abundant chlorite; strike 065. |
| 320 | Massive dark grey andesite; foliation strikes 050, dips 80N. Cut by granite fingers. |
| 321 | Dark grey andesite with traces of pyrite; the foliation strikes 060. Some quartz-chlorite veinlets |
| 322 | Dark grey pyritic andesite with foliation striking 040. Veins containing quartz, epidote, chlorite and sulphides strike 050. |
| 323 | Grey-black andesite with some pyrite-chlorite veins and thin aplitic intrusions. |
| 324 | Barite vein from the andesite of XHR 323. |
| 325 | Greyish black andesite; streaky texture with quartz blebs strikes at 020. |
| 326 | Grey andesite, chloritic and pyritic. |
| 327 | Greyish black, biotitic mica-schist. |
| 328 | Massive greyish black andesite; subdued foliation strikes 020. |
| 329 | As for XHR 328. |
| 330 | Grey andesite with some pyrite. |
| 331 | Grey andesite, containing chlorite and pyrite, in contact with granite. |
| 332 | Dark grey andesite with many fine chlorite-filled fissures which strike at 090. Also a vertical N-S joint pattern. |
| 333 | Massive, dark grey, chloritic andesite. |
| 334 | Rather granular, spotty, bluish black andesite. |
| 335 | Ignimbritic tuff; banding strikes 335 and dips 60W. |
| 337 | Greyish black, massive andesite adjacent to the granite contact. Some fine pyrite veinlets. |

APPENDIX 4 (cont.)

| XHR | Description or Remarks |
|---|---|
| 338 | Finely mottled grey andesite; foliation strike 290. |
| 339 | Massive grey-black andesite, foliation strike 255. |
| 340 | As for XHR 339, but foliation strikes 100 and dips55S. |
| 341 | Banded, greyish, siliceous rhyolite? |
| 342 | Pale pinkish grey rhyolite; foliation strikes 110. |
| 343 | Pale bluish grey, siliceous crystalline limestone; strike 090 and dip 80S. |
| 344 | Very pale greyish green, siliceous crystalline limestone; strike 070 and dip 80S. |
| 345 | Grey andesite; strike 100, dip vertical. |
| 346 | Light bluish grey streaky andesite with foliation striking 100. |
| 347 | Pink and blue streaky hornfels with disseminated pyrite; cut by joint surfaces coated with pyrite, molybdenite and K-feldspar. |
| 348 | Similar to XHR 347 but with chlorite banding. |
| 349 | Somewhat weathered granite with pyrite. |
| 350 | Grey, banded slate with dip 10SE. |
| 351 | Similar to XHR 350 with heavy veining; probably cut by fault. Banding strikes 065. |
| 352 | Similar to XHR 350 but with pronounced lamination which strikes at 0&0 and dips 60S. |
| 353 | Similar to XHR 352 but shallow dip. |
| 355 | Pale greenish grey crystalline limestone with dark grey calc-silicate patches; strike 060 and dip 70SE. |
| 356 | Dark grey slates strike 045 and dip 50SE. |
| 357 | Dark grey slates strike 055 and dip 55SE. |
| 358 | Dark grey slates, banded, strike at 055 and dip at60SE. There is a small amount of pyrite. |
| 359 | Dark grey slate strikes 070 and dips 60S. |
| 360 | Massive dark grey slate with small amounts of pyrite; strikes at 060 and dips at 60SE. |
| 361 | Massive grey andesite with pyrite; strikes 060. |
| 362 | Massive grey andesite with pyrite. |
| 363 | Light grey, massive, crystalline limeston with a little pyrite. |
| 364 | Light grey andesite with disseminated pyrite. |
| 365 | Spotted grey, recrystallised andesite. Much pyrite especially with K-feldspar veining. |
| 366 | Dark bluish grey and reddish pink, massive, crystalline rock (limestone?). Spotty and streaky texture with disseminated pyrite; strike 050-060. |
| 367 | As for XHR 366 but with molybdenite and pyrite. |
| 368 | Streaky blue-grey andesite. |
| 369 | Greyish blue recrystallised andesite with a small pyrite vein. |
| 370 | Greenish grey andesite, with chlorite-sulphide veins. Rock strike is 070 with veins parallel and at right angles to this. |

APPENDIX 5. XRF analyses of Shap rocks

| XHR | Ce | Ba | Sn | Pb | Zn | Cu | Fe | Ag | U | Sr | Zr | Mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 51 | 681 | 0 | 104 | 65 | 61 | 53370 | 2 | 0 | 168 | 164 | 4 |
| 302 | 45 | 462 | 1 | 721 | 773 | 109 | 87200 | 3 | 1 | 172 | 169 | 2 |
| 303 | 44 | 434 | 2 | 18 | 106 | 81 | 70540 | 1 | 1 | 302 | 169 | 0 |
| 304 | 38 | 850 | 2 | 18 | 161 | 127 | 90770 | 2 | 3 | 484 | 160 | 2 |
| 305 | 86 | 745 | 2 | 11 | 78 | 92 | 69230 | 2 | 2 | 302 | 246 | 1 |
| 306 | 36 | 634 | 0 | 39 | 49 | 49 | 33300 | 0 | 3 | 334 | 213 | 0 |
| 307 | 38 | 434 | 2 | 30 | 173 | 52 | 108600 | 4 | 3 | 202 | 195 | 1 |
| 308 | 11 | 474 | 0 | 30 | 132 | 55 | 81920 | 3 | 1 | 308 | 162 | 1 |
| 309 | 55 | 389 | 3 | 26 | 102 | 47 | 64050 | 0 | 1 | 338 | 186 | 2 |
| 310 | 54 | 904 | 0 | 23 | 103 | 29 | 61000 | 2 | 1 | 317 | 196 | 0 |
| 311 | 45 | 558 | 1 | 9 | 83 | 47 | 70070 | 2 | 2 | 355 | 180 | 0 |
| 312 | 13 | 91 | 4 | 8 | 52 | 5 | 40000 | 0 | 1 | 71 | 45 | 4 |
| 313 | 47 | 815 | 0 | 21 | 77 | 31 | 56980 | 1 | 2 | 367 | 190 | 2 |
| 314 | 59 | 1042 | 0 | 52 | 58 | 31 | 56650 | 1 | 2 | 196 | 223 | 0 |
| 315 | 44 | 528 | 2 | 38 | 58 | 43 | 60710 | 0 | 5 | 201 | 296 | 3 |
| 316 | 41 | 407 | 0 | 9 | 114 | 6 | 68570 | 4 | 1 | 537 | 152 | 1 |
| 317 | 33 | 910 | 2 | 11 | 91 | 206 | 74850 | 2 | 1 | 675 | 148 | 3 |
| 318 | 46 | 757 | 4 | 17 | 101 | 25 | 69910 | 1 | 1 | 362 | 207 | 1 |
| 319 | 39 | 34 | 4 | 4 | 99 | 7 | 68790 | 3 | 0 | 297 | 141 | 6 |
| 320 | 52 | 765 | 4 | 20 | 93 | 34 | 61140 | 0 | 2 | 407 | 215 | 2 |
| 321 | 75 | 360 | 6 | 12 | 98 | 125 | 79880 | 2 | 2 | 371 | 194 | 2 |
| 322 | 58 | 1060 | 2 | 40 | 48 | 19 | 34320 | 0 | 2 | 179 | 282 | 4 |
| 323 | 51 | 747 | 1 | 44 | 132 | 66 | 63800 | 0 | 2 | 762 | 235 | 0 |
| 324 | 0 | 495900 | 0 | 2616 | 27 | 0 | 400 | 0 | 0 | 10727 | 105 | 56 |
| 325 | 104 | 578 | 2 | 30 | 74 | 8 | 48160 | 1 | 4 | 259 | 280 | 2 |
| 326 | 37 | 464 | 2 | 6 | 61 | 104 | 45640 | 1 | 1 | 180 | 217 | 1 |
| 327 | 42 | 645 | 4 | 55 | 102 | 17 | 57180 | 0 | 1 | 177 | 274 | 7 |
| 328 | 48 | 475 | 3 | 15 | 48 | 136 | 52410 | 1 | 3 | 271 | 261 | 1 |
| 329 | 57 | 766 | 1 | 68 | 102 | 117 | 55450 | 2 | 2 | 239 | 283 | 3 |
| 330 | 44 | 507 | 3 | 16 | 85 | 49 | 57470 | 0 | 1 | 367 | 195 | 1 |
| 331 | 60 | 710 | 1 | 28 | 54 | 100 | 52830 | 1 | 3 | 244 | 227 | 2 |
| 332 | 62 | 855 | 2 | 14 | 45 | 85 | 43120 | 0 | 5 | 219 | 270 | 1 |
| 333 | 46 | 912 | 3 | 34 | 74 | 34 | 52400 | 2 | 2 | 222 | 183 | 3 |
| 334 | 35 | 614 | 0 | 17 | 114 | 1 | 80300 | 0 | 2 | 143 | 153 | 1 |
| 335 | 69 | 612 | 2 | 29 | 43 | 6 | 53400 | 0 | 3 | 48 | 393 | 2 |
| 336 | 70 | 1752 | 8 | 46 | 18 | 4 | 16590 | 0 | 3 | 171 | 402 | 11 |
| 337 | 46 | 440 | 5 | 24 | 47 | 50 | 60610 | 1 | 0 | 249 | 204 | 2 |
| 338 | 54 | 952 | 2 | 24 | 27 | 0 | 23260 | 0 | 1 | 132 | 161 | 1 |
| 339 | 20 | 649 | 0 | 8 | 80 | 8 | 66760 | 0 | 1 | 148 | 150 | 3 |
| 340 | 56 | 479 | 2 | 17 | 110 | 30 | 76000 | 2 | 1 | 183 | 252 | 2 |
| 341 | 36 | 176 | 15 | 41 | 44 | 0 | 8570 | 0 | 9 | 75 | 131 | 3 |
| 342 | 9 | 26 | 4 | 9 | 5 | 0 | 4630 | 0 | 4 | 89 | 79 | 1 |
| 343 | 56 | 177 | 11 | 42 | 17 | 0 | 6350 | 0 | 1 | 167 | 150 | 1 |
| 344 | 69 | 300 | 13 | 62 | 155 | 0 | 17410 | 0 | 2 | 376 | 181 | 2 |
| 345 | 58 | 418 | 2 | 52 | 60 | 8 | 26890 | 0 | 4 | 349 | 316 | 4 |
| 346 | 69 | 265 | 1 | 47 | 50 | 12 | 33940 | 0 | 7 | 183 | 241 | 3 |
| 347 | 67 | 275 | 2 | 47 | 50 | 12 | 33940 | 0 | 8 | 182 | 242 | 3 |
| 348 | 63 | 364 | 4 | 26 | 69 | 28 | 84520 | 1 | 5 | 148 | 236 | 7 |
| 349 | 81 | 587 | 1 | 50 | 48 | 1 | 24510 | 1 | 8 | 370 | 244 | 2 |

APPENDIX 5 (cont.)

| XHR | Ce | Ba | Sn | Pb | Zn | Cu | Fe | Ag | U | Sr | Zr | Mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 350 | 61 | 543 | 4 | 14 | 83 | 36 | 44650 | 1 | 6 | 233 | 242 | 2 |
| 351 | 42 | 421 | 5 | 16 | 85 | 29 | 44210 | 0 | 3 | 254 | 247 | 1 |
| 352 | 68 | 448 | 1 | 19 | 90 | 26 | 49070 | 0 | 3 | 177 | 252 | 4 |
| 353 | 60 | 481 | 0 | 15 | 77 | 28 | 44980 | 0 | 6 | 240 | 236 | 4 |
| 355 | 53 | 132 | 11 | 24 | 19 | 28 | 7000 | 0 | 5 | 380 | 142 | 5 |
| 356 | 89 | 948 | 0 | 11 | 139 | 13 | 62740 | 0 | 2 | 76 | 276 | 0 |
| 357 | 66 | 1504 | 0 | 82 | 123 | 7 | 104720 | 3 | 3 | 153 | 163 | 2 |
| 358 | 54 | 674 | 3 | 16 | 90 | 56 | 55760 | 0 | 5 | 162 | 216 | 4 |
| 359 | 64 | 712 | 4 | 11 | 77 | 93 | 46500 | 2 | 4 | 288 | 230 | 6 |
| 360 | 58 | 698 | 3 | 13 | 77 | 38 | 54030 | 1 | 5 | 176 | 221 | 5 |
| 361 | 48 | 526 | 2 | 14 | 58 | 22 | 50510 | 0 | 5 | 187 | 212 | 3 |
| 362 | 60 | 533 | 4 | 141 | 206 | 39 | 46000 | 1 | 6 | 195 | 295 | 1 |
| 363 | 9 | 28 | 1 | 8 | 8 | 3 | 9760 | 5 | 1 | 278 | 26 | 4 |
| 364 | 54 | 293 | 1 | 9 | 66 | 28 | 53780 | 4 | 3 | 147 | 168 | 3 |
| 365 | 103 | 590 | 0 | 10 | 52 | 8 | 65610 | 2 | 3 | 70 | 326 | 46 |
| 366 | 53 | 510 | 4 | 14 | 44 | 19 | 50640 | 1 | 4 | 187 | 284 | 1 |
| 367 | 66 | 450 | 2 | 20 | 70 | 259 | 61750 | 1 | 1 | 158 | 220 | 5 |
| 368 | 99 | 1783 | 4 | 35 | 57 | 11 | 33070 | 0 | 4 | 183 | 457 | 1 |
| 369 | 61 | 1191 | 0 | 26 | 65 | 10 | 43050 | 1 | 4 | 245 | 420 | 3 |
| 370 | 18 | 319 | 3 | 23 | 92 | 81 | 54400 | 1 | 0 | 326 | 77 | 3 |

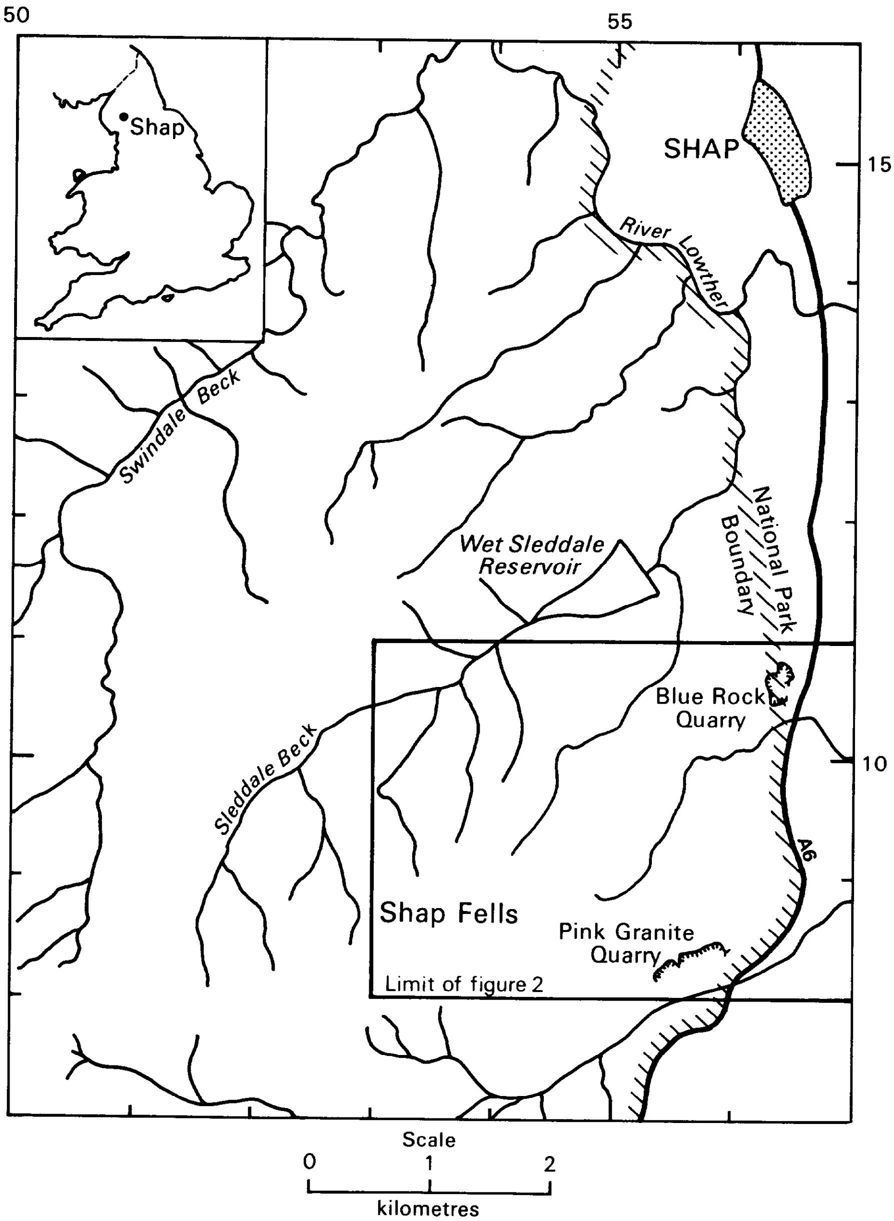


**Figure 1** Location map

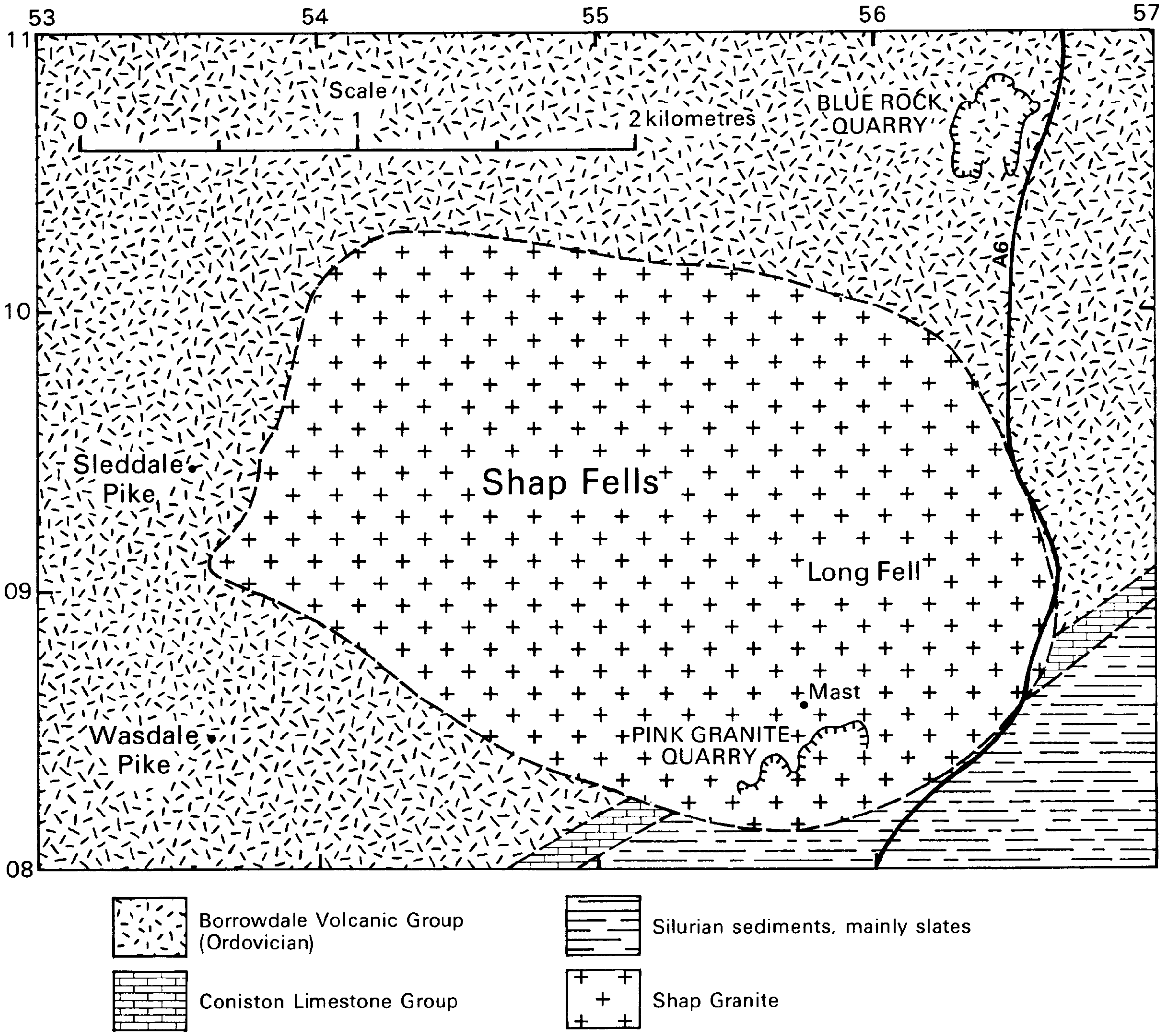


**Figure 2** Generalised geology of the Shap area

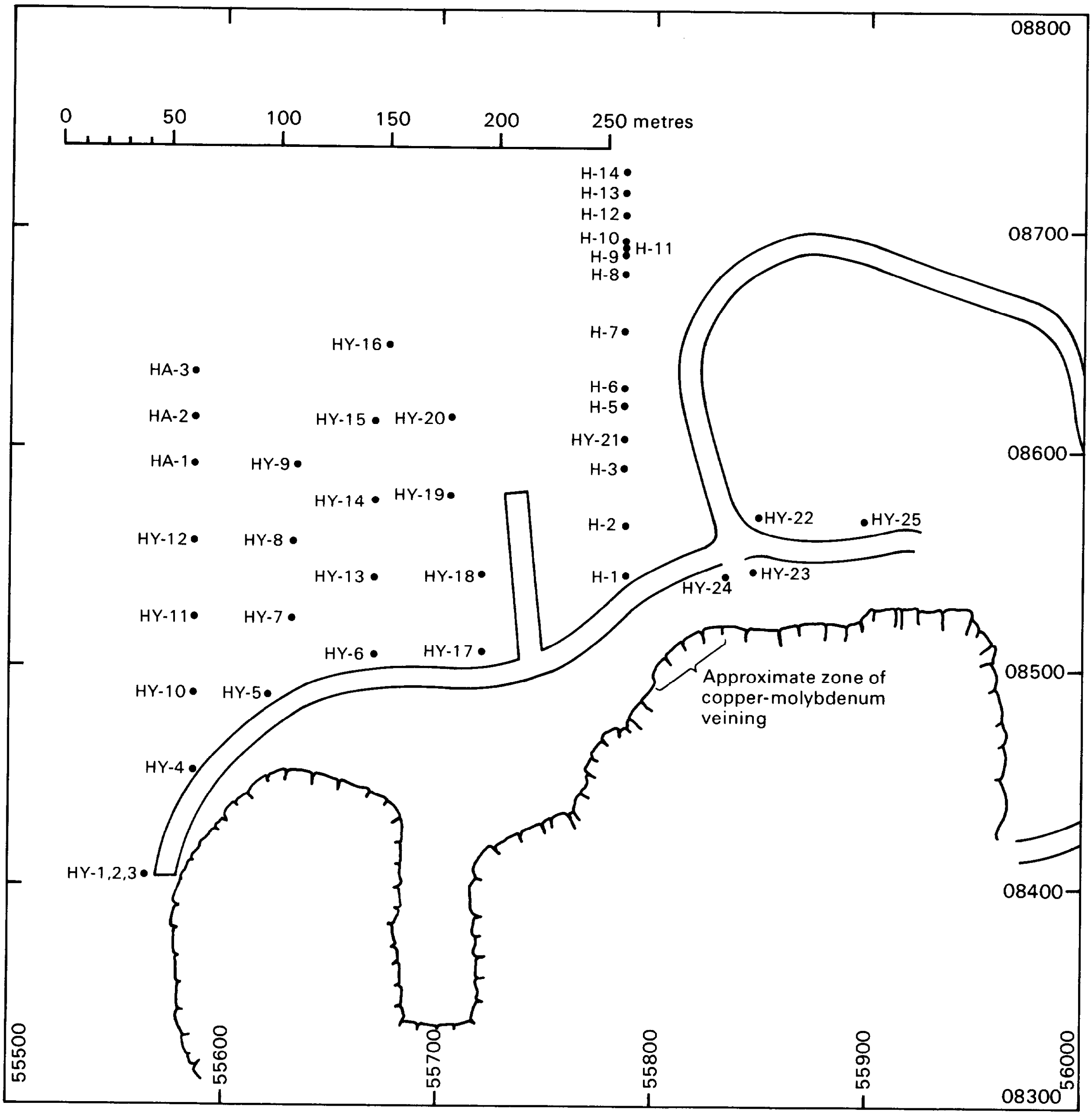


**Figure 3** The Pink Granite Quarry and drilling sites

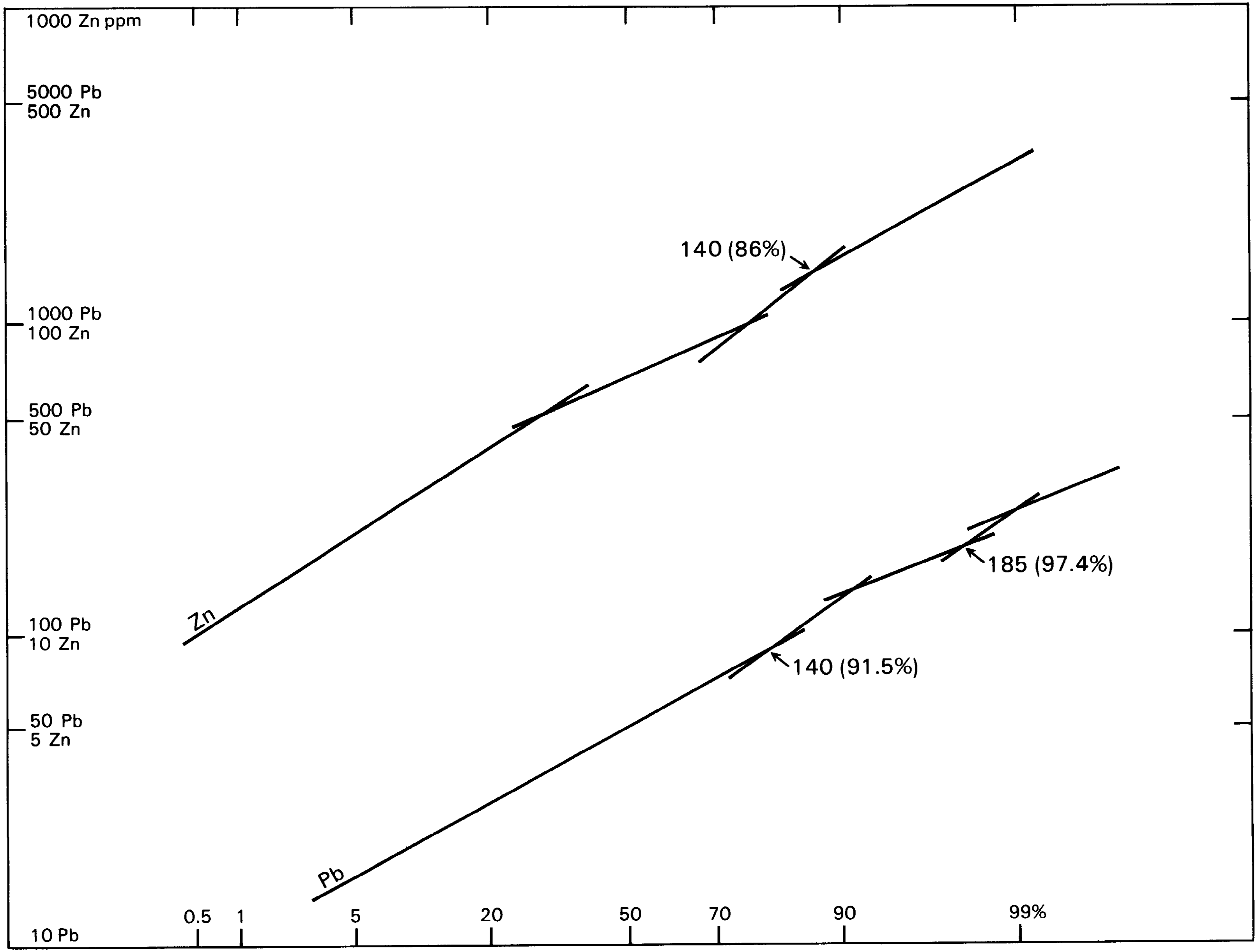


**Figure 4** Log-probability plot for Pb and Zn

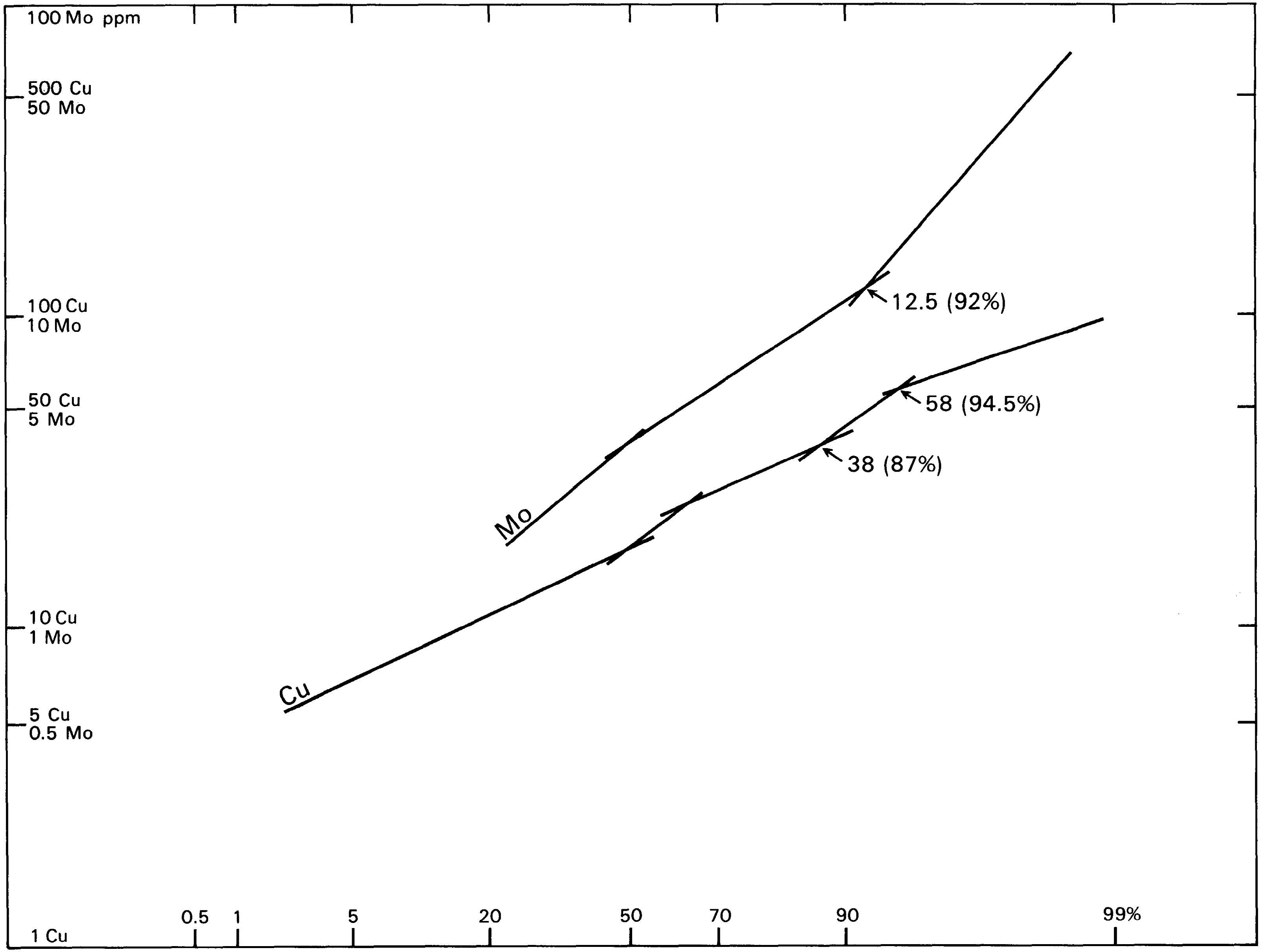


**Figure 5** Log-probability plot for Cu and Mo

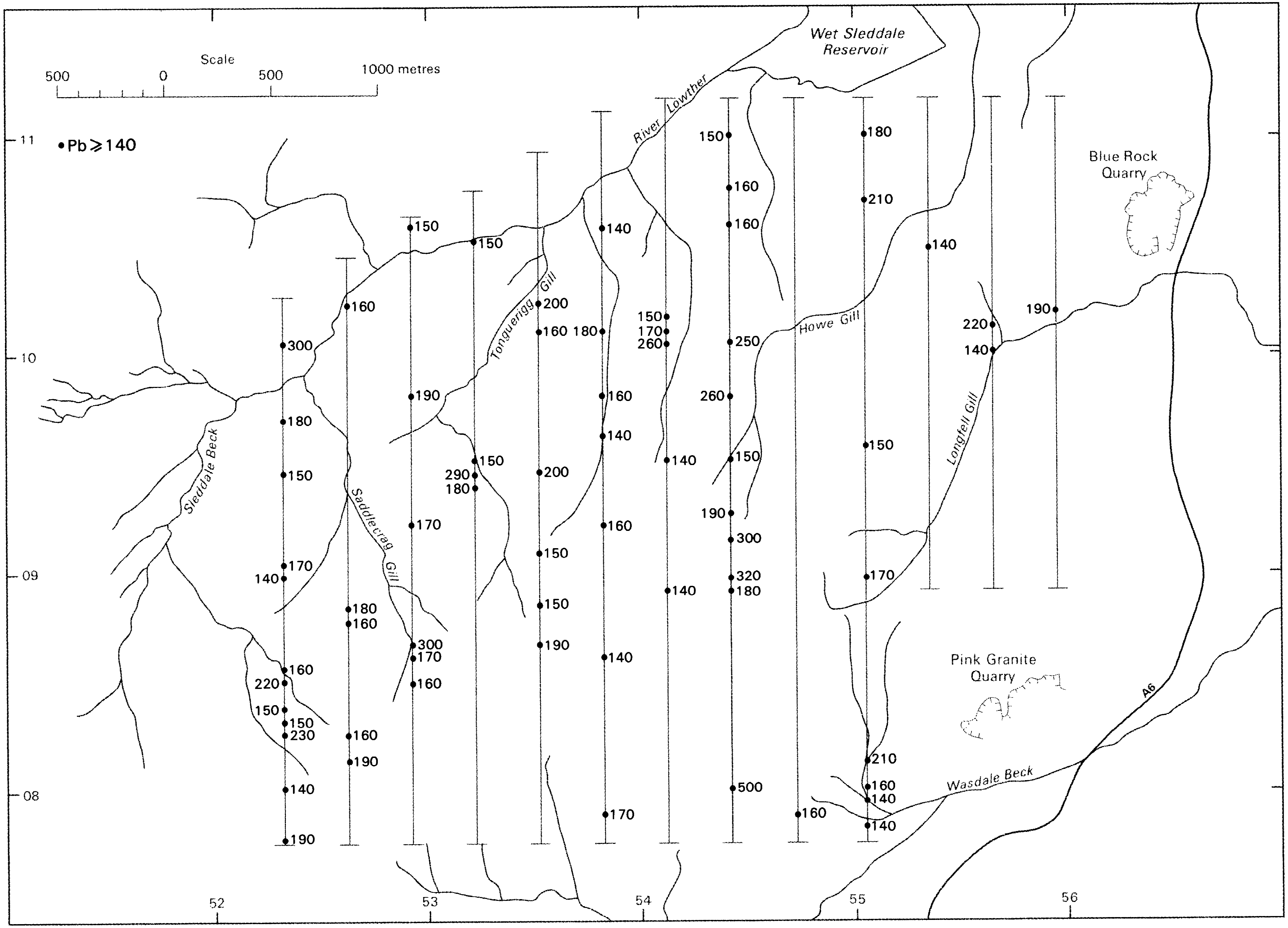


**Figure 6** Distribution of anomalous Pb values

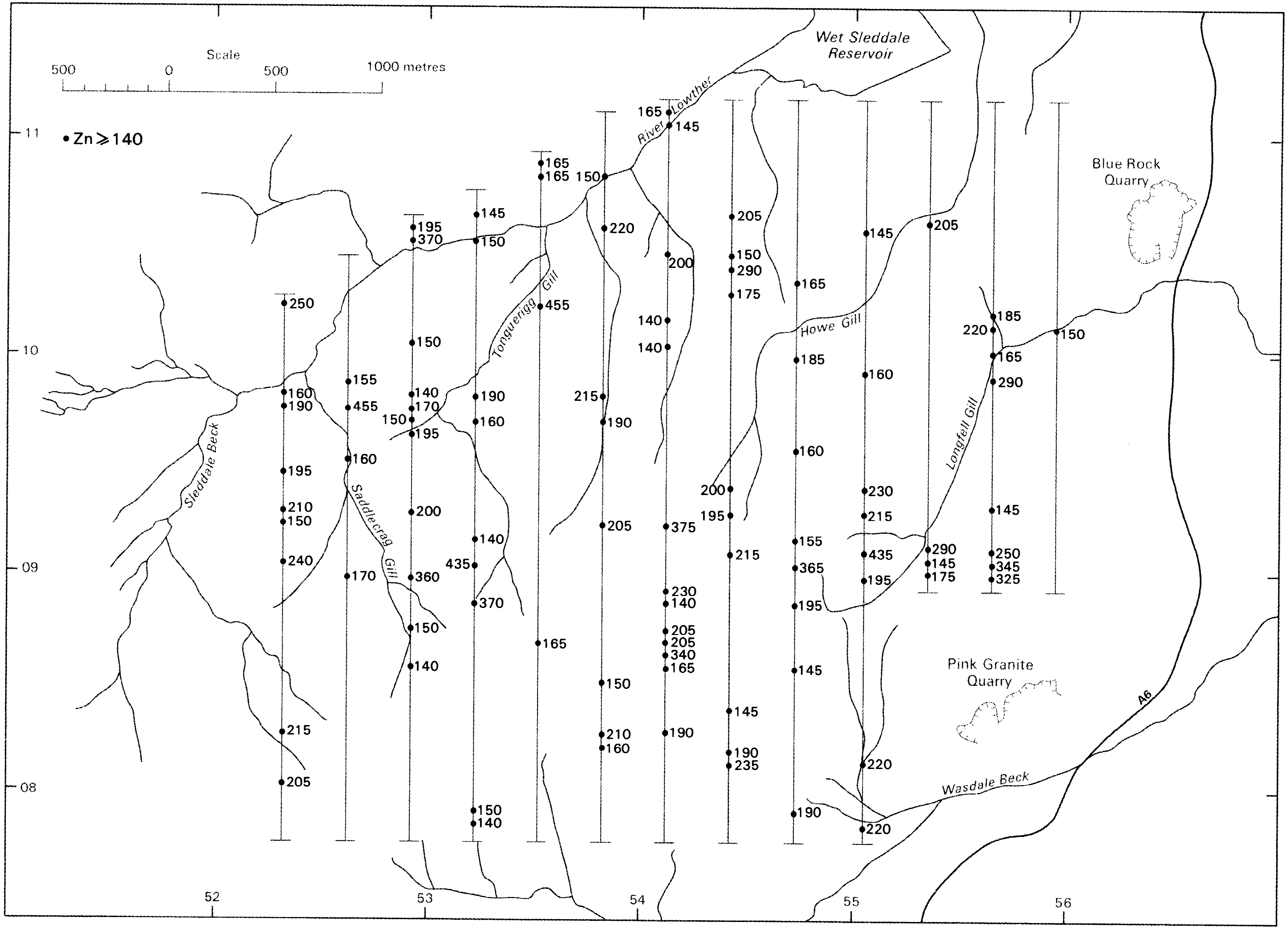


**Figure 7** Distribution of anomalous Zn values

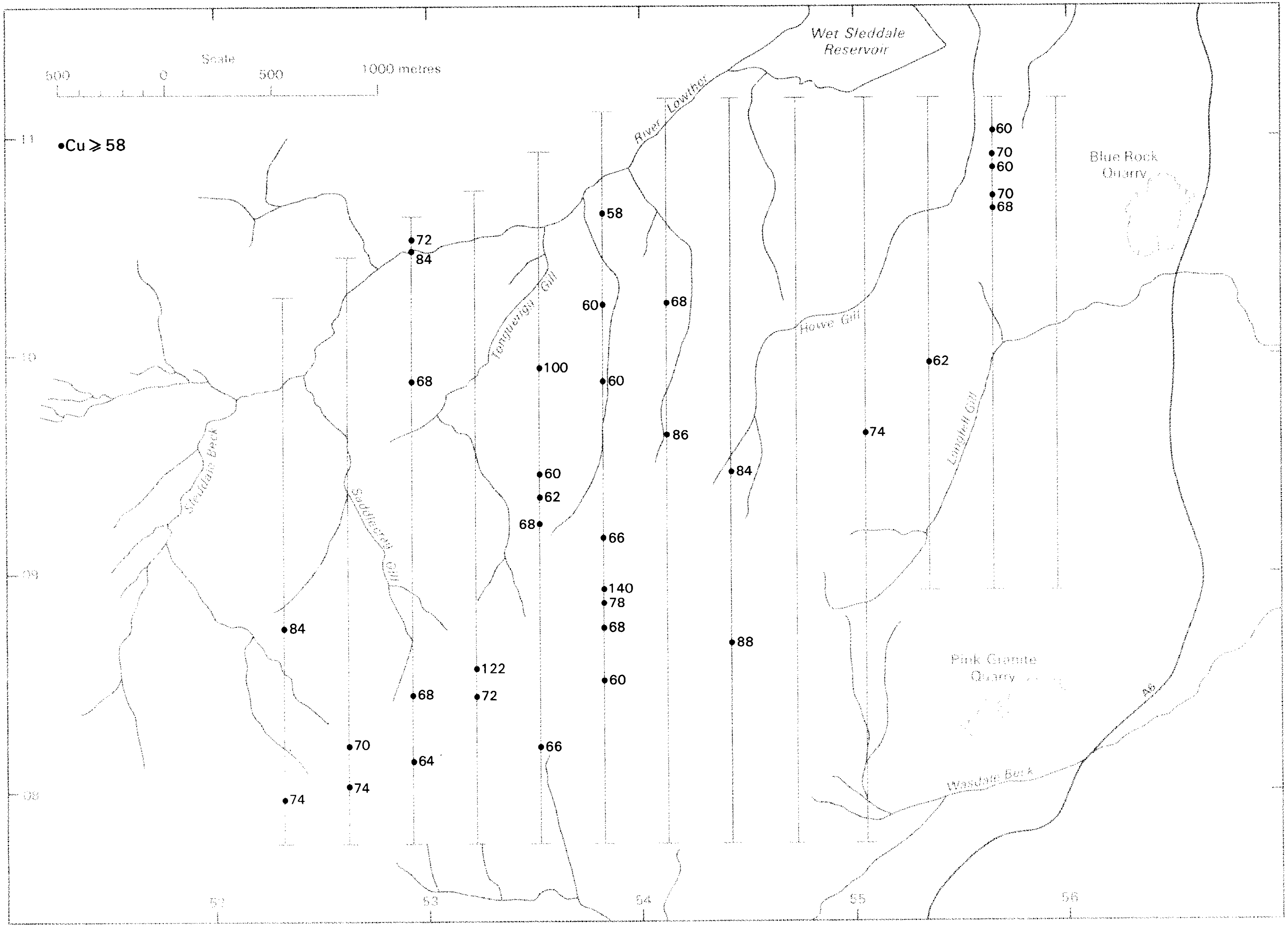


**Figure 8** Distribution of anomalous Cu values

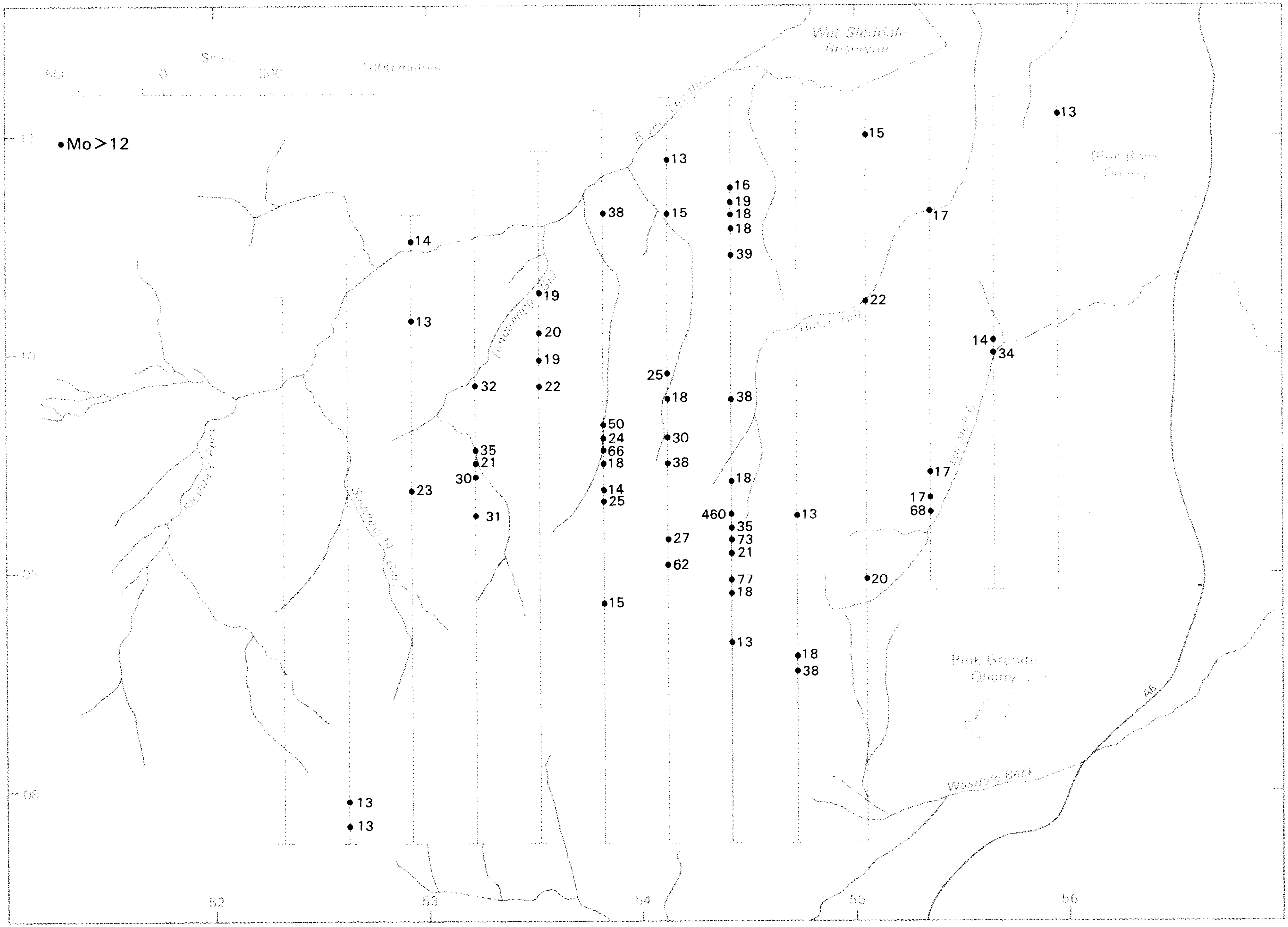


**Figure 9** Distribution of anomalous Mo values

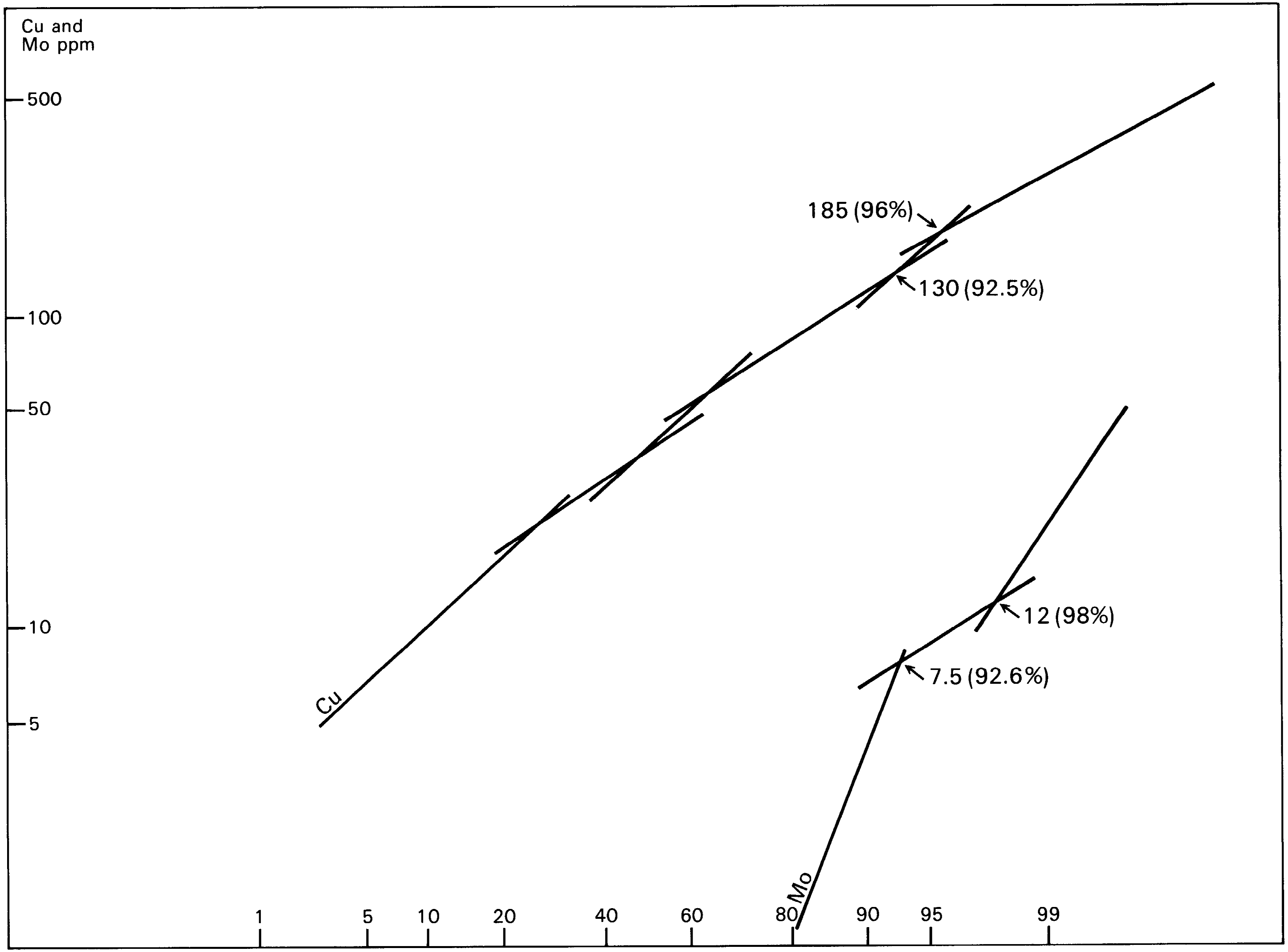


**Figure 10** Log-probability plot for Cu and Mo in drill pulps

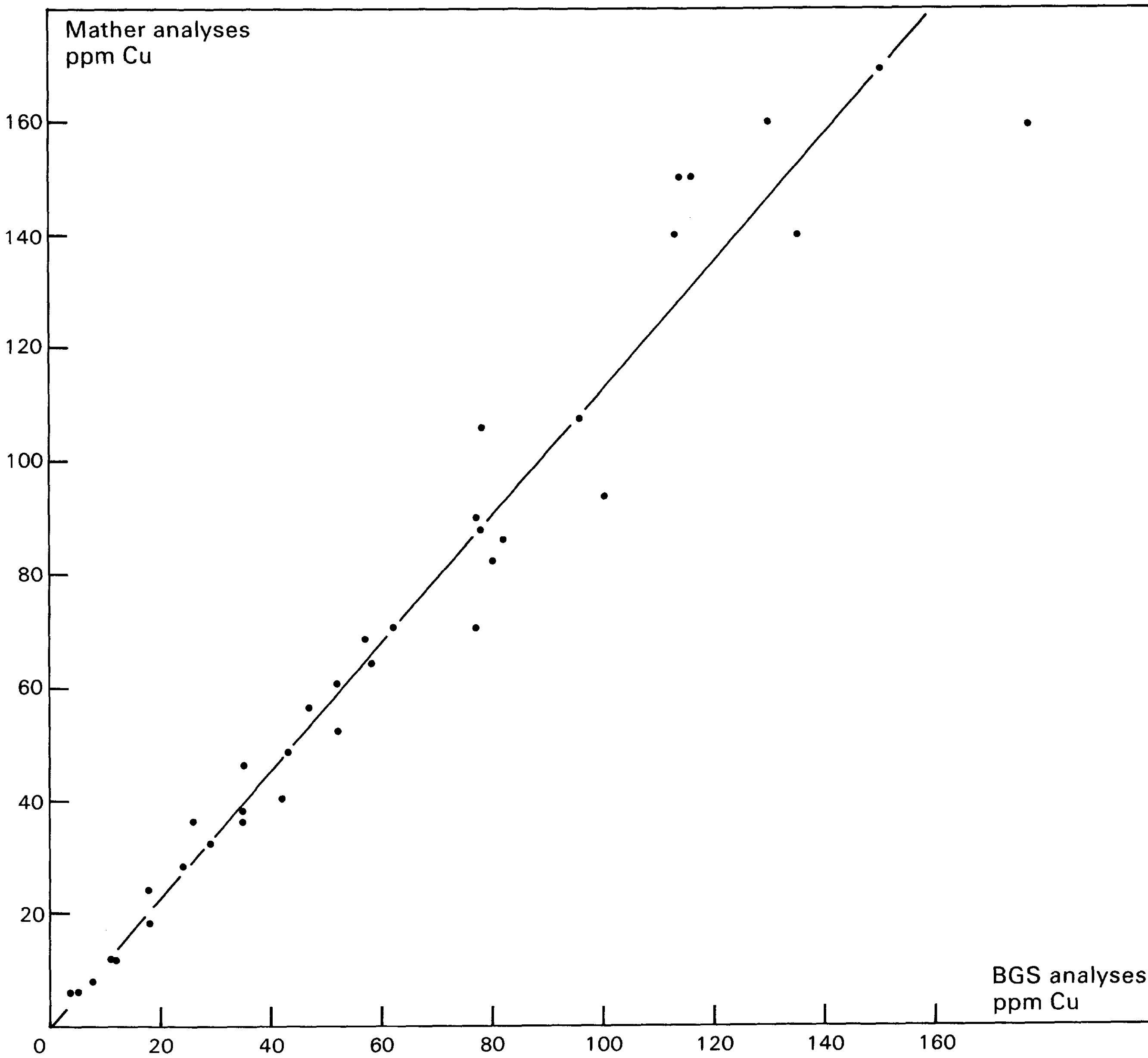


**Figure 11** Comparison of analyses for Cu

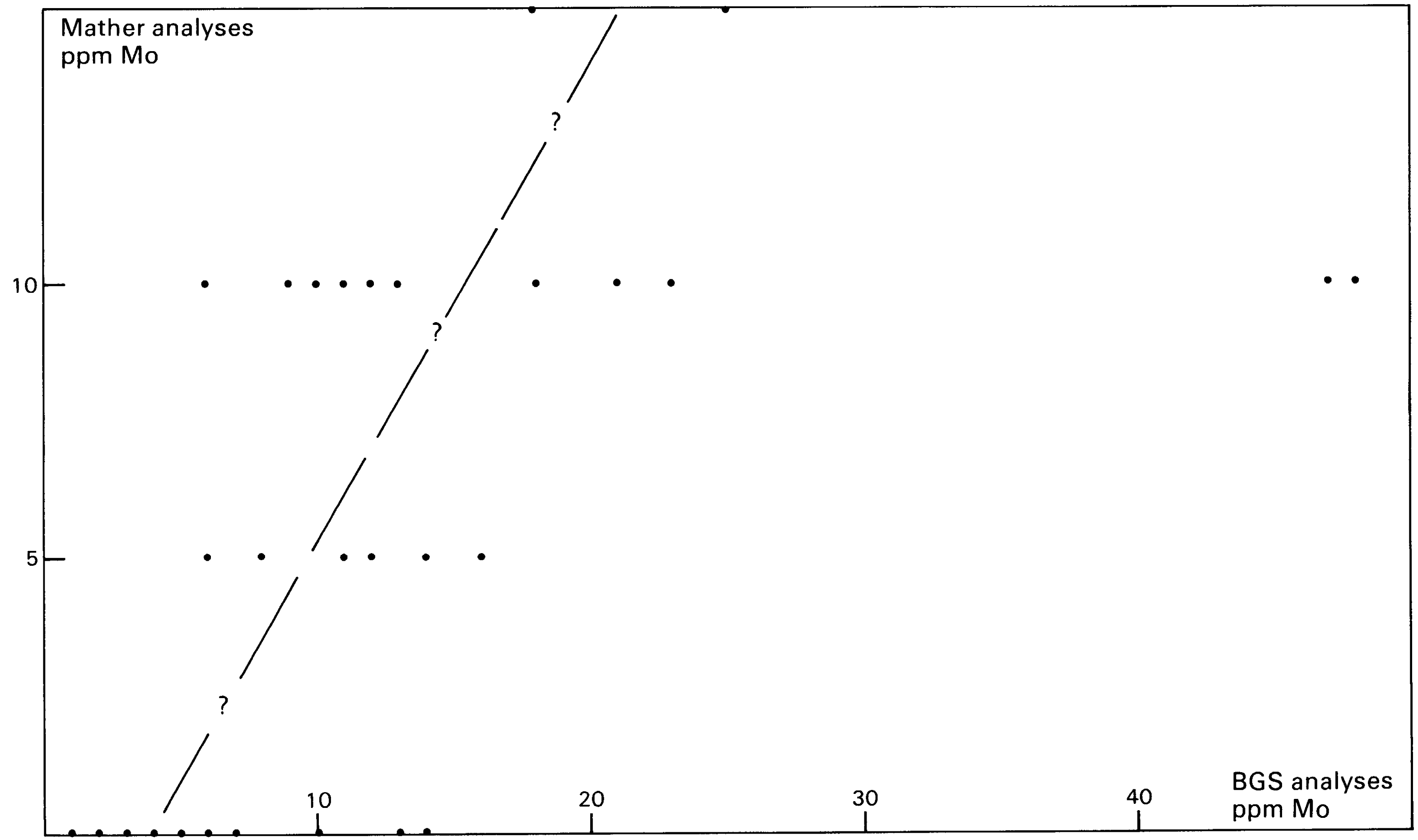


**Figure 12** Comparison of analyses for Mo

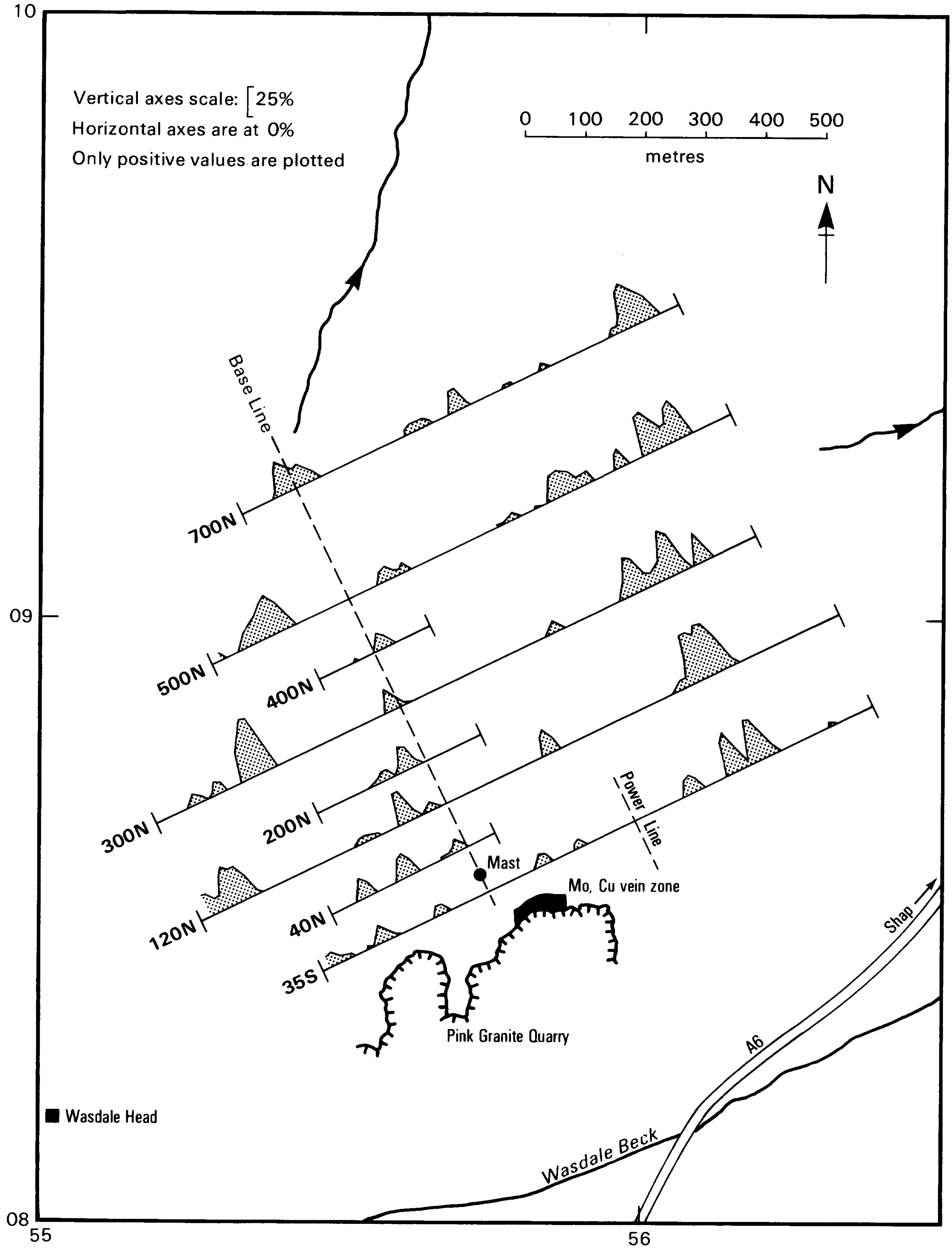


**Figure 13** Geophysical traverses and Fraser filtered in-phase VLF-EM profiles

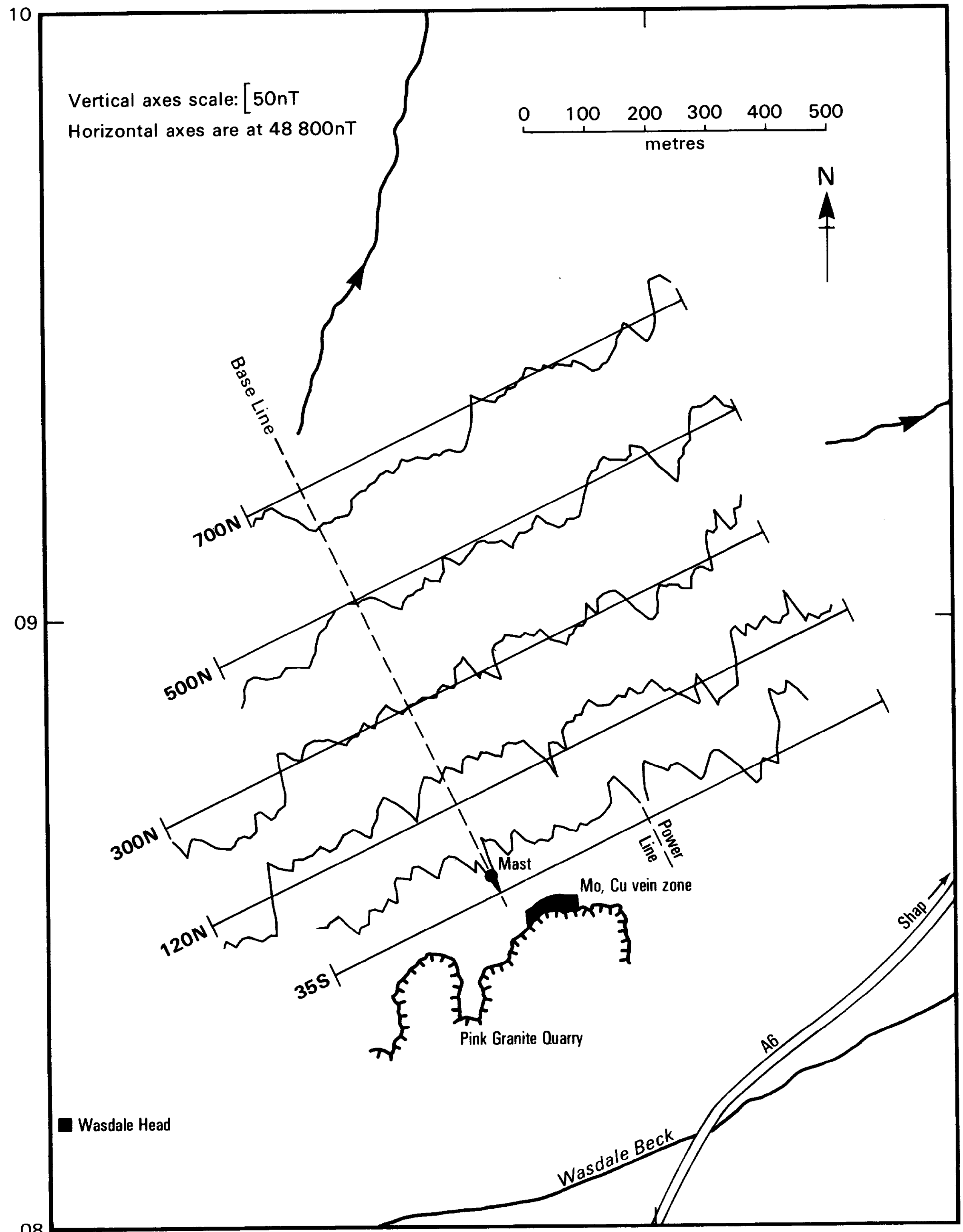


**Figure 14** Total magnetic field profiles

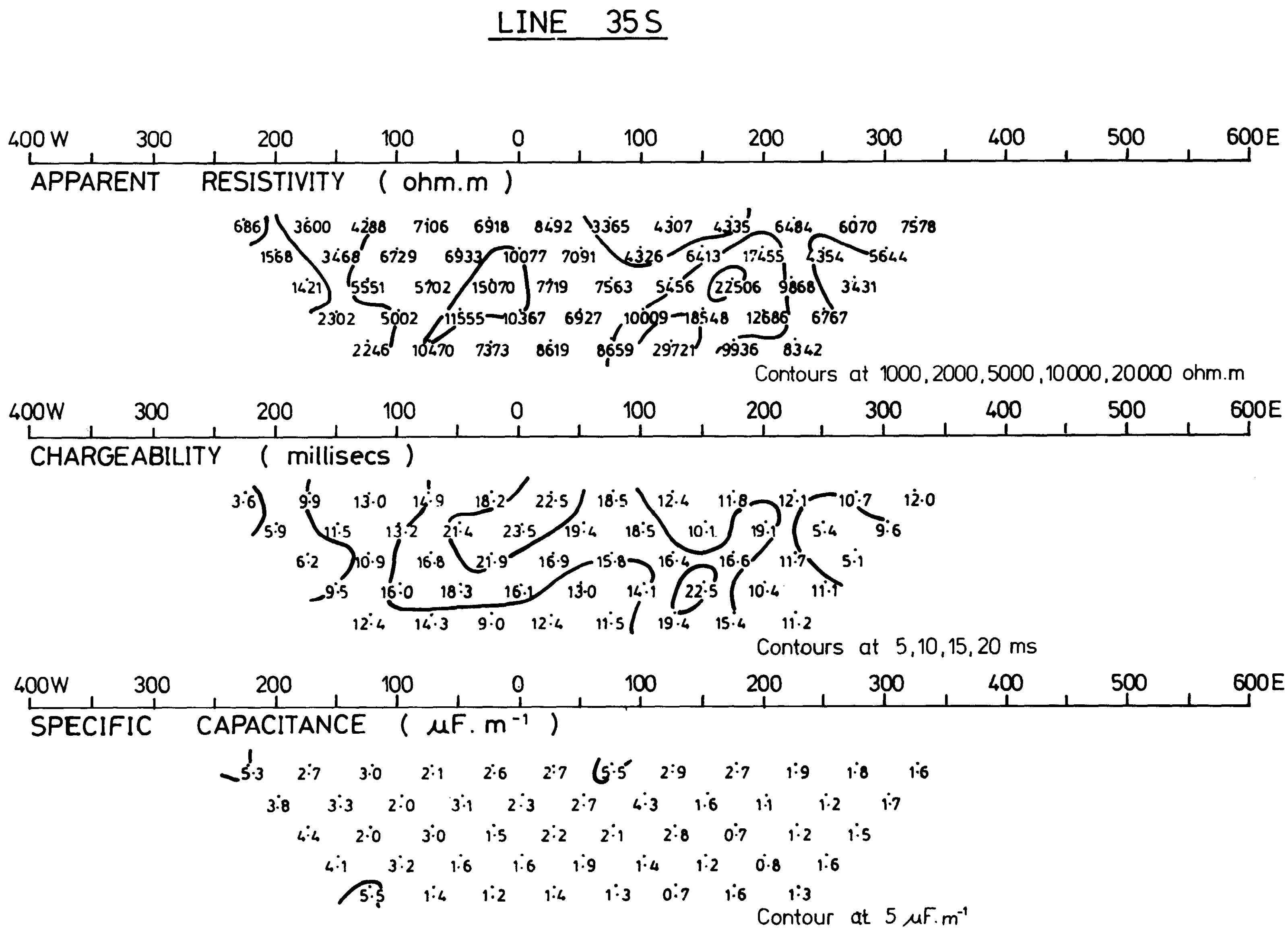


**Figure 15** Line 35S: IP and resistivity pseudosections

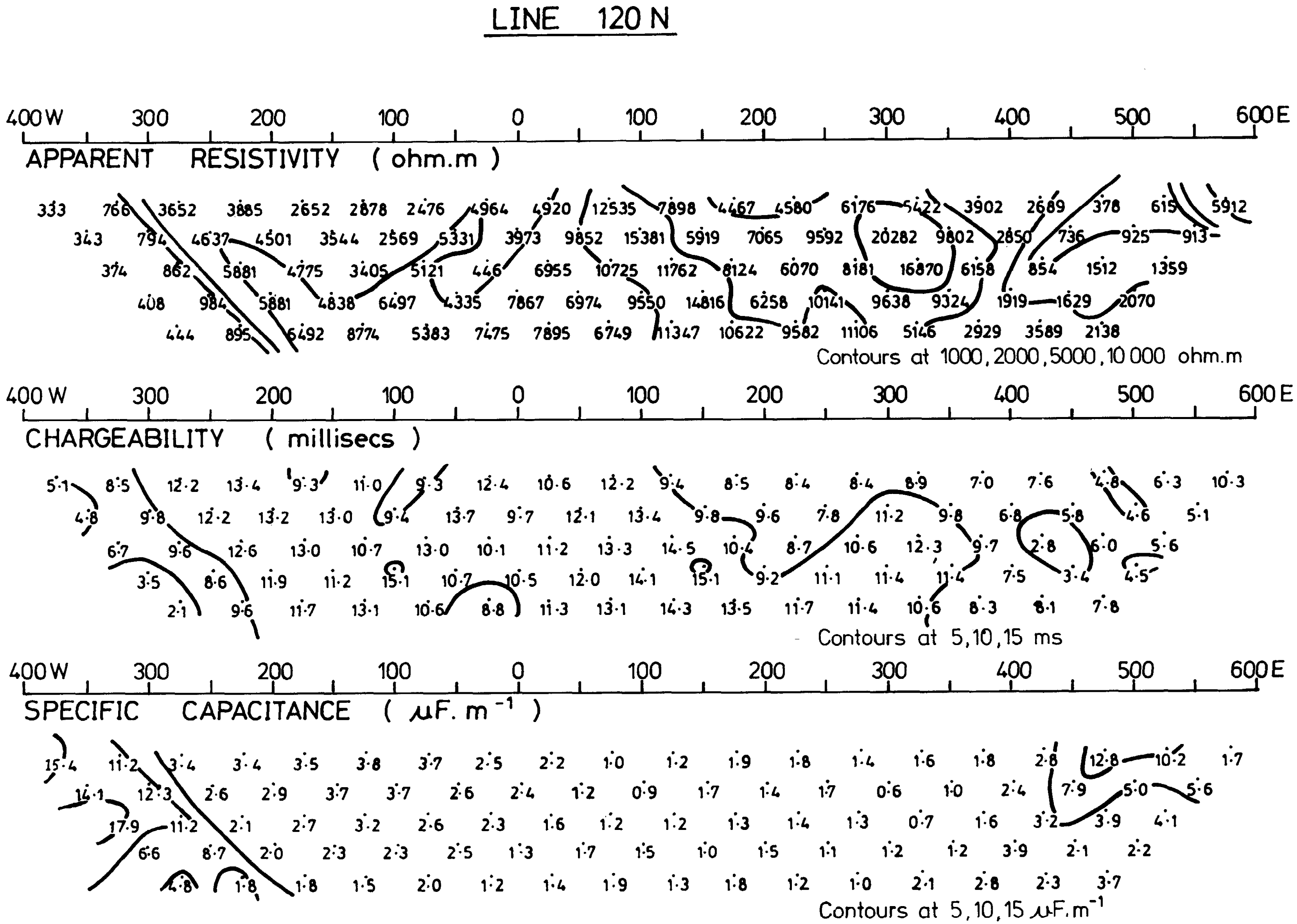


**Figure 16** Line 120N: IP and resistivity pseudosections

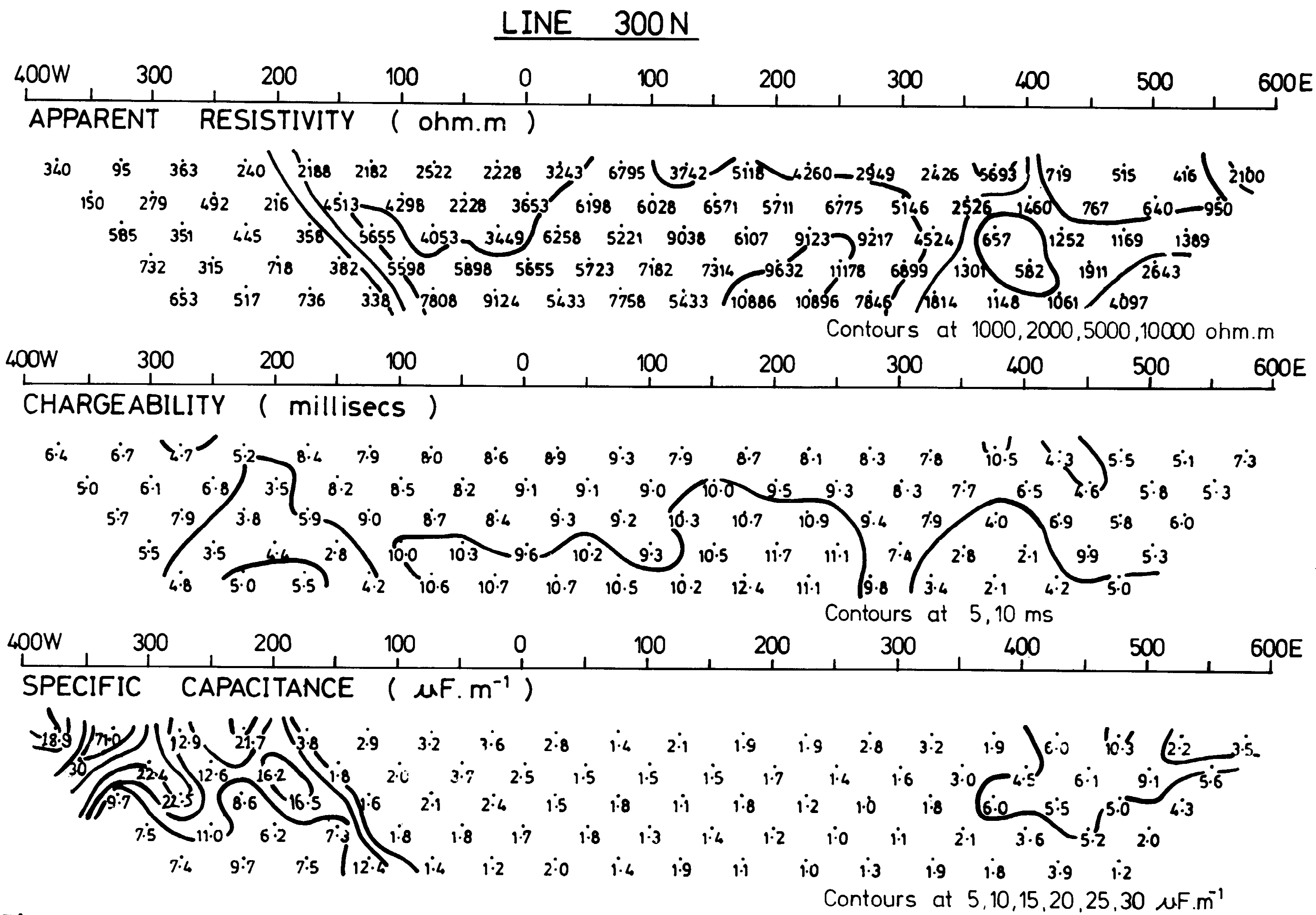


**Figure 17** Line 300N: IP and resistivity pseudosections