Natural Environment Research Council

Institute of Geological Sciences

Mineral Reconnaissance Programme Report No. 9

Investigation of disseminated copper mineralisation near Kilmelford, Argyllshire, Scotland

A report prepared for the Department of Industry

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This report relates to work carried out by the Institute of Geological Sciences on behalf of the Department of Industry. The information contained herein must not be published without reference to the Director, Institute of Geological Sciences.

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Investigation of disseminated copper mineralisation near Kilmelford, Argyllshire, Scotland

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London: 1977

The Institute of Geological Sciences was formed by the incorporation of the Geological Survey of Great Britain and the Museum of Practical Geology with Overseas Geological Surveys and is a constituent body of the Natural Environment Research Council

It is recommended that reference to this report be made in the following form:

ELLIS, R. A. and others. 1977. Investigation of disseminated copper mineralisation near Kilmelford, Argyllshire, Scotland. *Miner. Reconnaissance Prog. Rep. Inst. Geol. Sci.,* No. 9, 114 pp.

Photocopied in England by the Institute of Geological Sciences

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A reconnaissance geochemical drainage survey over an area of 20 km^2 in Argyllshire, Scotland, was undertaken by the Institute in 1975, following the suspension of active mineral exploration there by mining companies. The object was to investigate disseminated copper mineralisation associated with a small calc-alkaline intrusive complex of probable Caledonian age. The survey delineated a strong copper and molybdenum anomaly associated with the porphyritic component of the complex.

In 1976, an area of 1 km^2 was subsequently covered by detailed soil and rock geochemical surveys. This work was accompanied by detailed geological mapping on a scale of 1 : 2500, supplemented by photogeological interpretation.

Results of geochemical, mineralogical and field studies confirmed the presence of low-grade disseminated copper mineralisation, associated with strong hydrothermal alteration of the porphyry unit.

Following a brief geophysical survey over the strongest geochemical anomalies, a limited programme of diamond drilling was undertaken in the winter of 1976-77 to investigate the extent of mineralisation at depth. Two inclined holes were completed with a combined depth of 356m. Results of this work justify further drilling and confirmed the existence of porphyry style copper mineralisation.

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INTRODUCTION

Since the inception in 1971 of a government scheme to encourage mineral exploration in Britain by offering financial incentives (MEIG Act 1972), more than 140 exploration projects have been initiated by the private sector.

As consultants to the Department of Industry, the Institute of Geological Sciences has a remit to assess the merits of these projects and to keep abreast of their progress. In several instances projects have had to be curtailed for reasons which have not been wholly geological. In those cases where exploration has indicated significant but unresolved mineralisation, the projects have been further investigated by the Institute as part of the Mineral Reconnaissance Programme funded by the Department of Industry. One such investigation forms the basis of this report.

Exploration undertaken by Noranda Exploration (UK) Limited and Phelps Dodge Europa Ltd, between 1971 and 1974 involved geochemical, geophysical and geological surveys which outlined an area of disseminated copper mineralisation associated with a small igneous intrusion.

Our own work followed a similar pattern but in addition provided geological data for a more broadly-based investigation into mineralisation associated with Caledonian calc-alkaline intrusions.

Argyllshire also forms part of the area currently being covered by the Institute's Regional Geochemical Survey, a programme designed to provide geochemical data for a series of geochemical atlases of the British Isles.

LOCATION AND GEOGRAPHICAL SETTING

The area of interest is located on the west coast of Scotland in Argyllshire to the south of Loch Melfort at the northern limit of the Craignish peninsula, (Fig.1). The small village of Kilmelford is situated at the head of Loch Melfort on the main road from Oban which is some 22 km to the north and is the terminus of the West Highland railway line.

An east-west ridge of granodiorite forms a belt of rugged elevated terrain up to 365 metres above sea level (Tom Soilleir), over a distance of seven kilometres between Kilmelford in the east and Arduaine in the west and provides an effective watershed. To the north, streams drain directly into the sea (Loch Melfort) whilst to the south they drain into the alluvial plains of Staing Mhor and the Barbreck river. Streams frequently follow the courses of igneous dykes and faults and along the northern margin of the granodiorite a prominent scarp feature has produced local nick-points with the consequent development of waterfalls.

The population of the region is generally scattered in isolated farms and crofts and is principally engaged in agriculture although some provision for the tourist industry during the summer months has been made with small sailing centres on Loch Craignish and Loch Melfort. Apart from a modest amount of arable farming and cattle-rearing along the narrow coastal strip bordering Loch Melfort and in the alluvial valleys to the south, most of the district is suitable only for upland sheep-grazing, comprising rough pasture interspersed with extensive tracts of heather and peaty waterlogged flats in the more elevated areas.

The climate is relatively mild but wet (c.150cm/yr) and during the winter months the region is particularly prone to Atlantic gales (between 10 and 20 days in the year).

GENERAL GEOLOGY

The general geology of the district is shown in Fig. 2 and is described in some detail in Memoir Nos.36 and 37 of the Geological Survey of Scotland (Peach and others, 1909). An extensive bibliography for the area is contained in 'The Grampian Highlands' - British Regional Geology Series (Johnstone, 1966).

The region is largely underlain by low-grade Dalradian metasediments of probable Cambrian age. They are referred to as the Craignish phyllites in the Memoirs and correspond to the upper part of the Easdale Subgroup, Argyll Group of the Dalradian Supergroup (Harris and Pitcher, 1975). They comprise a sequence of folded and cleaved green and grey phyllites with thin bands of quartzite and limestone and possess a regional NNE strike. Intercalated with them is a series of meta-basic igneous rocks, termed epidiorites, which may represent intrusive sills or thin flows; these are more common in the eastern part of the area.

To the south of Loch Melfort the metasediments are extensively hornfelsed by several small calc-alkaline intrusions which collectively are referred to in this report as the Kilmelford granodiorites. The extent of the metamorphic aureole in the adjacent country rocks suggests that the granodiorites are cupolas of a single large intrusion of relatively shallow depth.

A suite of hypabyssal felsites and dacitic porphyries forms numerous sheets and dykes across the area. They conform to the regional Dalradian strike and are believed to be genetically related to the granodiorites and of similar age. Adjacent to a small granodiorite centred on Lochan Beinn nan Chaorach (NM 814 100), the porphyries form a small sheeted complex which shows considerable hydrothermal alteration and sulphide mineralisation. This forms the target for the present investigation.

To the north of Loch Melfort, the Dalradian phyllites are overlain unconformably by the southernmost limits, in this area, of the Lorne plateau lavas of Lower Old Red Sandstone age consisting essentially of andesites and basalts with some intercalated felsic flows and tuffs. The absence of pillow lavas and spilites, and their variable thickness, indicate continental conditions with the eruption of the lavas onto an undulating Dalradian land-surface.

It is likely that the Lorne plateau lavas are genetically related to the plutonic rocks to the south of Loch Melfort and their proximity to the latter suggests that the granodiorites form part of a relatively high-level intrusion or sub-volcanic centre.

The Mull centre of Tertiary igneous activity lies approximately 30 km to the north-west of the area; related radial dykes of basic and intermediate composition form extensive swarms in the vicinity of Loch Melfort.

NNE trending wrench faults exert major structural and topographic controls on the Dalradian rocks of the Grampian Highlands. The precise age of these faults is uncertain although Smith (1961) has shown that movement on at least one of these structures, the Garabal fault, was initiated prior to, or during, the emplacement of intrusive rocks of Lower Old Red Sandstone age.

It is likely that the NNE strike faults in the vicinity of Lochan Beinn nan Chaorach are of similar age and origin.

No metal mining has been recorded in the immediate area, but copper was worked on a minor scale during the eighteenth century near Kilmartin, 12 km to the south. There, chalcopyrite occurs in a quartz/calcite gangue in several small veins cutting a large sill of epidiorite (Wilson, 1921).

GEOCHEMISTRY

Drainage survey

A reconnaissance geochemical survey of the area of the Kilmelford intrusion was undertaken in 1975 and 1976, involving the collection of panned concentrate, stream sediment, and water samples at a density of 2 samples per square kilometre.

Stream sediments

Samples of the stream sediment were collected at each site by wet sieving through -100 mesh nylon bolting cloth. The samples after drying were analysed for Cu, Pb, Zn, and Ag by atomic absorption spectrophotometry using a nitric acid attack: for As by X-ray fluorescence; and Mn, Fe and Mo by emission spectrography. The distribution of each element is discussed in terms of its frequency distribution and plotted on a logarithmic versus probability scale. Generally the distribution breaks into three; background, intermediate and highly anomalous populations as discussed by Parslow (1974) and Lepeltier (1969). Class intervals on the figures were determined by reference to the arithmetic mean and mean plus one standard deviation but these intervals are not generally at variance with the thresholds derived from the cumulative frequency graph.

The frequency distribution of copper in the stream sediment samples (Fig. 3) shows a lognormal background population up to about 80 ppm, a sigmoidal intermediate population and an anomalous population above about 120 ppm. The anomalous samples (Fig. 4) come from Garraron stream, the stream leaving Lochan Beinn nan Chaorach, and one stream draining north from Tom Soilleir (NM8355 1111). During the follow up stage the stream at Garraron, which was the most strongly anomalous, was resampled at a closer interval and copper contents are shown in Figure 5a. The stream above the lowest sample is anomalously high in copper as defined by the regional survey and seems to indicate a large dispersed copper-rich source. The slightly irregular distribution may be due to transport of copper in acid stream water and adsorption on to clay particles or iron oxide coatings further downstream.

The frequency distribution of molybdenum is similar to that of copper, within the limits of analytical error (the detection limit of the method is 1 ppm Mo), and thresholds of just below 2 ppm and above 4.5 ppm were chosen by calculation of the arithmetic mean and confirmed graphically (Fig. 3). The highly anomalous samples form a well defined group from the top of Garraron stream and Lochan Beinn nan Chaorach east to Tom Soilleir (Fig. 4). Closer sampling of the Garraron stream revealed that the molybdenum values are rather erratic but again seems to show a large dispersed source, possibly situated to the north (Fig. 5b) of this area.

Lead in stream sediments shows two lognormal populations with a threshold at 75 ppm Pb (Fig. 3) and the upper class interval was taken at twice this value. The samples containing above this upper threshold were collected from a group of streams 0.8 km south of Kilmelford, which drain past Glenmore (NM8483 1228) and one stream to the east of these (NM8660 1179).

The frequency distribution of zinc in the regional stream sediments shows a nearly lognormal distribution with a slight inflexion at just over 400 ppm (Fig. 3). The highly anomalous samples come from two areas, the Glenmore streams, and the tributaries draining the north side of the Carn Dearg and Tom Soilleir ridge (Fig. 6). This latter group may be related to the high manganese content of the samples but not every high Mn sample contains high Zn, and the zinc content is thought to be only slightly enhanced by the scavenging effect of Mn-oxides.

Arsenic has a lognormal distribution up to 35 ppm and a clearly anomalous population above 75 ppm (Fig. 7) this latter population again comes from the Glenmore streams (Fig. 8).

Because of the generally low levels of silver and the low analytical precision at these levels only samples greater than 3 ppm are considered significant and these are concentrated at the western end of the area covered. There is a significant correlation with Pb, and silver probably occurs in galena.

The areal distribution of iron and manganese has not been plotted as they cannot be closely related to mineralisation. Manganese is anomalously high (threshold graphically determined as 0.4% Mn) in the samples from the streams draining Lochan Beinn nan Chaorach, the Carn Dearg to Tom Soilleir ridge, and the three easternmost streams sampled. This pattern probably reflects the outfall from peat areas where Mn is precipitated on a change of pH and eH of the stream water. The high Mn content may affect the trace element content and is known to scavenge Co, Ni, Cu, Zn and Mo but, for example, high Mo values are not related to high Mn contents. Iron has a lognormal distribution up to a level of 8% (Fig. 7) and behaves similarly to manganese, only one Fe anomaly is not coincident with high Mn.

Panned concentrates

The -30 mesh to +100 mesh size fraction of the stream sediment was collected by wet sieving and panned to produce a heavy mineral concentrate of about 25 gm. Half this sample was ground and analysed by X-ray fluorescence spectrometry and half retained for mineralogical analysis if required. The elements determined on the panned concentrates were Ce, Ba, Pb, Zn, Cu, Ca, Ni, Fe, Mn, Ti and As (Sb and Sn were below their detection limits in all the samples). Table I gives the thresholds for each element which were determined graphically using the methods described above and the anomalous samples plotted in Figure 9.

TABLE 1

Element	Threshold	% Samples above Threshold
Ce	(1 normal population)	
Ba	1600 ppm	12
Pb	90 ppm	14
Zn	200 ppm	16
Cu	100 ppm	10
Ca	(1 lognormal population with lower break at 2.0%)	
Ni	120 ppm	7
Fe	16%	5
Mn	0.15%	10
Ti	(1 lognormal population)	

The frequency distribution of barium is lognormal below 1600 ppm and is probably related to the presence of Ba in the plutonic rocks of the area, but above this threshold the graph rises steeply and barytes is probably present in the panned concentrate. The streams with anomalous Ba are at Garraron, Glenmore, Kames and one 1 km WSW of Tom Soilleir (Fig. 9). Barytes is probably present in minor veins related to faults.

Lead and zinc are anomalous in the same group of streams (Fig. 9) and the pattern is similar to that shown by the stream sediments (Fig. 6) except that the Kames and the easternmost streams are more highly anomalous. One sample (ZCP 3297) from the Glenmore group of streams was examined mineralogically for sulphide minerals and found to contain cerussite. This is probably the weathering product of galena as trace silver was found to be present. Sphalerite was not found and the Zn is probably adsorbed on the reddish iron oxide coating of the weathered pyrite.

Copper in the panned concentrates shows a similar distribution (Fig. 9) to that in the stream sediments with the Garraron and Lochan Beinn nan Chaorach streams being highly anomalous and isolated anomalies on the Kames and Glenmore streams. Mineralogical examination of the panned concentrate from the latter showed that chalcopyrite is present and it is probably distributed in minor veins with Ba, Pb and Zn.

The anomalous nickel values are scattered over the area but on the Garraron and Glenmore streams are probably connected with mineralisation, possibly present in pyrite or magnetite or adsorbed on to secondary iron oxides. The manganese distribution is also fairly scattered and related to secondary environmental effects.

Arsenic in the panned concentrates shows a similar distribution to that of the stream sediments with a group on the Glenmore streams and a scatter further west. No arsenopyrite was observed in the panned concentrate and it must be assumed that the As is present in pyrite or adsorbed on to the weathered iron oxide crust of the weathered pyrite. Nearly all the high arsenic values are associated with high lead and zinc values except for the one sample south of Tom Soilleir.

Water sampling

Thirty-millilitre water samples were collected from each sample site and analysed by atomic absorption spectrophotometry for Cu. Water sampling proved impossible in the summer of 1976 because of the dry conditions but was completed later in the autumn when rainfall was very heavy. Probably because of the excessive dilution by run-off the contribution from the groundwater was so small that only three samples contained 0.02 ppm Cu or above. These three samples are all from the stream that drains the south side of Carn Dearg but were all collected on the same day and may have been affected by local weather conditions and a greater groundwater contribution.

Summary

Both the panned concentrate and stream sediment survey showed the Garraron and Lochan Beinn nan Chaorach streams to be highly anomalous in copper content. There is a close relationship in the follow-up sampling of the Garraron stream between the values in the -100 mesh sediment and the heavy mineral fraction showing that the source is contributing copper to both phases. The source does not seem to be related to one horizon or set of veins but seems to be contributing copper at least as far down as the small north bank tributary of the Garraron stream. Molybdenum has a closely similar distribution. Comparison of these drainage anomalies with the geological map and the field investigation, which found disseminated chalcopyrite and molybdenite in the small porphyry intrusion centred on Lochan Beinn nan Chaorach, made this the target for the detailed soil and rock sampling which formed the second phase of the investigation.

The distribution of the other elements which were determined is not related closely to that of copper and molybdenum, except possibly zinc which is significantly higher to the north of the intrusion and is here not accompanied by lead. This is the only slight indication of an outer 'halo' around the central copper-molybdenum anomaly. The group of streams by

Glenmore, 0.8 km S of Kilmelford are anomalously high in Pb, Zn, Ba, As and Ag. Mineralogical examination has shown a pyrite, cerussite (possibly after galena), chalcopyrite, and barytes assemblage which is probably due to vein style mineralisation. Scattered small veins containing barytes, calcite and galena were found outside the margins of the Lochan Beinn nan Chaorach intrusion. Definite assignment of the group of anomalies at Glenmore to this style of mineralisation would need more field investigation.

Detailed soil and rock survey

The target for detailed geochemical investigation was identified on the basis of the drainage survey as the area between the Garraron stream and Lochan Beinn nan Chaorach. A 100 metre rectangular grid was laid out with central origin at NM 8156, 1019. Using an Atlas-Copco Minuteman powered auger, samples of the overlying peat, the basal till, and a core of the sub-outcropping rock were collected. This initial grid survey was supplemented by rock chip sampling of available outcrops to give a more detailed coverage in critical areas. Generally there is a sharp two-fold division in the soil profile with an upper organic-rich peat horizon and a lower grey silty-clay till with clasts of the underlying rock.

The samples were analysed for copper, lead, and zinc by atomic absorption, and molybdenum and arsenic by X-ray fluorescence spectrophotometry. Not all three sample types were collected at each site as occasionally peat lay directly on weathered bedrock or the auger failed to reach bedrock.

Peat sampling

The peat thickness is usually between 0.5 - 1.0m but increases in some areas to a maximum of 5.3m. The samples were collected from the base of the organic-rich layer avoiding any admixture with the till.

The frequency distribution of each element in the peats was studied using the same graphical methods as in the drainage survey, plotting logarithmic concentration against cumulative frequency percentage on a probability scale. Lead and zinc both showed an apparently lognormal distribution and are both at fairly low levels, the 50% probability level for Pb is 15ppm and Zn 20ppm. They are therefore not considered further.

The copper distribution shows two inflexion points at 120 and 260ppm and a lognormal relationship below and between these points (not illustrated). Isopleths were therefore chosen at 125 and 250ppm with 10% of the samples being above this upper limit. The areal distribution (Fig. 10) shows an irregular pattern except for a concentration of high values to the NE of the lochan and peak 100m E of the origin.

Molybdenum has an irregular distribution with several steps in the cumulative frequency curve but there are clear inflexion points at 7.5 and 15ppm, 8% of the samples being above this upper level. The areal distribution is similar to that of copper (Fig. 11).

Till sampling

The thickness of the till varies from 0.2 to over 6.0m but most commonly from 0.5 to 1.0m. It is usually grey or brown in colour, occasionally yellow where it overlies rotted mineralised porphyry, and the matrix is a silty clay with stony clasts of the underlying bedrock. No exotic fragments were noted and all the till appears to be locally derived and with only minor downslope movement. A limited development of possible lacustrine clay was found at locations 300N 00W and 200N 00W which are in a large peaty depression.

Copper in the tills has a lognormal distribution up to 350ppm and is again linear above this inflexion point up to another slight break at 700ppm (Fig. 12) with the top 6% of samples above this level. The concentrations chosen as isopleths on the grid were 175 (the median value), 350, and 700 ppm Cu. Samples with Cu exceeding 350ppm are concentrated around the east of the lochan with occasional highs to the SW and NE (Fig.13).

Molybdenum has breaks in the frequency distribution at about 7.5, 15 and 30ppm. The areal distribution is complex, with a broad zone (greater than 15ppm) visible, running NE-SW and nearly coinciding with the limits of the porphyry (Fig. 14).

Rock sampling

The cumulative frequency distribution of copper is shown in Figure 15 and its strongly stepped nature can be seen. The reasons for the presence of several lognormal populations are not known unless it is a feature of the mineralogy of the most hydrothermally altered porphyry. The 200ppm isopleth follows the margin of the porphyry (Fig. 16) but the higher Cu level forms an area straddling the centre of the intrusion, with a possible 'ring' feature to the east of the lochan. Two distinct areas are enclosed by the 800ppm isopleth one immediately east of the lochan and one further east crossing the headwaters of the Garraron stream.

The molybdenum frequency distribution has inflexion points at 10 and 30ppm (Fig. 15) and isopleths of 10, 20 and 30ppm were chosen. The lower isopleth outlines an irregular area in the centre of the porphyry intrusion and the higher levels outline the area to the east of the lochan. Peak anomalies for copper and molybdenum are thus coincident (Fig. 17).

Arsenic, which was not determined in all the rock and drill samples, has a nearly normal population up to 20ppm and another inflexion point at 40ppm (Fig. 15). Samples with greater than 20ppm As form a peripheral area around the central copper and molybdenum anomaly and thus might be a reflection of arsenopyrite in an outer pyrite halo. No significant Pb or Zn variation was found and no discernible Pb or Zn halo, which has been reported in some 'copper-porphyry' deposits.

Summary

Comparing the maps of copper values in peat, till and rock there are obvious differences. In general, high values in peat are only present in the low lying areas where the peat fills hollows and receives an influx of surface and ground water. Upland peat appears relatively leached even directly over mineralisation. The most marked difference between till and rock values is around BH1 where high rock values have no corresponding till anomaly. In this region the till was particularly thin and developed over a broken rock rubble. There may be a slight bias in the rock sampling here due to collecting from mineralised outcrops. The till over this upland area is of strictly local origin, the bulk of the material having moved only a few tens of metres. Residual debris produced by sub- and post-glacial weathering is incorporated. Enhanced values in the till are noted in areas of water logged ground particularly about the stream flowing out of the lochan. Downslope solifluction may also have caused translation of some of the anomalies. Metal values found in till and bedrock are broadly similar, a feature found generally in other prospects examined in this environment. Comparison of metal concentrations in samples from the upper and lower portions of auger holes drilled upto 1.6m into the bedrock showed a slight increase with depth. This may be the result of near surface leaching.

Molybdenum distribution exhibits many of the features discussed for copper, noticeably again the lack of an anomaly in the till around BH1. Consideration of both the copper and molybdenum in rock distributions does indicate the existence of an annular pattern of high values centred around region of low values c250m ~~west~~ east of the lochan. These are caused by the presence of disseminated sulphide, predominantly pyrite, and need not necessarily be coincident with high levels of copper and molybdenum. Such an annular pattern of geochemical anomalies is often associated with disseminated mineralisation of porphyry style.

Discussion

A comparison with the disseminated copper prospect at Coed-y-Brenin (Rice and Sharp, 1976) shows that the levels of copper in stream sediments are higher than at Kilmelford (threshold: Coed-y-Brenin 300 ppm Cu, Kilmelford 90 ppm; peak values: Coed-y-Brenin >1200 ppm Cu, Kilmelford 430 ppm Cu). However thresholds of the soil anomalies are similar; Kilmelford (Peats) 250 ppm Cu, and 7.5 ppm Mo; Coed-y-Brenin (Soils) 300 ppm Cu, 10 ppm Mo. Panned concentrate sampling at Coed-y-Brenin produced a large scatter of copper anomalies (Cooper, 1976), probably related to old mining activity which is absent at Kilmelford and there is a close correspondence between panned concentrate and stream sediment values. Water sampling was disappointing at Kilmelford and anomalous samples did not coincide with the stream sediment and panned concentrate anomalies.

The differences between the two areas are probably related to the more intense pyrite halo around the Coed-y-Brenin porphyry. The resultant lowering pH of the stream water because of the weathering of this halo enhanced the solution of copper. The stronger copper anomalies in the stream sediments at Coed-y-Brenin may be related to the greater solubility of copper and the subsequent fixation on organic material and iron oxide precipitates.

PHOTOGEOLOGY

Photogeological studies were undertaken in order to expedite the field mapping (Fig. 18). Good quality air-photographs of the region are available on a scale of 1:10,000. The photographs which provide stereoscopic coverage of the area of detailed investigation are Nos. 4240-4243 from sortie No CPE/SCOT/327 (1948).

The mineralised intrusive complex centred on Lochan Beinn nan Chaorach is readily distinguished on the air photographs from the surrounding metasediments. The latter are characterised by northeasterly striking lineaments, locally distorted around the margins of the intrusion and form relatively rugged ground with a pronounced, sub-parallel, topographic alignment.

The area occupied by the intrusive rocks is distinguished by slightly less rugged, but more elevated topography and is bounded to the north and south by well-defined breaks of slope. To the northeast and southwest, the porphyritic component of the intrusion narrows into a series of dykes which are less easily discerned on the air photographs.

Both the Dalradian metasediments and the Caledonian intrusive rocks are traversed by part of the Mull Tertiary dyke swarm, identifiable on the photographs by numerous pale-coloured, sub-parallel streaks which reflect vegetation changes from heather to deer-grass along the sub-outcrops of many of the dykes. The dyke traces traverse the area on a regional strike of approximately N150°E. Stereoscopic study shows that the dyke traces can form both positive and negative features; the larger multiple dykes however, appear to be more susceptible to erosion and water-courses in the northern and eastern sectors of the area frequently follow their outcrop.

Two prominent photolineations coincident with the northwestern and northern margins of the granodiorite portion of the intrusion are presumed to be faults and form marked scarp features striking at N35°E and N95°S respectively.

Associated with the porphyritic component of the intrusion, two sets of faults at N60°E and N35°E are evident on the photographs as well-defined valleys along the southern margin of the complex. There they provide a local control on the drainage pattern which comprises a series of small subsequent streams draining to the southwest. On the western margin of the intrusion, the photographs show a marked increase in the incidence of Tertiary dykes. These are associated with a topographic low which straddles the watershed on a strike of N150°E and is likely to reflect a fracture zone along the contact of the intrusion with the adjacent hornfels.

The intersection of this NNW striking fracture-zone with the NE and ENE striking faults is visible on the LANDSAT photographs as a faint but discernible stellate pattern to the south of Lochan Beinn nan Chaorach. In the field their intersection is marked by a strong negative topographic feature and poor outcrop.

Stereoscopic study reveals the presence of several additional but less pronounced lineaments within the southern porphyritic portion of the intrusion. These generally adhere to the N35°E - N60°E strike directions and field mapping suggests they trace the outcrops of minor faults and/or porphyry dykes.

FIELD MAPPING

Rapid reconnaissance field mapping was undertaken on a scale of 1:2500 in October and November 1976 over the mineralised area delineated by the geochemical soil-grids. In the central part of the area, the mapping was tied into the 100m grid squares used for the geochemical surveys (approximately 1 km^2). In outlying areas, outcrops were identified from air-photographs enlarged to a scale of 1:2500, and data were transferred to the relevant

1:10,000 ordnance survey sheets (Nos. NM8 1SW, NM80NW), enlarged to a similar scale. In areas of poor outcrop, the field mapping was supplemented by rock-sampling of the sub-outcrop using a powered auger. The results of the work are presented in Fig. 19.

For the purpose of mapping, the following rock-types were regarded as mappable units: hornfels, granodiorite, dacitic porphyry, breccia and Tertiary dykes.

A strict time limit for the work did not permit the mapping of distinct lithological horizons within the hornfels and no attempt was made to map the several intermediate and acid differentiates which occur within the granodiorite component of the intrusive complex as these are too poorly exposed and perhaps too erratic in their distribution. The sheets and dykes which constitute the porphyritic component of the complex were mapped as a single unit. Delineation of hydrothermal zones and the extent of sulphide mineralisation did not fall within the scope of the mapping programme. A total of 59 rock samples was collected for mineralogical examination and their petrographic descriptions including alteration type together with locations are included as part 1. of Appendix III.

Description of major rock types

Hornfels

Mapping of the Dalradian metasediments was confined to delineating the hornfels contact with the intrusive rocks. The outer limits of the contact aureole were not mapped.

In appearance the hornfels is characterised by dark grey biotite-rich pelitic bands alternating with paler, greenish-grey calc-silicate hornfels. Adjacent to igneous contacts the hornfels assumes a streaked appearance with veins and wedges of pink cherty quartz becoming prominent. On the south-western margins of the granodiorite the contact is generally fairly sharp and where exposed the hornfels frequently forms small zones of biotite - schist interdigitated with tongues of granodiorite. A strong topographic linear feature along the northern margin of the granodiorite suggests that the contact there is faulted but this could not be confirmed at outcrop. The eastern contact of the hornfels with the granodiorite is very poorly exposed. The line of contact on the map is based on a break of slope and has been tentatively traced along the northern edge of an extensive waterlogged flat.

The southern contact of the hornfels with the porphyry is largely controlled by faulting but elsewhere it is characterised by the development of intrusive breccias.

In the central, most poorly exposed sector of the area, sporadic outcrops of hornfels are believed to represent rafts and screens of country rock within the intrusive complex. Their limits on the map are based largely on topographic features shallow auger drilling and photogeological interpretation.

Disseminated sulphide, principally pyrite, is present in variable amounts throughout the hornfels, but does not normally exceed 2% by volume. There is however a perceptible increase in sulphide content towards the margin of the porphyritic portion of the intrusion.

Granodiorite.

Rocks of predominantly granodioritic composition occupy an area of approximately 0.5 km^2 to the north and west of Lochan Beinn nan Chaorach. In addition, several small masses have been mapped within the porphyritic unit to the south, but the precise relationship of these isolated masses to the porphyry unit has not been elucidated. The granodiorite suite of rocks ranges in composition and texture between fine-grained dark-grey quartz diorites through typical granodiorites to fairly coarse-grained pink adamellites. The gradational transition between these differentiates in the field, combined with a general paucity of exposures, precluded them from being mapped as separate units. There is some evidence to suggest however, that the more acid differentiates are more prevalent on the southeastern margin of the granodiorite and in the isolated masses within the porphyry unit.

Adjacent to the porphyry, the granodiorite is locally hydrothermally altered with development of sericite and quartz veining, otherwise it is relatively fresh in appearance and alteration is limited to the partial replacement of hornblende and biotite by chlorite.

Sulphide content of the granodiorite is variable but does not normally exceed 2% by volume and is usually less than 1%. Pyrite predominates but chalcopyrite has been observed at outcrop in small veinlets near the contact with the porphyry unit, and in isolated outcrops of fresh-rock on the north western margin of the intrusion.

Dacitic porphyry

Biotite-feldspar porphyries of dacitic composition occupy an area of 0.6 km^2 to the south and east of Lochan Beinn nan Chaorach. The area of porphyritic intrusive rocks is roughly rectilinear in outline with a long axis conformable to the regional NNE Dalradian strike and with long and short dimensions of 1500m and 450m respectively.

Within the central and southern sectors of the unit, pervasive hydrothermal alteration and deep surface weathering make it difficult to distinguish between individual sheets and dykes except in one case where heavily zoned feldspar megacrysts enable a late-stage porphyry dyke to be traced fairly consistently over several tens of metres. Scattered feldspar porphyry dykes also cut the granodiorite unit to the north.

At the southwestern limits of the complex the porphyritic rocks thin out into a series of individually recognisable dykes separated by broad breccia-zones of probable intrusive origin. At the north eastern limit, similar brecciation is present but less extensive. Hydrothermal alteration is also weaker and two fairly distinctive porphyries can be recognised; a salmon pink chloritised variety and a second, pale buff, non-biotitic, fine-grained porphyry or felsite. SW of Lochan Beinn nan Chaorach the limit of the porphyry unit is poorly exposed but is presumed to abut directly against the granodiorite unit. Northeast of the lochan, outcrop is again poor and the exposed limits of both units are separated by an extensive waterlogged flat thought to be underlain by a hornfels embayment. Along the southern edge of the flat the porphyry unit is represented as a series of thin, brecciated sheets or dykes separated by screens of hornfels which form pronounced sub-parallel ridge features.

The porphyry/hornfels contact along the southeast margin of the intrusion is frequently complicated by faulting. Many of the faults within the porphyry are associated with strong silicification and veining of the wall-rock.

Sulphide mineralisation within the porphyry frequently exceeds 2% by volume, with pyrite far in excess of chalcopyrite. The sulphides are disseminated, and in small strings and flecks in quartz veinlets, and show a perceptible increase adjacent to the faults.

Breccias.

Both tectonic and intrusive breccias have been recognised in the course of the mapping, the former associated with narrow, linear fracture-zones within the porphyry and adjacent hornfels, and the latter forming broader zones on the margins of the porphyry.

The tectonic breccias generally comprise angular fragments of country rock (up to 95%), normally set in a matrix of hydrothermal quartz and calcite. The intrusion breccias comprise a mixture of sub-angular fragments and comminuted granules of hornfels, porphyry and occasionally granodiorite, in some cases set in a felsitic matrix. Flow-banding is common and disseminated sulphides (pyrite and chalcopyrite), may exceed 2% by volume of the rock.

Tertiary dykes

Dykes of Tertiary age form extensive swarms which cross the area on a strike of N 30^{o}W. They are predominantly basaltic in composition, have a medium grain size and are frequently vesicular. In most instances they do not exceed 1 or 2m in width. Occasional larger dykes, up to 10 in width, do occur and where exposed, are generally composite and sometimes characterised by spheroidally weathered centres. A larger Tertiary dyke intersected at the base of drill-hole 2. proved to be crinanite. The position of the dykes was based largely on aerial photographic evidence.

Hydrothermal alteration

Regional low-grade metamorphism of the Dalradian rocks masks the extent of hydrothermal alteration of the contact aureole. Within the intrusive complex, alteration of the granodiorite is weak and is principally confined to the porphyritic unit. This consists largely of an extensive, but erratically distributed sericite/muscovite alteration associated with silicification and quartz-carbonate vein stockworks. Weakly sericitised patches are characterised by the retention of primary biotite and the development of kaolinite and dolomite after plagioclase. Deep surface weathering and extensive limonitic staining after sulphides prevents the positive identification of the various alteration types at outcrop.

Mineralisation

The mapping has shown that disseminated sulphides are present throughout the intrusive complex and surrounding hornfels and that the focus of mineralisation is within the porphyry unit to the south and east of Lochan Beinn nan Chaorach.

Pyrite is the predominant sulphide mineral with minor amounts of chalcopyrite. Molybdenite and bornite have been recorded occasionally in small veinlets within the more altered rocks of the porphyry unit. The total sulphide content of this unit rarely exceeds 5% but frequently ranges between 2 and 3%.

Within the hornfels aureole to the west of Beinn Chaorach a small mineralised vein carrying galena, cerussite, anglesite and barytes, in massive calcite gangue, is exposed in a small stream - section (NM8080 1014). Galena also occurs with specular hematite as thin veinlets within brecciated phyllite exposed in the road-cutting near Arduaine to the northwest (NM799 106).

DIAMOND DRILLING

A limited amount of diamond-drilling to test the major geochemical anomalies was undertaken during the winter of 1976-77. A drilling contract was awarded to Rockfall Company Limited of Glasgow and investigations with a Craelius D750 rig commenced on the 29th October 1976.

Obligations towards land-owners and other constraints imposed a considerable limit on the amount of drilling which could be undertaken and the programme was scheduled for completion by the end of December 1976. In the event drilling was protracted into February 1977 and two holes were completed with combined depths totalling 358.83m.

The principal target was the high copper anomaly in rock immediately east of Lochan Beinn nan Chaorach (Fig. 16). A preliminary IP traverse across the area showed significant chargeability with an increase in intensity to the northeast. To test this anomaly, BH2 was sited at NM8149 0992 at an inclination of 60° and an azimuth of 20° true north. No significant copper mineralisation was encountered beyond 114m and the hole was stopped at a depth of 174.20m.

A second drill-hole, BH1, was sited further east at NM8195 0981 to investigate a further area of high copper in rock. BH1 was inclined at 50° on an azimuth of $352\frac{1}{2}^{\circ}$ (true north). A second objective for this drill-hole, to assess the relationship between mineralisation and the prominent fault 200m to the north of the drill collar, was not realised owing to slow drilling rates and poor core recovery at the base of the hole (184.63m). Coring in BH2 was completed on the 1st February 1977.

Wireline equipment was used to recover the core and except in the broken ground encountered near the collar in both drill-holes, recovery was good and generally exceeded 98%.

Tropari surveys of both holes provided the following information:-

	Depth	Inclination	Azimuth	
<u>BH1</u>	0.00m	50°	$352\frac{1}{2}^{\circ}$	(true north)
	102.00m	49°	$351\frac{1}{2}^{\circ}$	" "
<u>BH2</u>	0.00m	60°	20°	(true north)
	114.00m	59°	$19\frac{1}{2}^{\circ}$	" "
	174.00m	58°	29°	" "

Drill-core was logged and split in a rented cottage at Garraron Farm and samples of core were sent to the Analytical and Ceramics Unit of the Geochemical Division for analysis.

Except for some Tertiary dyke intersections, the whole of the core from both drill-holes was sampled, generally in 2m lengths. After conventional preparation, every sample was analysed for Cu, Pb, Zn by atomic absorption spectrometry and for Mo and As by X-ray fluorescence spectrometry. Selected samples were also assayed for Au. (A.A.S).

Detailed core-logs including descriptive geology and assay results are presented as Appendix II. Except in certain samples towards the base of BH2, levels of Pb and Zn are consistently low (averaging 20 ppm and 40 ppm respectively) and have been omitted from the core-logs.

Geochemical, geophysical and geological data for BH1 and BH2 are depicted graphically in Figures 20 and 21. Hydrothermal alteration and sulphide mineralisation encountered in both drill-holes are discussed in general terms in the section on mineralogy and detailed descriptions of selected core-specimens are included as parts 2 and 4 of Appendix III.

Average assay results for copper from BH1 and BH2 ranged between 0.04% and 0.1%. Several samples provided copper levels in excess of 0.2% with a maximum assay value of 0.34% Cu from a 2.15m sample of porphyry at a depth of 34m in BH2.

Average molybdenum assays ranged between 0.001% and 0.003% in BH1, but in BH2 the levels are higher with a maximum of 0.04% Mo at 79m.

MINERALOGY

Mineralogical examination of specimens of outcrop and drill-core was carried out to elucidate the type of mineralisation associated with the intrusive complex centred on Lochan Beinn nan Chaorach. Investigations were made by petrographic examination of polished and covered thin-sections and results of this work are presented in Appendix III. In addition, X-ray diffractometry provided identifications of specific minerals (D Atkin), and assisted in establishing the validity of the optical methods used to identify the principal mineral types (A Shilston and D J Morgan).

Manual XRF (D J Bland) provided preliminary information on certain element ·iations in the surface rocks and showed that the pervasive sericite/kaolinite ..teration of the porphyry unit is marked by a rapid depletion of zinc, more gradual depletion of calcium and strontium, an increase in potassium and rubidium, and wiue fluctuation in barium content. There is no significant increase in alumina associated with the development of kaolinite.

Hydrothermal metasomatism has apparently added K, Rb, H_2O and H^-, to the system whilst subtracting Ca, Sr, and probably Ti. The elements, Si, Fe Mg and Na were not investigated.

Petrography of the major rock-types

Country rocks

Specimens examined included hornfelsed siltstone, sandstone and feldspathic sandstone. Of these, siltstone baked to a biotite-rich hornfels is the most common. Calcareous, pelitic and orthoquartzitic types were observed.

Granodioritic series

The rocks consist essentially of labradorite-andesine plagioclase, quartz, orthoclase, biotite and hornblende with accessory apatite and small amounts of primary oxide minerals. In the most basic rock types the quartz content is about 2%, orthoclase is a minor constituent, and hornblende is more abundant than biotite. Where the quartz content is of the order of 10% an appreciable orthoclase content is found and biotite is the major mafic constituent. Since plagioclase is still dominant over orthoclase in these rocks they have been termed biotite-granodiorites. They grade into adamellites with increase in quartz and orthoclase and the virtual disappearance of hornblende. Examples of extreme differentiation to granite are rare but do occur. Specimen CZR 2556 is a monzonitic adamellite crossed by late-stage granite veins.

It is probable that these rocks were formed by progressive fractionation of an andesitic or tonalitic parent magma.

Felspar-biotite porphyries

Strong hydrothermal alteration has made the original composition of the porphyritic rocks difficult to ascertain, but it is likely that they were originally tonalitic or dacitic porphyries rich in plagioclase and biotite. Quartz phenocrysts occur consistently but in very small numbers. Hornblende phenocrysts have been located in the freshest specimens but being susceptible to alteration their original abundance remains uncertain. Orthoclase phenocrysts are generally rare, apatite microphenocrysts are common and zircon is a frequent accessory.

It is unlikely that the porphyries differ greatly in overall composition from the coarse-grained rocks.

Breccias

Those specimens examined consisted typically, of sub-rounded fragments of hornfels, porphyry and granodiorite in matrices of comminuted rock rich in quartz and chlorite or felsite. The breccias lack the appearance of sedimentary breccias and were possibly formed during explosive gas release along fractures which were exploited by the sheets and dykes of porphyry.

The fragments of porphyry contained in the breccias provide evidence to support a multiple intrusion interpretation for the complex.

Tertiary dykes

Specimens of Tertiary dyke rock proved to be olivine basalt, dolerite with accessory olivine, and porphyritic crinanite.

Hydrothermal alteration

Hydrothermal alteration and associated sulphide mineralisation constitute the two most important mineralogical features of the intrusive complex and are principally confined to rocks within the porphyritic unit. At least two phases of alteration have been recognised; an earlier, predominantly sericitic alteration and a later phase in which kaolinite is the dominant secondary mineral. The development of both is closely related to the degree of quartz and/or carbonate veining. The occurrence of dolomite veins and the frequent presence of dolomitic carbonate replacing plagioclase felspars are enigmatic features of the hydrothermal alteration.

Sericitic alteration; plagioclase felspars show partial conversion to sericite but frequently retain remnant albite rims. Primary orthoclase, where identified, shows little alteration but most primary mafic minerals have been converted to interlaminated muscovite/calcite pseudomorphs. Some secondary quartz has developed but secondary orthoclase and biotite are absent. Hematite, pyrite and goethite are present and are all of secondary origin. Partial silicification of the sericite-rich rocks adjacent to quartz-veins is common and where well-developed, the rocks become pinkish-grey or flesh-pink in colour and are often hard and splintery.

Kaolinitic alteration; plagioclase phenocrysts are partially or completely made over to kaolinite and dolomite. Both minerals are prominent in the groundmass although orthoclase tends to resist alteration. Primary biotite remains relatively unaltered. Veins of kaolinite with varying amounts of dolomite and quartz are common and occasionally were found to contain the clay mineral dickite. The alteration is characterised by white powdery, kaolinised felspar and fresh biotite plates which impart a speckled appearance to the rock. This is best seen in numerous intersections in the first drill-hole (BH1).

Composite sericite-kaolinite alteration: combines features of both sericitic and kaolinitic types. It is common in the porphyritic rocks but rare in the coarse-grained rocks. In thin-section secondary muscovite and sericite are evident but in addition there is a pronounced kaolinite (+ dolomite) alteration of the feldspars, and muscovite has frequently been converted to a colourless, low-birefringent clay mineral. The alteration imparts a greenish-grey colour to the rock which is relatively soft.

Chlorite alteration; deuteric chlorite-calcite alteration of the granodiorites is widespread away from the porphyries and in masses included as screens within the porphyries. It is also seen in certain specimens of the clasts within the breccias. The chloritised rocks are barren except where traversed by sulphide-bearing quartz veins within envelopes of sericitic alteration.

Potassic alteration: secondary orthoclase and biotite have not been identified except in one specimen from BH1 (103.00m), where coarse crystals of orthoclase have grown in porphyry otherwise showing strong quartz veining and composite alteration. A sample of drill-core at this intersection provided a copper level of 0.2%.

Hydrothermal veins

Veining is common throughout the mineralised area and it is clear that fluid passage along the veins has been a major factor in the development of mineralisation and alteration. At least four distinct sets of veins have been recognised. The first two, grey chalcedonic quartz and later, white quartz veins, are associated with the main phases of alteration (a sericite/kaolinite composite). A third set, kaolinite/calcite/dolomite veins, is associated with advanced development of kaolinitic alteration. Finally, spidery hair-veinlets of calcite are widespread but are not associated either with the alteration or the development of sulphide minerals. Quartz veins rarely exceed 1cm in thickness and often form thin veinlets (1mm). No preferred vein directions could be gauged from core-sections, and the more prominent veins generally form stockworks with local brecciation of the porphyry.

Mineralisation

Sulphide mineralisation is intimately related to the hydrothermal alteration and veining. Three stages of ore deposition appear to have occurred. Initial development of pyrite in very fine disseminations and veinlets is closely associated with the sericitic alteration. At a slightly later stage, chalcopyrite, bornite, molybdenite and pyrite were deposited along with composite sericite/

kaolinite alteration. Later kaolinitic alteration and associated veins carry patchy developments, often on veins or vein-like zones, of pyrite and molybdenite. It is likely that arsenopyrite was deposited with the early pyrite, but the relative positions of galena and sphalerite which occur very locally in BH2, have not been elucidated.

Pyrite is the dominant sulphide mineral often occurring in amounts between 1% and 5% by volume but rarely exceeding 5%. Chalcopyrite, bornite and molybdenite are present in minor amounts and galena and sphalerite are rare.

Mineralisation is controlled on a large scale by the limits of the porphyry unit and on a small scale by the intensity of quartz/carbonate veining and associated alteration. This is well illustrated in BH1 by specimens in which mineralisation shows a zonal relationship to quartz veins (e.g. specimens from 76.05m and 94.74m). Thin sections show symmetrical zones of alteration arranged about the quartz veins which are themselves barren (Fig. 22). Copper and molybdenum minerals are confined to the zone of mixed sericite/kaolinite alteration. A further specimen from BH1 (63.50m) showed a quartz vein separating sericitic-pyrite porphyry from kaolinised porphyry bearing chalcopyrite and molybdenite.

In BH2 where zones of composite alteration are associated with quartz and carbonate veining, chalcopyrite and molybdenite are significant. By contrast, a widespread but patchily developed, intense sericite-muscovite/kaolinite dolomite mineral assemblage intersected between 120m and 174m in the same drill-hole is not accompanied by silicification or veining, and sulphide mineralisation is restricted to pyrite with very local development of arsenopyrite, galena and sphalerite and only rarely, chalcopyrite.

The overall scheme of alteration and mineralisation is depicted in Figure 23.

GEOPHYSICAL SURVEYS

Measurements of magnetic field, induced polarization (IP) effect, and resistivity were carried out by C Johnson and M Parker in October 1976 along the two lines A and B centred on the sites of the two proposed boreholes (shown in Fig. 19). As the boreholes were completed, downhole measurements of IP effect, resistivity, and self potential (SP) were carried out by C Johnson and F Collar in December 1976 and February 1977, in order to correlate surface and downhole geophysics with the geological and mineralogical borehole logs.

Measurements

For the ground surveys, Huntec Mark 3 IP equipment was used to measure chargeability and resistivity with a dipole-dipole array and dipole length 50m, for n=2 to 6 dipole lengths (centre to centre dipole separation). Chargeability was defined as the time integral of the decay voltage (normalised with respect to the transmitter voltage), measured between 240 and 1140ms after termination of a two second square wave transmitted pulse. For the downhole surveys measurements were taken at metre intervals using a pole-dipole array with one current electrode at the base of the sonde, two potential electrodes 0.5m and 1.0m above this, and the second current electrode on the ground surface approximately 50m from the borehole or effectively at infinity compared with the electrode separation on the sonde. Total magnetic field was measured at 10m intervals along the lines using a Geometrics proton magnetometer.

Results

Magnetic field profiles, chargeability and resistivity pseudo-sections, and borehole positions for lines A and B are shown in Figs. 24 and 25. Chargeability, resistivity, and SP logs for BHS 1 and 2 are shown in Figs. 26, 27 and 28.

Line A

A zone of high chargeability and low resistivity occurs at the southern end of the line near the boundary between Dalradian metasediment and the porphyry intrusives. A second zone of high chargeability occurs at the northern end of the line within metasediment and porphyry. These anomalous zones may be caused by disseminated sulphides from porphyry style copper mineralisation and the highest IP anomalies probably reflect a pyrite zone.

The low resistivity in the south may be caused by metasediments separated from higher resistivity intrusives by the fault at 120m S. The low resistivity zone dipping S from 300m N is caused by metasediments within intrusives, bounded at their southern margin by a fault zone at 220m N.

A comparison of the IP and Cu analysis logs for BN1 shows that all Cu anomalies greater than 1000 ppm correspond to chargeability and resistivity anomalies (depths 10-20m, 47m, 80m, and 95-100m). The high Cu anomalies of over 2000 ppm at 95-100m correspond with high chargeability, although dolerite dykes at 106-107m and 108-109m increase the IP anomalies in this zone. Chargeability anomalies with no associated resistivity anomalies occur at 22m 28m and 149m. The irregularity of the resistivity log is explained by variations in composition or alteration of the rock, degree of mineral dissemination, and the presence of fracture zones.

Disseminated chalcopyrite and pyrite are visible in the core and both will contribute significantly to the IP effect. Thus the correlation between the IP effect and Cu concentration implies a correlation between concentrations of chalcopyrite and pyrite.

BH1 is situated near the margin of the chargeability high at the south of line A. The low chargeability background throughout the borehole log is consistent with the low values north of the anomalous zone of the pseudo section. The position of the borehole anomaly at 100-110m depth is consistent with the higher anomaly at 75m N on n=6, which may therefore be associated with high Cu and pyrite in the felspar porphyry and mineralisation in the dolerite dykes.

Line B

Chargeability values are high throughout the pseudo-section, but the main anomalous zone occurs over the granodiorite at 200-300m NE, broadening at depth into the porphyry and the metasediments. The anomaly is associated with low resistivity at depth and may be caused by sulphides in disseminations and veinlets although again the highest chargeability values would probably indicate a pyrite zone.

At the SW end of the line, a zone of low resistivity may be attributed to the fault at 410m SW, or the dolerite dyke at 375m SW. Further NE, a similar zone of low resistivity is probably associated with dolerite dykes at 310 and 275m SW.

The chargeability log for borehole 2 is very irregular with numerous high peaks from 0-100m depth, and smaller peaks below 100m. The Cu analysis log indicates that nine of the fourteen Cu anomalies greater than 600 ppm correspond to chargeability and resistivity anomalies (depths 10m, 27m, 33m, 43m, 69m, 75m, 88m, 94m, 166m), although the magnitudes of the chargeability anomalies do not relate to the magnitudes of the associated Cu anomalies. Dolerite dykes at 25m and 115m depth produce high chargeability, low resistivity peaks. Low resistivity below 115m is caused by the occurrence of up to 10% cubic pyrite together with a lack of silicification of the rock, and many of the high resistivity peaks above this depth can be correlated with very strong silicification. This may explain the high resistivity associated with the high chargeability zone at 75-90m. The SP log shows several distinct anomalies above 110m, all with associated chargeability peaks, and several with associated Cu anomalies. The SP anomalies may indicate the more massive sulphide occurrences which would be predominantly pyrite.

The IP anomalies in BH2 are attributed mainly to disseminated pyrite, associated with smaller amounts of chalcopyrite above 110m, where the higher IP anomalies occur. Below 110m lower chargeability values are associated with trace amounts of chalcopyrite and pyrite, with disseminated cubic pyrite producing small chargeability and lower resistivity.

BH2 dips toward the southern margin of the main chargeability high at the NE end of line B, although slightly offset to the N. Moderately high chargeabilities above 110m depth in borehole 2 are consistent with pseudo-section values for n=2 to 5, which can therefore be explained by disseminated pyrite with some chalcopyrite. Below 110m the borehole IP anomalies decrease, indicating that the source of the main anomalous chargeability zone of the pseudo-section was not intersected.

Magnetics

Total magnetic field profile for line A shows sharp anomalies of several hundred gammas magnitude, generally positive to the S and negative to the N, which can be attributed to normally magnetized steeply dipping dolerite dykes of the Tertiary dyke swarm. Inferred positions of the dykes are shown in Fig. 22, and those at 75m and 120m N are confirmed in borehole 1. The small positive anomaly at 240m N is caused by an electric fence, and the anomaly from 300-350m N is associated with metasediments.

Line B shows a much more irregular magnetic profile with sharp anomalies of up to 1500 gammas magnitude, attributed to the numerous Tertiary dykes which are known to cut this line.

The magnetic profiles give no indication of other intrusive rock types, or the presence of pyrrhotite in areas of high chargeability, although any such effects might be masked by the steep gradients due to the Tertiary dykes.

Discussion

The IP anomalies of the ground surveys are caused by disseminated sulphide found throughout the porphyry intrusives and the margins of the metasediment. Very high chargeability values at each end of lines A and B indicate zones of enriched pyrite with minor chalcopyrite and other sulphides. The IP and SP downhole surveys could not confirm this as the bore-holes were not sited to intersect the main IP anomalies. They do indicate however, that pyrite is the main cause of the very localised downhole anomalies and a close association of the pyrite with minor chalcopyrite is apparent from the core analyses. This association is particularly strong in BH1.

The suggested enriched pyrite zones at the ends of lines A and B may be intersections of a pyrite 'halo' occurring within the porphyry and across its boundaries with the metasediment to the south, and granodiorite to the west. This is in general agreement with the form of results from the broader scale IP surveys carried out by companies in 1971-1974.

DISCUSSION AND CONCLUSIONS

The investigations have demonstrated quite clearly that the intrusive complex exhibits many of the features associated with porphyry copper style mineralisation.

The calc-alkaline composition of the complex, the size and extent of the porphyritic component, the evidence of some structural control, the presence of intrusive breccias, disseminated sulphides and pervasive hydrothermal alteration, are all features of the Kilmelford intrusion which also typify many of the well known porphyry copper deposits elsewhere in the world (Lowell and Gilbert, 1970).

The sulphide mineralisation in the form of blebs and veinlets associated with quartz/carbonate vein stockworks, and the pervasive hydrothermal alteration, are perhaps the most important of the above features. Four distinct alteration zones are recognised by Lowell and Guilbert; potassic, phyllic, argillic, propylitic. The potassic zone appears to be absent at Kilmelford and only vestiges of a porpylitic zone can be recognised within the intrusive complex. Regional, low-grade metamorphism (green-schist facies), hinders any attempt at plotting the extent of this zone in the surrounding hornfels. The quartz-sericite-pyrite-carbonate mineral assemblage at Kilmelford can be safely ascribed to the phyllic zone and resembles the metasomatic sericite alteration discussed by Hemley and Jones (1964) and Rose (1970). In the less sericitised zones, the development of kaolinite after plagioclase, and the retention of primary megascopic flakes of biotite are typical of the argillic alteration described by Lowell and Guilbert (1970).

The scope of the surface mapping and insufficient sub-surface data has prevented the lateral and vertical extent of the alteration zones from being deduced although our own geochemical results, and geophysical surveys undertaken by the mining companies, suggest that a concentric zonal pattern of alteration and sulphide mineralisation probably does exist. On a small scale, mineralisation intersected in the drill-core can be seen to be controlled by alteration which is itself controlled by quartz/carbonate veining and is similar in some respects to the zonal arrangement of mineralisation and alteration noted by Ambler and Facer (1974) in a Silurian porphyry copper near Yeoval, New South Wales.

The apparent lack of a potassic zone and the absence of a well-defined propylitic zone are atypical features of porphyry coppers as is the strong development of dolomitic carbonate observed in much of the core from BH2. However, in similar biotite-felspar porphyries in the Babine Lake area of British Columbia, where the extent of economic copper mineralisation is confined to centrally positioned potassic zones characterised by secondary biotite, these zones are sometimes surrounded by pyrite haloes containing prominent dolomite/carbonate (Carson and Jambor 1974).. The prominence of dolomitic carbonate in the Kilmelford drill-core may thus indicate a potassic zone at depth. The presence of this carbonate with kaolinite might also reflect a high proportion of meteoric to juvenile water in the hydrothermal system.

Radiometric age determinations of representative rock-types from the intrusive complex are incomplete. However, preliminary age determinations on a biotite concentrate from a specimen of fresh granodiorite using the K-Ar isotope dating technique have given a provisional age of 418 ± 14m.y. (C Rundle, Isotope Geology Unit). Xenoliths of granodiorite in porphyry have been logged in several intersections in BH2 indicating that the porphyritic component is later than the granodiorite. Similarities in their chemical composition suggest that both rocks originated as different intrusive phases from a common parental magma. Xenolithic porphyry fragements intersected in breccia-zones in BH2 plus the evidence from surface-mapping, indicate that several distinct porphyries occur. Their probable sheeted disposition may have provided more effective pathways for hydrothermal solutions and accompanying sulphides than the adjacent granodiorite. It is possible that a second-phase of porphyry/felsite dyke intrusion post-dates the major sulphide mineralisation. The attitude of the porphyry sheets is not apparent at outcrop although the porphyry-hornfels contact intersected in BH1 suggests that the porphyries are sub-vertical or steeply dipping to the south and probably conformable to the regional dip of the metasediments. There is no unequivocal evidence however, that this is the case throughout the complex.

The Lorne plateau lavas, which lie unconformably on Dalradian metasediments to the north of Loch Melfort, overlie and are intercalated with Lower Devonian sediments (Mercy 1965). The lavas and the Kilmelford granodiorites may therefore be of similar age, and although the lavas are now absent to the south of Loch Melfort it is possible that a volcanic pile once extended over that area and has since been removed by erosion to expose a sub-volcanic centre near Lochan Beinn nan Chaorach. Thus the present outcrop there may represent a high structural level within the intrusive complex and it is possible that a potassic zone and accompanying higher grade mineralisation exist at depth.

The recognition in Scotland of porphyry style copper mineralisation in a calc-alkaline intrusive complex is of considerable interest both as a possible economic deposit and because of its Caledonian age. Current investigations by the Institute of several other small Caledonian intrusions within the Grampian Highlands suggest that the Kilmelford mineralisation is not unique and that subeconomic copper mineralisation may have developed in association with subduction within the early Devonian.

Although the drilling programme in the south-central part of the complex failed to intercept economic copper mineralisation the results are sufficiently encouraging to justify additional sub-surface exploration. The geochemical auger sampling should be extended, particularly to the northwest to close the strong anomalies located near Lochan Beinn nan Chaorach. Further geophysical surveys are required to determine the structure and the disposition of the sulphide conductors and hence to provide more precise future drilling targets.

ACKNOWLEDGEMENTS

The Institute is indebted to the land-owners for their co-operation and particularly to Miss Strang-Steel of Garraron who permitted the use of her farm tracks for access to the drill-sites and provided facilities for storage of drill-core and equipment.

Access to the confidential reports of Noranda Exploration (UK) Limited and Phelps Dodge Europa Limited is gratefully acknowledged.

The following members of the Institute have contributed substantially to the preparation of the report; Messrs B Scarth and K Jacobs (Radioactive and Metalliferous Minerals Unit), who undertook the powered auger drilling; Miss B P Allen and Mr T K Smith (Analytical and Ceramics Unit) were responsible for the analytical work, Messrs B Lister and B Skilton (Mineralogy Unit), for preparation of Polished thin-section. Mr K F Clarke and colleagues (London Drawing Office), prepared most of the illustrations. Miss C Collingborn assisted in some of the field work and has been largely responsible for editing and collating the report. Thanks are also due to Mrs Folami and Miss P. Raymond (typing).

The investigation has been under the overall supervision of Dr M S Garson, Liaison Officer for the Mineral Reconnaissance Programme.

REFERENCES

Published

AMBLER, E.P., FACER. R.A., 1975 A Silurian porphyry copper prospect near Yeoval, New South Wales. J. Geol. Soc. Australia Vol. 22. p. 229-241.

CARSON, D.J.T., JAMBOR J.L. 1974 Mineralogy, zonal relationships and economic significance of hydrothermal alteration of porphyry copper deposits, Babine Lake area, British Columbia. Bull Can. Inst. Min. Vol. 98 p. 99-109.

COOPER D.C. 1976 Contribute remarks in discussion on - Copper mineralisation in the forest of Coed-y-Brenin, North Wales. Trans. Inst. Min. Metall (Sect. B: Appl. Earth Sci.) Vol. 85 p B296-B297.

DEPARTMENT OF INDUSTRY 1972. Mineral exploration and investment grants act - A guide for industry - Department of Industry 13pp.

HARRIS A.L. PITCHER W.S. 1975. The Dalradian Supergroup In Harris A L (ed) A correlation of the Precambrian rocks in the British Isles. Geol. Soc. Lond. Spec. Rep. No.6, p.52-75.

HEMLEY, J.J., JONES, W.R., 1964. Chemical aspects of hydrothermal alteration with emphasis on hydrogen metasomatism. Econ. Geol. Vol.59 p538-569.

JOHNSTONE G.S. 1966 The Grampian Highlands, 3rd Edtn. Brit. Reg. Geol. 103pp.

LEPELTIER, C., 1969 A simplified statistical treatment of geochemical data by graphical representation. Econ. Geol. Vol. 64 p538-550.

LOWELL, J.D., GUILBERT, J.M., 1970. Lateral and vertical alteration - mineralisation zoning in porphyry ore deposits. Econ. Geol. Vol.65 p373-408.

MERCY, E.L.P., 1965. In the geology of Scotland (Ed. G.Y.Craig) p229-267.

PARSLOW, G.R., 1974. Determination of background and threshold in exploration geochemistry. J. Geochem. Expl. Vol.3. p.319-336.

PEACH, B.N., KYNASTON, H., MUFF, H.B., 1909 The geology of the sea-board of mid-Argyll, including the islands of Luing, Scarba, the Garvellachs and the lesser isles together with the northern part of Jura and a small portion of Mull. Mem. Geol. Surv. Scotland No.36. 121pp.

RICE, R., SHARP.G.J., 1976. Copper mineralisation in the forest of Coed-y-Brenin, North Wales. Trans. Inst. Min. Metall. (Sect. B: Appl. Earth. Sci.) p 1-13.

SMITH, D.I., 1961. Patterns of minor faults in the south central highlands of Scotland. Bull. Geol. Surv. G.B. No.7 p 145-152.

WILSON.G.V., FLETT, J.S., 1921. The lead, zinc, copper and nickel ores of Scotland. Mem. Geol. Surv. Spec. Rep. Min. Res. G.B. Vol. XVII p.134.

Unpublished

FORTEY, N.J. 1976. Petrographic examination of rock-specimens from the Kelmelford intrusion centre, Argyllshire. IGS Mineralogy Unit Report No. 181.

FORTEY, N.J. 1977. Mineralogical investigation of drill-core from borehole 1, Kilmelford, Argyllshire. IGS Mineralogy Unit Report No. 192.

FORTEY, N.J. 1977. Mineralogical examination of specimens from drill-hole 2, Kilmelford, Argyllshire. <u>IGS. Mineralogy Unit Report</u> No. 193.

APPENDIX I

1 GEOCHEMICAL SAMPLE LOCATIONS

SUMMARY OF LOCATION OF SOIL (PEAT AND TILL) SAMPLES

POWERED AUGER SAMPLING

Sample No.	Grid	Depth (m)	Description
KMS1	100S 300E	0.3	Peat
KMS3	00 400E	0.4	Peat
KMS4		3.6	Yellow gritty clay
KMS5	200N 400E	0.2	Peat
KMS6		0.8	Grey gritty clay
KMS7	00 500E	0.3	Peat
KMS8		1.5	Brown gritty clay
KMS9	113S 600E		Till
KMS10	110S 525E		Till
KMS11	100S 445E		Till
KMS12	100S 375E		Till
KMS15	00 600E		Till
KMS17	400S 300E	0.7	Peat
KMS18		1.8	Brown gritty clay
KMS20	400S 100E	1.1	Peat
KMS21		5.4	Brown till with felsite calsts
KMS22	400S 200E	0.4	Brown gritty clay
KMS23	500S 200E	1.0	Peat
KMS25	500S 300E	0.2	Peat
KMS26		0.4	Brown gritty clay
KMS28	500S 400E	0.7	Peaty clay
KMS29	400S 500E	0.2	Peat
KMS30		0.5	Brown clay
KMS50	400S 600E		Brown gritty clay
KMS51	500S 100E	0.3	Peat
KMS52		0.4	Brown clay
KMS54	400S 400E	0.4	Red/brown clay
KMS56	600S 500E	1.4	Peat
KMS57		2.3	Till
KMS58	200S 600E	0.1	Peat
KMS59	300S 700E	0.5	Orange-brown clay
KMS61	100N 00	1.3	Grey gritty clay
KMS62	00 00	0.9	Peat
KMS63		4.1	Grey clay
KMS64	500S 00	0.9	Peat

Sample No.	Grid	Depth(m)	Description
KMS65	500S 00	1.0	Light brown clay
KMS66	650S 00	1.4	Peat
KMS67		8.1	Fluvio-glacial orange-brown sandy clay
KMS68	300S 300E	0.1	Peat
KMS69		0.5	Dark grey clay silt + rock fragments
KMS70	200S 300E	0.2	Clayey peat with felsite porphyry fragments. Bedrock encountered
KMS71	200S 400E	0.1	Peat
KMS72		0.8	Dark grey clay with blue/green clay clasts. Bedrock 0.8m?
KMS73	300S 400E	0.1	Peat
KMS74		1.1	Dark grey clay with common porphyry clasts and sparse green/blue clay clasts.
KMS75	300S 500E	0.1	Peat
KMS76	300S 600E	0.1	Peat
CZS3003	300N 00	9.0	Grey lacustrine clay/silt, flat peat bog, hornfels clasts.
CZS3004	200N 00	3.0	Approx. Peaty.
CZS3005		8.1	Grey lacustrine clay/silt, flat peat bog, hornfels clasts.
CZS3007	200N 100W	2.0	Dk grey clay with coarse clasts of hornfels.
CZS3008	100N 100W	0.2	Peat
CZS3009		0.7	Brown clay/silt on slope of hill.
CZS3010	100N 00	1.0	Peat
CZS3011		1.5	Grey clay/silt with fine clasts of hornfels.
CZS3012	50N 00	0.9	Peat overlying solid rock, 1 frag of Felsite with sulphide.
CZS3015	50N 100W	3.5	Brown clay with large clasts of hornfels with sulphides 2m N of peg.
CZS3017	00 100W	3.9	Brown clay/sand with clasts of hornfels and sulphide.
CZS3018	00 50W	2.0	Brown peat
CZS3019		3.6	Grey clay/silt with felsitic clasts of bedrock with abundant pyrite.

Sample No.	Grid		Depth (m)	Description
CZS3020	50S	50W	2.5	Peaty
CZS3021			3.4	Grey till and bedrock, gritty no visible sulphides.
CZS3022	100S	00	1.5	Peaty
CZS3023			2.8	Grey till, no visible sulphides, gritty.
CZS3024	50S	00	1.1	Peaty
CZS3025			1.4	Grey till, gritty, clasts of felsite no visible sulphides.
CZS3030	00	100E	5.3	Peaty, no till, no bedrock clasts recovered.
CZS3032	50N	100E	2	Peaty
CZS3033			3.5	Grey clay/silt, trace sulphide poss. weathered bedrock.
CZS3035	100N	100E	2.4	Grey clay with clasts of felsite.
CZS3036	100N	200E	1.0	Peaty
CZS3037			2.0	Grey clay/Pink weathered felsite bedrock?
CZS3038	150N	250E	1.0	Peaty and gritty clasts.
CZS3040	200N	300E	0.8	Peaty with gritty clay and large clasts of felsite with sulphides.
CZS3042	200N	350E	0.9	Peaty
CZS3043			2.0	Grey/Brown clay with large clasts of felsite and hornfels and 1 frag of dolerite. Very stony not probable bedrock.
CZS3045	200N	400E	1.6	Peaty but with gritty clasts of felsite.
CZS3046	200N	450E	0.5	Peaty with some fine rock frags no identifiable clast.
CZS3048	150N	450E	0.6	Peaty
CZS3049			1.2	Brown clay with felsite clasts.
CZS3050	150N	400E	1.5	Peaty
CZS3051			1.7	Peaty with felsite frags and abundant sulphides.
CZS3052	150N	350E	0.9	Peaty with felsite frags.
CZS3054	100N	300E	0.5	Peaty with felsite clasts.
CZS3056	100N	350E	0.8	Peaty
CZS3057			1.5	Grey/Green till with hornfels clasts.
CZS3058	100N	400E	1.0	Peaty
CZS3059			1.7	Dk grey till with hornfels clasts. Drilled down 2.4m with only broken hornfels in hole, hole collapsed, no core.
CZS3060	50N	400E	1.0	Peaty and gritty
CZS3061			2.0	Grey till with clasts of felsite, hornfels and qtz.
CZS3062	50N	350E	1.2	Peaty
CZS3063			1.8	Gritty brown clay with felsite clasts.

Sample No.	Grid		Depth (m)	Description
CZS3064	00	350E	0.2	Peaty
CZS3065			1.0	Grey/brown clay abundant hornfels clasts.
CZS3066	50S	300E	1.0	Peaty with hornfels clasts.
CZS3067			2.8-	Yellow/brown sandy till with abundant clasts of hornfels and <u>sulphides</u> and dolerite?
CZS3068	00N	300E	0.4	Peaty
CZS3069			1.0	Grey/green till with felsite clasts.
CZS3070	50N	300E	0.5	Peaty
CZS3071			1.4	Brown clay silt with felsite clasts.
CZS3072	50N	250E	3.2	Peaty
CZS3074	50N	200E	0.6	Peaty with qtz clasts
CZS3075			1.0	Sandy, yellow/brown till with qtz and dolerite (?) clasts.
CZS3076	00	200E	2.5	Peaty
CZS3077			3.5	Grey till with felsite clasts and sulphides.
CZS3078	50S	200E	3.5	Peaty
CZS3079			4.4	Grey till.
CZS3080	100S	200E	0.2	Peaty and gritty
CZS3081			1.0	Brown clay/sand with abundant clasts of Granodiorite (?)
CZS3082	50S	150E	0.4	Peaty
CZS3083			1.0	Sandy yellow/brown till
CZS3084	100S	100E	0.4	Peaty
CZS3085			1.3	Grey/green till and clast of hornfels.
CZS3086	150S	00	2.2	Peaty
CZS3087			2.5	Sandy, brown with clasts of felsite.
CZS3088	150S	100E	0.4	Peaty
CZS3089			1.3	Grey/green, sandy with clasts of gray hornfels? (as 100S 100E).
CZS3090	150S	200E	0.5	Peaty
CZS3091			1.2	Orange/brown, sand/clay, no clasts, offset 10m south.
CZS3092	200S	200E	1.8	Peaty
CZS3093			2.4	Clay/sand and peat with clasts of felsite.
CZS3094	200S	150E	0.5	Peaty with some sandy material and felsite frags with <u>sulphides</u>.
CZS3096	200S	50E	0.5	Peaty
CZS3097			1.0	Peaty/gritty with fine clasts of weathered felsite?
CZS3098	200S	00	1.5	Peaty
CZS3099			2.7	Weathered felsite and rock flour.

Sample No.	Grid.	Depth (m)	Description
CZS3100	250S 50E	0.5	Peaty
CZS3101		1.0	Brown, sand/clay with small felsite clasts.
CZS3102	250S 00	1.5	Peaty
CZS3103		2.3	Peaty and gritty clay/silt with felsite frags. no sulphides seen.
CZS3104	200S 50W	0.4	Peaty
CZS3105		1.3	Brown, v. stony, clay/sand, same rock (as 100S, 100E).
CZS3106	250S 100W	0.8	Peaty
CZS3107		2.0	Yellow/brown, stony/sand/clay with clasts of felsite.
CZS3108	250S 200W	0.5	Peaty with some green weathered clasts.
CZS3110	300S 250W	0.2	Peaty with sandy material
CZS3111		1.4	Yellow/brown, sand/clay, gritty no clasts.
CZS3112	300S 200W	1.5	Peaty
CZS3113		2.4	Peaty with some mineral material and clasts of hornfels?
CZS3114	300S 100W	0.4	Peaty
CZS3115		0.7	Peaty and red/brown sand/clay.
CZS3116	300S 00	0.6	Peaty
CZS3117		1.2	Peaty with brown clay and felsite clasts.
CZS3118	650S 400S	0.2	Peaty
CZS3119	Offset 7m W	1.3	Very stony, grey/brown, sandy.
CZS3121	650S 500W	4.0	Grey/brown till abundant clasts of altered country rock.
CZS3127	600S 600W	1.3	Lt. sand/clay with abundant clasts of felsite + sulphides.
CZS3123	600S 500W	3.6	Grey/brown, wet, sand/clay with clasts of hornfelsic country rock.
CZS3124	600S 400W	0.2	Peaty
CZS3125		0.4	Brown, sand/clay, soil with abundant felsite clasts.
CZS3129	500S 600W	1.1	Sandy, grey/brown till with country rock clasts + sulphides.
CZS3130	500S 500W	2.7	Peaty
CZS3131		3.1	Grey/green till/wet with green clasts.
CZS3132	450S 450W	0.6	Peaty
CZS3133	Offset 20m NW	1.1	Brown, sandy till with peat contamination.
CZS3134	550S 440W	0.6	Peaty
CZS3135		0.8	Red/brown, sandy with peat contamination.
CZS3137	500S 100W	0.2	Peaty clay with felsite clasts.

Sample No.	Grid.	Depth (m)	Description
CZS3139	600S 00 Offset 10m W	4.0	Grey/brown till + abundant country rock clasts.
CZS3141	600S 100W Offset 10m W	1.2	Brown/clay/sand with diorite/country rock clasts abundant.
CZS3143	600S 200W Offset 5m SE	1.1	Grey/brown, sand/clay with country rock clasts.
CZS3144	550S 350W	1.5	Peaty
CZS3145		2.5	Brown/grey till with clasts of country rock and felsite. Drilled through boulder to 4.2m hole abandoned as bits and rods were wearing badly.
CZS3146	450S 350W	0.8	Peaty
CZS3147		1.7	Light brown sand with clasts of felsite?
CZS3149	400S 400W Offset 12m E	1.7	Lt. brown, sandy till + clasts of country rock.
CZS3150	350S 250W	1.1	Peaty with clasts of felsite?
CZS3151	Offset 10m ENE	3.6	Light brown, clay/sand with abundant clasts of felsite + disseminated sulphides.
CZS3152	400S 300W	0.7	Peaty
CZS3153		0.9	Wet brown clay/silt.
CZS3154	500S 300W	0.8	Peaty
CZS3155	Offset 10m E	1.5	Light brown, sandy till with abundant felsitic clasts.
CZS3156	400S 200W	0.8	Peaty
CZS3157	Offset 12m SW	3.5	Brown till + abundant clasts of dyke rock?
CZS3158	350S 150W	0.5	Peaty with felsite clasts.
CZS3159		1.5	Mainly very weathered felsite.
CZS3160	400S 100W	0.4	Peaty
CZS3161		1.4	Peaty + felsite clasts.
CZS3163	450S 150W	2.3	Wet brown clay with abundant fine gritty clasts.
CZS3165	400S 00	0.8	Brown sandy weathered felsite.
		0.8-1.2	Felsite + a few sulphides.
		0.5	Felsite with pyrite in veinlets.

Sample No.	Grid.	Depth (m)	Description
CZS3166	350S 50W	0.3	Peaty
CZS3168	350S 50E	0.2	Peaty
CZS3169	Offset 4m E	0.8	Grey/brown clay with peat contamination.
CZS3170	300S 200E	0.2	Peaty with felsite weathered clasts.
CZS3171		0.6	Brown clay/sand with abundant felsite clasts.
CZS3172	250S 200E	0.4	Peaty
CZS3173		1.5	Brown, sand/clay with abundant clasts of dark fine grained rock + quartz.
CZS3174	300S 100E	0.2	Peaty
CZS3175	Offset 6m N	0.7	Peaty + felsite clasts.
CZS3176	250S 100E	0.4	Peaty
CZS3177	Offset 6m N		Weathered felsite (pink).
CZS3178	200S 100E	0.6	Peaty
CZS3180	200S 250E	0.5	Peaty
CZS3181		1.0	Brown, clay with gritty clasts.
CZS3182	400S 100E	1.2	Peaty
CZS3183		1.5	Brown, clay/sand with abundant gritty clasts.
CZS3185	500S 00W	1.1	Brown, sand/silt + fine rock clasts.

SUMMARY OF LOCATION OF OUTCROP ROCK AND POWERED AUGER DRILL SAMPLES

(KMR/CZR - outcrop rock sample; KMD/CZD = drill sample)

Sample No.	Grid	Depth (m)	Description
KMR1	100S 300E	1.9	Weathered porphyry
KMD4	00 400E	3.9	Grey hornfels breccia; sulphides, abundant
KMR6	200N 400E	1.0	Porphyry; no visible sulphides
KMD8	00 500E	1.8	Pink porphyry
KMR9	113S 600E	outcrop	Hornfels
KMR10	110S 525E	outcrop	Grey-green metasediment
KMR11	100S 445E	outcrop	Hornfels/porphyria breccia; sulphides sparse
KMR12	100S 375E		Porphyry; sulphides, abundant (chalcopyrite)
KMR15	00 600E		Hornfels breccia; sulphides, common
KMR19	400S 300E	2.0	Hornfels; sulphides, abundant on joints.
KMD21	400S 100E		Felsite; sulphides, common
KMR22	400S 200E	outcrop (offset 10m N)	Metasediment; sulphides, common (pyrite)
KMR26	500S 300E	outcrop (offset 10m W)	Quartzite; sulphides, common (pyrite)
KMR28	500S 400E	outcrop (offset 15m E)	Metasediment, sulphides, fairly common
KMR30	400S 500E	1.0	Porphyry scree debris
KMR31	300N 380E	Rock-bar on stream	Medium/coarse adamellite?
KMR32	340N 520E	Sheep-scrape	Porphyry debris
KMR33	340N 600E	Rock-bar	Silicified porphyry; sulphides, abundant (chalcopyrite, bornite?).
KMR34	260N 660E	outcrop	Porphyry (weathered).
KMR35	00 400E	outcrop	Hornfels (duplicates KMD4)
KMR36	180N 580E	outcrop	Sheared porphyry with epidote/chlorite
KMR37	70N 500E	Sheep-scrape	Weathered porphyry
KMR38	170N 500E	outcrop	Sheared adamellite? No visible sulphides
KMR39	210N 500E	outcrop	Sheared pink porphyry.

Sample No.	Grid	Depth (m)	Description
KMR40	30N 630E	outcrop	Baked hornfels (adjacent tertiary dyke)
KMR41	410S 730E	outcrop	Adamellite? sulphides, common
KMR42	320S 640E	outcrop	Sheared, silicified hornfels sulphides, common
KMR43	270S 700E	outcrop	Dark grey porphyry dyke; sulphides, common
KMR44	210S 670E	outcrop	Porphyry (silicified?) sulphides, sparse/common
KMR45	200S 500E	Sheep-scrape	Weathered porphyry
KMR46	120S 690E	outcrop? float	Grey silicified porphyry, sulphides, abundant
KMR50	400S 600E	outcrop	Porphyry
KMD52	500S 100E	0.5	Weathered hornfels?
KMR54	400S 400E	0.5	Hornfels
KMR58	200S 600E	0.4	Weathered porphyry; sulphides, abundant
KMR59	300S 700E	>0.5	Weathered porphyry
KMR60	300S 200E	outcrop	Weathered porphyry
KMD61	100N 00	1.6	Grey rock cuttings (hornfels?)
KMR65	500S 00	outcrop (offset 10m E)	Tertiary dyke
CZR2517	850S 530W	outcrop	Igneous breccia + pyrite
CZR2518	720S 510W	outcrop	Sulphide in country rock material
CZR2519	830S 440W	"	Pyrite in feldspar porphyry
CZR2520	395N 00	"	Sulphide disseminated in pinkish granodiorite.
CZR2521	400N 00	"	Similar to 2520 + more feldspar phenocrysts + galena (1 small grain).
CZR2522	395N 10E	"	Granodiorite; more orange weathering; trace chalcopyrite + malachite.
CZR2523	290N 100E	"	Hornfels (? amphibolite); pyrite vein + chalcopyrite + copper secondaries. Next to intrusion breccia material (hornfels breccia) Sulphide poor.

Sample No	Grid	Depth (m)	Description
CZR2524	120N 170E	outcrop	Igneous breccia (felsite breccia); pyrite only seen
CZR2525	40S 170W	"	?Feldspar porphyry - flesh pink, weathering orange; pyrite + trace? chalcopyrite
CZR2561	370S 320E	"	Contact hornfels
CZR2562	390S 340E	"	Contact hornfels
CZR2563	510S 390E	"	Feldspar porphyry
CZR2564	490S 395E	"	Contact hornfels
CZR2565	465S 415E	"	Contact hornfels
CZD3000	50S 300E		As 3009
CZD3001	100S 100E	2.1	Grey rock with some pyrite
CZD3002	50S 150E	2.3	V. broken felsite with sulphides. Out of water, cuttings sample taken
CZD3003	300S 00	1.5	Felsite with some pyrite
CZD3004	200S 50W		Bag of stones collected as no water to drill
CZD2005	250S 100W	2.3	Some pyrite seen. Poor coring much weathered material falling into hole. Meagre sample.
CZD3006	150N 350E	0.9-1.9	Felsite with some sulphide v.broken
CZD3007	100N 300E	0.5-1.2	Felsite with sulphides v.broken
CZD3008	50N 350E	1.8-	Weathered felsite bedrock and sulphides. Hole collapsed at 2.3m
CZD3009	50S 300E		Poor core, v.broken hornfels. Sample of drill cuttings taken
CZD3010	00 300E	1.65	Felsite with sulphides
CZD3011	50N 250E	3.8	Cuttings from drilling attempt. Felsite and hornfels fragments.
CZD3012	100S 200E	2.3	Plenty pyrite in rock
CZD3013	50S 150E	2.3	As 3002
CZD3014	100S 100E	2.1	As 3001
CZD3015	200S 00	3.3	Felsite and sulphides, v.weathered and broken
CZD3016	300S 200W	3.0	Felsite with some sulphides
CZD3017	300S 100W	1.5	Felsite, some pyrite
CZD3018	650S 40W	1.4 offset 7m W	Clasts of b/rock, hornfelsic country rock + pyrite.

Sample No.	Grid	Depth (m)	Description
CZD3019	650S 500W	4.5	Boulders in till, no bedrock: felsite + country rock frags
CZD3020	600S 500W	3.6-4.3	Hornfels + pyrite veins, definite bedrock
CZD3021	600S 400W	0.5	Felsite + ? + country rock + sulphides. Taken from outcrop.
CZD3022	600S 600W		Felsite with disseminated sulphides
CZD3023	500S 600W	1.6	Country rock + sulphides
CZD3025	450S 450W	1.3 offset 20m NW	Diorite ?, few sulphides
CZD3026	550S 440W	1.3-4	Felsite?, few sulphides
CZD3027	500S 100W	outcrop	Felsite?, few if any sulphides
CZD3028	600S 00	4-4.6 offset 10mW	Grey country rock + some pyrite and calcite in veins
CZD3029	600S 100W	1.2-1.9 offset 10mW	No rock recovered, cuttings sample taken. Note probable scree material of slope.
CZD3030	600S 200W	1.8-2.5 offset 5mSE	V. broken diorite: weathered + sulphides disseminated. Outcrops all around this site of country rock and dyke rock
CZD3031	350S 250W	3.6-4.7 offset 10m ENE	
CZD3032	400S 300W	0.9-1.5	Weathered felsitic rock + sulphides in veinlets.
CZD3033	400S 400W	1.7-2.2 offset 12mE	Disseminated sulphides in diorite
CZD3034	450S 350W	1.7-2.3	Felsite with few sulphides + inclusions of country rock.
CZD3035	500S 300W	cuttings	
CZD3036	" "	offset 10m	Felsite + disseminated sulphides
CZD3037	500S 200W	0.2-0.7	No till, little peat. Brown weathered dyke rock?
CZD3038	400S 200W	3.5-4 offset 12mSW	Felsitic rock with sulphides in veins and disseminated
CZD3039	350S 150W	1.3-1.7	Felsite + disseminated and vein sulphides
CZD3040	400S 100W	1.4-2.0	Felsite + some sulphides
CZD3041	450S 150W	2.3-2.9	Dark black/grey igneous rock. No visible sulphides.

Sample No.	Grid	Depth (m)	Description
CZD3042	400S 00	0.8-1.2	Felsite + a few sulphides
CZD3042B	offset 5mS	0.5	Felsite with pyrite in veinlets
			Felsite with pyrite in veinlets.
CZD3043	350S 50W	0.8-1.2 offset 4mE	Pink felsite with vein and some disseminated pyrite.
CZD3044	250S 200E	1.5	Large clasts of dark fine grained (dyke?) rock with abundant pyrite
CZD3045	300S 100E	0.7-1.1 offset 6mN	Felsite + abundant pyrite
CZD3046	250S 100E	1-1.4 offset 4mE	Felsite with little pyrite
CZD3047	200S 100E	0.6-1.1	Felsite + some pyrite
CZD3048	150S 200E	1.4-1.7	Felsite + abundant pyrite in veins and disseminated
CZD3049	200S 200E	2.4 +	Felsite + little pyrite.
CZD3050	200S 250E	1.1.5	No core, cuttings sample taken.
CZR3200	120E 450S	outcrop	Dark granodiorite NVS
CZR3201	175E 260S	"	Felspar porphyry + Py (Cp? on fractures).
CZR3202	260E 175S	"	V. weathered felspar porphyry + Py
CZR3203	370E 70S	"	Felspar porphyry
CZR3204	410E 110S	"	Hornfels, brecciated in part. Py: 2%
CZR3205	425E 265S	"	Felspar porphyry + Py + Cp?
CZR3206	500E 315S	"	Xenolithic porphyry + Py and Cp?
CZR3207	380E 330S	"	Porphyry + Cp and 2ndry copper.
CZR3208	350E 310S	"	Porphyry + Py: 1%, Cp + Mo in QVS.
CZR3209	310E 260S	"	Brecciated hornfels and porphyry (Cp + Mo).
CZR3210	340E 225S	"	Pink felspar porphyry. Py: tr.
CZR3211	480E 200S	"	" " "
CZR3212	210E 130N	"	V. weathered felspar porphyry + Py
CZR3213	330E 170N	"	No data
CZR3214	290E 140N	"	Weathered, leached felspar porphyry
CZR3215	200E 200N	"	Felspar porphyry breccia (marginal?)
CZR3216	240E 225N	"	Xenolithic felspar porphyry
CZR3217	260E 240N	"	Pink, fresh porphyry + Py
CZR3218	320E 260N	"	Felspar biotite porphyry
CZR3219	370E 360N	"	Pink barren porphyry
CZR3220	300E 360N	"	Felspar porphyry + Py
CZR3221	40W 300N	"	Hornfels?

Sample No.	Grid	Depth (m)	Description
CZR3222	150W 300N	outcrop	Felspar biotite porphyry + Py
CZR3223	70W 90S	"	" " "
CZR3224	120W 85S	"	" " "
CZR3225	90W 130N	"	Pale felspar biotite porphyry + Py (Cp? on fracture).
CZR3226	25E 180N	"	Felspar biotite porphyry. Py on fractures
CZR3227	60E 190N	"	Felspar biotite porphyry. Py on fractures
CZR3228	70E 125N		Hornfels. Py; trace
CZR3229	125E 010N	"	Felspar porphyry

2. SUMMARY OF ANALYTICAL RESULTS OF GEOCHEMICAL SAMPLES

DRAINAGE SAMPLES

A. Garraron Stream samples

	CU	PB	ZN	AG	AS	MO
KMC 204	270	100	260	1	30	16
KMC 205	105	50	380	1	20	6
KMC 243	195	40	330	0	10	8
CZC3169	110	40	180	1	20	2
CZC3171	120	50	230	1	50	0
CZC3172	140	40	150	0	20	6
CZC3173	430	20	90	0	15	9
CZC3174	325	30	100	1	20	8
CZC3177	160	50	230	1	25	4
CZC3178	200	50	840	1	20	13
CZC3179	70	40	180	1	35	2
CZC3185	160	60	230	1	20	4
CZC3186	140	40	200	1	10	4
CZC3187	80	40	80	1	10	2
CZC3191	280	40	630	2	20	15

B. Regional Samples

KMC 219	60	40	310	1	15	2
KMC 225	60	30	350	0	20	1
KMC 226	40	70	750	1	25	5
KMC 247	30	40	330	0	20	2
CZC3172	140	40	150	0	20	6
CZC3174	325	30	100	1	20	8
CZC3175	60	80	260	1	40	1
CZC3176	25	50	270	1	15	0
CZC3179	70	40	180	1	35	2
CZC3188	50	70	110	1	25	1
CZC3189	40	110	250	1	75	1
CZC3192	40	60	310	1	15	1
CZC3193	60	60	540	1	25	2
CZC3194	50	50	350	1	15	4
CZC3195	60	60	260	1	10	8
CZC3197	85	50	190	1	30	1
CZC3198	45	70	250	1	20	0
CZC3200	30	50	210	1	20	2
CZC3201	60	70	120	1	20	2
CZC3202	65	60	200	1	10	1
CZC3203	40	40	140	1	40	1
CZC3204	50	60	180	1	15	2
CZC3205	40	50	120	1	20	1
CZC3206	15	40	220	1	30	1
CZC3207	50	50	150	2	30	0
CZC3208	65	100	360	2	70	0
CZC3209	25	40	160	3	30	2
CZC3210	25	70	470	1	40	2
CZC3211	30	40	160	1	10	1
CZC3212	30	30	160	1	15	1
CZC3213	40	50	250	1	35	1
CZC3214	50	50	200	1	30	1
CZC3215	15	30	100	0	15	1
CZC3221	115	50	200	2	15	0
CZC3228	35	50	320	1	50	1
CZC3229	40	50	210	1	15	0
CZC3230	30	80	260	1	30	1

	Cu	Pb	Zn	Ag	As	Mo
CZC3291	35	90	300	2	25	1
CZC3292	70	50	60	4	50	1
CZC3293	20	230	110	1	10	0
CZC3244	40	160	300	2	90	1
CZC3295	40	200	450	3	70	2
CZC3296	55	190	300	4	80	1
CZC3297	40	470	850	6	300	2
CZC3302	10	30	90	1	15	1
CZC3303	20	70	180	0	-1	1
CZC3304	30	70	190	1	60	2
CZC3305	25	50	220	0	15	1
CZC3306	20	70	220	0	30	1
CZC3307	25	70	210	1	30	2
CZC3308	40	70	170	1	40	3
CZC3309	45	50	150	1	20	1
CZC3310	55	60	160	1	30	1
CZC3311	50	80	240	1	30	0
CZC3316	70	70	200	1	40	2
CZC3317	40	320	580	3	65	2
CZC3318	30	50	230	0	15	1
CZC3319	40	120	360	1	20	0
CZC3322	50	60	220	1	50	1
CZC3385	40	80	420	1		1
CZC3322	50	60	220	1	50	1
CZC3385	40	80	420	1	-1	1

PEAT SAMPLES

	CU	PB	ZN	MO
KMS 1	15	90	30	2
KMS 3	60	30	40	2
KMS 5	60	270	50	1
KMS 7	60	20	20	4
KMS 17	60	60	40	4
KMS 20	60	30	50	5
KMS 23	60	20	30	7
KMS 25	70	30	50	5
KMS 29	160	40	80	3
KMS 51	40	60	20	9
KMS 56	90	50	120	4
KMS 58	10	40	20	2
KMS 62	950	30	50	11
KMS 64	30	30	40	4
KMS 66	220	30	50	12
KMS 68	20	20	10	3
KMS 71	5	20	10	1
KMS 73	15	70	20	5
KMS 75	20	70	70	3
KMS 76	10	30	20	0
CZS3004	250	20	60	15
CZS3008	70	20	20	9
CZS3010	100	20	40	20
CZS3012	80	40	50	19
CZS3018	110	20	40	6
CZS3020	440	30	50	10
CZS3022	340	30	50	11
CZS3024	65	30	30	4
CZS3030	1165	20	40	56

	Cu	Pb	Zn	Mo
CZS3032	165	20	30	5
CZS3036	305	20	50	7
CZS3038	105	50	60	5
CZS3042	150	20	20	5
CZS3046	65	20	30	2
CZS3048	190	30	230	30
CZS3050	50	10	10	3
CZS3052	240	20	20	2
CZS3054	95	30	20	6
CZS3056	45	10	10	0
CZS3058	75	20	10	3
CZS3060	75	10	30	5
CZS3062	10	20	40	3
CZS3064	85	10	20	4
CZS3066	85	30	50	6
CZS3068	325	10	50	3
CZS3070	190	10	30	3
CZS3072	350	20	30	4
CZS3074	50	20	40	2
CZS3076	40	10	20	7
CZS3078	720	20	20	13
CZS3080	165	10	30	4
CZS3082	110	10	20	4
CZS3084	30	10	20	4
CZS3086	70	20	100	4
CZS3088	15	10	10	3
CZS3090	25	10	20	6
CZS3092	10	10	20	6
CZS3094	105	10	20	14
CZS3096	15	10	10	5
CZS3098	20	10	10	3
CZS3100	30	10	20	6
CZS3102	45	10	10	11
CZS3104	45	10	10	8
CZS3106	95	10	20	11
CZS3108	60	20	30	6
CZS3110	55	10	30	6
CZS3112	5	10	10	5
CZS3114	40	10	10	4
CZS3116	460	50	40	19
CZS3118	200	20	40	1
CZS3124	160	20	30	4
CZS3130	225	46	70	59
CZS3132	30	20	40	8
CZS3134	50	10	10	1
CZS3144	245	30	70	5
CZS3146	25	15	10	2
CZS3150	95	30	40	5
CZS3152	20	15	10	0
CZS3154	25	15	10	2
CZS3156	40	20	30	6
CZS3158	120	15	10	5
CZS3160	140	15	10	3
CZS3166	50	20	10	-1
CZS3168	60	30	20	-1
CZS3170	10	30	20	-1
CZS3172	5	10	10	-1
CZS3174	150	10	10	-1
CZS3176	145	10	20	-1
CZS3178	205	20	10	-1
CZS3180	10	20	10	-1
CZS3182	45	30	30	-1

TILL SAMPLES

	CU	PB	ZN	MO
KMS 4	750	180	50	11
KMS 6	140	50	70	5
KMS 8	80	40	90	2
KMS 9	145	30	80	13
KMS 10	10	30	70	26
KMS 11	70	20	40	8
KMS 12	450	80	70	21
KMS 15	20	20	90	5
KMS 18	110	120	60	1
KMS 21	650	20	30	18
KMS 22	60	30	70	10
KMS 26	90	30	50	5
KMS 28	140	40	60	7
KMS 30	210	20	10	6
KMS 50	200	20	30	6
KMS 52	270	50	60	11
KMS 54	250	20	40	5
KMS 57	60	40	70	2
KMS 59	260	40	60	6
KMS 61	340	30	70	24
KMS 63	10	20	10	3
KMS 65	70	40	60	5
KMS 67	160	40	90	7
KMS 69	10	20	10	6
KMS 70	10	10	10	7
KMS 72	65	20	40	2
KMS 74	20	30	30	14
CZS3003	65	30	90	4
CZS3005	50	20	80	6
CZS3007	1310	10	80	13
CZS3009	120	30	60	7
CZS3011	230	30	80	27
CZS3015	800	20	50	19
CZS3017	610	20	40	6
CZS3019	65	30	80	7
CZS3021	375	30	80	11
CZS3023	530	40	80	16
CZS3025	170	40	50	6
CZS3033	240	40	70	14
CZS3035	70	30	90	6
CZS3037	70	20	50	14
CZS3040	400	20	20	4
CZS3043	460	30	80	4
CZS3045	105	20	40	0
CZS3046	65	20	30	2
CZS3049	90	30	120	42
CZS3051	235	30	40	4
CZS3057	470	20	60	3
CZS3059	140	30	70	7
CZS3061	300	10	40	0
CZS3063	85	40	70	9
CZS3065	225	20	40	4
CZS3067	130	30	90	13
CZS3069	75	10	10	8
CZS3071	410	20	50	7
CZS3075	70	10	50	2

	Cu	Pb	Zn	Mo
CZS3077	80	20	60	13
CZS3078	770	70	70	13
CZS3079	160	50	130	17
CZS3081	500	20	30	13
CZS3083	440	40	40	11
CZS3085	265	40	60	10
CZS3087	240	30	80	6
CZS3089	160	40	70	11
CZS3091	265	30	50	22
CZS3093	170	30	50	15
CZS3097	220	20	10	29
CZS3099	450	40	20	23
CZS3101	120	20	100	9
CZS3103	280	20	30	29
CZS3105	440	40	20	11
CZS3107	600	10	40	39
CZS3111	95	10	40	19
CZS3113	175	10	10	5
CZS3115	130	10	20	12
CZS3117	50	10	10	6
CZS3119	550	10	50	7
CZS3121	350	30	90	15
CZS3123	600	10	40	9
CZS3125	285	20	30	5
CZS3127	160	30	70	3
CZS3129	60	20	80	3
CZS3131	115	20	30	77
CZS3133	140	20	60	7
CZS3135	240	10	40	3
CZS3137	95	40	30	16
CZS3139	145	50	80	9
CZS3141	210	25	60	11
CZS3143	100	40	80	11
CZS3145	185	40	80	7
CZS3147	330	20	2	5
CZS3149	90	25	50	4
CZS3151	300	30	30	24
CZS3153	50	20	40	3
CZS3155	300	20	40	7
CZS3157	195	30	80	9
CZS3159	240	40	10	10
CZS3161	165	15	10	3
CZS3163	850	30	70	13
CZS3165	175	30	50	3
CZS3169	145	40	50	-1
CZS3171	60	30	80	-1
CZS3173	1350	30	30	-1
CZS3175	455	20	20	-1
CZS3177	350	20	30	-1
CZS3181	300	130	40	-1
CZS3183	135	40	90	-1
CZS3185	100	30	130	-1

ROCK AND DRILL SAMPLES

	CU	PB	ZN	AS	MO
KMR 1	270	20	30	-1	15
KMD 4	170	20	20	-1	9
KMR 6	55	10	50	-1	-1
KMD 8	35	10	30	-1	0
KMR 9	50	10	30	-1	4
KMR 10	270	10	60	-1	13
KMR 11	110	10	50	-1	39
KMR 12	700	20	30	-1	17
KMR 15	20	20	40	-1	6
KMR 19	90	20	30	-1	4
KMD 21	215	10	20	-1	4
KMR 22	120	20	40	15	8
KMR 26	25	20	30	30	3
KMR 28	40	20	40	20	5
KMR 30	200	20	30	10	1
KMR 31	35	20	40	-1	1
KMR 32	160	22	20	-1	2
KMR 33	1600	10	20	-1	7
KMR 34	180	20	20	-1	1
KMR 35	50	20	50	-1	1
KMR 36	600	10	10	-1	1
KMR 37	150	20	30	-1	9
KMR 38	130	20	30	-1	-1
KMR 39	110	20	30	-1	1
KMR 40	35	10	20	-1	3
KMR 41	230	20	30	-1	1
KMR 42	20	20	30	-1	0
KMR 43	10	10	20	-1	5
KMR 44	95	10	30	-1	2
KMR 45	25	20	30	-1	2
KMR 46	10	10	40	-1	0
KMR 50	800	20	20	30	2
KMD 52	120	20	40	15	19
KMR 54	300	20	40	15	7
KMR 58	10	10	20	15	0
KMR 59	15	20	90	50	4
KMR 60	25	10	90	10	0
KMD 61	110	20	70	10	6
KMR 65	70	20	70	20	
CZR2517	420	20	40	-1	10
CZR2518	150	20	30	4	7
CZR2519	25	10	10	7	14
CZR2520	65	20	50	7	7
CZR2521	15	400	90	3	2
CZR2522	1700	20	50	1	2
CZR2523	600	30	50	20	7
CZR2524	90	30	60	1	15
CZR2525	400	20	20	16	22
CZR2561	120	10	20	20	2
CZR2562	105	10	30	20	0
CZR2563	40	10	20	25	2
CZR2564	180	20	20	15	13
CZR2565	300	20	20	10	2
CZD3000	550	20	40	-1	5
CZD3001	240	20	50	-1	10
CZD3002	270	20	20	-1	7

		Cu	Pb	Zn	As	Mo
	CZD3003	625	20	20	-1	16
	CZD3004	330	30	20	-1	5
	CZD3005	700	10	30	-1	6
	CZD3006	305	10	20	-1	3
	CZD3007	2150	10	10	-1	29
	CZD3008	550	10	10	-1	2
	CZD3009	550	10	30	-1	4
	CZD3010	240	10	20	-1	5
	CZD3011	60	10	20	-1	7
	CZD3012	240	10	20	-1	30
	CZD3013	220	10	10	-1	4
	CZD3014	250	10	40	-1	7
	CZD3015	600	10	20	-1	9
	CZD3016	295	10	10	-1	9
	CZD3017	205	10	20	-1	3
	CZD3018	360	20	40	3	4
	CZD3019	300	20	60	3	3
	CZD3020	85	20	40	4	4
	CZD3021	45	10	20	1	5
	CZD3022	360	10	10	2	1
	CZD3023	275	40	60	6	0
	CZD3025	50	20	50	4	1
	CZD3026	70	10	30	3	1
	CZD3027	0	10	10	9	0
	CZD3028	90	20	40	24	4
	CZD3029	255	20	70	3	8
	CZD3030	120	10	30	5	0
	CZD3031	125	10	10	4	5
	CZD3032	140	10	30	4	2
	CZRD033	120	10	20	5	1
	CZD3034	280	10	20	3	6
	CZD3035	245	10	10	3	1
	CZD3036	215	20	30	0	4
	CZD3037	85	20	60	2	4
	CZD3038	335	10	30	8	2
	CZD3039	240	10	10	2	6
	CZD3040	80	20	50	5	6
	CZD3041	270	10	20	6	1
	CZD3042	520	10	20	13	18
B	CZD3042	100	10	20	30	18
	CZD3043	85	10	10	30	11
	CZD3044	1280	10	30	20	45
	CZD3045	340	20	10	20	5
	CZD3046	160	10	30	10	12
	CZD3047	340	10	10	20	43
	CZD3048	335	10	20	15	23
	CZD3049	260	20	20	11	3
	CZD3050	283	90	40	20	45
	CZR3200	240	10	50	20	1
	CZR3201	800	10	10	15	12
	CZR3202	25	10	10	12	14
	CZR3203	550	10	30	25	14
	CZR3204	50	10	40	0	63
	CZR3205	3200	10	40	12	10
	CZR3206	320	10	30	15	0
	CZR3207	1300	20	20	30	6
	CZR3208	1200	10	20	35	25

	Cu	Pb	Zn	As	Mo
CZR3209	500	10	40	12	28
CZR3210	1000	10	20	12	0
CZR3211	35	20	30	20	4
CZR3212	240	20	20	15	4
CZR3213	110	10	20	10	1
CZR3214	360	10	20	20	0
CZR3215	30	10	30	15	-1
CZR3216	15	10	20	0	-1
CZR3217	310	10	20	20	1
CZR3218	205	10	20	10	3
CZR3219	45	10	20	0	2
CZR3220	600	20	30	10	0
CZR3221	135	10	30	15	0
CZR3222	500	20	30	10	70
CZR3223	105	20	20	60	22
CZR3224	750	10	30	50	20
CZR3225	75	10	20	30	3
CZR3226	600	10	30	20	6
CZR3227	240	10	30	15	2
CZR3228	125	10	40	10	4
CZR3229	600	20	20	10	25

APPENDIX II

DIAMOND DRILL CORE LOG SHEETS BH1 AND 2

INSTITUTE OF GEOLOGICAL SCIENCES - DIAMOND DRILL CORE RECORD SHEET

DDH No. 1.
Depth; 184.63m
Inclination; 50°
Azimuth; 352½°
Collar Elevation; 228m.

Coordinates; NM 81950981
Location; Garraron Est., Argyllshire
O/S Sheet No. 52
Objective; Test Geochemical Anomaly
Logged by; J S Coats, H W Haslam, M S Garson, R A Ellis

Drilled by; Rockfall
Date commenced; 29.10.76
Total %age Core Recovery; 95%
% Recovery by core-size; TNX 85% (0.00 - 7.55m)
NQ 98% (7.55 - 149.0m)
BQ 98% (149.00 - 184.63m)

Project; KILMELFORD
Date completed; 29.11.76

Log Sheet No. 1

53.

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Rcvrd.	% Cu	Mo ppm		Au ppm
0.00	1.97	NIL	No core recovered											
1.97	2.85	HORNFELS	Broken fragments of grey silicified hornfels. All sulphides limonitised.	Weathered Lm; common										
2.85	3.36	- " -	Relatively fresh, banded, with frequent quartz/pyrite veins	Lm; common	Py:c Cp:tr	Quartz	KMD 71 (1.78m)	1.97	3.75	75%	0.04	9		0.3
3.36	4.10	- " -	As above, shattered.	Lm; common										
4.10	5.45	- " -	Banded at 60° to core axis Sulphides; disseminated	Si; patchy	Py:ab	Qtz/ Calcite	KMD 72 (2.00)	3.75	5.75	95%	0.03	9		
5.45	5.85	FRACTURE ZONE	Brecciated hornfels with some felspar porphyry veinlets in qtz-carbonate vein stockwork		Py:c Cp;tr.	Qtz/ Calcite								
5.85	6.35	HORNFELS	Prominent quartz/calcite veins											
6.35	7.05	BRECCIATED HORNFELS	Heavily fractured and fragmented in qtz./carbonate vein stockwork. Sulphide; Pyrite abundant in fine disseminations, veinlets and on fractures.	Si; patchy	Py:ab Cp:sp	Qtz Calc. Dol.	KMD 73 (1.30)	5.75	7.05	95%	0.04	17		
7.05	7.30	FELSPAR PORPHYRY	Thin grey dyke with fine disseminated pyrite.	Kl: mod.	Py:sp		KMD 74 (0.25)	7.05	7.30	95%	0.008	16		
7.30	7.65	HORNFELS	Silicified, and brecciated with numerous small strings of sulphide	Si; mod.	Py:ab Cp:c		KMD 75 (0.35)	7.30	7.65	90%	0.06	21		

Logged by; M S GARSON

Log Sheet No; 2

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov'd.	% Cu	Mo ppm		Au ppm
7.65	16.20	BIOTITE FELSPAR PORPHYRY	Partially silicified, kaolinised brown porphyry. Most of the mafic constituents are made over to laminated pseudomorphs of carbonate and muscovite(?)	Kl; strong Ca: strong	Py:ab Cp:c.	Quartz veinlets common	KMD 76 (2.10)	7.65	9.75	95%	0.06	11		
		[PTS 10.75]	The plagioclase phenocrysts are generally kaolinised and carbonated.	Si; patchy Musc; common.			KMD 77 (1.92)	9.75	11.67	95%	0.05	6		
			Sulphide is disseminated throughout and is best developed adjacent to small quartz veinlets and associated silicified zones.in discrete grains. Minor haematite				KMD 78 (2.00)	11.67	13.67	95%	0.10	34		
16.20	16.40	BRECCIATED PORPHYRY	Brecciated and silicified with fault gouge.				KMD 79 (1.93)	13.67	15.60	95%	0.06	8		
16.40	18.04	FELSPAR PORPHYRY [PTS 17.40]	Grey fractured, altered porphyry criss-crossed by small hair veinlets of illite(?) after orthoclase and quartz Disseminated sulphides throughout	Si; patchy Kl: intense Ca; strong Sc; heavy	Py:ab Cp:c.	Qtz. illite(?) on hair fractures	KMD 80 (2.78)	15.60	18.38		0.09	31		0.3
18.04	18.38	QUARTZITE												
18.38	19.55	HORNFELS	Grey, silicified with numerous veins of porphyry locally rich in sulphide	Si; strong	Py:c Cp:c		KMD 81 (1.17m)	18.38	19.55	95%	0.11	27		
19.55	20.50	IGNEOUS BRECCIA	Xenoliths of hornfels in felspar porphyry	Si: strong	Py:c Cp:c		KMD 82 (0.95)	19.55	20.50	95%	0.06	25		

Logged by; M S GARSON/R A ELLIS

Log Sheet No; 3

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		
20.50	25.00	QUARTZ FELSPAR PORPHYRY [PTS 20.7m]	Light grey, partially silicified, with abundant pools of primary quartz (amygdaloidal?). Most of the felsic groundmass and phenocrysts are kaolinised and carbonated. Sulphides in fine disseminated grains and thin veinlets. Shattered between 21.59-21.70m.	Si; mod. Kl; heavy Ca; heavy Sc; light	Py:c Cp:sp	Spidery calcite veins	KMD 83 (0.89) KMD 84 (2.51)	20.50 21.39	21.39 23.90	95% 95%	0.09 0.09	28 18		
25.00	27.97	FELSPAR PORPHYRY [PTS 25.25m]	Light grey with brown patches reflecting zones of more intense sericitic/silicic alteration. Felspars otherwise altered to kaolinite and carbonate.	Ca; strong Kl; strong Si; Patchy Sc; patchy musc; trace after biot.		Quartz Calcite; common in reticulate vein net-work	KMD 85 (2.10) KMD 86 (1.97)	23.90 26.00	26.00 27.97	97% 97%	0.03 0.03	13 7		
27.97	29.80	FELSPAR PORPHYRY [PTS 28.90]	Greyish-brown heavily fractured with 0.5m. breccia zone at 28.65m. Plagioclase phenocrysts are set in groundmass of quartz, orthoclase and granular carbonate. All biotite replaced by interlaminated carbonate and muscovite. Sulphides disseminated and on fractures.	Sc; moderate Ca; moderate Kl; light	Py:sp Cp:sp	Calcite; Sp.	KMD 87 (1.83)	27.97	29.80	95%	0.07	17		
29.80	30.50	XENOLITHIC FELSPAR BIOTITE PORPHYRY [PTS 30.0m]	Reddish-brown with pale 'bleached' patches, and numerous xenolithic fragments of adamellite and micro-adamellite.	Kl; mod. Ca; mod. Chl; minor	Py:sp Cp:sp	Quartz Calcite	KMD 88A (0.70m)	29.80	30.50	95%	0.03	11		
30.50	31.90	FELSPAR PORPHYRY	Brownish-grey partially silicified, heavily fractured and sheared. Early thin glassy quartz veins. Later, 1cm. thick quartz/carbonate veins, brecciated in limonitic matrix at 31.60m. Sulphides; v. fine disseminated.	Si; mod. Lim; rare.	Py:sp Cp:sp	Quartz Quartz/ Carb.	KMD 88B (1.40)	30.50	31.90	95%	0.08	13		

Logged by; R A ELLIS

Log Sheet No; 4

METRES		GEOLOGICAL RECORD					ASSAY RECORD					
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm
31.90	34.85	FELSPAR PORPHYRY /PTS 34.00m/	Medium/fine greyish altered porphyry with occasional zones of brown porphyry carrying biotite and Kaolinite after the felspar phenocrysts. Infrequent sections of fine-grained felsite (33.5m) Flow-banding occurs between 34.00-34.70m. Sulphide; disseminated and in small hair fractures.	Sc; strong Ca; strong Kl; patchy	Py:sp Cp:sp	Thin quartz veinlets.	KMD 89	31.90	33.40	98%	0.06	19
34.85	35.90	FELSPAR /BIOTITE/ PORPHYRY	Dark grey with 'bleached' patches. = white opaque, powdery felspars and small biotite flakes in reddish-brown groundmass. Sulphides; sparse, disseminated.	Sc; mod. Kl; patchy Musc;	Py:sp	glassy Qtz in thin hair veinlets	KMD 90 (0.8m)	34.85	35.65	90%	0.03	21
35.90	36.90	FELSPAR PORPHYRY	Reddish-brown with no mafic constituents apparent but sulphides more prominent as fine disseminations in the groundmass and as fracture infillings associated with increase in quartz-veining.	Sc; mod. Si; strong	Py.	Qtz veining becoming more intense	KMD 91 (1.50m)	35.65	37.15	90%	0.08	12
36.90	38.64	FELSPAR PORPHYRY	Heavily quartz-veined with occasional isolated blebs (1mm) of chalcopyrite visible in the groundmass.	Si; strong Lm.	Cp.py (Sp-common)	Qtz. vein Stockwork	KMD 92 (1.49m)	37.15	38.64	99%	0.07	17
38.64	41.80	FELSPAR PORPHYRY	Greyish-brown partially silicified. no mafic constituents apparent. Sulphides; sparsely disseminated in the groundmass. Some limonite developed on fracture surfaces between 36.64 m and 37.00 m.	Sc; mod. Si; mod. Ca; mod. local Lm.	Py. (sp)		KMD 93 (2.10m)	38.64	40.74	95%	0.06	7

Logged by; R A ELLIS

Log Sheet No; 5

METRES		GEOLOGICAL RECORD					ASSAY RECORD					
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm
41.80	42.90		As above but with prominent qtz vein sub-parallel to core axis (4cm. thickness). Single plate of chalcopyrite observed at 41.80m. Some chlorite on fracture surfaces.		Cp; (sp)	Qtz vein (4cms).	KMD 94 (2.16m)	40.74	42.90	98%	0.04	9
42.90	45.80	FELSPAR PORPHYRY	Greyish-brown, relatively fresh moderate qtz./calcite veining, heavy in places (4cm. thick calcite vein at 44.05m), occasional chlorite(?) coatings on fractures. Sulphides: sparse fine specks in groundmass.	occasional chlorite	Py; (sp)	Qtz. calcite (moderate)	KMD 95	42.90	45.80	98%	0.02	8
45.80	46.55	FELSPAR PORPHYRY	Grey, shattered, with finer phenocrysts. Criss-crossed with qtz./carbonate stockwork, brecciated in places. No visible sulphides.		NIL	Qtz/carb stockwork						
46.55	46.80	FELSPAR PORPHYRY	Greyish brown, flecked with occasional streaks of chlorite. Sulphides: common, in plates streaks and lenses associated with qtz. veins.	chlorite	Cp;py (common)		KMD 96 (1.95m)	45.80	47.55	98%	0.11	26
46.80	47.55	FELSPAR PORPHYRY	Grey and shattered with occasional fragments of coarser, pink porphyry No visible sulphides.	Sc; light Lm; light on joints Si; patchy	NIL	Qtz/carb stockwork						
47.55	51.50	XENOLITHIC PORPHYRY	Greyish brown as above with occasional xenoliths of hornfels. Characterised by frequent veins of cherty quartz. Qtz. cemented porphyry breccia occurs between 48.15m and 48.25m after which there is increasing proportion of qtz./carb. veins. Sulphides: sparse in small qtz. veinlets (~ 1mm).	Si; light	covellite at 48.32 m	chalcedony? (veins) Qtz./calc. (heavy)	KMD 97 (2.15m) KMD 98 (1.80m)	47.55 49.70	49.70 51.50	98% 98%	0.07 0.03	18 8

Logged by; R A ELLIS

Log Sheet No; 6

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov.	% Cu	Mo ppm		
51.50	52.50	FELSPAR PORPHYRY	Greenish-grey, sheared and broken with heavy carbonate veining cutting cherty quartz veins. (sub-vertical?). Sulphides; sparse, disseminated.	Sc; strong Ca; heavy chlorite on shears. Kl; strong muscovite	Py: (sp)	Qtz./Ca								
52.50	53.30		As above, more shattered, more carbonate, brecciated in part.				KMD 99 (1.80m)	51.50	53.30	98%	0.07	19		
53.30	55.50	FELSPAR BIOTITE PORPHYRY	Bleached powdery felspar phenocrysts (Kaolinised) + small biotite flakes in greyish-brown matrix. Occasional streaks of Fe-stained carbonate impart a banded appearance. Carbonate prominent in branching veins (up to 1cm. thickness) Sulphide: v. sparse occasional blebs in carb.	Sc; heavy Kl; after plag. phenocrysts Ca; strong	Py: (tr)	Qtz. carb.	KMD 100 (2.45m)	53.30	55.75	98%	0.04	9		
55.50	56.45	FELSPAR PORPHYRY	Greenish-grey, broken porphyry. with highly altered plagioclase. Veining: moderate to heavy. Sulphides: v. sparse disseminations	Kl; strong	Py: (tr)	Qtz.								
56.45	56.75	FELSPAR PORPHYRY	Coarse, greyish brown with thin grey qtz. veins.		Py: (tr)	Qtz.								
56.75	59.05	FELSPAR PORPHYRY	Greenish-grey highly fractured, kaolinised. Qtz. and carbonate veining heavy. Sulphides: rare.		Py: (tr)	Qz. Ca (stockwork)	KMD 101 (3.15m)	55.75	58.90	98%	0.04	18		
59.05	61.30	FELSPAR-BIOTITE PORPHYRY	Brown, bleached plag. phenocrysts streaks of Fe stained carbonate material. Moderate Qtz. Calcite veining. Sulphides: sparse.	Kl; strong		Qz. Ca. (moderate)	KMD 102 (2.40m)	58.90	61.30	98%	0.02	6		

Logged by; R A ELLIS/J S COATS

Log Sheet No; 9

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm	Au ppm
75.90	77.20	FELSPAR PORPHYRY	Brownish-grey sheared, broken Chloritic clay mineral on fractures. Sulphides; trace.	Kl; strong Dl; (after plag) Sc; after biotite	Cp; (sp) Mo; (tr)	Qz. Dol.	KMD 110 (1.74m)	74.46	77.20	98%	0.08	46		0.3
77.20	77.55	SILICIFIED FELSPAR PORPHYRY	Grey broken silica-rich rock, relict porphyry texture in parts. Clay mineral and carbonate on fractures.	Si; heavy Kl; heavy		Qtz-Chl, Q, Clay Min. carbonate	KMD 111 (0.35)	77.20	77.55	98%	0.12	37	17	
77.55	78.82	FELSPAR PORPHYRY	Brownish grey white felspars prominent carbonate + clay minerals after biotite. Fe-stained carb. veins carry most of chalcopyrite.	Kl; heavy Si; light	Cp;sp	Qtz Qtz, Clay Min-carbonate	KMD 112 (2.82)	77.55	80.37	98%	0.05	7	<3	
78.82	80.37	FELSPAR PORPHYRY	Greyish brown, kaolinised. Ca after biotite and as thin streaks and veins with Qtz and Cpy. Carbonate and clay mineral on irregular fractures and one 5mm chalcedony vein.	Kl; light	Cp; (tr)	Q, carb. Clay Min-Carbonate, Chalcedony								
80.37	80.60	BRECCIATED FELSPAR PORPHYRY	Brownish grey. Mod altered felspars and abundant clay mineral and carbonate on fracture surfaces which are later than quartz-veins with chalcopyrite.	Kl; mod.	Cp; (c)	Qtz, Carb-Clay Min	KMD 113	8037	81.70	98%	0.17	23	7	
80.60	81.70	BIOTITE FELSPAR PORPHYRY	Greyish-brown. Silicified patches with indistinct felspars and no biotite alternate with Biotite-F-P with moderately kaolinised felspars. Cp in streaks and veinlets common in silicified patches, approx. 35° to core length. These are cut by Qtz-Cpy veins and late Qtz-Carbonate veins.	Kaol; strong	Cp;c	Qtz-Cpy Qtz-Carb.								

Logged by; J S COATS/R A ELLIS

Log Sheet No; 10

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
81.70	82.50	FELSPAR PORPHYRY	Greyish-brown, indistinct felspars Cognate xenolith of green felspar porphyry at 82.45m. Traversed by thin veins of sulphide and later quartz and carbonate veins	Si; patchy Ca; mod. Kl; mod. Sc; local, associated with silic.	Cp;sp	Qtz, carb.	KMD 114 (2.30m)	81.70	84.00	99%	0.06	18	6
82.50	83.20	FELSPAR PORPHYRY	Greyish-brown; phenocrysts more distinct, greyish and reddish patches of more aphyric material (partially silicified). Sinuous veinlets of Fe-stained carbonate carry cp.	Si; patchy	Py;sp Cp;sp	Qtz (mod.) carb.							
83.20	84.00	BIOTITE FELSPAR PORPHYRY	Brown biotite bearing felspar porphyry. Fresh biotites and white, moderately sericitised, feldspars. Some reddish silicified patches	Si; patchy	Py;sp Cp;sp	Qtz, carb.							
84.00	86.72	FELSPAR PORPHYRY	Greyish-brown, non-biotite bearing. Patchily silicified with indistinct phenocrysts. Occasional red Fe-oxide staining adjacent to carbonate veins (70° inclination to core length) with quartz-dolomite centres. Broken with quartz coated fractures.	Si; patchy Sc; local Kl/Ca; strong diokite at 84.55	Py;sp Cp;sp	Chl-Qtz-Carb. Qtz	KMD 115 (2.72)	84.00	86.72	99%	0.09	34	10
86.72	89.18	BIOTITE FELSPAR PORPHYRY	Brown in colour. In biotite bearing areas felspars are moderately kaolinised and/or greenish in colour. Patchily silicified adjacent to quartz veins where biotite is lost and feldspars indistinct. Stained carbonate as streaks and veinlets carries cp.	Si; patchy Sc; light Kl: mod. Ca: strong	Py;sp Cp;sp	Quartz, Dolomite	KMD 116 (2.46)	86.72	89.18	99%	0.08	26	6

Logged by; J S COATS/R A ELLIS

Log Sheet No; 11

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
89.18	91.40	BIOTITE FELSPAR PORPHYRY	Reddish-brown, homogenous biotite-felspar-porphyry. Fairly fine-grained groundmass (hard, dense texture) but not silicified as shown by lack of alteration and less porphyritic, fresh felspars except very slight sericitisation. Indistinct darker grey streaks. Quartz veins 70° to Corel axis. Little veining.	Kl; light	Cp; (sp)	Qtz(light)	KMD 117 (2.22m)	89.18	91.40	99%	0.06	22	2
91.40	94.74	BIOTITE FELSPAR PORPHYRY	Greyish-brown, biotite bearing almost throughout except partially sericitised, silicified zones, felspars are indistinct but mod. kaolinised in other patches. Occ. green felspars. Some finer grained, biotite bearing areas like above unit. Breccia zones 1-2cms-Quartz-Dolomite at 93.38m. Cpy in disseminations and veinlets.	Sc; patchy Kl; mod. Si; patchy	Cp; (sp) (minor in veins)	(70° to C. L.) (light) Qtz, Qtz-Dol.	KMD 118 (3.34)	91.40	94.74	99%	0.12	53	5
94.74	95.57	BIOTITE FELSPAR PORPHYRY [PTS 94.74]	Brown colour relatively fresh Min. Spec. at 94.80m shows outer unaltered BFP, then white felspars, green felspars, silicified zone and innermost central quartz vein. (? Alteration sequence)	Si; patchy Ca strong adjacent Kl to qtz. veins. Sc; after biotite	Cp; (sp)	Qtz	KMD 119 (1.96)	94.74	96.70	99%	0.09	19	12
95.57	96.70	FELSPAR PORPHYRY	Brownish grey, more silicified with remnant patches of kaolinised B.F.P. Pyrite on late fractures with cpy.	Si: mod. Kl; mod.	Cp (tr) Py (tr)	Qtz							
96.70	97.25	BIOTITE FELSPAR PORPHYRY	Brownish-grey silicified moderately but white felspars in parts but mainly indistinct.		Cp (tr)	Qtz, Clay Min.	KMD 120 (1.56)	96.70	98.26	97%	0.22	44	27

Logged by; J S Coats

Log Sheet No; 12

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm	Au ppm
97.25	98.26	FELSPAR PORPHYRY	Brownish-grey, indistinct felspars Heavily quartz-veined almost brecciated in parts especially (97.60-97.90) Cpy near qtz-chlorite veinlets, Py on fractures.	Si; moderate	Cp;tr Py;tr	Qtz-chl, Qtz, Clay Min.								
98.26	101.55	FELSPAR PORPHYRY	Greyish-brown, Moderate silicified sericitised throughout except a few bleached patches with biotite and kaolinised felspars. Sulphides trace in dissemination and minor in qtz-carb veins. Thin quartz-veinlets form stockwork. Pyrite-quartz on fracture surfaces, later clay-mineral.	Kl; patchy Sc; mod. Si;	Cp;sp Py;tr	Qtz-chl, Qtz, carbonate, Clay Min.	KMD 121 (3.29)	98.26	101.55	98%	0.10	26	14	
101.55	102.70	BIOTITE FELSPAR	Brown colour. Relatively fresh glassy felspars. Slightly chloritised in patches. Near quartz veins slight alteration to greenish plag. and reddish colour. Sulphide sparse dissemination and on thin quartz veins cut by later calcite Small 5mm dark xenolith of Hornfels	Chl; minor Sc; minor	Cp;sp	Qtz, calcite	KMD 122 (1.15)	101.55	102.70	100%	0.06	20	6	
102.70	105.00	FELSPAR PORPHYRY [PTS; 103m]	Brownish-grey, non biotitic. Felspars indistinct. Quartz stockwork in places. Chalcopyrite sparse to minor as blebs and in veinlets.	Sc; strong Kl; " Ca; " Si; mod. secondary Orth. is common.	Cp;f/c Bo;tr Mo;tr	Qtz stockwork Dolomite	KMD 123 (2.30)	102.70	105.00	99%	0.23	42	29	0.3
105.00	105.63	FELSPAR PORPHYRY	Dark grey, felspars. Strongly veined by quartz and cp (Baked?)		Cp;c	Cp-qtz Qtz calcite	KMD 124 (0.63)	105.00	105.63	98%	0.18	55	70	

Logged by; J S COATS

Log Sheet No; 13

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd	% Cu	Mo ppm	As ppm
105.63	106.78	DOLERITE	Fine grained margin, centre medium grained size. 30° inclined to core.			Calcite Qtz-calcite	Not sampled						
106.78	107.63	FELSPAR PORPHYRY	Grey, and silicified (Baked by dolerite?) Chalcopyrite in chlorite (?) stockwork and groundmass blebs and strings.	Si; mod	Cp;c	Cp-Q, calcite	KMD 125 (0.85)	106.78	107.63	95%	0.17	78	26
107.63	109.40	DOLERITE	Dark chilled margin, medium grained centre.		Py;tr	Calcite-Py	Not sampled						
109.40	109.85	FELSPAR PORPHYRY	Grey, brecciated F.P. Heavily chloritised and silicified-Chlorite-calcite veins.	Chl; heavy Si; mod.	Cp;tr	Chl-calcite, Qtz.	KMD 126 (1.10)	109.40	110.50	95%	0.04	10	37
109.85	110.50	FELSPAR PORPHYRY	Brownish-grey, Indistinct felspar showing moderate sericite and silicification.Fe-stained carbonate veins.		Cp;tr Py;tr	Qtz, calcite							
110.50	112.35	FELSPAR PORPHYRY	Greyish-brown. Patches of less altered white felspar and biotite F.P. but generally silicified. Carbonate streaks cut by later Qtz vein and calcite-clay mineral on fractures.	Si; mod Sc; mod.	Cp;sp Py;tr	Qtz, calcite-Clay Min	KMD 127 (3.10)	110.50	113.60	98%	0.06	16	12
112.35	113.60	FELSPAR PORPHYRY	Brown, locally silicified and sericitised but also patches with biotite and unaltered glassy felspar.		Cp;tr Py;tr	Chl-Qtz, calcite-Clay Min.							

Logged by; J S COATS/H W HASLAM

Log Sheet No; 14

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
113-60	116.70	FELSPAR PORPHYRY	Brownish grey; felspar mod. distinct chlorite after biotite. Irregular streaks of stained carbonate and a more chloritic zone at 115.60-115.70. Irregular Qtz. veins and stockwork. Occasional 5mm carbonate veins at 50° to core. Bleached near bottom of section. Sulphides in veins and disseminated.	Si; light Sc; light Kl; local	Py;sp	Clay Min Qtz calcite Dolomite	KMD 128 (2.25) KMD 129 (1.70)	113.60 115.85	115.85 117.55	98% 96%	0.06 0.07	17 19	16 22
116.70	117.55	FELSPAR PORPHYRY	Grey. Felspars indistinct. Chlorite after biotite, locally, and in veins and patches. Shear surfaces and veins with clay minerals = dickite(?) Later Qtz-Carb veins + Py. Sulphides disseminated and in veins.	Si; strong Sc;	Py;tr Cp;tr	Clay Min. quartz carbonate							
117.55	119.05	FELSPAR PORPHYRY	Grey-brown. Felspars generally abundant and distinct, kaolinised. Biotite rare, mainly chloritized.	Si; local Chl: rare	Py;sp Cp;sp	Qtz.	KMD 130 (2.85)	117.55	120.40	99%	0.03	6	6
119.05	120.40	FELSPAR PORPHYRY	Brownish-grey. Felspars generally indistinct. Chlorite after biotite, in less silicified parts. Qtz stockwork. Three 1.cm thick dolomite-qtz veins. Sulphides locally disseminated.	Si; strong	Py;tr Cp;tr	Qtz Dolomite dickite							
120.40	122.23	FELSPAR PORPHYRY	Greyish-brown. Felspars indistinct, but locally distinct and kaolinised. Biotite altered to chlorite. Strongly brecciated parallel to core length with qtz, calcite, dolomite dickite in veins up to 4cm thick, and perpendicular to core. Py disseminated and in veins. Cp in patches.	Chl: minor Si; mod. Sc: strong	Py;tr Cp;tr	Qtz Calcite Dolomite	KMD 131 (2.95)	120.40	123.35	98%	0.04	13	12

Logged by; J S COATS/H W HASLAM

Log Sheet No; 15

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
122.23	123.35	FELSPAR PORPHYRY	Greyish to reddish brown. V. indistinct felspars. Biotite altered to chlorite. Cognate grey xenolith, 15mm across. Cp in qtz veins and chlorite streaks (?)	Si;strong Sc;strong	Cp;sp	calcite quartz chlorite							
123.35	125.06	FELSPAR PORPHYRY	Grey to brownish grey. Felspars indistinct stockwork of qtz veins. Breccia in part, with calcite.	Sc; mod	cpy; tr	calcite	KMD 132 (2.12)	123.35	125.47	96%	0.09	11	15
125.06	125.47	FAULT BRECCIA	Grey and brown felspar porphyry broken and traversed by numerous veins of dickite? and clay minerals.	Si; strong Chl; strong	NVS	Dickite + clays							
125.47	126.21	FELSPAR PORPHYRY [PTS; 126.20 m]	Mixed red and grey; grey and baked near to dolerite. Traces of felspar visible. Light stockwork of chlorite and qtz veins. Baked margin has rectangular patches of chlorite. Calcite-chlorite veining due to dolerite.		Cp;tr Py;tr	quartz chlorite calcite	KMD 133 (0.74)	125.47	126.21	99%	0.002	3	14
126.21	130.11	DOLERITE DYKE	Upper contact at 15° to core. Fine-grained dark margin coarse centre. Rare veins of epidote (?) calcite. Bottom contact at 55°.			calcite							
130.11	131.70	FELSPAR PORPHYRY	Greenish, with distinct felspars, black at contact with dolerite, palegreen elsewhere. Biotite replaced by black chlorite pseudomorphs.		NVS		KMD 134 (1.59)	130.11	131.70	99%	0.02	6	9
131.70	135.12	FELSPAR PORPHYRY [PTS 134.54 m]	Greyish brown. Felspars distinct, greenish at top of section. Rare biotite. Cpy in local disseminated and in vein.		Cp;tr Py;tr	quartz chlorite	KMD 135 (3.42)	131.70	135.12	99%	0.05	5	7

Logged by; J S COATS/H W HASLAM

Log Sheet No; 16

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
135.12	136.10	FELSPAR PORPHYRY	Brownish grey; no biotite; felspars indistinct. Light quartz-calcite veining, with Cp. Traces of disseminated Cp.	Sc; strong	Cp;sp	quartz calcite	KMD 136 (1.66)	135. 12	136. 78	99%	0.04	12	13
136.10	136.78	FELSPAR PORPHYRY	Brownish grey. Felspars moderately distinct. Strongly veined. Brecciated in parts with stockwork about 136.10 to 40. Trace pyrite associated with scarce chlorite veins and patches.	Sc; strong	Py;tr	quartz calcite							
136.78	139.90	FELSPAR PORPHYRY	Grey, commonly brecciated in parts. Frequent veining and local stockwork. Felspars very indistinct. A little chlorite veining, mostly later than quartz-dolomite. Disseminated sulphides, especially 137-08 to 40.	Sc; intense	Cp;sp Py;sp	quartz dolomite chlorite clay minerals	KMD 137 (3.12)	136. 78	139. 90	98%	0.07	19	
139.90	141.68	FELSPAR PORPHYRY	Greyish brown. Top 15cm grey-white Chlorite after biotite, and feathery chlorite veins. Indistinct felspars. Cp disseminated and in chlorite vein.		Cp;sp	clay minerals chlorite quartz	KMD 138 (1.78)	139. 90	141. 68	98%	0.04	5	
141.68	142.36	BIOTITE FELSPAR PORPHYRY	Reddish brown, biotitic. Lighter felsite patches (? cognate xenoliths). Felspars white. Light quartz veining. Cp in chlorite patches.	Chl; light Kl; mod.	Cp;tr	quartz clay minerals	KMD 139 (2.42)	141. 68	144. 10	99%	0.02	7	12
142.36	144.10	FELSPAR PORPHYRY	Brownish grey. Indistinct felspars Quartz-dolomite veining, moderate, stockwork. Earlier quartz-chlorite veins. Py and Cp in quartz veins.	Sc; mod. Kl; mod. Co; mod.	Py;tr Cp;sp	Dolomite quartz chlorite							

Logged by; H W HASLAM/J S COATS

Log Sheet No; 17

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd	% Cu	Mo ppm	As ppm	Au ppm
144.10	144.95	FELSPAR PORPHYRY	Grey, whitish and brownish in parts Felspars indistinct. Large quartz-calcite vein at 144.40. Near bottom, felspars are white and greenish in patches. Py and Cp disseminated and in veins.	Ca; strong Kl; strong Sc; mod. occasional secondary muscovite.	Cp;tr Py;tr	quartz chlorite calcite	KMD 140 (0.85)	144.10	144.95	98%	0.02	8	10	
144.95	146.85	BIOTITE FELSPAR PORPHYRY	Brown. Biotitic in less silicified parts. Felspars white, locally indistinct. Some red felspars. Quartz-chlorite veins subparallel to core. Carbonate veins 60° to core.	Sc; mod. Kl; strong	NVS	quartz chlorite clay min.	KMD 141 (1.90)	144.95	146.85	99%	0.02	6	4	
146.85	148.75	FELSPAR PORPHYRY	Grey to brownish grey. Indistinct white felspars. Light to moderate stockwork of quartz veins. Early dolomite quartz veins at 70°. Cp in veins and patches.	Kl; strong Sc; light Ca; strong musc; common	Cp;tr As;tr	quartz dolomite	KMD 142 (2.40)	146.85	149.25	99%	0.02	6	18	0.3
148.75	149.12	IGNEOUS BRECCIA	Dark grey with abundant xenolithic fragments of quartzite, siliceous hornfels and pelite in matrix of carbonate, sericite and quartz. Sulphides; exceed 1% by volume of the rock.	Sc; strong Ca; strong	Py;c Cp;c As;sp									
149.12	149.25	FELSPAR PORPHYRY	Grey. Felspars not visible. Light quartz stockwork and brecciation.	Sc; intense	Py;tr	quartz								
149.25	152.33	FELSPAR PORPHYRY	Greyish brown, phenocrysts indistinct. Fine-grained cognate xenolith at 151.50m. Irregular dark grey qtz veinlets with later, thicker qtz-carbonate veins with sulphide. Later barren, spidery, calcite veins.	Sc; strong	Cp;tr	Grey qtz. Qtz-carb calcite	KMD 143 (3.08)	149.25	152.33	98%	0.02	6	16	

Logged by; H W HASLAM/J S COATS

Log Sheet No; 18

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
152.33	153.15	FELSPAR PORPHYRY	Pale grey but with 'bleached' patches with white powdery felspar (= kaolin/dolomite).	Sc; strong Kl; dol; patchy	Cp;tr Py;tr	grey Qtz. Qtz-carb. calcite	KMD 144 (0.82m)	152.33	153.15	99%	0.02	7	3
153.15	156.64	FELSPAR PORPHYRY	Brown sericitised porphyry with 'bleached' patches at 154.30m (0.6m) and 155.35m (0.4m). Qtz-vein stockwork developed, often with earlier dark grey qtz. forming marginal zones to the veins. Lager carbonate developed on thin fractures.	Sc; mod. Kl; dol; patchy	Py;tr	Qtz. carb.	KMD 145 (2.66)	153.15	155.75	99%	0.02	7	4
156.64	158.02	FELSPAR PORPHYRY	As above but more frequently kaolinised. Occasional fresh orthoclase (5mm) and rare biotite				KMD 146 (2.27m)	155.75	158.02	97%	0.003	1	3
158.02	160.08	FELSPAR PORPHYRY	Brownish grey altered porphyry with prominent development of secondary muscovite. Sulphides; very sparse. Qtz veining; occasional.	Sc; mod. Kl; mod dol; mod.	Py;tr	Qtz.	KMD 147 (2.06)	158.02	160.08	98%	0.001	1	5
160.08	160.75	FELSPAR PORPHYRY	Pale grey 'bleached' porphyry with distinct phenocrysts and secondary muscovite.	Ca; strong Kl; strong Sc; patchy musc; common	Py;tr								
160.75	161.02	BRECCIATED PORPHYRY	Dark grey carbonate matrix enclosing strongly kaolinised fragments of porphyry	Kl; strong Ca; strong		Qtz	KMD 148 (0.98m)	160.08	161.02	98%	0.002	0	8
161.02	162.01	FELSPAR PORPHYRY	Grey, partially kaolinised with early dark grey, feathery qtz. veins and later qtz veins at 45° to c.a.	Sc; moderate Kl; patchy		Qtz							

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Logged by; H W HASLAM/J S COATS

Log Sheet No; 19

METRES		GEOLOGICAL RECORD					ASSAY RECORD						
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm
162.01	162.51	FELSPAR PORPHYRY	Grey, pale grey felspar-rich, flow-banded porphyry.	Sc; strong musc; common Kl; patchy dol; patchy	Py;tr As;tr	Qtz.	KMD 149 (2.83m)	161.02	163.85	98%	0.002	0	5
162.51	163.85	FELSPAR PORPHYRY	Greyish brown, indistinct phenocrysts generally sericitised with patches of green altered plagioclase (= kaolinite + dolomite). Sulphides; fine disseminations throughout.	Sc; mod. Kl; locally strong Dol; musc; occasional	Py;tr As;tr	Qtz (mod)							
163.85	169.83	FELSPAR PORPHYRY	Brownish grey generally sericitised with local silification adjacent to quartz veins and frequent kaolinised carbonated patches. (= green plagioclase). Sporadic quartz veining with grey, earlier qtz. margins e.g. 166m. Frequent muscovite after biotite.	Sc; mod Kl; locally dol; strong musc; common	Py;tr	Qtz carb.	KMD 150 (3.50m)	163.85	167.35	98%	0.003	1	3
							KMD 151 (2.48m)	167.35	169.83	99%	0.001	1	7
169.83	171.69	FELSPAR PORPHYRY	Grey heavily kaolinised with patchy, remnant sericitisation (indistinct porphyry texture). Secondary muscovite/carbonate after biotite. Minor quartz veining.	Kl: strong Sc; patchy dol; strong musc: common	Py;tr	Qtz (minor)	KMD 152 (2.59)	169.83	172.42	99%	0.001	0	4
171.69	172.42	FELSPAR PORPHYRY	As above but sericitic alteration predominant. Moderate qtz. veining.										
172.42	175.40	FELSPAR PORPHYRY	Pale grey, 'bleached' porphyry. Small dark grey qtz. veinlets form local stockwork. (173.32m)	dol; strong Kl: intense Sc: patchy	Py;tr								
175.40	175.50	BRECCIATED PORPHYRY	Fragmented porphyry in dark grey Fe-stained carbonate matrix(?) chlorite(?).	Ca; intense			KMD 153 (2.98)	172.42	175.40	98%	0.001	0	5

Logged by; H W HASLAM/J S COATS

Log Sheet No; 20

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	As ppm	Au ppm
175.50	177.50	FELSPAR PORPHYRY	Brownish grey, phenocrysts indistinct, generally sericitised.	Sc; strong	Py;tr		KMD 154 (2.15)	175. 40	177. 55	97%	0.002	3	6	
177.50	177.55	BRECCIATED PORPHYRY	Fragmented porphyry in dark grey Fe-stained granular carbonate matrix.											
177.55	178.27	FELSPAR PORPHYRY	Grey, 'baked' silicified porphyry adjacent to Tertiary dyke. Sericite forms major mineral in groundmass and in plag. phenocrysts together with stained granular carbonate and goethite. Veining absent apart from minute limonitic hair-line fissures.	Si; strong Sc; heavy Ca; in phenocs. musc; after biot. Lm; sp	Py;tr	Lim. in fissures	KMD 155 (0.78m)	177. 55	178. 27	99%	0.002	1	8	
178.27	184.63	CRINANITE	Dark fine-grained margins, becoming porphyritic towards centre, with prominent phenocrysts of plagioclase (Lab.), and amygdales with zeolites. Clusters of pyrite associated with fracturing at 180.6m. White clay mineral and chlorite developed on fractures beyond 183.50m	Chlorite after amphibole	Py	Chlorite clay min.	KMD 156 (2.25m)	178. 27	180 52	98%	0.002	3	2	0.3
							KMD 157 (2.97m)	180. 52	183. 49	95%	0.003	0	0	
			END OF HOLE.											

73.

INSTITUTE OF GEOLOGICAL SCIENCES - DIAMOND DRILL CORE RECORD SHEET

DDH No. 2
Depth; 174.20 m
Inclination; 60°
Azimuth; 020°T
Collar Elevation; 235 m

Coordinates; NM 81490992
Location; Argyllshire, Scotland.
O/S Sheet No. 52
Objective; Test Geochem Anomaly
Logged by; J S Coats, R A Ellis, M S Garson.

Drilled by; Rockfall
Date commenced; 20.12.76 Date completed; 12.2.77
Total %age Core Recovery; 97%
% Recovery by core-size; NQ. 0-6.40 metres = 60%
TNX 6.40 m - 10.55 m 95%
NQ 10.55 m - 55.00 m = 98%
BQ. 55.00 m - 174.20 m

Project; KILMELFORD

Log Sheet No. 1

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS	FRACTURE VEINING	SAMPLE NO.	From	To	% Rcvry.	% Cu	Mo ppm		As ppm
0.00	3.20	Granodiorite Rubble	No core recovered											
3.20	6.40	Granodiorite [MIN SPEC. 5.30 m]	Pinkish grey medium-grained, with finer-grained darker patches of biotite-quartz-diorite. Suphides; Py common on joints. Cp. as scattered blebs in Sc. zones.	Locally sericitised adjacent to qtz. veins. Limonite heavy in patches.	Py;v/c cp;c	Qtz; v/c Heavily fractured at 40° to core %	KMD 161 (1.60) KMD 162 (1.60)	3.20 4.80	4.80 6.40	90% 95%	0.05 0.07	3 8		2 8
6.40	7.05	Quartz-diorite	Grey,hornblende,biotite, quartz diorite.Mafics partially chl.tsd, Sericitic zones adjacent to quartz veins.	Sc (moderate) Chl (light) Lm(occasional)	Py;Ab Cp;C	Qtz;common								
7.05	7.10	"	Broken limonitic rubble.	Lm; heavy			KMD 163 (1.00)	6.40	7.40	98%	0.08	21		9
7.10	9.50	Quartz-diorite	Dark pinkish grey biotite, quartz diorite. Sulphides;Ab;2-5% disseminated and in small strings assoctd. with qtz-veins. massive py at 9.30 m. Later thin barren carb veinlets.	Sc. mod. Chl. light	Py;Ab Cp;C	Qtz;common Carb.	KMD 164 (1.00) KMD 165 (1.10)	7.40 8.40	8.40 9.50	98% 98%	0.05 0.07	45 69		1 5

Logged by; R A ELLIS

Log Sheet No; 2

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
9.50	10.55	Quartz-diorite	As above but more heavily quartz veined - brecciated at 9.55 m with massive sulphides. Two sets of veins; early pink barren aplite veins (up to 5mm thick). Later qtz. veins carry sulphides.	Si(moderate)	Py;Ab Cp;C	Pink aplite vein sub-parallel to ca. Qtz-heavy (local stockworks)	KMD 166 (1.05)	9.50	10.55		0.07	38		22
10.55	10.65	Xenolithic felspar porphyry	Dacitic porphyry with small fragments of granodiorite.											
10.65	13.00	Felspar porphyry	Greyish brown, phenocrysts indistinct; silicification and sericite adjacent to quartz veins.	Sc; strong Si; strong	Cp;Sp Py;C	Qtz;common (sub-parallel at 40° to c.a)	KMD 167 (2.45)	10.55	13.00	98%	0.03	9		23
13.00	19.20	Xenolithic biotite/felspar porphyry /PTS 15.90m/	Dark greyish brown altered porphyry with frequent fragments of granodiorite with partially chloritised mafics. Early barren quartz veins sub-parallel to core and later hair veinlets carrying sulphide which is also disseminated in the groundmass.	Sc; strong Si; strong Chl;light Musc. Lm;v. occasional	Py;C Cp;Sp	Qtz;common (30-40° to c.a.)	KMD 168 (2.00)	13.00	15.00	98%	0.01	3		11
							KMD 169 (2.00)	15.00	17.00	98%	0.01	5		12
							KMD 170 (200)	17.00	19.00	98%	0.02	9		21
19.20	21.35	B.F.P.	More heavily fractured and sericitised; grey clay mineral prominent on fractures. Sulphides; disseminated throughout, in small veinlets and in blooms on fracture surfaces.	Si; strong Sc; intense	Py;C Cp;Sp	Qtz.common Carb. occasional	KMD 171 (2.35)	19.00	21.35	98%	0.02	9		11

Logged by; R A ELLIS

Log Sheet No; 3

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
21.35	22.95	Quartz-diorite	Greenish-grey chloritised biotite-quartz diorite variable texture with some flow-banding evident and cognate xenolith at 22.85. Sulphides; common in strings veinlets and small blebs.	Sc;moderate Ca;strong Chl;strong	Py;C Cp;Sp	Pink Qtz. moderate fracturing at 20.30 to c.a.	KMD 172 (1.60)	21.35	22.95	98%	0.07	16		22
22.95	24.42	Biotite quartz-diorite	Greenish grey chloritised slightly porphyritic between 22.95 and 23.30 m. Carbonate veinlets become prominent adjacent to dolerite dyke.	Chl;strong Carb;strong Sc; mod.	Py;C Cp;Sp	Qtz. (moderate) Calcite (local)	KMD 173 (1.47)	22.95	24.42	98%	0.05	9		29
24.42	25.00	Dolerite	/Not sampled 7.											
25.00	26.00	Biotite quartz-diorite	Greenish grey chloritised heavily veined with pink medium grained granophyre (1 cm thick) sub-parallel to core axis. Assoctd. with the veining are frequent pink zones of sericite and quartz and veins of dolomite(?) Sulphides; abundant in strings and veinlets associated with qtz/carbonate veining.	Chl;strong Sc; strong Si; strong Ca; strong	Py;Ab Cp;C	Aplite Qtz. Dol.	KMD 174 (1.55)	25.00	26.55	98%	0.23	119		35
26.00	26.55	B.Q.D.	As above but slightly porphyritic.											

Logged by; R A ELLIS

Log Sheet No; 4

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	Au ppm	As ppm
26.55	28.35	B.Q.D.	Greenish grey chloritised, with frequent pink silicified/sericitised 'tongues' prominent; 26.90-27.10 m 27.40-27.55 m 27.90-28.10 m Sulphides; abundant as coarse aggregates, plates and beads in the pink zones and in small stringers and veinlets in the adjacent chloritised BQD.	Sc; locally strong Si; locally strong Chl; mod. Ca; strong. Musc.	Py; ab Cp; C Ba; tr	Pink aplite Qtz. Dol. (two sets.	KMD 175 (1.55)	26.55	28.10	98%	0.26	36	<0.3	21
28.35	31.00	Felspar porphyry	Brownish grey altered, heavily veined with qtz. and later carbonate (dolomite?) occasional patches of BQD. Suphides up to 5% in small veinlets and disseminations.	Sc; heavy Si; heavy	Py; ab Cp; f.c.	Qtz (stock-works) Dol. Carb.	KMD 176 (1.45)	28.10	29.55	98%	0.08	18		31
							KMD 177 (1.45)	29.55	31.00	98%	0.05	11		30
31.00	32.45	B.Q.D. /PTS 31.45/ /PTS 32.45/	Dark brownish grey, fine-grained characterised by development of secondary biotite and dolomite carbonate after the primary mica. Reticulate network of thin barren dolomite(?) veins present. Parallel hair veinlets of sulphide impart a 'banded' appearance to the rock.	Biot. Ca; strong Kl; minor Si; light	Py; vc Cp; sp.	Qtz. Dol.	KMD 178 (1.45)	31.00	32.45	98%	0.08	24		22
32.45	32.65	Granodiorite	Grey, with more coarse-grained, pinkish-grey patches of adamellite, the plagioclase in the GD shows some alteration to kaolinite.	Sc; mod. Kl; light.	Py; c	Dol. Qtz. Calc (later)	KMD 179 (2.15)	32.45	34.60	98%	0.34	12		16

Logged by; R A ELLIS

Log Sheet No; 5

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
32.65	34.60	Biotite felspar porphyry	Greyish brown, fractured with patchy development of sericitic alteration. Less sericitised porphyry retains the biotite and exhibits extensive kaolinite after plagioclase (white, powdery phenocrysts). Prominent qtz.veins at 33.05 m carry massive sulphide. Sulphides; Abundant as disseminations, strings and veinlets.	Si; strong Sc; strong Ki; local	Py; ab Cp; c	Qtz. Dol. fracture at 45° to c.a.								
34.60	35.90	B.Q.D.	Dark pinkish grey, fine-grained with occasional pink 'patches' of adamellite. Characterised by thin, straight, parallel fractures infilled with dolomite and opaque granular sulphide? imparting a 'banded' appearance to the rock. Later barren spidery veinlets of calcite.	Sc; light Chl; mod.	Py; ab Cp. sp	Dol/Py Calc.	KMD 180	34.60	35.90	98%	0.05	23		11
35.90	36.20	B.Q.D.	As above, more fractured brecciated and heavily veined with carbonate at 36.00 m.			Dol/calc. heavy (stockwork)								

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Log Sheet No; 6

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov'd	% Cu	Mo ppm	Au ppm	As ppm
36.20	39.55	Granodiorite [PTS 38.35]	Dark pinkish grey 'banded' biotite granodiorite with zones of strong sericitic alteration associated with the development of dolomite and muscovite. Less altered rock retains biotite and exhibits bleached appearance due to kaolinite after plagioclase. Sulphides; most prominent in sericitised zones and assoctd. qtz. veins, also in small parallel fractures in the adjacent granodiorite. Late barren calcite veinlets.	Sc; locally intense Sc; locally intense Musc. Chl. mod Kl; local	Py;Ab Cp;c	Qtz. Dol. Calc.	KMD 181 (1.65) KMD 182 (2.00)	35.90 37.55	37.55 39.55	98% 98%	0.10 0.07	26 15	 <0.3	19 19
39.55	40.95	Brecciated porphyry [PTS 40.90m]	Argillised, pale grey, dacitic(?); sheared, brecciated with fragmented, grey cherty qtz. vein material all in carbonate vein matrix, grey clay mineral. Sulphides; v.fine disseminations.	Kl;intense Sc;strong	Py;vc Cp;fc	Fracture 20° to c.a. Qtz Dol Calcite	KMD 183 (1.40)	39.55	40.95	98%	0.07	15	<0.3	20
40.95	41.84	Felspar porphyry	Pale grey, soft kaolinised. Reticulate development of small sulphide veinlets.	Kl;intense Sc;heavy	Py;vc Cp;fc									
41.84	43.50	"	As above, but less kaolinite and more sericitised zones associated with heavy qtz. veining. Qtz. vein stockworks are developed locally.	Kl; mod. Si; mod. Sc; strong.	Py; Cp;sp Bo;	Dark grey cherty qtz.+ qtz. stockworks.	KMD 184 (1.85) KMD 185	40.95 42.80	42.80 43.50	98% 98%	0.12 0.09	27 27		23 28
43.50	43.65	Granodiorite	Grey medium grained fresh rock. Sulphides; disseminated py.		Py;c									
43.65	43.90	Felspar porphyry	Pale greyish brown, sericitised several parallel fractures normal to core axis carry sulphides.	Sc; heavy Ca; mod. Chl; light	Py;ab Cp;sp	Qtz.								

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Log Sheet No; 7

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
43.90	44.30	B.Q.D.	Pinkish buff, sericitised with much chlorite after biotite. Sulphides; Py abundant on fractures and in veinlets. Cp. sparse disseminations in groundmass.	Sc; strong chl; mod	Py;Ab Cp;Sp		KMD 186 (0.80)	43.50	44.30	98%	0.08	41		9
44.30	45.95	Biotite felspar porphyry	Heavily fractured, sericitied and veined with quartz. Mafics are generally chloritised. Kaolinite after plagioclase becomes common towards base. Sulphides; disseminated and in strings and veinlets associated with quartz veins. Later carb. veins are barren.	Sc; heavy Chl;strong Si; strong Kl; strong (locally)		Qtz. Carb.	KMD 187 (1.70)	44.30	46.00	98%	0.05	30		26
45.95	46.80	Felspar porphyry	Hard, greyish pink, well-jointed (50° to c.a). Porphyritic texture indistinct. Sericitised zones carry dolomite veins with abundant pyrite in cubes and spangles.	Sc; patchy Si; patchy Chl.	Py;Ab Cp;Sp	Qtz; mod. Dol; common	KMD 188 (1.40)	46.00	47.40	98%	0.05	37		26
46.80	48.75	"	Pale grey, argillised thin grey qtz. veins carry sulphides.	Kl; strong Ca; strong Sc; light	Py;C Cp;Sp Mo;Sp	Qtz. (network)	KMD 189 (1.35)	47.40	48.75	98%	0.06	29		45
48.75	48.85	"	As above but brecciated in carbonate cement.											

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Log Sheet No; 8

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov.	% Cu	Mo ppm		As ppm
48.85	49.65	Felsite	Heavily sericitised brown porphyry (?) with fragments of microdiorite . No visible sulphides. Several barren calcite veins. Rare qtz. veinlets.	Sc; strong	Py;tr	Calcite; common Qtz. sparse.	KMD 190 (0.90)	48.75	49.65	98%	0.07	13		18
49.65	50.35	Granodiorite	Pale grey argillised - strong development of carbonate and kaolin after plagioclase (carbonate imparts green colour to plagioclase). Grey clay and carbonate on shear fractures. Thin hair veinlets of qtz. carry sulphides.	Kl; strong Ca; strong	Py; F/C Cp;Sp	Calc. Qtz.(hair veinlets)	KMD 191 (1.95)	49.65	51.60	98%	0.05	9		13
50.35	50.80	Granodiorite	Pale brownish grey, sharp angular fractures. Silicified with local development of dolomite and sericite after plagioclase (green spots). Sulphides; in fine disseminations and veinlets.	Si; strong Sc; light Ca; light	Py;C Cp;Sp									
50.80	51.60	Granodiorite /PTS 51.15/	As above but less silification and more kaolinite in patches.	Sc; mod. Kl; strong										
51.60	52.10	Granodiorite	Partially altered.	Sc; mod. Ca; light.	Py;C									
52.10	52.70	Granodiorite	Pale brownish grey moderately sericitised becoming progressively more kaolinised towards base.	Sc; mod. Kl; strong. Carb; strong.	Py;C	Qtz. Carb.	KMD 192 (0.70)	51.60	52.30	70%	0.04	26		7
52.70	53.00	Clay gouge								50%				

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Log Sheet No; 9

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
53.00	53.67	Granodiorite	Pale green argilli sed, heavily veined with calcite and quartz.	Kl; strong Sc; mod.	Py;C Cp;tr	Qtz. Dol.	KMD 193 (1.37)	52.30	53.67	90%	0.03	15		10
53.67	55.30	Granodiorite	Hard greyish pink sericitised with minor kaolinite. Frequent 3 mm thick dolomite/ qtz. veins carry clusters of sulphide (pyritohedra) occasional patches of unaltered granodiorite eg. at 55.20 m.	Sc; strong Kl; light	Py;Ab		KMD 194 (1.63)	53.67	55.30	95%	0.04	18		15
55.30	58.75	Granodiorite	Dark pinkish grey; medium-grained with minor development of chlorite and sericite, occasional coarser patches associated with qtz. veining carry orthoclase. Regular parallel fractures at 20° to core axis (1-2 mm. thick) carry chlorite? + sulphi e?. Sulphides; in small stringers with qtz. and as isolated blebs in groundmass.	Sc; minor. Chl;minor.	Py;C Cp; F/C	Qtz; common Carb. Chl?	KMD 195 (2.00)	55.30	57.30	98%	0.05	11		7
58.75	58.83	Granodiorite	As above. 1 cm thick vein of dolomite carrie abundant cube of pyrite and small clots of chalcopyrite.											
58.83	59.40	Granodiorite	Dark greenish grey, chloritised. Numerous small qtz. veins carry sulphide; also in small sub-parallel carbonate fractures.	Chl; strong.	Py;Ab Cp;Sp		KMD 196	57.30	59.30	98%	0.04	53		9

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Log Sheet No; 10

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
59.40	59.85	Granodiorite	Pink, fractured, with prominent carbonate veins (dolomite?) carrying spangles and clusters of pyrite.	Ca; strong. Sc; mod.	Py;Ab	Carb (network) Qtz.minor								
59.85	61.66	Granodiorite /PTS 61.60/	Medium/fine-grained pinkish grey, partially sericitised.	Chl; Sc; mod.	Py;Sp Cp;Sp		KMD 197 (2.00)	59.30	61.30	98%	0.05	11		7
61.66	64.36	Qtz.diorite/ granodiorite	Alternating zones of pinkish grey granodiorite and dark grey quartz diorite. Early pink barren quartz veins (up to 1 cm thick). Later thin grey qtz veins carrying sulphide. Later thin grey qtz. veins carrying sulphide. Later thin barren carbonate veinlets. Sulphides; cp. as small agregates in quartz vein associated with Fe oxide.	Sc; mod. Chl; strong. Kl; mod. Ca; mod.	Py;Ab Cp;C Haem?	Qtz. (2 sets) Carb.	KMD 198 (2.00)	61.30	63.30	98%	0.24	23		4
							KMD 199 (1.06)	63.30	64.36	98%	0.06	28		1
64.36	64.50	Brecciated granodiorite	Pink fragmented, in chlorite/ carbonate cement, occasional flakes of muscovite.	Chl; mod. Carb;intense Musc.	Py;Sp	Carb; stockwork								
64.50	68.00	Granodiorite	Mottled greenish/buff altered with development of kaolinite and carbonate after the felspars and sericite adjacent to quartz veins. Veining; 3 sets, early branching q.v.s. with small massive aggregates of Cp + Fe oxide. Later thin qts. veinlets with py. Later barren hair veinlets of calcite.	Kl; mod. Chl; strong Ca; strong Sc; mod.	Py;Ab Cp;C	Qtz;strong Carb.	KMD 200 (2.00)	64.36	66.36	98%	0.16	229		13
							KMD 201 (1.24)	66.36	67.60	98%	0.10	32		1

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Log Sheet No; 11

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
68.00	69.76	Granodiorite	Pinkish brown, chloritised heavily qtz. veined; two sets. Cp. is common in qtz. veins associated with Fe oxide. No appreciable sulphide in the groundmass.	Chl; heavy Sc; mod.	Py;Ab Cp;C Haem?	Qtz; strong.	KMD 202 (2.16)	67.60	69.76	98%	0.18	64		2
69.76	70.50	Granodiorite	Pale buff, mottled, chloritised kaolinised. V.fine hair fractures and occasional qtz. veinlets carry small specks of cp. but sulphide generally confined to disseminated py. in the groundmass.	Chl; heavy Kl; mod. Sc; light Ca		Qtz. (occasional) Chl.	KMD 203 (0.74)	69.76	70.50	98%	0.12	42		5
70.50	71.10	Felspar porphyry	Heavily, veined, fractured, kaolinised with threads and disseminations of Cp. Prominent grey cherty qtz. veins. Later qtz/carb veinlets.	Kl;intense Ca; strong	Cp;C Mo;tr	Qtz;heavy Carb	KMD 204 (0.60)	70.50	71.10	98%	0.06	83		5
71.10	71.85	Granodiorite [PTS 71.70]	Altered, with small tongue of silicified adamellite at 71.70. Veins of qtz/dolomite carry Cp, Py is disseminated throughout. Later barren calcite veinlets.	Sc; mod. Kl; strong Ca; strong Chl;local Chl.	Py;Ab Cp;C	Qtz. Dol. Calc. Chl.	KMD 205 (0.75)	71.10	71.85	98%	0.10	17		3
71.85	73.60	Felspar porphyry	Fragmented kaolinised porphyry? in stockwork of dolomite and calcite veins.	Kl; heavy	Py;Sp Cp;tr	Carb (stock-works)	KMD 206 (1.81)	71.85	73.66	50%	0.02	12		5

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Log Sheet No; 12

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov'd	% Cu	Mo ppm	Au ppm	As ppm
73.60	74.76	Granodiorite	Pale buff, chloritised, kaolinised with pink sericitised zones. Frequent veinlets of qtz/carb with sulphide which also occurs in small threads in groundmass.	Kl; strong Chl; strong Sc; local Ca; mod.	Cp; C Py; Ab	Qtz. Carb.	KMD 207 (1.10)	73.66	74.76	98%	0.11	22		7
74.76	76.71	Porphyritic granodiorite	Greenish grey heavily altered. Secondary orthoclase developed adjacent to qtz. veins.	Chl; strong Kl; strong Ca; strong Sc; mod. Si; mod.	Py; Ab Cp; Sp	Qtz.	KMD 208 (2.20)	74.76	76.96	95%	0.08	55	<0.3	7
76.71	79.79	Xenolithic porphyry /PTS 77.66m/ /PTS 79.68m/	Pink dacitic porphyry? with xenolithic fragments of granodiorite and metasediment. Abundant secondary development of sericite, kaolinite muscovite and dolerite.	Sc; strong Kl; strong Si; in xens Musc. Ca; strong.	Py; Ab Cp; Sp	Grey qtz. white qtz. (local stockworks)	KMD 209 (2.00)	76.96	78.96	95%	0.06	30		23
79.79	84.76	Felspar porphyry	Pink, silicified and sericitised with kaolinite developed locally associated with calcite veining. Prominent Qtz/Dol, vein at 82.50 with later infilling of calcite. Sulphides; in small qtz. veinlets and as threads and specks in g.m.	Sc; intense Si; strong Kl; light Musc.	Py; Ab Cp; tr Mo; tr	Grey Qtz. White Qtz. Calcite	KMD 210 (1.80)	78.96	80.76	98%	0.01	406		7
							KMD 211 (2.00)	80.76	82.76	98%	0.04	37		20
							KMD 212 (2.00)	82.76	84.76	98%	0.05	16		10

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Log Sheet No; 13

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm		As ppm
84.76	86.85	Felspar porphyry	Greyish-brown, hard, silicified, phenocrysts indistinct; chlorite in clots and streaks associated with pyrite. Pyrite also occurs in thin strings and as fine specks in g.m.	Si; strong Sc; mod. Chl; mod.	Py; F/C	Qtz. (meagre) Carb. (occasional)	KMD 213 (2.00)	84.76	86.76	98%	0.05	5		11
86.85	90.83	"	Pinkish-brown, hard, splintery silicified, becoming broken and fractured after 89.00 m. Veining is less prominent. Sulphides; predominantly pyrite as disseminations, strings and as plates on fractures.	Si; strong Sc; mod.	Py;C	Qtz; occasional Calc occasional	KMD 214 (2.00)	86.76	88.76	98%	0.07	27		15
							KMD 215 (2.00)	88.76	90.76	98%	0.01	32		15
90.83	95.00	Xenolithic porphyry	Light brownish grey silicified with numerous xenolithic fragments of hornfels and granodiorite and some porphyry fragments towards the base. Sulphides; up to 5% py - platy on fractures and disseminated in g.m.	Si; strong Chl; clots Sc; hvy. White clay on fractures.	Py;C	Qtz. Calc.	KMD 216 (2.00)	90.76	93.28	98%	0.02	3		5
							KMD 217 (2.00)	93.28	95.28	98%	0.07	14		8
95.00	95.30	Sheared porphyry	Argillised, soft greyish green clay gouge and grey cherty qtz. veins. Later small (1 mm) qtz. veinlets carry Cp. Pyrite is common in strings; spangles and v. fine disseminations.	Chl. Kl; intense. Musc.	Cp;Sp Py;C	Qtz.	KMD 218 (2.00)	95.28	97.28	98%	0.03	19		13
95.30	96.00	Xenolithic porphyry	Light brown, mottled.		Py; 5%									

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Log Sheet No; 14

98.

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovl	% Cu	Mo ppm	Au ppm	As ppm
96.00	101.30	Porphyry breccia	Light-brown mottled fractured with numerous fragments of granodiorite and porphyry in biotite-felspar porphyry rock with moderate alteration. Chlorite heavy in clots and fractures. 2mm. qtz. veins carry odd specks of Cp and Mo. Shear-zone at 100.75 m.	Sc; mod. Kl; mod. Chl; in clots. Dol; mod.	Py;8% Cp;tr Mo;tr	Qtz.	KMD 2A[19] (2.00)	97.28	99.28	98%	0.02	9		12
							KMD 220 (2.00)	99.28	101.28	98%	0.03	8		15
101.30	101.65	Xenolithic porphyry	Brownish pink biotite felspar porphyry with numerous xenoliths (up to 10 cms) of hornfels, granodiorite and porphyry. Porphyry fragm nts are of two types a) grey argillised b) reddish-brown fine-grained type. Sulphides: Py - disseminated. Cp. sparse in small qtz. veins.	Sc; mod. Kl; mod Sc; strong Musc.	Py;3% Cp} Sp cc}	Qtz.	KMD 221	101.28	103.90	98%	0.10	44		19
							KMD 222 (2.33)	103.90	106.23	98%	0.02	6		19
							KMD 223 (2.42)	106.23	108.65	98%	0.01	3		17
108.65	109.85	Brecciated porphyry /PTS 109.00m/	Pink, mottled, silicified heavily fractured, xenolithic. Sulphides; coarse clusters of cubic pyrite.	Si; strong Sc; strong dd. Chl;clots	Py;Ab Cp;tr	Qtz.	KMD 224 (1.20)	108.65	109.85	98%	0.03	4	0.4	27
109.85	113.00	Felspar porphyry	Pale, greenish grey argillised with zones of brownish pink sericitised porphyry carrying sulphide.	Kl; intense Carb;strong Sc; locally strong Si; strong	Py; F/C	Qtz.	KMD 225 (2.00)	109.85	111.85	98%	0.02	3		24

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Log Sheet No; 15

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	% Pb	As ppm
113.00	113.20	Fault breccia	Fragmented porphyry and green clay cemented with quartz.	Kl Si Chl	Py;C	Qtz. (stockwork)								
113.20	113.90	Felspar porphyry	Brown, fine-grained, highly fractured with development of qtz. stockwork.	Sp;strong.	Py;Ab	DTZ (stockwork)	KMD 226 (2.00)	111.85	113.85	98%	0.03	1		21
113.90	115.00	Dolerite	Black dolerite with prominent plagioclase phenocrysts /NOT SAMPLED/.											
115.00	115.18	Brecciated porphyry	Grey, brecciated, with clay gouge and abundant pyrite cubes to 2 mm.	Kl } strong Sc }	Py;Ab 2%	Clay min.	KMD 227 (1.40)	115.00	116.40	75%	0.001	7		56
115.18	123.61	Felspar porphyry	Greenish grey highly sericitised and kaolinised, locally brecciated and infrequent, pink sericite/silic patches carrying traces of Cp. Pyrite abundant throughout (up to 5%).	Kl intense Sc Carb } Musc } strong Dol }	Py;Ab Asp? Cp;tr	White clay on fractures.	KMD 228 (2.49)	116.40	118.89	98%	0.001	6		13
							KMD 229 (1.72)	118.89	120.61	98%	0.001	5		18
							KMD 230 (3.00)	120.61	123.61	98%	0.01	0	0.06	28
123.61	124.22	Felspar porphyry	Brownish grey sericitised and silicified with abundant pyrite, and rare qtz. phenocrysts.	Si; light Sc; strong Chl; spots Carb;strong	Py;Ab Cp;tr	Clay min.	KMD 231 (2.64)	123.61	126.25	98%	0.009	5		23
124.22	127.97	"	Greyish green, sericitised, kaolinite with predominent development of secondary dolomite carbonate occasional, brownish pink patches contain more sericite.	Kl; strong Sc; strong Dol;strong Musc.	Py;Ab Aspy; C		KMD 232 (1.72)	126.25	127.97	98%	0.007	3		37

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Log Sheet No; 16

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	Pb%	As ppm
127.97	130.10	Felspar porphyry	Pinkish grey, sericitised. Green altered plagioclases = dolomite carbonate. Sulphides: Pyrite plus arsenopyrite both show patchy distribution from ≥5% to <1% generally in cubes and pyritohedra.	Sc; strong Dol;strong Carb; strong Kl; light Musc; ab.	Py;Ab Aspy; C	Clay min. on fractures Qtz. (occasional)	KMD 233 (213)	127.97	130.10		0.03	6	0.03	54
130.10	133.23	"	Greenish-grey as above but with more kaolinite and less sericite. Sulphides; in fine disseminations, cubes and on fractures, pyrite and arsenopyrite.	Kl;strong Sc; mod. Dol/Carb; strong.	Py;Ab Asp;		KMD 234 (1.23)	130.10	131.33		0.006	2		50
							KMD 235 (1.90)	131.33	133.23		0.005	7	0.03	107
133.23	134.30	Felspar porphyry	Brownish grey, brecciated over first 0.25 m generally kaolinised and carbonated plagioclase phenocrysts in sericitic groundmass. Sulphides; Pyrite common as cubes in groundmass and as blooms on fractures.	Sc; strong Kl; strong Ca;strong	Py;Ab (Aspy)	Clay min on fractures								
134.30	135.63	Felspar porphyry /PTS 135.60/	Greyish green intensely altered showing flow-banding locally. (134.30 - 134.50 m). Sulphides; pyrite in cubes and clots, up to 5% in some sections. Occasional patches show pale pink plagioclase phenocrysts = less kaolinised	Sc;intense Kl; strong Ca; strong Muscovite flakes.	Py;Ab Asp;C		KMD 236 (3.06)	133.23	136.29	98%	0.02	0	Au ppm <0.3	112

[redacted]

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Log Sheet No; 17

89.

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recovd.	% Cu	Mo ppm	%Pb	As ppm
135.63	136.29	Felspar porphyry	Greenish grey, with major dolomite carbonate alteration rare quartz phenocrysts. Pyrite as isolated specks and in veinlets with arsenopyrite.	Sc; intense Kl; heavy Ca; intense Musc; common.	Py;C	White clay min. on fractures.	KMD 237 (3.48)	136.29	139.77	98%	0.003	4	0.06	100
136.29	139.77	" /PTS 136.37/	As above but less carbonate alteration, hence less green in colour - limited to occasional patches.											
139.77	141.40	"	Alternating pinkish-grey and greenish grey reflecting varying proportions of sericite to dolomitic carb. Brecciated towards base with green clay mineral.	Sc; intense Ca; strong Ca; locally intense Musc; common	Py;C Cp;tr	Green clay in brecciated zone.	KMD 238 (2.02)	139.77	141.79	98%	0.005	2		94
141.40	150.18	Felspar porphyry	Intensely altered pale porphyry with occasional quartz phenocrysts and streaks of chlorite? Pinkish grey colour reflects intense sericisation, with greenish tinges showing more restricted development of intense dolomitic carbonate alteration. Secondary muscovite, and kaolinite in the phenocrysts are common throughout. Sulphide; predominantly pyrite (cubic), and locally abundant in spangles and clusters in the groundmass. Some arsenopyrite(?) developed on fractures. Rare quartz veins between 143.80 - 144.10 m.	Sc; intense Ca; intense Chl; occasional xenolithic spots Musc;common Kl; common.	Py;C	Grey clay on fractures at 142.0m	KMD 239 (2.52)	141.79	144.31	98%	0.003	2		47
						Rare qtz. veins.	KMD 240 (3.12)	144.31	147.43	98%	0.004	10		28
							KMD 241 (2.75)	147.43	150.18	98%	0.003	10		42

Logged by; J S COATS

Log Sheet No; 18

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov.	% Cu	Mo ppm		As ppm
150.18	161.65	Felspar porphyry	As above, pale pinkish grey with greenish grey, dolomitic alteration zones becoming more common. Brecciated between 159.05 m and 159.20 m with grey clay common on fractures together with cubic pyrite. Flow-banding prominent (at 65° to core axis), between 159.90 and 161.65, associated with a few chloritised xenolithic fragments. Pyrite veins between 3-7%.	Sc; intense Ca; intense Chl; occasional streaks and xenolithic clots. Musc; common Kl; common	Py; Ab Cp; tr		KMD 242 (1.45)	150.18	151.63	98%	0.004	2		39
							KMD 243 (2.65)	151.63	154.28	98%	0.007	8		33
							KMD 244 (1.75)	154.28	156.03	98%	0.008	1		37
							KMD 245 (2.32)	156.03	158.35	98%	0.01	5		19
							KMD 246 (1.80)	158.35	160.15	98%	0.02	3		26
							KMD 247 (1.05)	160.15	161.10	98%	0.02	4		16
							KMD 248 (1.57)	161.10	162.67	98%	0.01	6		24
161.65	162.10	"	As above but dolomitic carbonate alteration is more pervasive, hence overall greenish gray colour.											

Logged by; R A ELLIS

Log Sheet No; 19

METRES		GEOLOGICAL RECORD					ASSAY RECORD							
From	To	ROCK TYPE	DESCRIPTION	ALTERATION	ORE MINS.	FRACTURE VEINING	SAMPLE NO.	From	To	% Recov'L	% Cu	Mo ppm	% Pb	As ppm
162.10	168.70	Felspar porphyry /PTS 169.86m/	Pale pinkish grey sericitised porphyry with frequent zones of more intense carbonate alteration (greyish green). Rare quartz phenocrysts, occasional flow-banding and chlorite clots. Minor fracture-zones associated with the development of a dark grey clay gouge occur at 162.90m, 163.90 m, 165.85 m a green clay gouge occurs at 166.25 m (0.1 m). Sulphides; almost wholely pyrite; shows uneven distribution ranging from >5% to <1%.	Sc;intense Ca;intense Kl;strong Musc;common Chl; occasional streaks and clots.	Py;Ab Cp;tr	Grey clay	KMD 249 (3.95)	162.67	166.62	82%	0.03	4		19
							KMD 250 (2.10)	166.62	168.72	99%	0.10	4		18
168.70	174.20	"	Greyish green with major development of dolomite carbonate. Pyrite is generally abundant, locally up to 10% in cubes, pyritohedra, and occasional thin stringers.	Ca;intense Sc;intense Chl;common Kl; intense Musc; common.	Py;Ab Cp;tr		KMD 251 (2.53)	168.72	171.25	99%	0.02	8		20
							KMD 252 (2.95)	171.25	174.20	99%	0.02	9	0.06	16
			END OF HOLE.											

APPENDIX III

MINERALOGY OF ROCK SPECIMENS FROM SURFACE OUTCROP, SUBCROP AND CORE FROM BORE-HOLES 1 AND 2

This appendix is given in four parts. The first deals with rock specimens from outcrops (CZR specimens) and with sub-crop specimens obtained during powered augering (CZD specimens). The details of location refer to the sampling grid used in the geological and geochemical surveys.

The second part deals with selected specimens of drill-core from BH1 (see Appendix II, Part 1).

The third part gives the results of qualitative bulk-analyses by X-ray diffractometry, carried out to determine the major clay and carbonate minerals present in six samples from BH1.

The fourth part deals with selected specimens of drill-core from BH2 (see Appendix II Part 2).

In each description the polished thin-section (pts) number and/or the covered thin-section (ts) number refer to the Mineralogy Unit thin-section collections.

The mineralogical examinations were carried out by examination of thin-sections in transmitted and incident light, and by examination of hand-specimens using a stereoscopic microscope. Additional data was provided by quantitative and qualitative XRF (analyst D J Bland) and by X-ray diffractometry (analysts D Atkin and A M Shilston).

Appendix III

Key to Part I

(1) Grid references refer to the surveyed grid used in IGS investigations at Kilmelford (see Figs 2 & 19).

(2) Rock type abbreviations are as follows:-

Bfp	- biotite-feldspar-porphyry	Brec	- breccia
Q-dior	- quartz-diorite	Qtzite	- quartzite
Granod	- granodiorite	Silt	- hornfelsed siltstone
Adam	- Adamellite		
Vein	- mineral vein material		

(3) Alteration type abbreviations are as follows:-

F	- fresh rock or mild alteration	Str	- strong
P	- chloritic alteration	Mod	- moderate
A	- kaolinitic alteration	Biot	- secondary biotite of uncertain origin
S	- sericitic alteration		
A/S	- composite sericite/kaolinite alteration		

(4) Mineral name abbreviations are as follows:-

Py	- pyrite	Ga	- galena	Mg	- magnetite
Cp	- chalcopyrite	Ba	- barytes	Il	- ilmenite
Moly	- molybdenite			Hm	- hematite
Po	- pyrrhotite				

Information in the Table which follows is based on more detailed data contained in Mineralogy Unit (Geochemical Division, IGS) reports numbers 172, 181 and 194.

APPENDIX III Part I

Mineralogy of rock specimens from surface outcrops and subcrop

Specimen Number (CZR)	Reference (IGS Grid)	Section Number	Rock type	Alteration type	Minerals	Comments
813	027N/828W	ts 3371 pts 2390	Q-dior	F	Py Cp My I1	Trace only of Cp Mg/I1 grains common
814	045S/738W	ts 3372	Vein	-	Ga Py Ba Cp	Also cerussite, anglesite and calcite
815		ts 3373 pts 2391	Bfp	A str	Py Cp	Cp very minor
816	217S/517W	ts 3374 pts 2392	Granod	P mod	Py Cp Hm I1	Trace only of Cp Hm/I1 grains common
817	285S/470W	ts 3375 pts 2393	Bfp	S	Py Cp Po	Po as minute inclusions in Py
818	380S/433W	ts 3376	Granod	A/S str	Py	Disseminated blebs
819	185S/076W	ts 3377 pts 2394	Bfp	S str	Py	Disseminated blebs
820	178S/066W	ts 3378 pts 2395	Adam	S	Py Cp Moly	1430 ppm Cu 155 ppm Mo
821	088S/092W	ts 3379 pts 2396	Q-dior	F	Py Cp Mg/I1	70 ppm Cu Mg/I1 grains common
822	110N/120W	ts 3380 pts 2397	Brec	S str	Py	Disseminated Trace of malachite
823	127N/160E	ts 3381	Pelite	P str	Py	Trace only
824	304S/561E	ts 3382 pts 2398	Qtzite	A	Py	

Appendix III Part I continued.

Specimen Number (CZR)	Reference (IGS Grid)	Section Number	Rock type	Alteration type	Minerals	Comments
825	309S/549E	ts 3383	Silt	A/S mod	-	No sulphide
826	299S/565E	ts 3384 pts 2399	Bfp	A/S	Py Cp	Disseminated 2740 ppm Cu
827	262S/292E	ts 3385 pts 2400	Silt	F	Py Cp	In coarser bands 1380 ppm Cu overall
828	034N/832W	ts 3386 pts 2401	Granod	F	Py Cp Mg	Trace of Cp
829	039N/818W	ts 3387 pts 2402	Granod	S str	Py Cp	On hair veinlets
2550A	622S/683W	pts 2699	Silt	P	Py	2% vol.
2550B	622S/683W	pts 2718	Bfp	P	Py	2% vol.
2551	319S/537W	pts 2700	Q-dior	Biot	Py Cp	Trace only of Cp Sulphides mostly in veins
2552	041S/166W	ts 3565	Adam	S	Py	
2553		pts 2701	Q-dior	P mod	Py Cp	0.1% total sulphide
2554	446S/012W	pts 2702	Bfp	A/S str	Py Cp	Trace of Cp 2% sulphide in rock
2555	468S/041W	pts 2703	Adam	A/S str	Py Cp	Trace of Cp 3% sulphide in rock
2556	503S/103W	pts 2704	Adam	A str	Py Cp	0.1% vol
2557A		pts 2705	Granod	A/S str	Py	2.5% vol

Appendix III Part I continued.

Specimen number (CZR)	Reference (IGS Grid)	Section number	Rock type	Alteration type	Minerals	Comments
2557B		pts 2706	Granod	F	Py	2% vol.
2558	352S/137E	pts 2707	Adam	A	Py	4% vol.
2559	202S/096E	pts 2708	Bfp	P mod	Py Cp	5% vol. Cp minor
3000	050S/300E	pts 2734	Brec	P mod	Py	2.5% vol.
3001	100S/100E	pts 2709	Bfp	F	Po Cp	Trace only of Cp
3002	050S/150E	pts 2735	Granod	A/S mod	Py	1.5% vol.
3003	300S/000	pts 2710	Bfp	A str	Py	
3004	200S/050W	pts 2736	?Bfp	S	Py	
3005	250S/100W	pts 2737	Granod	S str	Py Cp	Trace only of Cp
3006	150N/350E	pts 2711	Bfp	P mod	Hm	
3007	100N/300E	pts 2712	Bfp	S str	Py Cp	3% vol Cp minor
3008	050N/350E	pts 2713	Bfp	A/S str	Py Cp Po	Traces of Cp and Po
3010	000/300E	pts 2714	Bfp	A/S str	Py	
3011	050N/250E	pts 2738	Bfp	A/S str	Py	
3012	100S/200E	pts 2715	Granod	A str	Py Cp	Very minor Cp

Appendix III Part I continued

Specimen Number (CZD)	Reference (IGS Grid)	Section number	Rock type	Alteration type	Minerals	Comments
3015	200S/000	pts 2716	Adam	A/S	Py Cp	1.5% vol Trace only of Cp
3016	300S/200W	pts 2717	Bfp	A/S	Py Cp	0.5% vol Trace only of Cp
3017	300S/100W	ts 3564	Bfp	F	Py	1% vol.
3020	600S/500W	pts 2798	Silt	P	Py Cp	Trace only of Cp
3022	600S/600W	pts 2799	Adam	F	Py	0.2% vol.
3023	500S/600W	pts 2800	Silt	F	Py	
3024	500S/500W	pts 2801	Bfp	F	-	
3025	450S/450W	pts 2802	Granod	F	Py Cp Hm	Trace only of Cp
3026	550S/440W	pts 2803	Bfp	A	Py	
3028	600S/000	pts 2804	Silt	F	Py	2% vol
3031	350S/250W	pts 2805	Granod	A/S str	Py Cp	Trace only of Cp
3032	400S/300W	pts 2806	Adam	F	Py	2% vol.
3033	400S/400W	pts 2807	Bfp	?F	Py Cp	Trace only of Cp
3034	450S/350W	pts 2808	Granod	A	Py Cp	Trace only of Cp

Appendix III Part I continued

Specimen Number (CZD)	Reference (IGS Grid)	Section number	Rock type	Alteration type	Minerals	Comments
3035	500S/300W	pts 2809	Granod	A/S mod	Py Cp	3% vol Trace only of Cp
3038	400S/200W	pts 2810	Granod	A/S	Py Cp	Trace only of Cp
3039	390S/105W	pts 2811	Adam	A/S	Py	
3041	450S/150W	pts 2812	Gabbro	F		Tertiary dyke

APPENDIX III Part II

Mineralogy of rock specimens from BH1

In the following descriptions identifications of kaolinite and dolomite are based upon bulk-analyses by X-ray diffractometry of six specimens (analyst A M Shilston; reported in Appendix III Part III) together with X-ray powder photograph indentifications of material replacing feldspars in selected specimens (analyst D Atkin; data not reported separately).

The descriptions are listed below in order of increasing depth.

10.75m specimen (pts 2984)

Tan-brown porphyry with white feldspar phenocrysts. The rock contains about 40% phenocrysts of feldspar (likely plagioclase) and biotite, together with accessory prisms of apatite.

The plagioclase has been altered to clay + carbonate (likely kaolin + calcite) pseudomorphs; the micas to lâminated pseudomorphs of carbonate and white mica with small amounts of a fibrous mineral (possible zeolite). Carbonate granules are abundant in the fine-grained, felsic groundmass. Silicified patches are common, and often contain sulphide grains.

Point counting (1731 points) showed the ore-content to be 1.16% by volume, of which 0.81% is pyrite and 0.35% is chalcopyrite. The ore is disseminated. Chalcopyrite is developed mostly within and close to veinlets. The larger pyrite grains contain minute rounded inclusions of chalcopyrite and pyrrhotite. Chalcopyrite occurs as discrete grains, mostly within and close to quartz veinlets which in addition contain pyrite grains and small patches of calcite associated with the sulphide. A minor amount of hematite is present.

17.4m specimen (pts 2985)

Grey porphyry-highly altered

Alteration has produced pseudomorphs after plagioclase made up of carbonate and sericite, crossed by irregular veins and replacements of clay (likely kaolin). Mafic phenocrysts are represented by interlaminated patches of carbonate and a clay-like mineral, which in rare cases contain laminae of muscovite. The groundmass is rich in clay, carbonate, quartz and possible sericite. Silicified patches are associated with ore grains.

The rock is crossed by hairline veinlets thought to consist of illite replacing orthoclase, and quartz.

Disseminated ore forms about 2.5% of the rock. It consists of pyrite, a minor amount of chalcopyrite and a trace of hematite. The pyrite contains a few minute rounded inclusions of chalcopyrite and pyrrhotite.

20.7m specimen (pts 2986)

Light grey, highly altered porphyry crowded with phenocrysts and possibly amygdaloidal. Quartz is abundant, and certain patches have sub-regular ovoid forms suggesting formation by infilling of vesicles.

Feldspar phenocrysts may be distinguished, though they now consist of carbonate and clay very similar to the replaced groundmass. Some of the phenocrysts contain sericite. Likely orthoclase occurs in the groundmass where argillic replacement is incomplete. Mica phenocrysts are now interlaminated patches of carbonate and a likely clay mineral, with rare occurrences of muscovite. The quartz is in part a primary constituent of the groundmass, part present as the ovoid patches mentioned above, and part of secondary origin.

The rock contains some 1% of disseminated sulphide-pyrite with a little chalcopyrite. Pyrite occurs as minute grains thinly dispersed along the veinlets.

The rock is crossed by hairline calcite veinlets.

25.25m (pts 2987)

Grey porphyry containing zones of brown rock. The colour change is secondary but reflects the presence of lower phenocryst-contents in the brown rock. The rock contains reticulate veinlets of calcite and likely chlorite.

The groundmass is rich in medium-grained orthoclase and quartz (the latter being in part secondary). Set in this are feldspar and mica phenocrysts amounting to more than 50% of the rock. The feldspars are made over to carbonate and sericite material, itself partly replaced by patches of clay. The micas are made over to interlaminated patches of iron-stained carbonate, a colourless likely clay mineral, and trace amounts of muscovite.

Finely disseminated pyrite, hematite and a trace only of chalcopyrite form some 0.1% of the rock.

28.9m specimen (pts 2988)

Brown porphyry containing veinlets of carbonate (likely calcite). Phenocrysts amount to some 60% of the rock. Also present are a few ovoid patches of quartz, which may be amygdales.

Alteration has been moderate. Plagioclase phenocrysts close to An_{34} are part replaced by carbonate and sericite. Mica phenocrysts are replaced by interlaminated carbonate, likely clay and muscovite. The groundmass consists of orthoclase, quartz and carbonate granules. A few drawn out, irregular patches of clay have developed.

A few carbonate veinlets are present.

Ore amounts to about 0.3% of the rock. It consists of ragged patches of chalcopyrite, finely disseminated chalcopyrite and pyrite, and a trace of hematite/

goethite.

30.0m specimen (pts 2989)

Plagioclase-biotite-porphyry crowded with xenoliths of biotite-adamellite and biotite-micro-adamellite. This rock appears to have been granulitised to give a pseudo-sedimentary texture seen in certain parts of the specimen. Boundaries between this material and the normal igneous rock are well marked but not sharp.

Alteration is moderate. The plagioclases show all stages of replacement by carbonate and clay. The biotites show development of interlaminated opaque material and muscovite. Some groundmass has been replaced by clay material. Chlorite is a minor secondary constituent.

The rock contains disseminated pyrite and chalcopyrite in roughly equal amounts which together form some 0.2% of the rock.

34.0m specimen (pts 2990)

Feldspar-biotite-porphyry containing accessory apatite.

Alteration has formed carbonate and sericite replacements after plagioclase, themselves part made over to clay material. The biotite is part made over to carbonate and muscovite. The groundmass consists largely of orthoclase partly replaced by clay, carbonate granules, quartz and accessory prisms of albite (probably secondary).

Thin veinlets of carbonate are present.

In hand-specimen it is evident that the degree of argillic alteration varies widely.

The thin-section contains only an accessory amount of finely disseminated pyrite; and traces of oxide were observed.

63.5m (pts 3008)

Altered porphyry crossed by a 1cm wide zone of intense quartz veining. The hydrothermal veins contain minor amounts of calcite and a brown, fibrous, argillaceous mineral, but do not contain sulphide crystals.

The position of the zone of veining coincides with a change in the alteration of the porphyry. On one side the rock is a pink, sericitic type with minor though pervasive silicification. On the other side it is buff-coloured rock containing secondary kaolinite, sericite, muscovite and dolomite. The sericitic rock has disseminated pyrite and minor amounts of hematite and chalcopyrite. The argillaceous rock has finely disseminated chalcopyrite, and small patches made up of quartz, chalcopyrite, pyrite and molybdenite.

Crossing both rock-types and the quartz veins are barren veinlets of calcite.

As in the 76.05m and 94.74m specimens (see below) there appears to be a concurrence of copper mineralisation and argillaceous alteration. This may be misleading, in that the distributions of both may be controlled locally by the early-formed siliceous zones.

63.9m (pts 3009)

Buff coloured, altered porphyry similar to the argillaceous part of the 63.5m specimen. Bulk-XRD scanning of crushed rock confirmed the predominance of kaolinite over sericite and feldspar, an abundance of quartz, the presence of dolomite and the near absence of calcite.

Two sets of veinlets are present. Both consist of carbonate minerals. The earlier set contains opaque patches and small areas of fine, hydrothermal quartz. The later ones are barren.

Disseminated through the rock are abundant grains of pyrite with accessory amounts of chalcopyrite and arsenopyrite. Opaque patches in the veins are pyrite with small inclusions of arsenopyrite.

68.70m (pts 2999)

Feldspar-biotite-porphyry showing strong pervasive alteration. The plagioclase phenocrysts vary from being little altered to being entirely made over to kaolin + dolomite. Biotite phenocrysts are almost unaltered save for the presence of thin reaction rims of an unidentified mineral. The groundmass is fine, brown-tinted felsic material rich in kaolin, granules and crystals of dolomite, and opaque or semi-opaque granules. Also present are patches of secondary quartz often containing granules of chlorite and limonitic material. Discrete patches of chlorite occur in the groundmass, and often have angular forms suggesting formation by replacement of an amphibole.

In hand-specimen the groundmass is chocolate-brown. It is seen to be crossed by quartz veinlets and to contain small xenoliths of adamellite.

The opaque-mineral content is very low. Chalcopyrite and a trace of pyrite are finely disseminated but form less than 0.1% of the rock. Hematite occurs in a similar amount and in equally small grains.

74.10m (pts 3000)

Porphyry very similar to the 68.70m specimen. Argillaceous alteration is well developed, while the biotite phenocrysts are little affected. Secondary quartz occurs in patches and hairline veinlets. Veinlets of kaolin and dolomite are present, but no intersections between them were observed. Comparison with other specimens suggests a later origin for the carbonate (see Min. Unit. Rpt. 181).

Again, opaque minerals are very subordinate. Chalcopyrite occurs in excess of pyrite. The sulphide content is generally below 0.1%, though it is notably higher adjacent to the dolomite vein.

75.55m (pts 3001)

Strongly altered feldspar-biotite-porphyry in which the primary biotites have been made over to interlaminated pseudomorphs of sericite + carbonate + opaque granules. This apart, the rock shows argillaceous alteration similar to the preceding two specimens, but differing in containing calcite rather than dolomite. In hand-specimen the rock is grey rather than brown, and contains calcite veinlets.

Chalcopyrite occurs in excess of pyrite. Both are finely disseminated and together amount to some 0.1% of the rock (visual estimation).

76.05m (pts 3002, 3007)

Strongly altered feldspar-biotite-porphyry in which plagioclases are largely replaced by dolomite + kaolin and primary mica has been made over to sericitic pseudomorphs.

Two sets of mineral veins cross the specimen. The earlier ones are represented in thin-section by sub-parallel quartz veinlets which are restricted to a single zone within the specimen. These veins contain coarse growths of a colourless mineral considered likely to be one of the zoisite group of silicates, and isolated patches of a fine argillaceous mineral.

The later set consists of veinlets of white calcite which usually are at large angles to the quartz veins.

The siliceous parts of the rock are almost barren of sulphides. Elsewhere the sulphide-content is relatively high, and in certain minute pockets in the calcite veins the chalcopyrite content exceeds 50%. Sulphides occur disseminated and as grains and elongate or porous patches in calcite veins. Chalcopyrite is the dominant opaque mineral, and very minor amounts of bornite and molybdenite are also present. The overall sulphide content was not estimated in view of the specimen's inhomogeneity.

94.74m (pts 3004, pts 3005)

Feldspar-biotite-porphyry in which complex hydrothermal alteration is centred about a vein of quartz.

The host rock contains some 30% sub-idomorphic phenocrysts of intermediate plagioclase, some 10% phenocrysts of biotite and "hornblende", and a small number of rounded quartz phenocrysts.

The major alteration type is argillaceous. The more calcic parts of the plagioclases are replaced by a carbonate (likely dolomite) plus clay (likely kaolinite) assemblage. This replacement is mild in those parts of the rock remote from the vein, and becomes intense as the vein is approached. In the remote parts the biotites are unaffected, a feature seen in argillic alteration elsewhere at Kilmelford, but primary amphibole crystals have been completely replaced by a carbonate plus sericite or clay assemblage.

Close to the vein all primary mafic phenocrysts have been destroyed. Biotites are replaced by a carbonate plus sericite assemblage so that it is not possible to distinguish them from altered amphiboles.

The groundmass is medium-grained throughout. Close to the vein it is rich in carbonate granules.

The vein itself shows a hydrothermal texture of intimately intergrown quartz crystals. It is dilational in origin. At some points patches of brecciation of the country rock are seen, while at others small displacements of phenocrysts can be seen. Running along the vein are intermittent patches and lengths of clay and carbonate. These are believed to be of significantly later origin than the vein proper.

A number of thin subsidiary veinlets led off at a large angle from the main vein. These are filled with quartz and clay, and are considered to have formed when the main quartz vein formed, although their clay patches may be of later origin.

Opaque minerals occur in minor amounts. Minute irregular patches of chalcopyrite intergrown with bornite occur within the subsidiary veinlets and, to a lesser extent, as individual grains within the groundmass of the porphyry close to the main vein (which is itself barren). Hematite occurs as minute secondary grains in altered mafic phenocrysts, and associated with limonite and carbonate in small clusters within the groundmass of the porphyry.

The types of alteration appear to be present; an argillic type and an earlier sericitic type. The evidence for the latter type includes the biotite alteration close to the main vein and the presence of copper sulphides associated with vein formation. It is postulated that this alteration provided favourable pathways for fluids giving rise to the later argillic phase, thus producing overlap of the two types.

Green colouration of altered plagioclases is due to the presence of a chloritic clay mineral. This phenomenon is absent immediately adjacent to the main quartz vein owing to the higher proportion of carbonate to clay in altered plagioclases in this setting.

<u>103.0m (pts 3006)</u>

This specimen represents a part of the core found to contain 2280 ppm Cu (datum supplied by R Ellis; analysis by A & C Unit). It is a highly altered porphyry. Plagioclases have been largely made over to sericite + kaolin + carbonate, and primary opaque silicates have been replaced by sericite + stained carbonate + opaque granules pseudomorphs. The rock contains patches and veinlets of secondary quartz and is crossed by a dilational vein (0.6cm wide) of hydrothermal quartz. It has a grey colour when viewed in hand specimen.

An additional element in the alteration, not previously observed at Kilmelford, is the presence of secondary orthoclase. Coarse, yellowish, clouded crystals of orthoclase formed in association with relatively coarse crystals of carbonate are common. Their occurrences indicate formation by feldspar replacement, yet they also show a spatial association with the pervasive silicification.

Opaque grains are common. Chalcopyrite and pyrite occur along a hairline calcite vein formed within the main quartz vein. Chalcopyrite, molybdenite and a trace of bornite occur along the margins of the quratz vein and generally throughout the rock.

In this specimen potassic alteration occurs in conjunction with relatively high levels of Cu-Mo mineralisation.

108.33m (pts 3010)

Holocrystalline dolerite in which augite occurs as anhedral, granular crystals within a framework of labradorite laths. Small, serpentinised olivines are of accessory status only.

The rocks contains a few phenocrysts of labradorite and augite.

The abundant opaque granules are all magnetite save for a few pyrite grains. No ilmenite was observed.

126.20m (pts 3011)

Grey welded quartzite crossed by complex 'chlorite' + carbonate veins.

Three stages of vein formation may be distinguished. The earliest are thin quartz veinlets commonly seen as margins to the later veins, but also forming rare isolated veinlets. The second stage is expressed by the development of irregular veins in which stained calcite crystals set in green clay minerals (chlorite?). The third stage involves the formation of veinlets of clear calcite. These late carbonate veins are straight, cross-cutting bodies when set in the quartzite, but show a complex, irregular relationship to the calcite + clay material. It is suggested that in the second stage,fissure-infilling was incomplete so that irregular cavities remained to be exploited at the third stage to produce the complex relationships observed.

The host quartzite is made up of extremely irregular, interlocking, stained crystals whose identity is apparent only where they are seen to be in optical continuity with clear crystals in the early quartz veinlets. It contain isolated areas of calcite and a clay mineral.

Pyrite is very sparsely disseminated through the quartzite and occurs as minute specks and rare subhedral grains in the second-stage calcite + clay veins.

134.54m (pts 3012)

Orange porphyry showing sericitic alteration and an element of argillaceous alteration. Plagioclases are largely made over to sericite, carbonate (dolomite?) and kaolinite, only their most sodic rims being preserved. Primary mafic crystals are replaced by muscovite + carbonate pseudomorphs, many of which contain kaolinite formed after muscovite. The groundmass is fine-grained, felsic material rich in carbonate granules but not in secondary quartz.

The rock is crossed by a set of sub-parallel, barren hairline veinlets of quartz with rare carbonate grains. Also present, sub-parallel to the quartz veinlets, are carbonate veinlets. Although it is likely that the veinlets formed at two different times it is reasonable to view them as representing one broad phase of hydrothermal activity.

The opaque content of this rock is very low. Chalcopyrite accompanied by bornite is very sparsely disseminated. Also present are trace amounts of pyrite and hematite.

147.30m (pts 3013)

Altered light brown porphyry in which an argillaceous assemblage dominates earlier sericitic alteration. Plagioclases are completely made over to kaolinite + dolomite. Muscovite flakes appear in various stages of alteration to clay. The groundmass is fine, kaolinitic and rich in dolomite. Veinlets of dolomite are present.

The rock contains about 0.5% (visual estimate) of disseminated opaque grains. These are arsenopyrite with accessory amounts of chalcopyrite and pyrite.

148.75m (pts 3014)

Altered brecciated quartzite presumably representing an included slice of country rock. The fragments are mostly quartzite with a carbonate cement. Also present as coarse fragments are silt-grade siliceous hornfels, argillaceous rock, vein quartz and coarse carbonate crystals. Fragments form about a half of the rock. They are set in a comminuted matrix of sericite and carbonate with fine argillaceous bands and frequent quartz grains. It is doubtful if any truly magmatic material is present.

Disseminated pyrite accompanied by minor amounts of chalcopyrite and arsenopyrite form more than 1% of the rock (visual estimate).

163.7m (pts 3015)

Porphyry in which an argillaceous kaolinite + dolomite assemblage overprints an earlier sericitic alteration. Bulk-XRD scanning of crushed rock showed, "Major quartz with mica, kaolinite and dolomite, possible also a trace of feldspar". The groundmass is fine-grained, felsic material with sericitė, dolomite and opaque grains.

Disseminated through the rock are arsenopyrite and a trace of pyrite.

164.80m (pts 3016)

Altered orange porphyry in which primary mafic grains have been replaced by interlaminated pseudomorphs of muscovite + carbonate (calcite?) + sphene, while feldspar alteration has produced patchy developments of kaolinite. The groundmass is rich in grains and hairlines of carbonate (dolomite?) but is not silicified to any large extent.

Opaques are very minor, pyrite and a trace of hematite being the only opaque minerals present.

This rock is unusual in combining kaolinitic plagioclase alteration and secondary muscovite after biotite.

177.80m (pts 3017)

Phyllic alteration of porphyry in which plagioclase has been made over to fine sericite with goethite and stained carbonate granules. Primary biotite is pseudomorphed by muscovite + calcite + sphene. The fèlsic groundmass contains sericite and opaque granules but very little carbonate.

Veining is absent save for limonitic hairline fissures.

Finely disseminated are a very small amount of pyrite and a trace of chalcopyrite.

178.30 (pts 3018)

Phyllic alteration of porphyry very similar to the 177.8m specimen. Bulk-XRD scanning of crushed rock showed, "Major quartz with mica and calcite, lesser kaolinite and dolomite, possibly a trace of feldspar". The "mica" includes sericite and muscovite. Optical examination revealed secondary silicification of the groundmass, but failed to detect the presence of kaolinite or dolomite.

The rock is crossed by vein-like zones of comminuted porphyry. These are sharply defined, and at some points it can be seen that minor displacements have occurred on them. The comminuted material is sericitic and contains veinlike segregations of secondary quartz.

A minor amount of disseminated pyrite is present.

180.30m (pts 3019)

Porphyritic crinanite consisting largely of labradorite, titanaugite, magnetite and a strongly coloured chlorite formed by breakdown of an alkaline amphibole. Also present are andesine (as rims to labradorite laths), interstitial analcite, accessory pyrite, apatite abundantly present as acicular crystals, a zeolite identified as natrolite or thomsonite (XRD, Ph. 5564) present as amygdales, and a trace of likely pyrophyllite formed in association with the zeolite. The presence of only a minor amount of analcite dictates that the rock is a crinanite rather than a teschenite.

Additional specimens

Two additional specimens were examined briefly.

The first, from 116.8m, was submitted for identification of a clear, gypsum-like, vein mineral. XRD identification (Ph. 5554) showed it to be, "Quartz + di-octahedral kaolinite mineral, likely dickite". No further work was carried out.

The second, from 120.4m, contained soft, white veins which again proved to be, "Di-octahedral kaolinite mineral, likely dickite" (Ph. 5555). Bulk-XRD scanning of the altered porphyry containing these veins showed it consist mostly of, "Major quartz with kaolinite, lesser dolomite and feldspar with calcite and a trace of mica". No further work was carried out.

APPENDIX III Part III

Bulk analyses by X-ray diffractometry of six core-specimens from BH1

The samples were ground to pass 120 mesh and examined as 'random' mounts, using Ni-filtered cu K radiation and scanning the angular range 2^{o}-40^{o} 2θ. Quartz was found to be the dominant constituent, being accompanied by variable amounts of mica, kaolinite, feldspar, dolomite and calcite. The d-spacing of the (104) dolomite reflection in two sample (68.7m and 74.7m) suggests there may be some degree of iron substitution.

Peak heights of the diagnostic reflection from each mineral are given in the table below. These values may be used to compare ratios of particular mineral pairs from sample to sample.

Sample depth (m)	quartz (101)	mica (002)	kaolinite (001)	feldspar (002)	calcite (104)	dolomite (104)
63.9	O/S	9	40	10	nd	28
68.7	O/S	26	25	24	nd	23
74.7	O/S	27	20	32	nd	21
120.4	O/S	tr	40	18	5	34
163.6	O/S	24	29	tr	nd	48
178.3	O/S	30	8	tr	32	9

O/S = peak off scale. nd = not detected. tr = trace

APPENDIX III Part IV

Mineralogy of rock-specimens from BH2

5.30m (ts 3580)

Biotite-quartz-diorite showing only minor alteration. Partial to complete alteration of biotite to calcite + chlorite is prevalent, but plagioclase alteration is restricted to minor developments of calcite and sericite. The quartz content is visually estimated to be 1.5%.

The specimen is crossed by a quartz veinlet bordered by a pink sericitised zone. Pyrite occurs in the vein and the sericitic zone, but not elsewhere.

15.90m (pts 3043)

An unusual rock in that although many areas of fine to medium grained groundmass are present the greater part of the rock has a coarse grained plutonic texture. No simple distribution of these textural types is present. It seems best to regard this rock as a porphyry crowded with fragments of granodiorite, an impression supported by observation of a cut rock surface.

Strong sericitic alteration is present, with secondary muscovite and quartz present, although primary biotite and plagioclase are common. Disseminated pyrite forms 5.4% of the thin-section (pt. counting).

27.45m (pts 3027, 3028)

Biotite-quartz-diorite showing calcite + chlorite + sericite alteration. Disseminated pyrite forms 0.7% and chalcopyrite 0.2% (point counting). The rock is crossed by a pink, parallel-sided vein of medium grained granopyre (quartz + orthoclase + minor albite) with accessory pyrite and rare patches of calcite + sericite.

This propylitic diorite is altered over 1.5cm to a pink rock showing strong sericite + muscovite + carbonate alteration. The pink rock is crossed by two sets of dolomitic veins. The earlier ones consist of granules of dolomite enclosed poikilitically in quartz crystals. The later veins consist of coarse dolomite with opaque patches and minor amounts of quartz and calcite. Pyrite occurs disseminated and in both sets of veins, and forms 4.2% of the rock (point counting). Chalcopyrite and bornite form 0.2% of the rock.

It is important to note that in both parts of this specimen the primary rock is a coarse quartzose dioritic rock.

31.45m (pts 3029)

Dark grey biotite-quartz-diorite in which much of the primary mica has been replaced by a dolomitic carbonate and secondary biotite. The secondary mica is a green variety forming sugary textured areas. Other alteration products include small amounts of quartz and kaolinite.

The rock contains a reticulate network of barren white dolomite[1] veins. Also present are hairline veinlets of pyrite + dolomite apparently coeval with the barren veins, and late formed hairline veinlets of calcite.

Some 1.5% (visual estimate) of pyrite + chalcopyrite occur disseminated. Dark laminae noted in hand-specimen (see core-log sheets) appear to be thin zones in which minute opaque granules (not specifically identified) are abundantly developed in dolomite.

32.45m (pts 3030)

Dark granodioritic rock with pink sericitic zone.

The dark rock is a true granodiorite with appreciable amounts of orthoclase and quartz. The plagioclase is much replaced by dolomite + kaolinite. Biotite is common, but exists as porous crystals enclosing minute laths of quartz (or albite). The pink rock lacks biotite but contains pseudomorphs of muscovite + carbonate. Plagioclase is altered to sericite + kaolinite + dolomite. Areas of fine-grained 'matrix' are present, but the rock is not a true porphyry. Orthoclase is prominent, and the rock is probably adamellite.

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[1]In most cases 'dolomite' identifications are based upon sluggish reactions to 10% HCl where a carbonate is known to be present.

The colour change noted in hand-specimen is largely due to the change to a more sericitic type of alteration.

Quartz + dolomite veinlets with opaque patches are common. Later formed calcite hairline veinlets are also present. Pyrite and minor amounts of chalcopyrite and bornite form some 1.5% (visual estimate). They occur as disseminated grains associated with mica alteration and as small patches in the veins.

38.35m (pts 3031)

Biotite-granodiorite showing sharp variations in types of alteration. The dominant rock is a pink sericitic type with appreciable amounts of dolomite and muscovite and containing a higher content of sulphide than the second alteration type. The latter alteration is kaolinite + dolomite development which leaves primary biotite little affected. This alteration forms 'islands' having the initial appearance of xenoliths.

The rock is crossed by a 5mm width barren vein of dolomite. Of earlier formation are dolomite veinlets and pools genetically associated with sulphide development during a period of pervasive fracturing of the rock. Also present are late formed hairline veinlets of calcite.

Point counting shows that sulphide levels are pyrite 0.6% and chalcopyrite 0.5% in some parts of the rock. However, sulphide segregations are visible in hand-specimen, and it is likely that the overall sulphide levels are somewhat higher.

40.90m (pts 3032, 3033)

Brecciation and veining in intensely altered dacitic rock. The alteration has developed much kaolinite, sericite, quartz and dolomite. Biotite, muscovite and chlorite are absent. Coarse primary quartz and orthoclase grains are present. In addition, the rock contains areas of medium grained 'groundmass' and it does not seem to be possible to give a definitive name to the primary rock type.

This rock is crossed by a zone in which it is brecciated and set as fragments in a matrix of finegrained quartz and carbonate. Also present are small pools of clear dolomite connected in places in a vein-like fashion.

The brecciated zone is crossed by a 7mm barren vein of dolomite containing isolated crystals of calcite. This vein has intermittently developed selvages of quartz often accompanied by pyrite and a minor amount of chalcopyrite. These sulphides also occur disseminated. Point counting showed levels close to the vein to be 1.8% pyrite and 0.1% chalcopyrite. About 1cm from the vein, levels had changed to 0.7% pyrite and 0.4% chalcopyrite. Further away the levels fall to very low values.

49.35m (pts 3034)

Intensely altered felsitic rock. Sericitised fragments of microdioritic rock, sericitised individual feldspars and irregular quartz crystals occur in a fine, dark stained groundmass probably rich in kaolinite or sericite. The rock may be a porphyry.

Rare sulphide-bearing quartz veinlets occur, but the major set are barren white calcite veins.

A minor amount pyrite and a trace of chalcopyrite are disseminated and developed on quartz veinlets.

49.64m (pts 3035)

Granodiorite showing strong argillic alteration and associated development of dolomite veinlets. Pyrite and a minor amount of chalcopyrite form some 2% of the rock, as disseminated grains and developed on early formed quartz veinlets.

51.15m (pts 3036)

Granodiorite showing argillic alteration with a minor amount of sericite. Green spots visible in hand-specimen are composed largely of dolomite and sericite.

A minor amount of pyrite and a trace of chalcopyrite occur disseminated and on quartz hairline veinlets.

55.0m (pts 3037)

Granodiorite showing sericitic alteration with dolomite, secondary quartz and a minor amount of kaolinite. Veinlets of dolomite + sericite and quartz + sericite contain clusters of sulphide grains. Pyrite and a very minor amount of chalcopyrite occur disseminated and in the veinlets, and amount to some 4% of the rock.

57.9m (pts 3038)

Granodiorite showing minor chlorite + sericite alteration. The rock is crossed by quartz veins bordered by thin potassic zones in which orthoclase is conspicuous. The occurrence of sulphides is continued to the veins and their borders, and consists of chalcopyrite, pyrite and a trace of likely chalcocite, often in vein-like segregations.

61.60m (ts 3581)

Monzonitic quartz-diorite showing minor alteration to chlorite and calcite, and crossed by veinlets of quartz with pyrite and chlorite, and a calcite with chlorite. Primary orthoclase occurs in distinct clots rather than evenly through the rock.

61.95m (ts 3582)

Biotite-granodiorite containing more quartz and biotite than the 61.60m specimen, but less hornblende. Moderate plagioclase alteration to sericite, kaolin and carbonate, and replacement of mafic crystals by chlorite and calcite are present. Quartz veins with minor calcite and pyrite are common.

71.70m (pts 3039)

A tongue of silicified, argillised adamellite set in granodiorite rich in secondary chlorite, carbonate, sericite and kaolinite. The host granodiorite has developed a pink zone adjacent to the tongue. In thin-section this zone appears to be one of intense development of stained clay, carbonate and chlorite by replacement of feldspar and mica.

The rock is crossed by a veinlet of quartz with dolomite, pyrite and chalcopyrite. Pyrite also occurs disseminated through the rock.

76.05m (pts 3040)

Granodiorite showing pervasive sericitic alteration and the development of orthoclase adjacent to quartz veinlets. Dolomite is disseminated through the rock, together with pyrite and chalcopyrite. These sulphides, accompanied by molybdenite, occur also along the veinlets. The total sulphide content is of the order of 3.5%.

77.06m (pts 3041)

Adamellite with abundant secondary kaolinite, sericite, muscovite, dolomite and oxide granules. Xenolithic areas of sericite, quartz, dolomite and opaque granules are common.

An estimated 1% pyrite and 0.5% chalcopyrite are disseminated through the rock.

79.68m (pts 3042)

Granodioritic rock showing sericitic alteration with minor kaolinite and silicification. Disseminated pyrite is the only sulphide present, and forms 9.7% of the rock (point counting).

96.71m (pts 3026)

Fragments of coarse grained plutonic rock set in biotite-feldspar-porphyry. The porphyry shows moderate alteration to chlorite, sericite, dolomite and kaolinite. The xenolith encountered in the thin-section consists of altered plagioclases and biotites poikilitically enclosed in a large crystal of likely orthoclase.

Some 8% of pyrite and a trace of chalcopyrite occur disseminated.

109.0m (pts 3044)

Granodiorite showing sericitic alteration with abundant dolomite. Pyrite and a very minor amount of chalcopyrite form some 8% of the specimen.

135.60m (pts 3049)

Porphyry showing intense alteration to sericite, kaolinite, muscovite and dolomitic carbonate. Albite and rare quartz phenocrysts are conspicuous. Sulphides occur as sparsely disseminated grains and patches, and as veins set in planar zones of carbonate. In both modes the sulphide consists of pyrite and arsenopyrite in roughly equal amounts.

136.34m (ts 3583)

Porphyry showing intense sericite, muscovite, kaolinite and major dolomite alteration. Accessory apatite, zircon and rutile are present. No veining is present and the sulphide content is very low. In hand specimen isolated grains of pyrite may be observed. Material provisionally identified as sphalerite in the field is considered likely to be pyrite following examination under a stereoscopic microscope.

169.86m (pts 3050)

Porphyry showing intense alteration to sericite, muscovite, kaolinite, quartz and abundant dolomite. Minor amounts of pyrite and chalcopyrite occur unevenly disseminated through the rock.

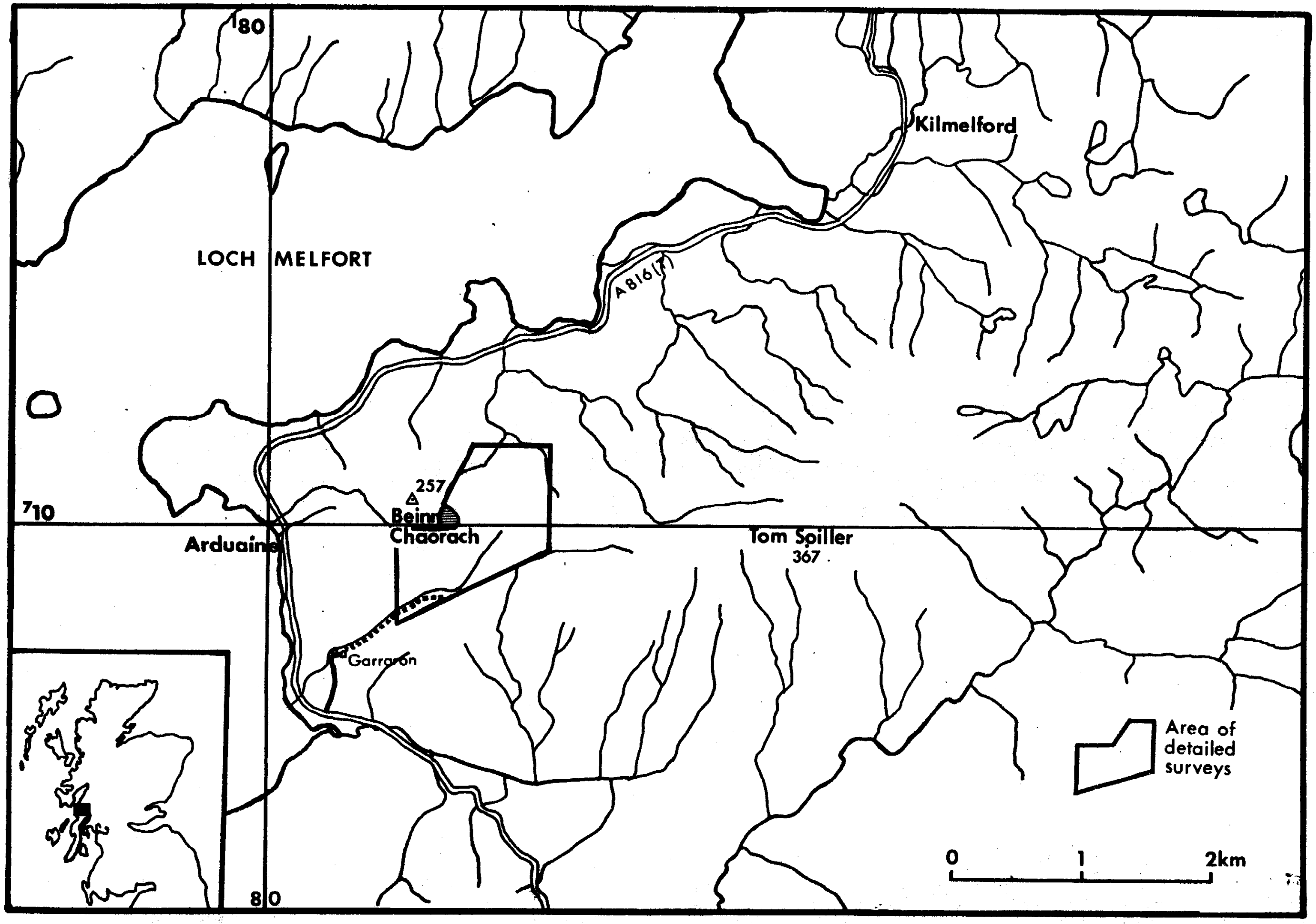


Fig. 1 Locality map

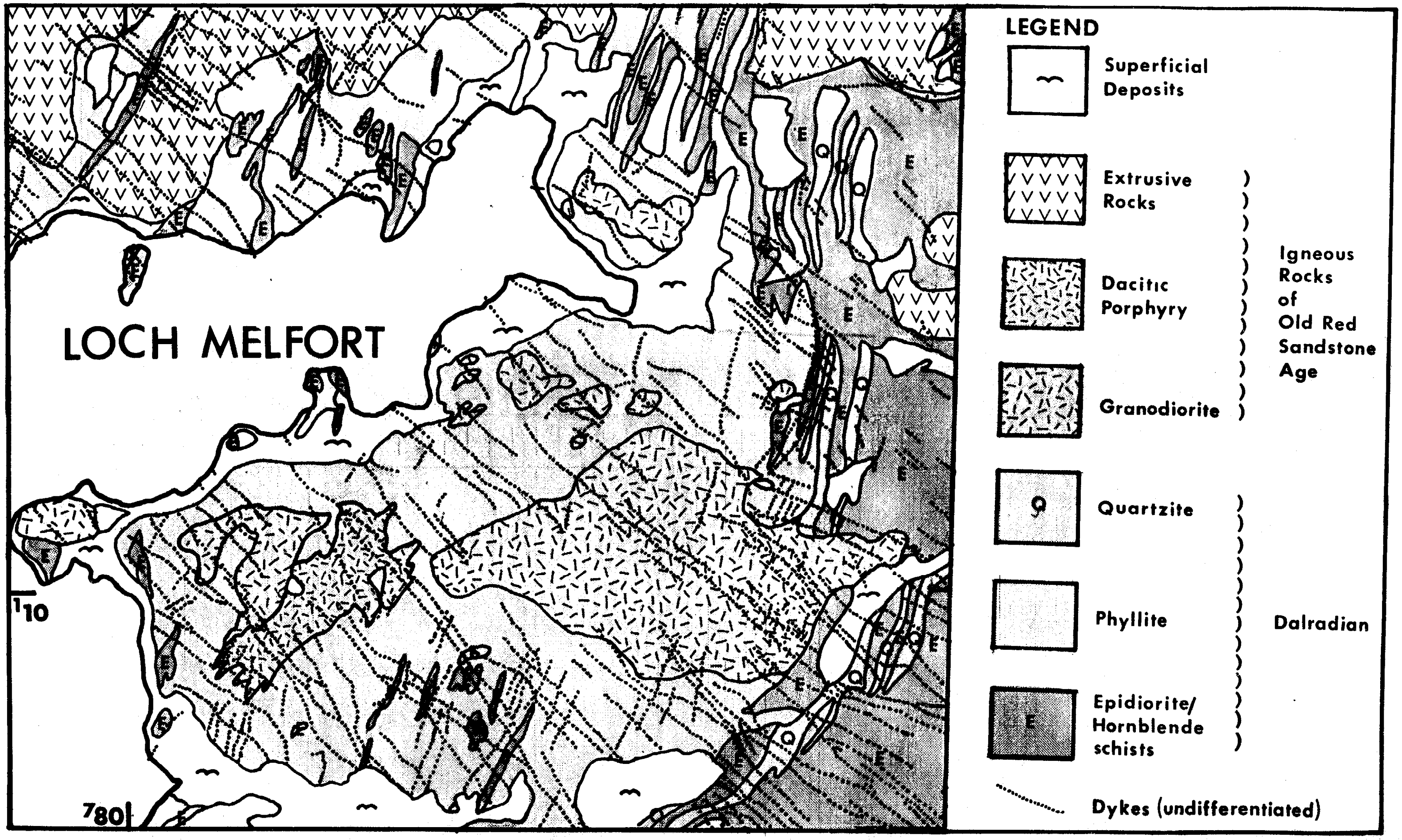


Fig. 2 Geology of Kilmelford area, Argyllshire

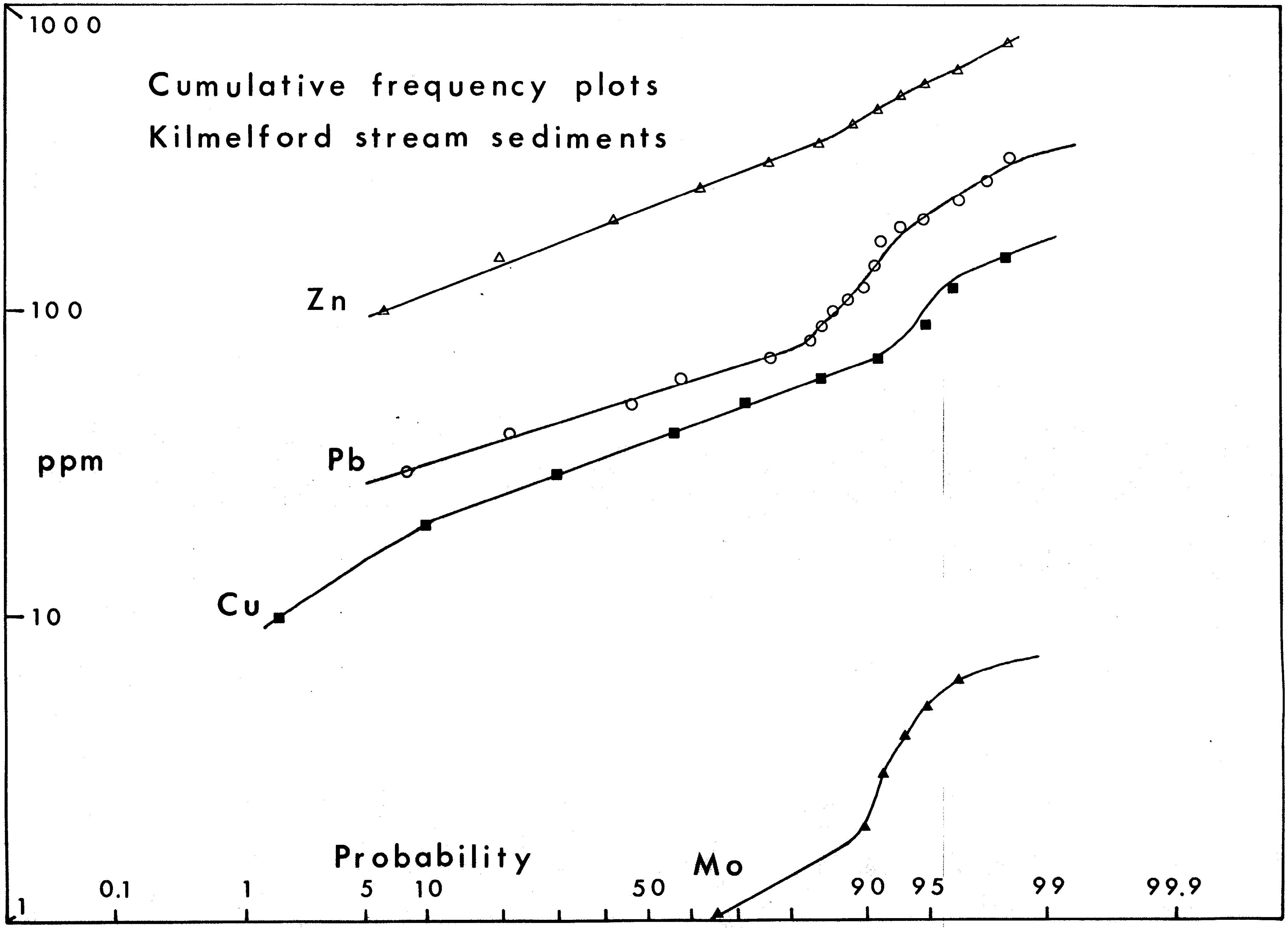


Fig. 3 Cumulative frequency plots for Cu, Pb, Zn, Mo, in stream sediments

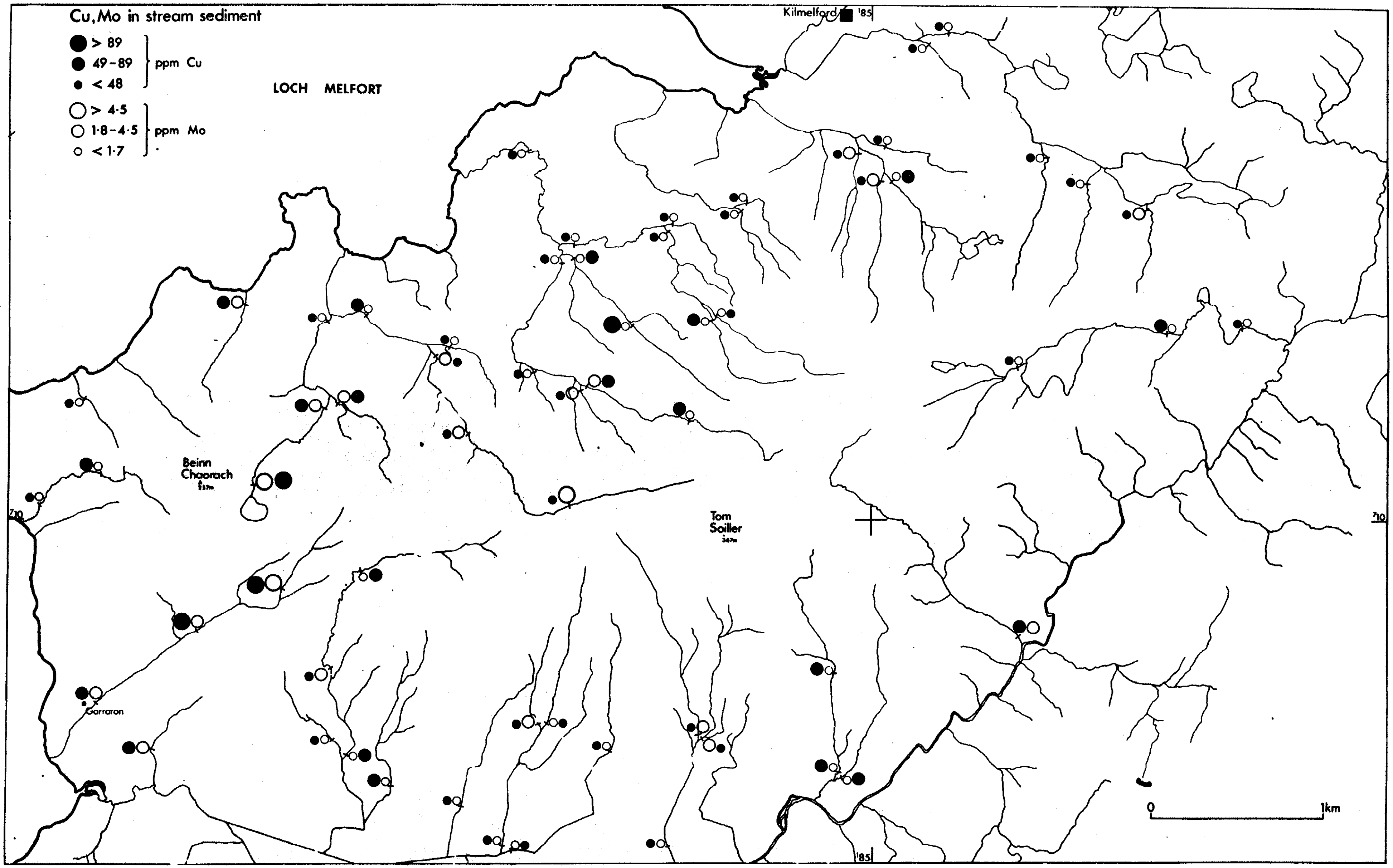


Fig. 4 Distribution map for Cu, Mo, in stream sediment samples

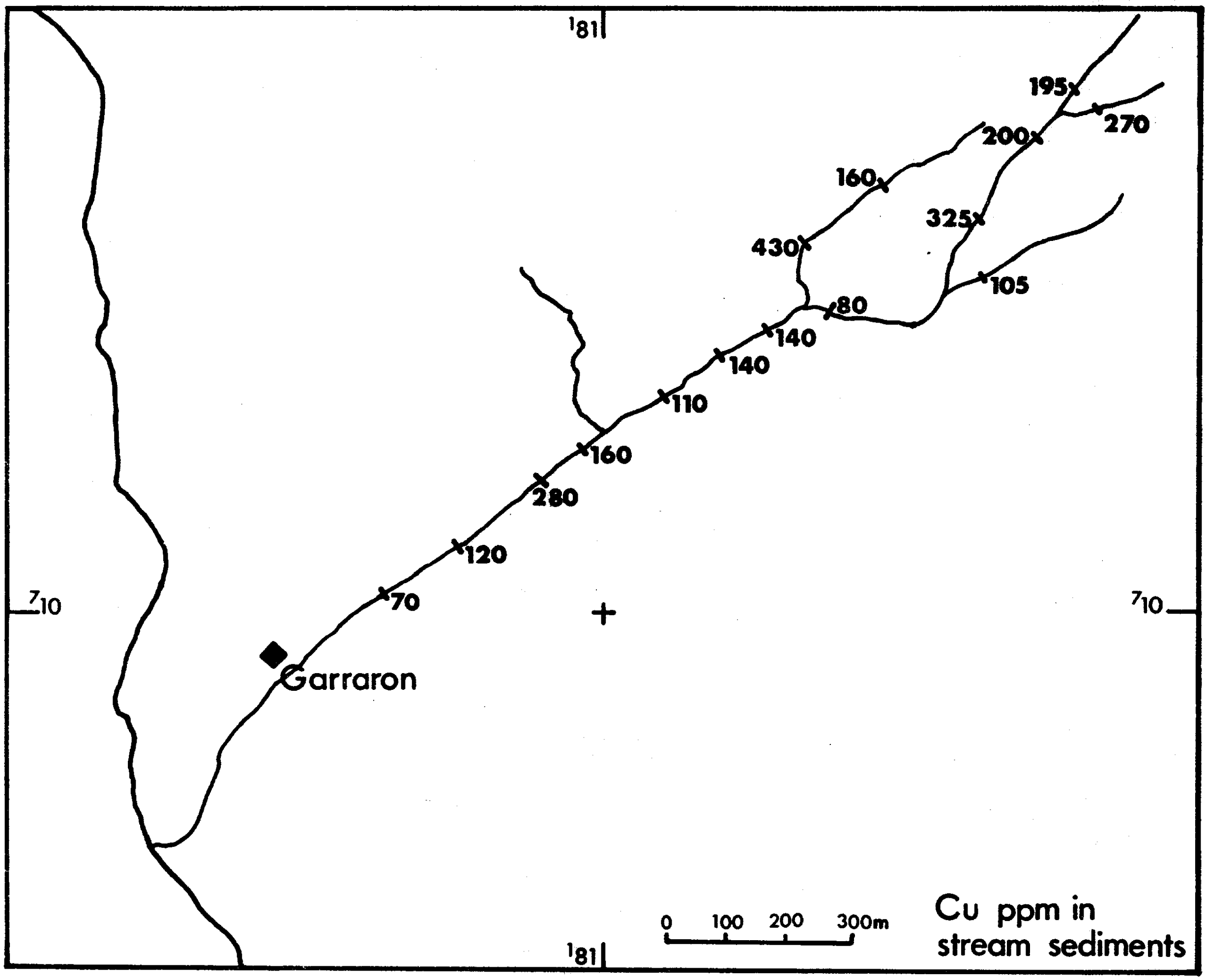


Fig. 5a Map of Cu in sediment samples - Garraron stream

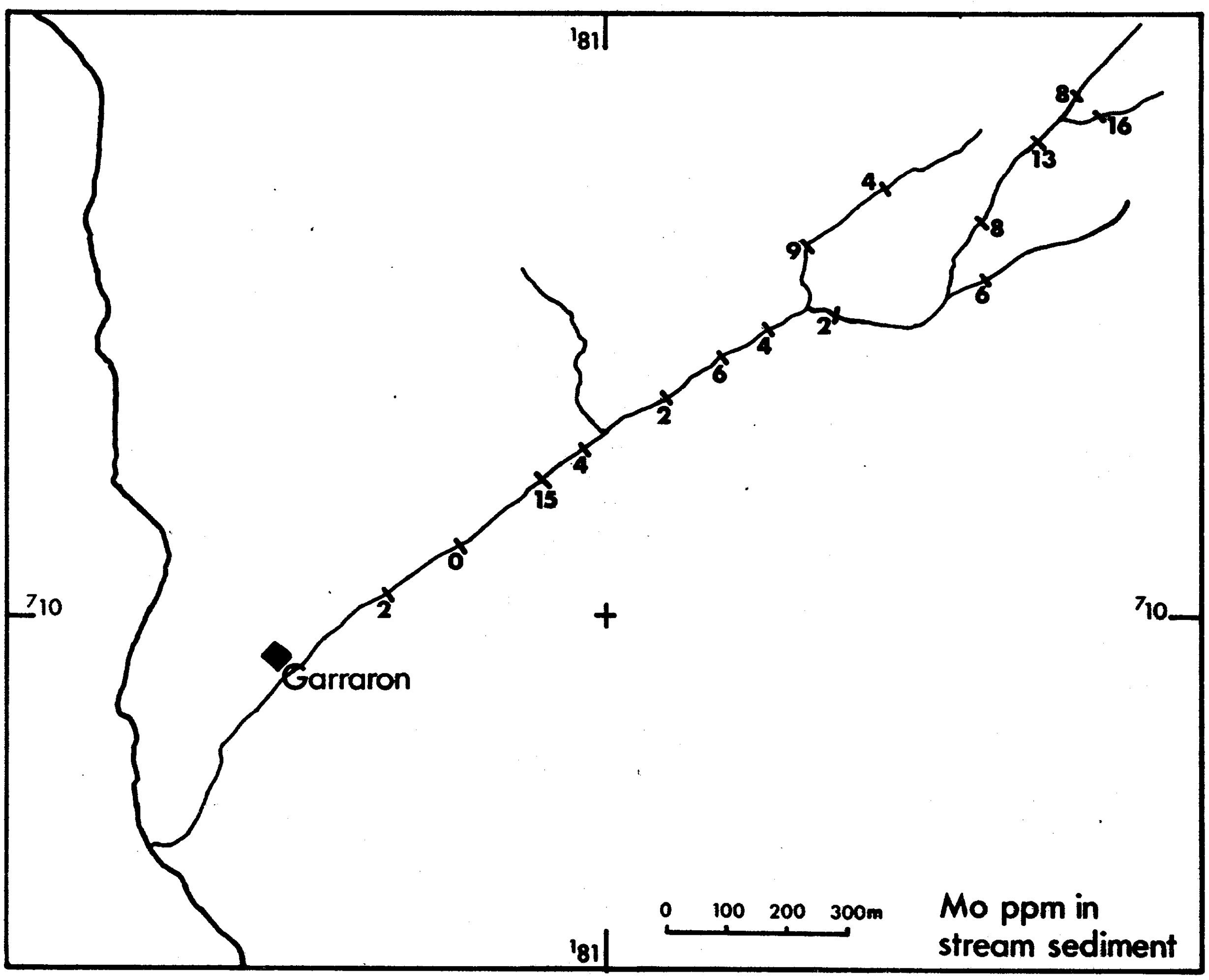


Fig. 5b Map of Mo in sediment samples - Garraron stream

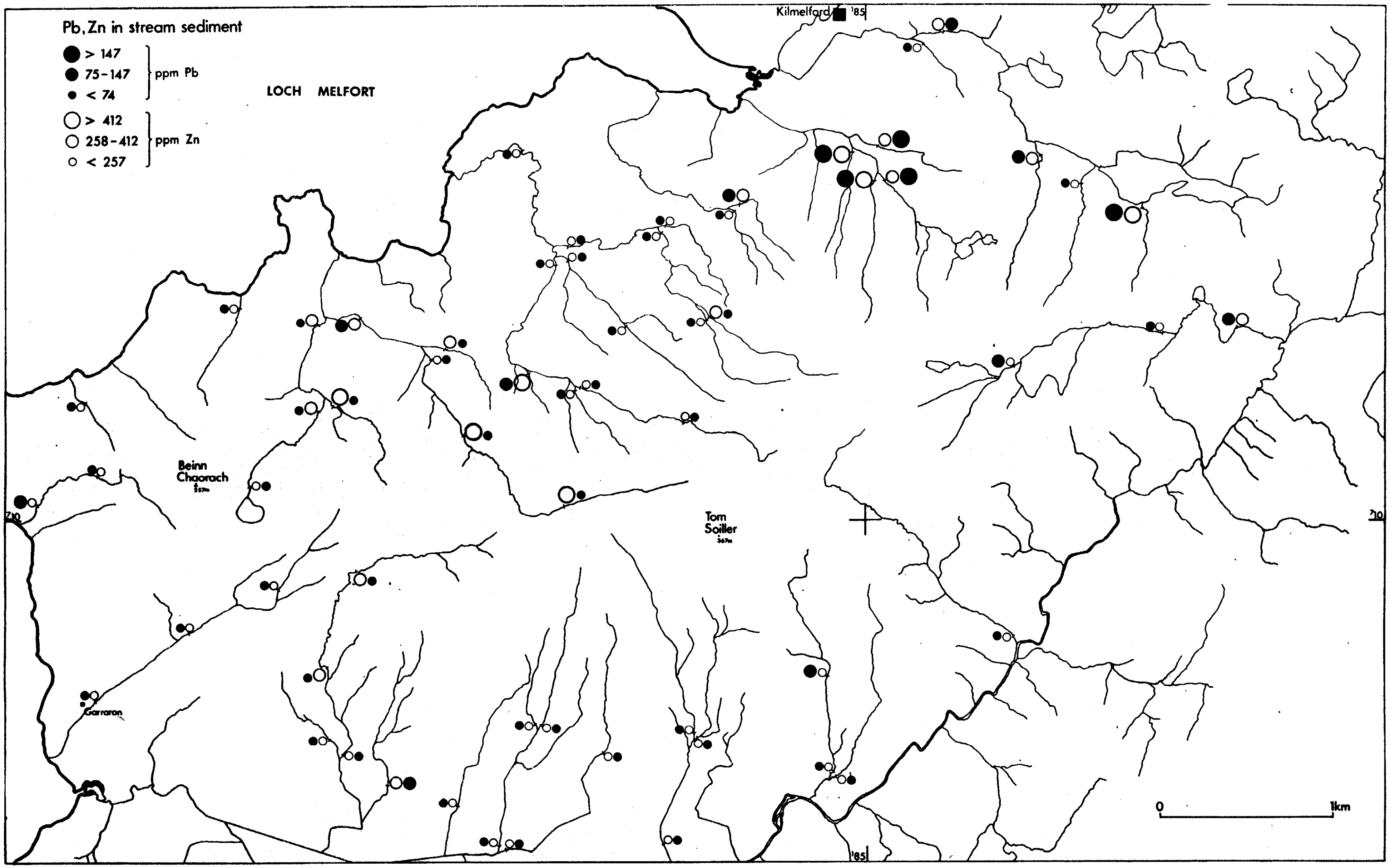


Fig. 6 Distribution map for Pb, Zn in stream sediment samples

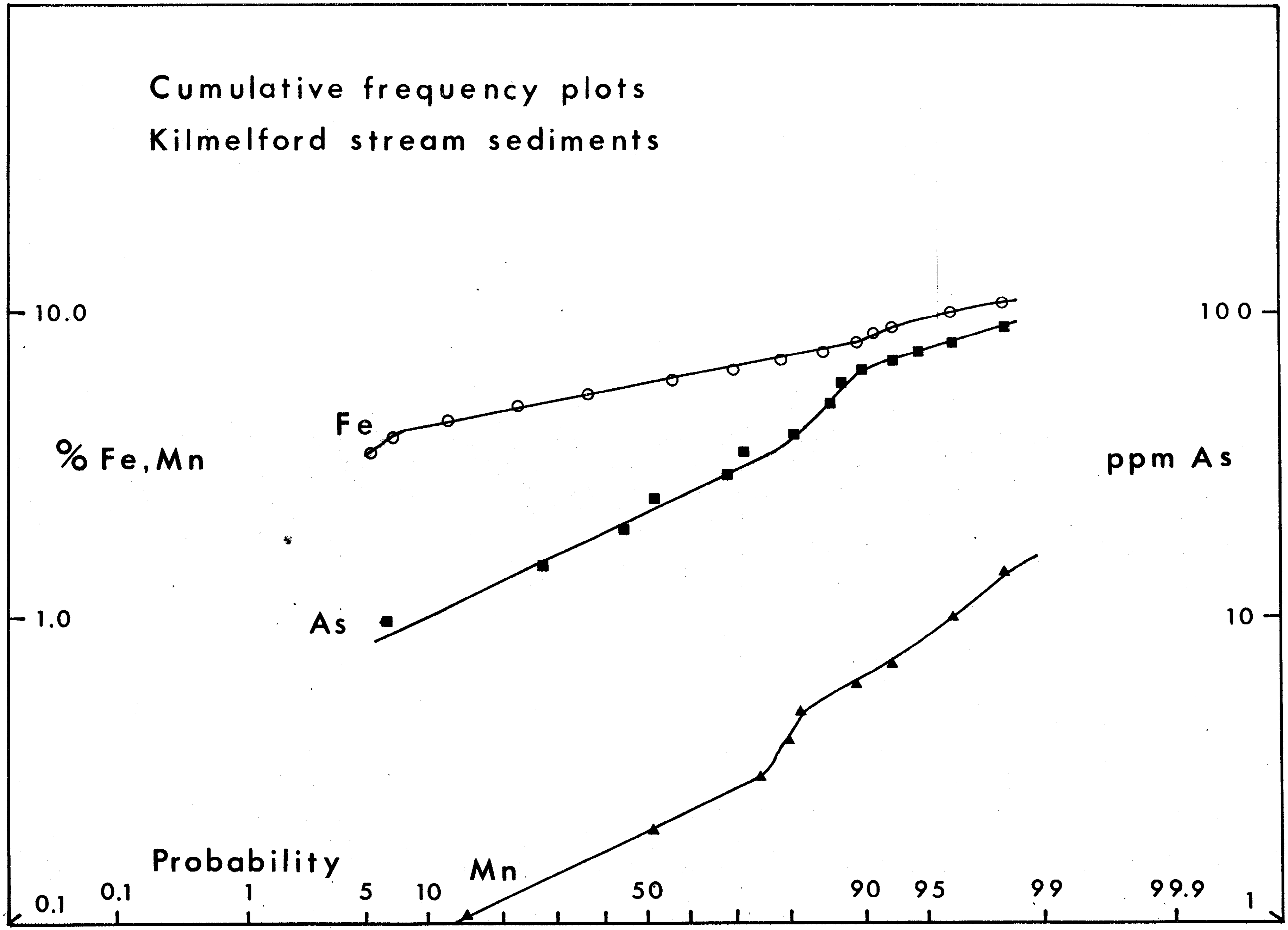


Fig. 7 Cumulative frequency plots for Fe, As, Mn in stream sediment samples

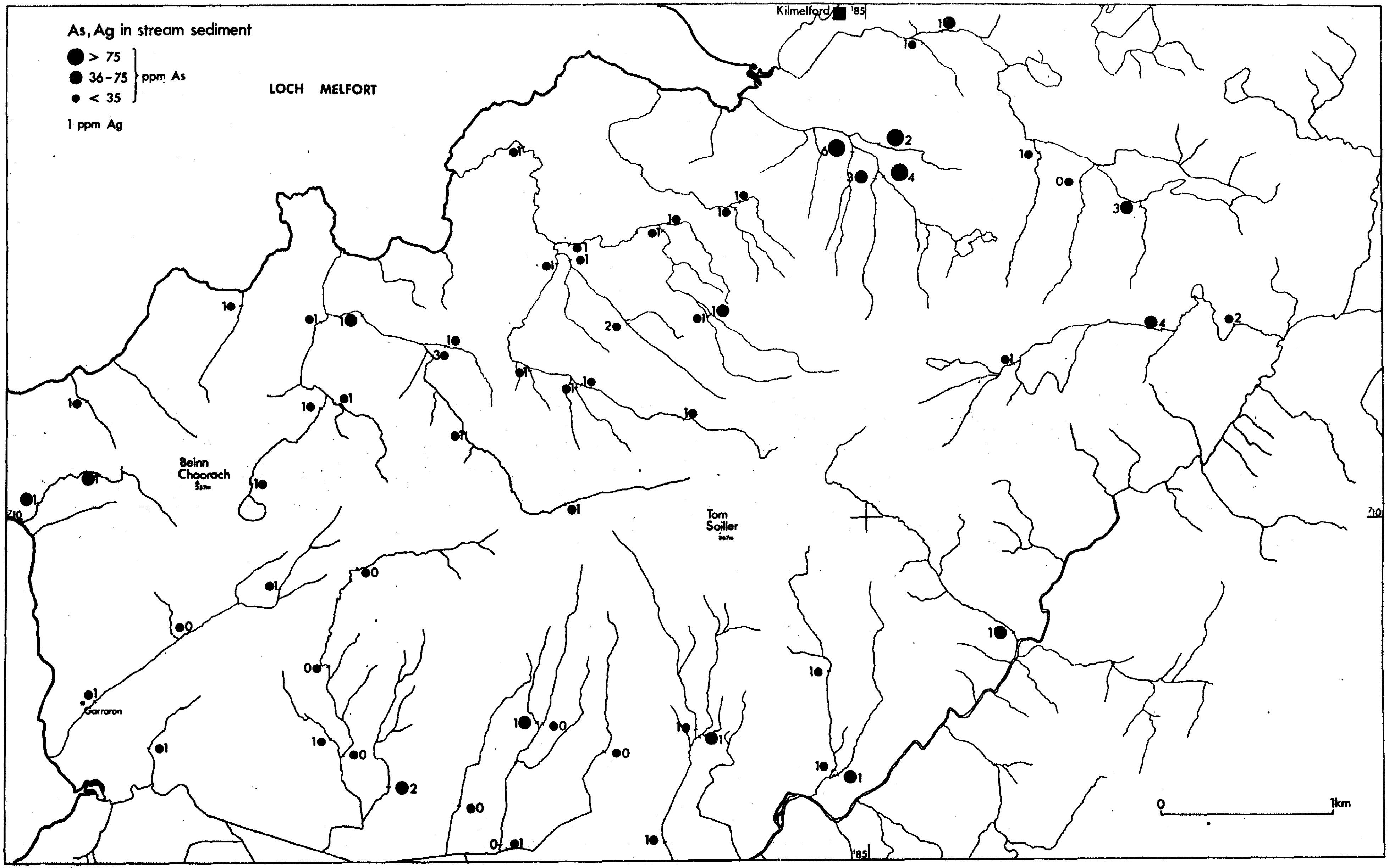


Fig. 8 Distribution map for Ag, As in stream sediment samples

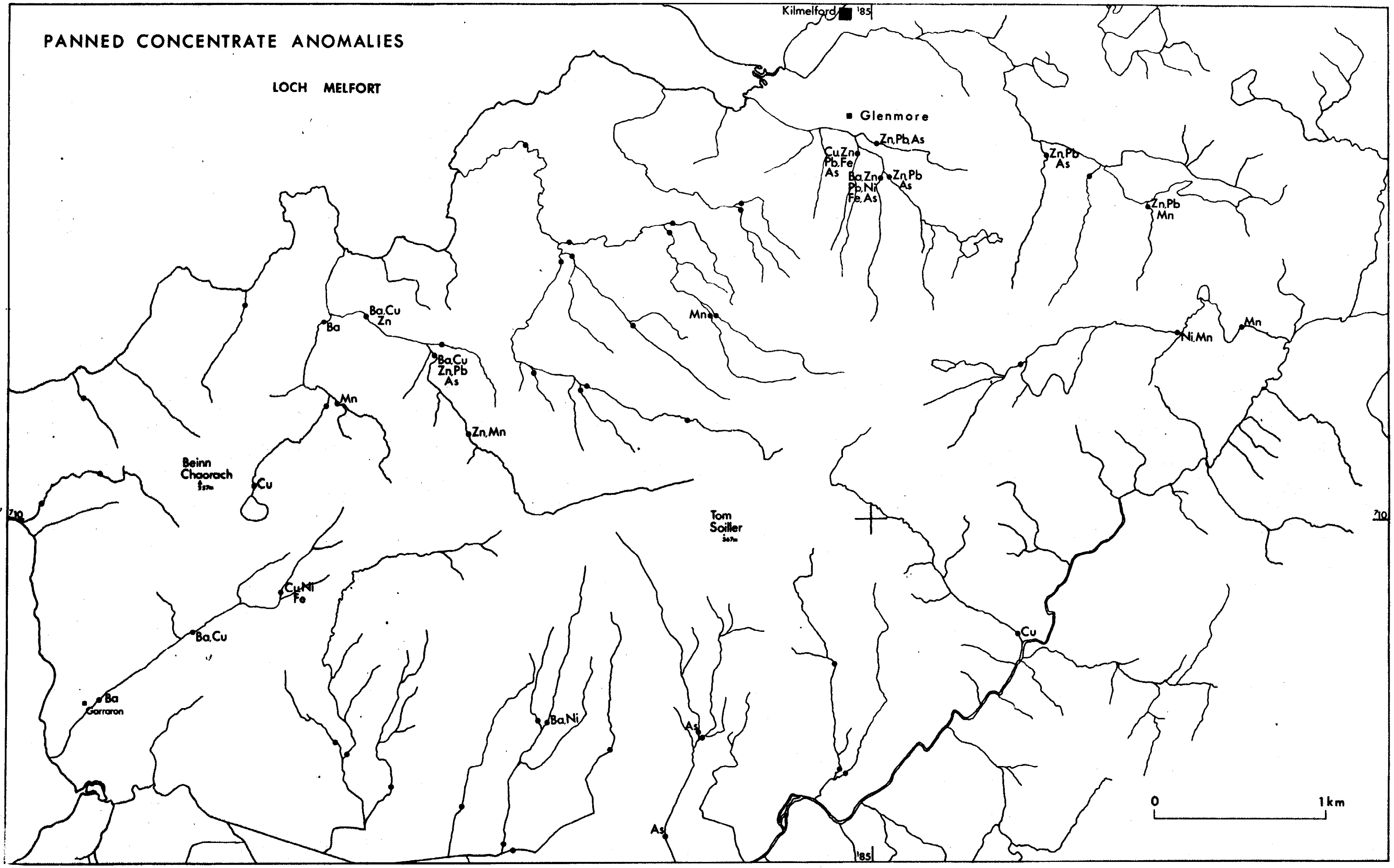
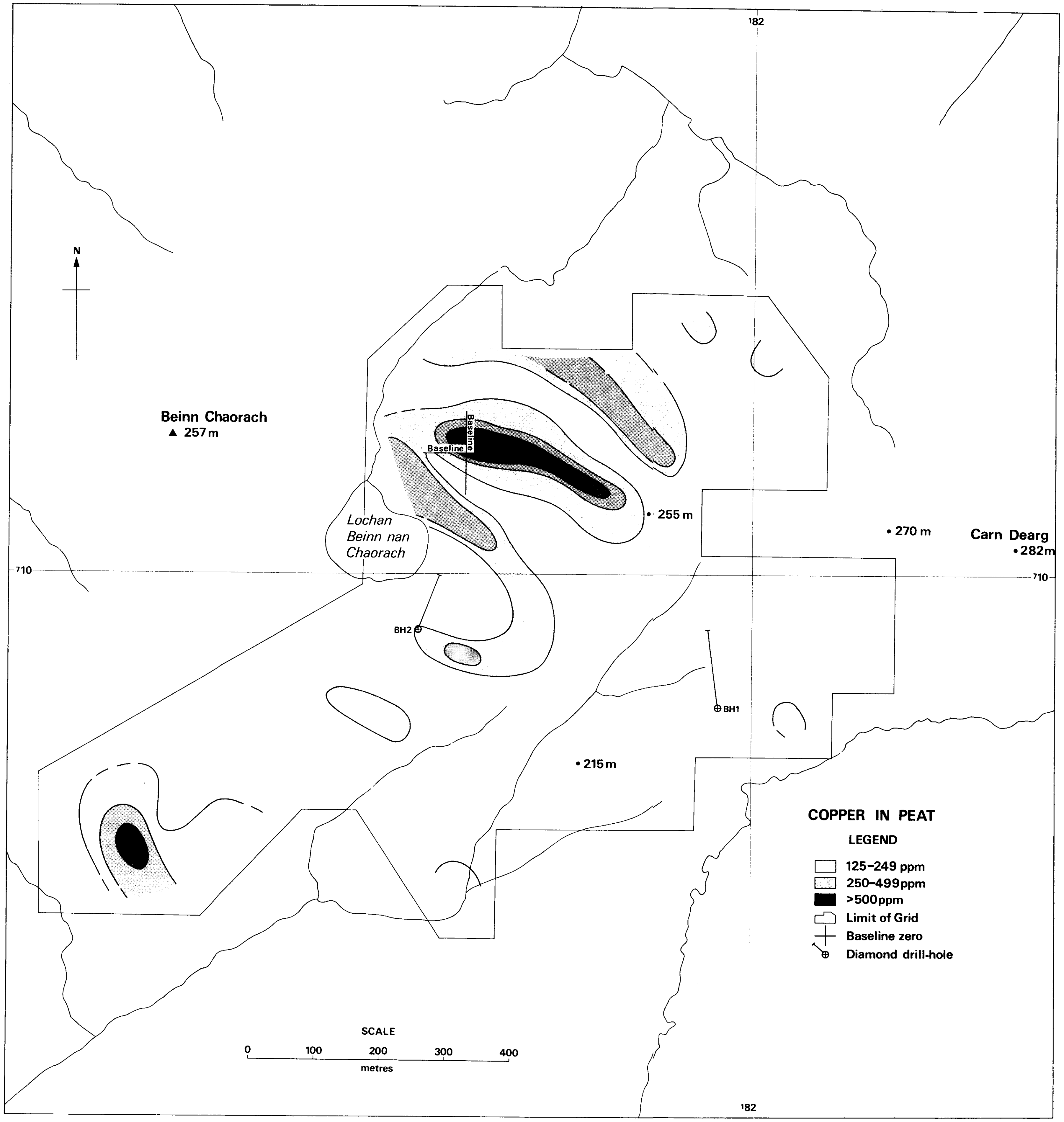
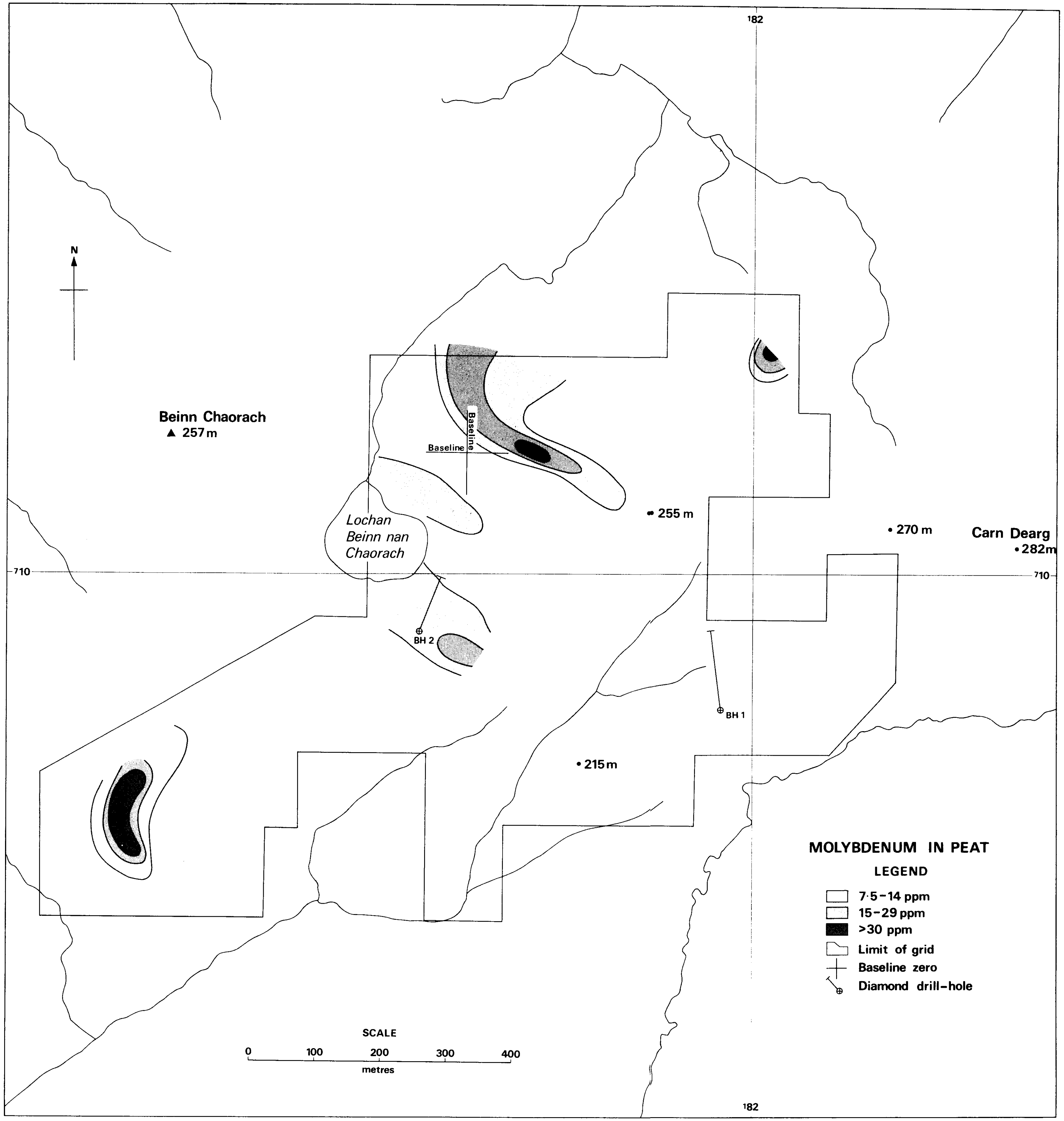


Fig. 9 Map of anomalous panned concentrate samples


182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
• 255 m
• 270 m
Carn Dearg
• 282m
Lochan
Beinn nan
Chaorach
710
710
BH2
BH1
• 215m
COPPER IN PEAT
LEGEND
125–249 ppm
250–499ppm
>500ppm
Limit of Grid
Baseline zero
Diamond drill-hole
SCALE
0
100
200
300
400
metres
182


182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
Lochan
Beinn nan
Chaorach
• 255 m
• 270 m
Carn Dearg
• 282m
710
710
BH 2
BH 1
• 215m
MOLYBDENUM IN PEAT
LEGEND
7·5–14 ppm
15–29 ppm
>30 ppm
Limit of grid
Baseline zero
Diamond drill-hole
SCALE
0
100
200
300
400
metres
182

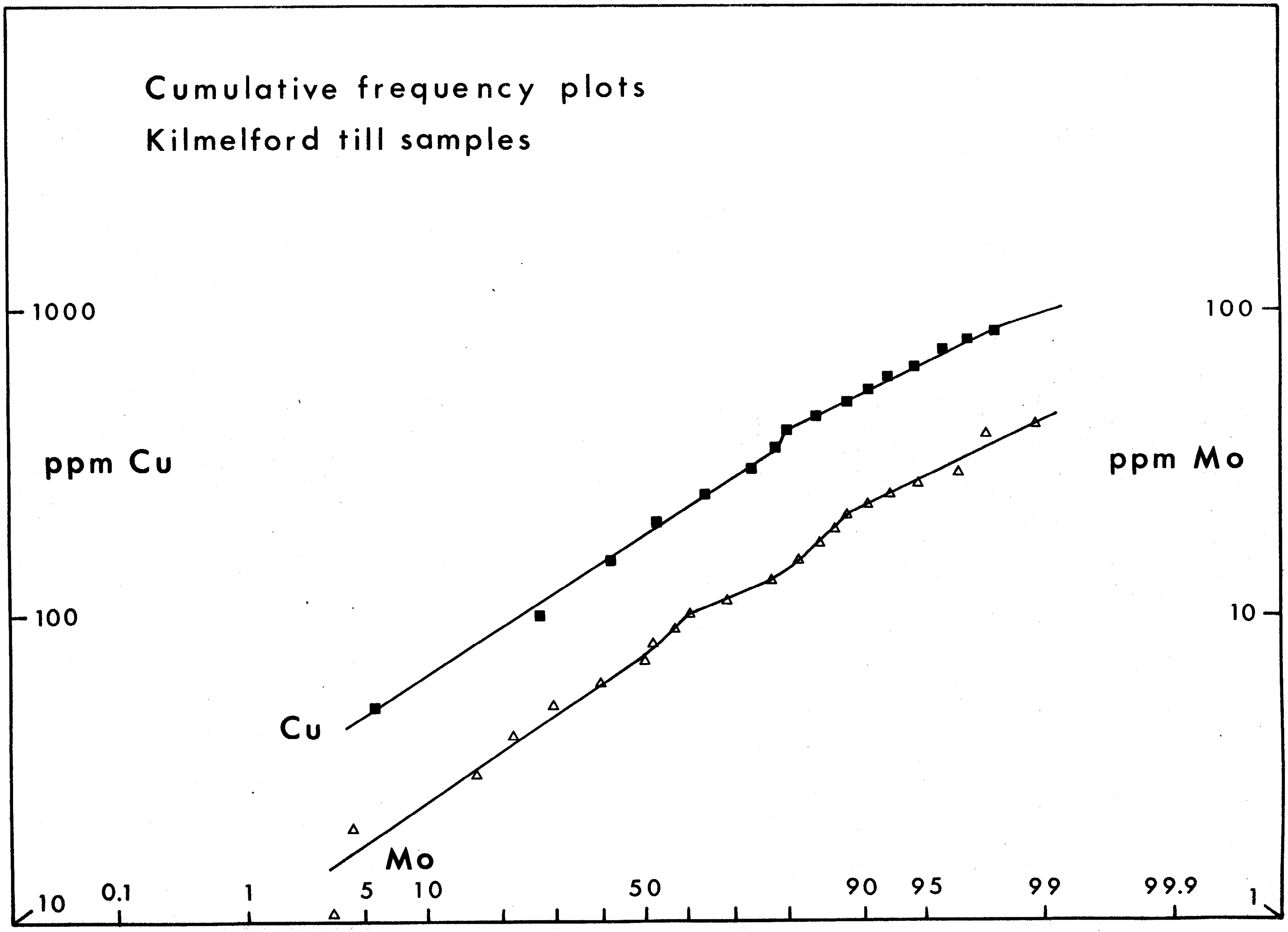
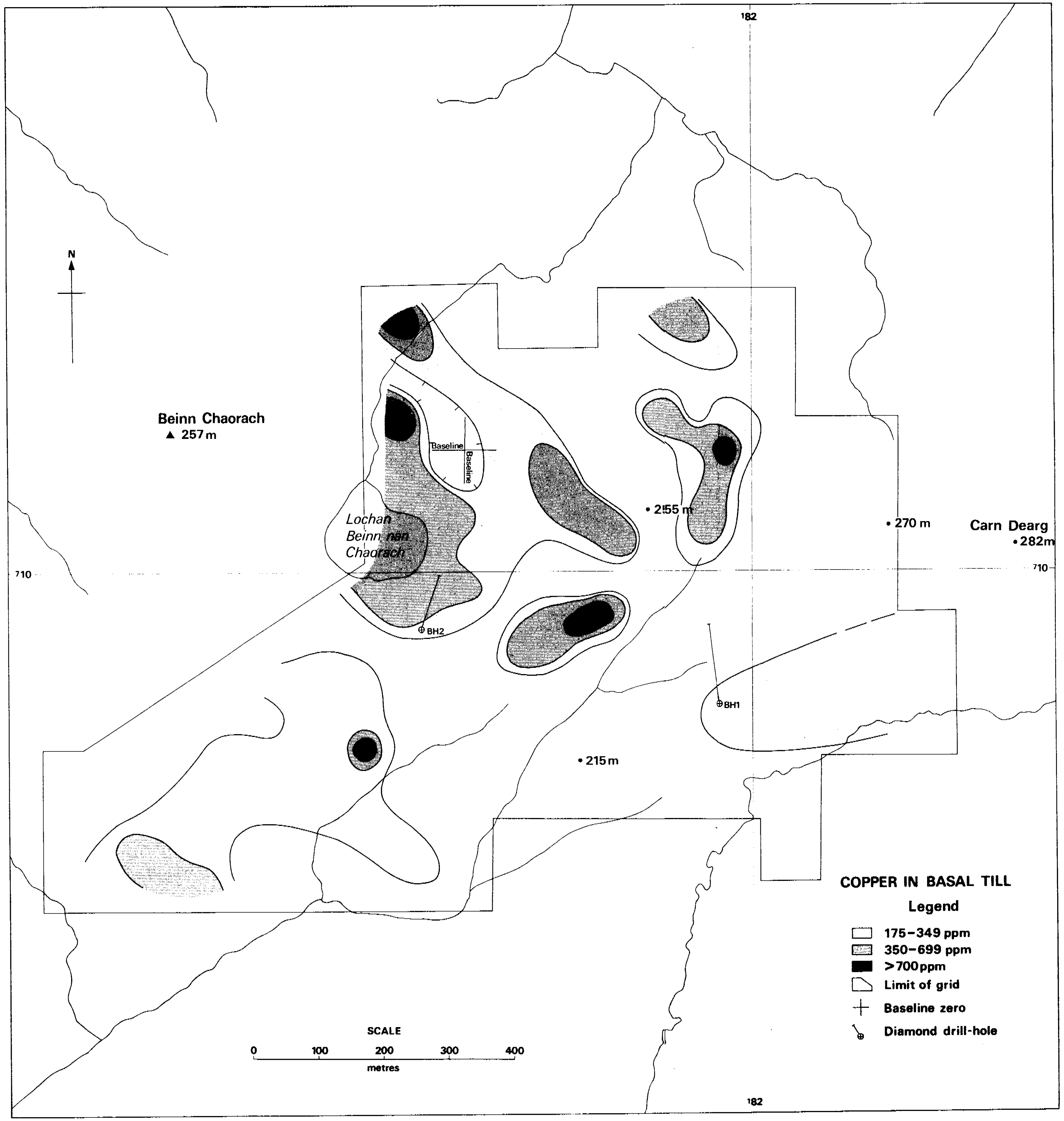
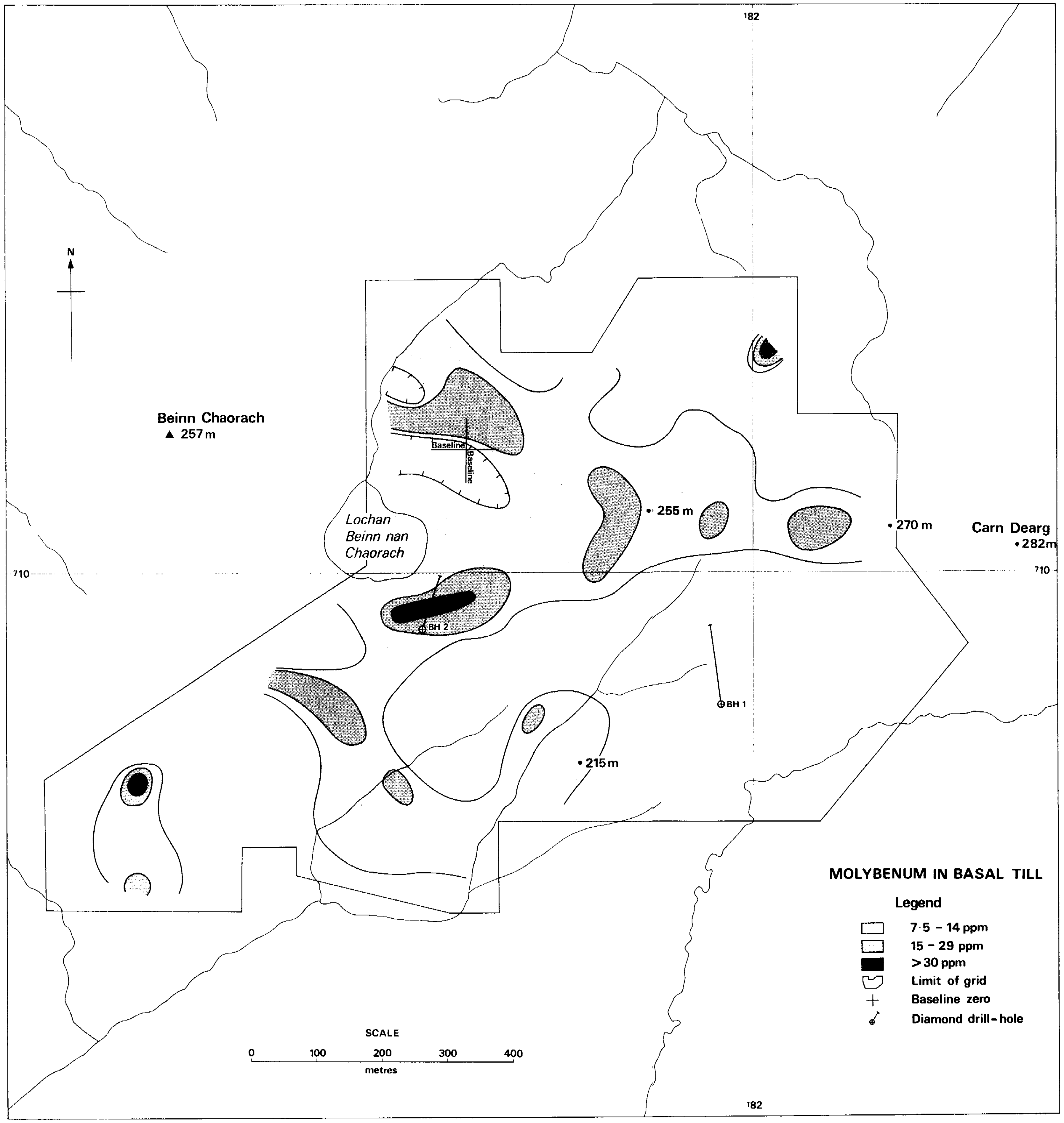


Fig. 12 Cumulative frequency plot for Cu, Mo in till samples



182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
• 255 m
• 270 m
Carn Dearg
• 282m
Lochan
Beinn nan
Chaorach
710
710
BH2
BH1
• 215 m
SCALE
0
100
200
300
400
metres
182
COPPER IN BASAL TILL
Legend
175–349 ppm
350–699 ppm
>700ppm
Limit of grid
Baseline zero
Diamond drill-hole



182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
Lochan
Beinn nan
Chaorach
255 m
270 m
Carn Dearg
282m
710
710
BH 2
BH 1
215m
MOLYBENUM IN BASAL TILL
Legend
7·5 - 14 ppm
15 - 29 ppm
>30 ppm
Limit of grid
Baseline zero
Diamond drill-hole
SCALE
0
100
200
300
400
metres
182

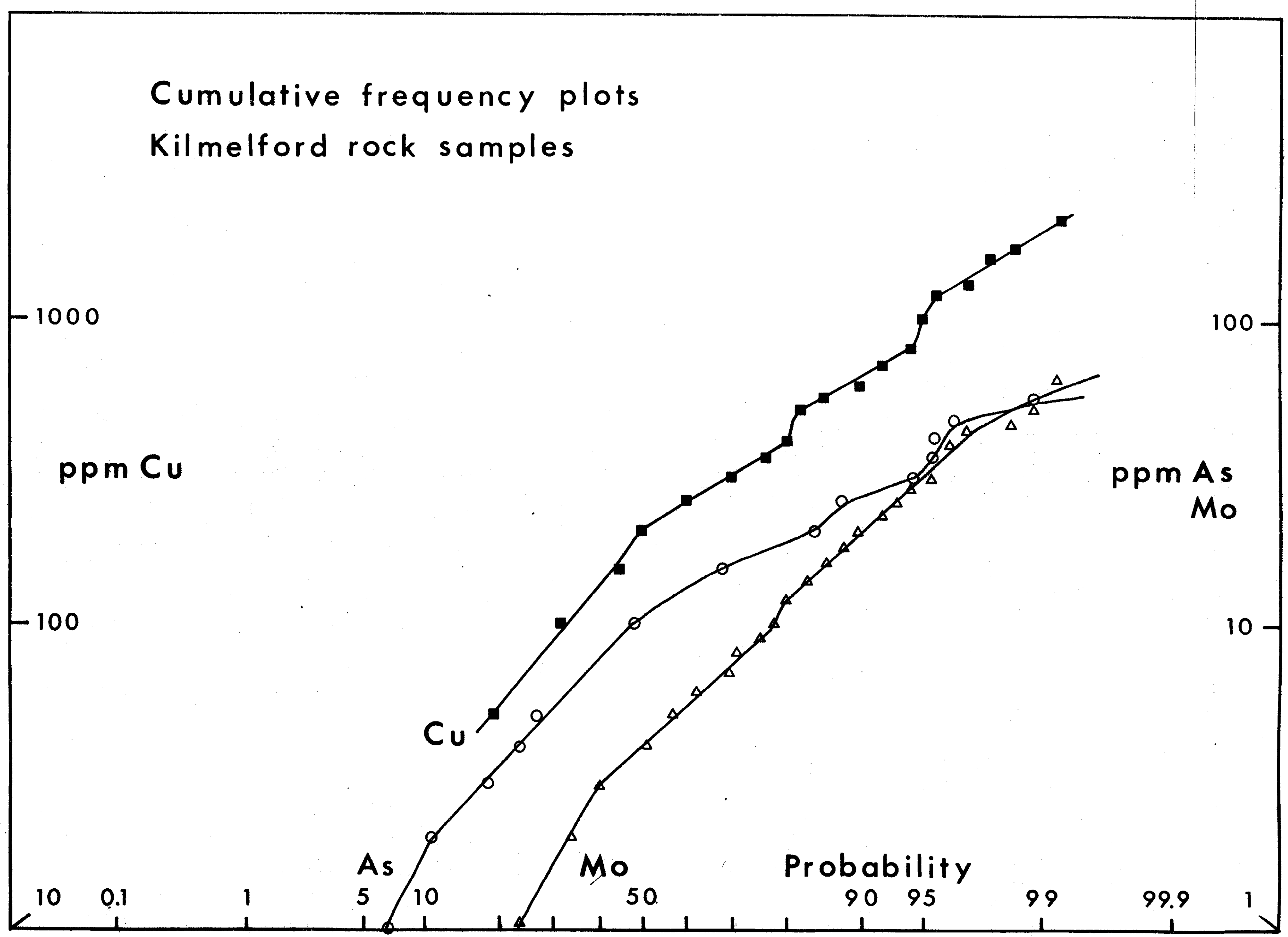
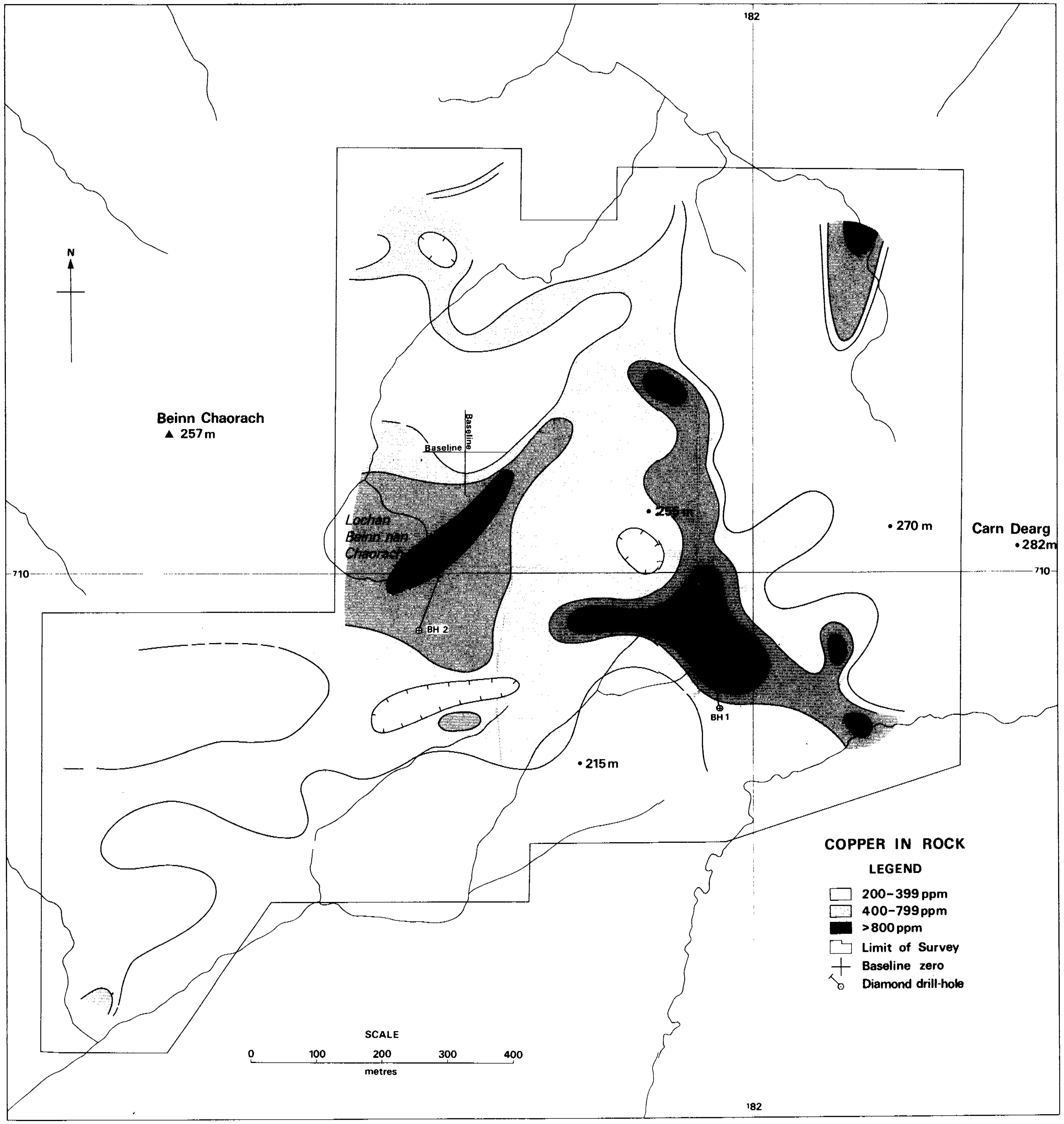
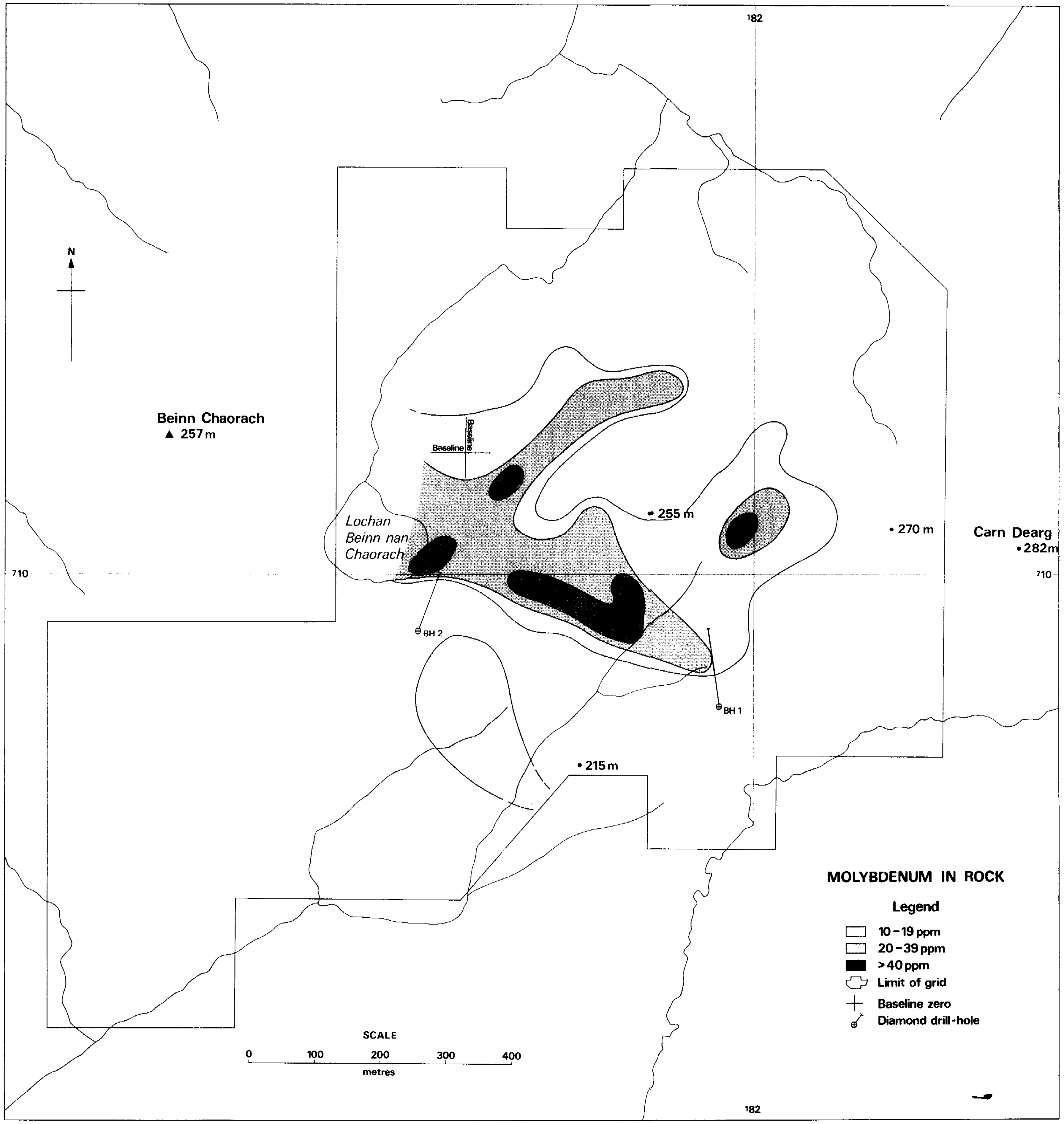


Fig. 15 Cumulative frequency plot for Cu, Mo, As in rock samples


182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
Lochan
Beinn nan
Chaorach
BH 2
BH 1
• 270 m
Carn Dearg
• 282m
710
710
• 215m
COPPER IN ROCK
LEGEND
200–399 ppm
400–799 ppm
>800 ppm
Limit of Survey
Baseline zero
Diamond drill-hole
SCALE
0
100
200
300
400
metres
182



182
N
Beinn Chaorach
▲ 257 m
Baseline
Baseline
Lochan
Beinn nan
Chaorach
• 255 m
• 270 m
Carn Dearg
• 282m
710
710
BH 2
BH 1
• 215 m
MOLYBDENUM IN ROCK
Legend
10 - 19 ppm
20 - 39 ppm
> 40 ppm
Limit of grid
Baseline zero
Diamond drill-hole
SCALE
0
100
200
300
400
metres
182

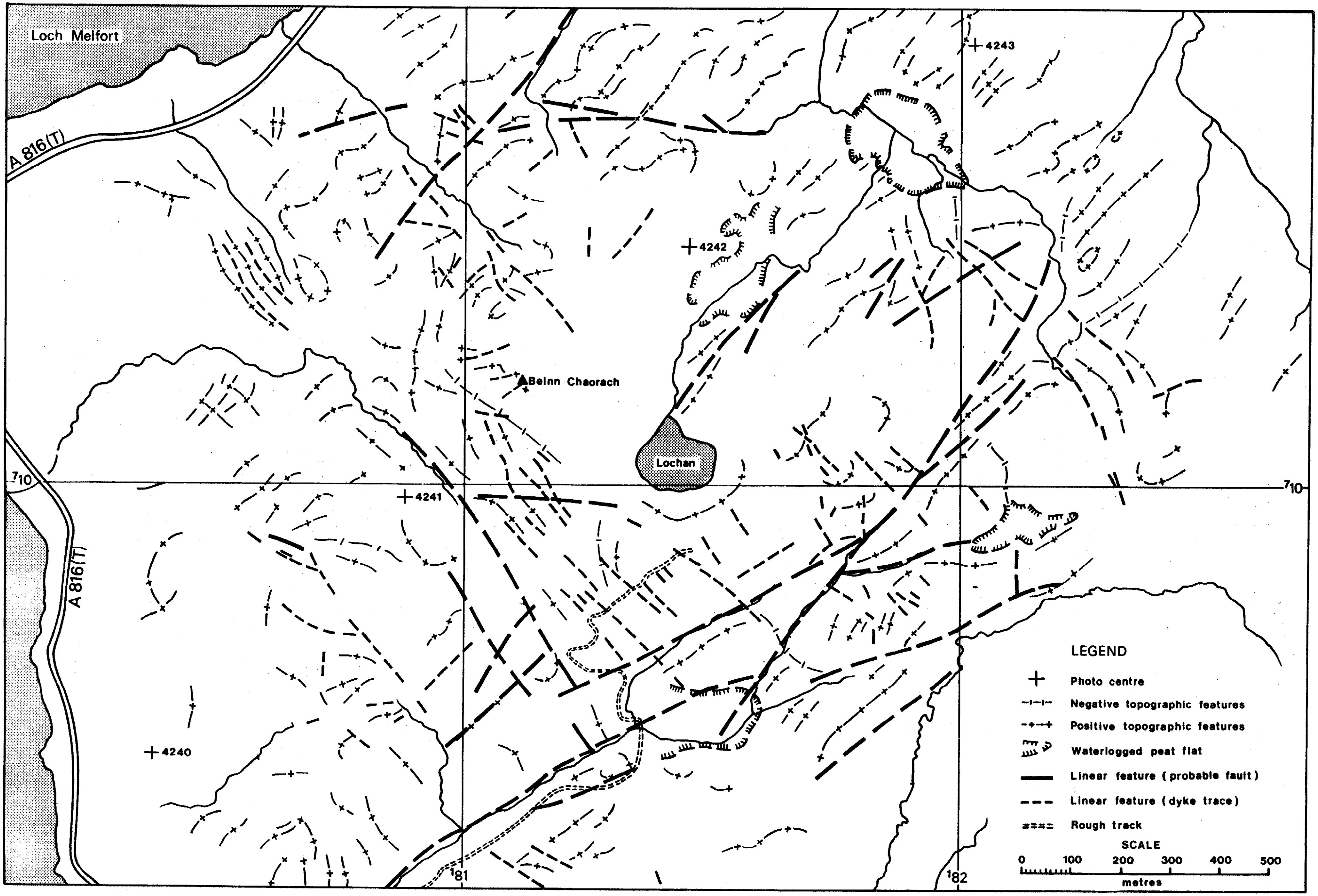
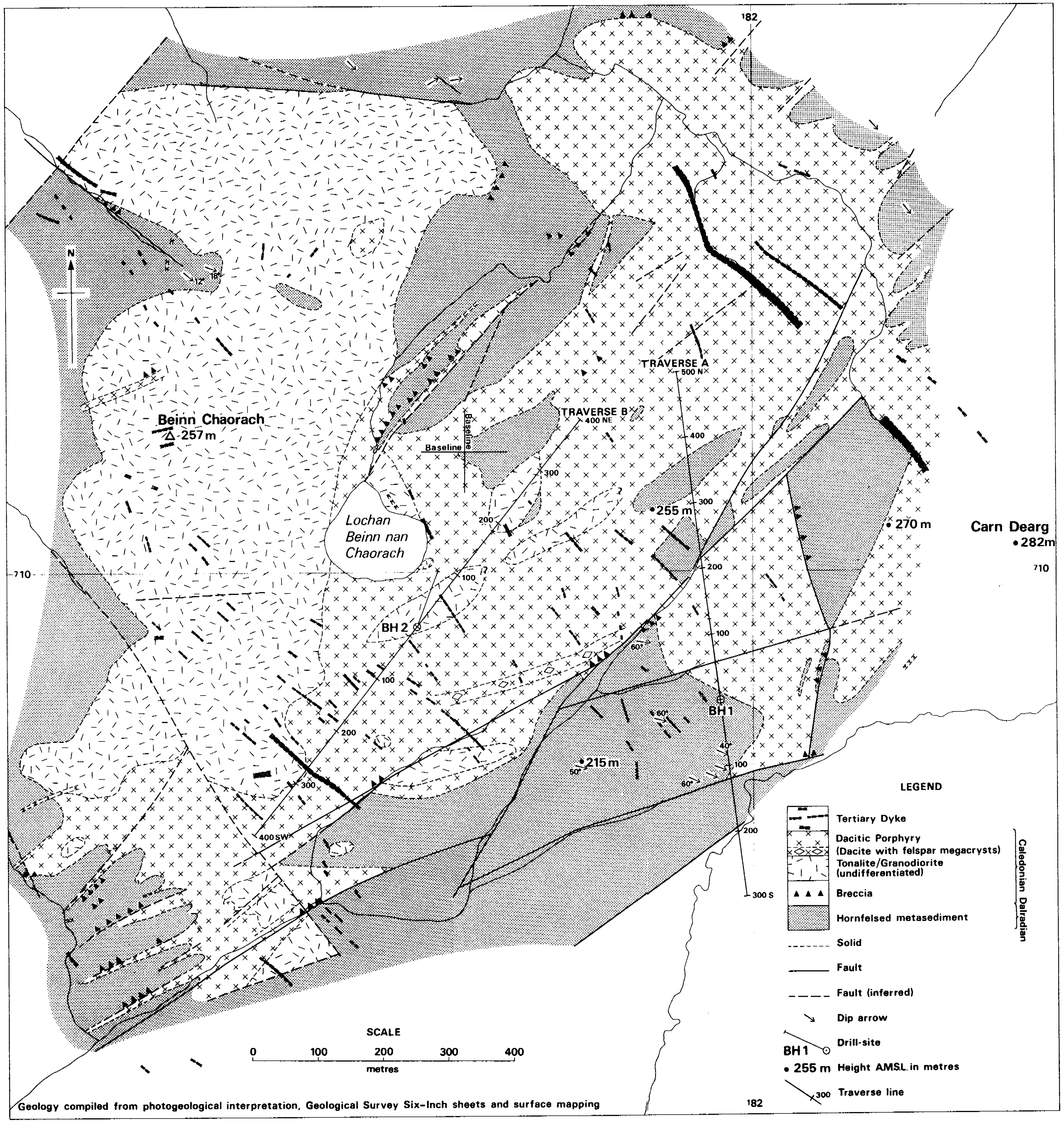
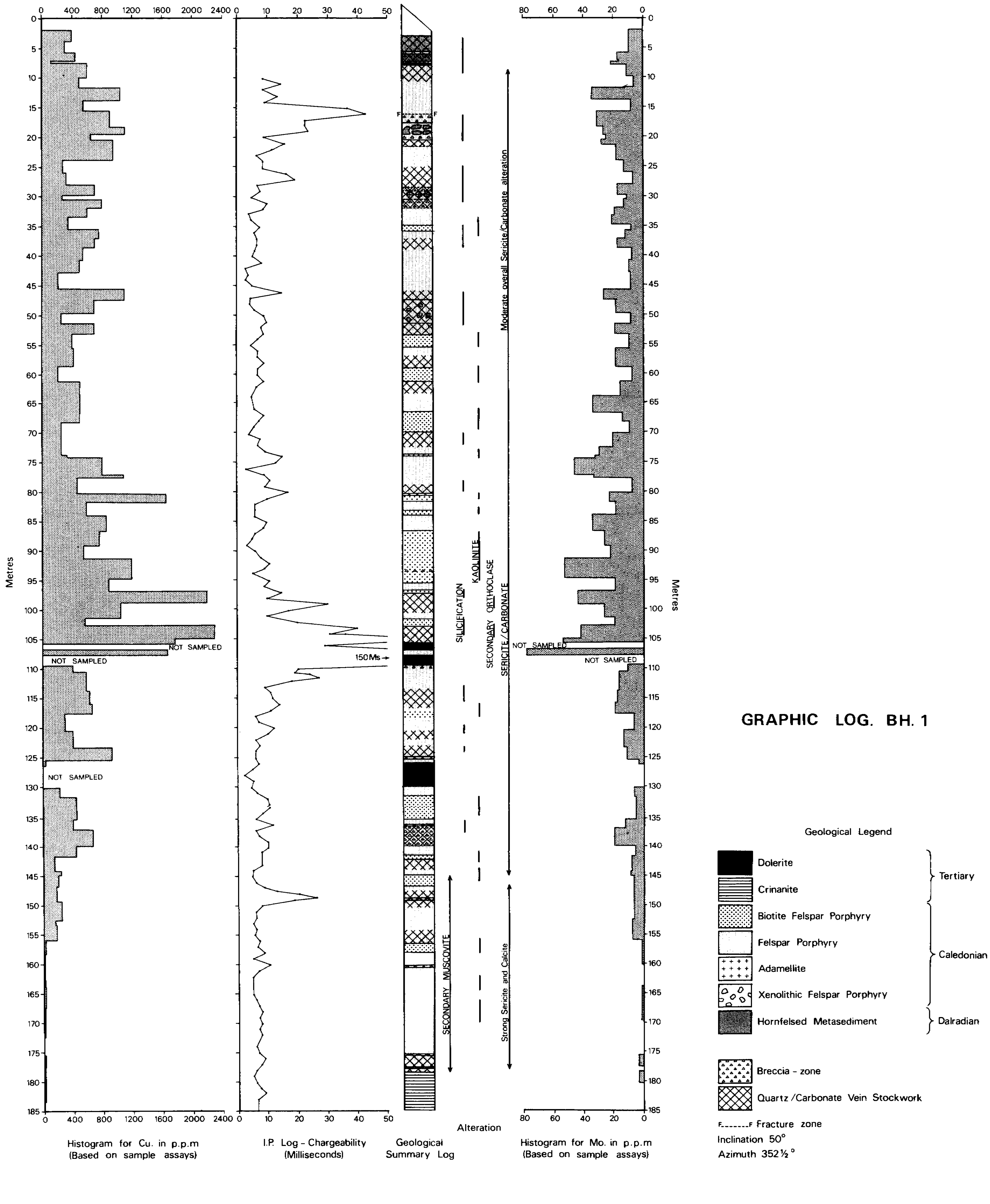
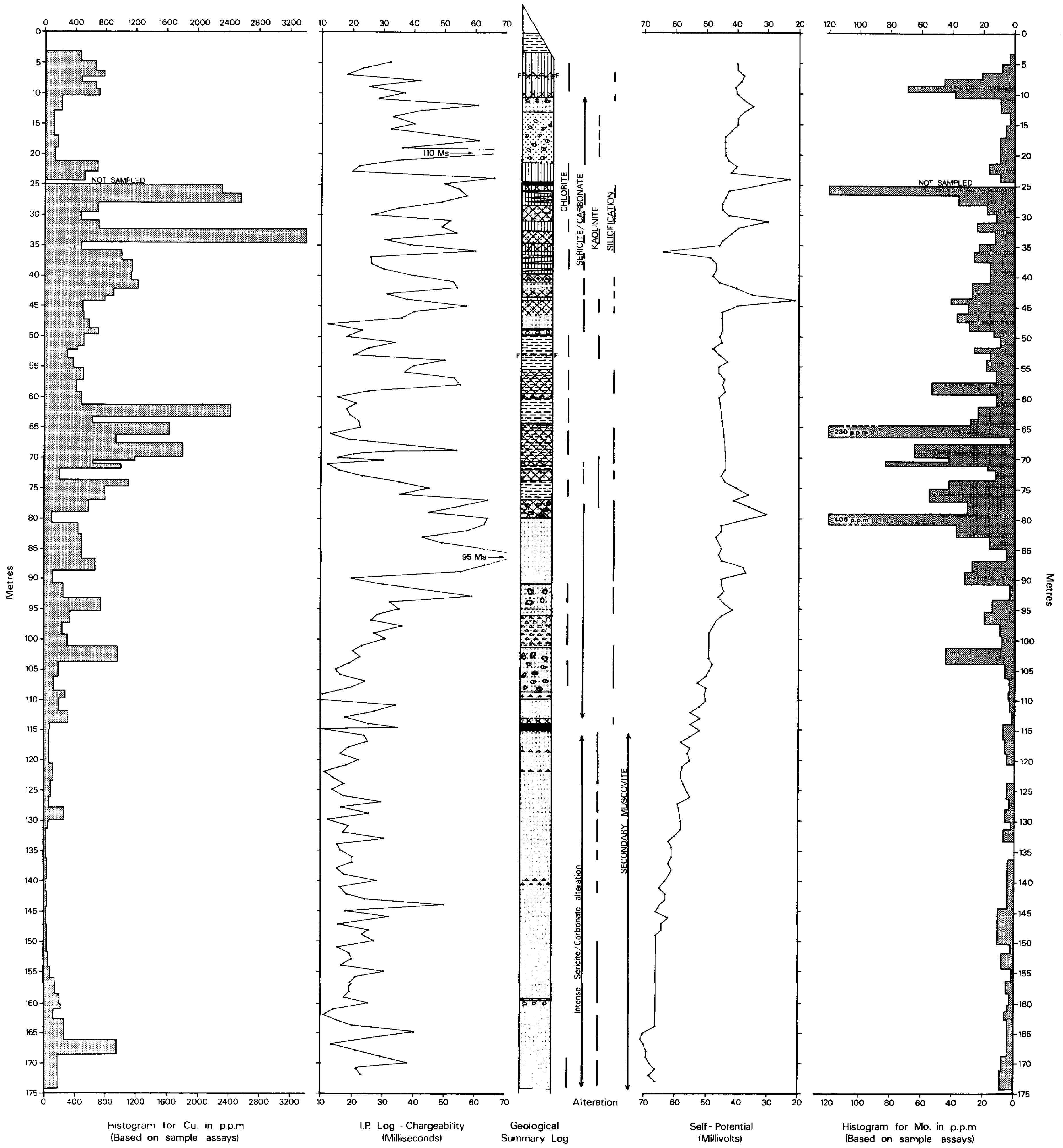


Fig. 18 Photogeological map of mineralised area

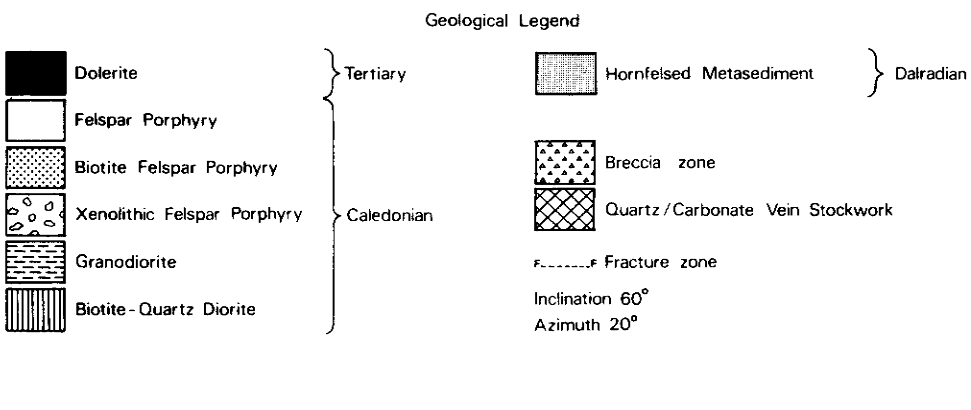

182
N
Beinn Chaorach
257 m
Lochan
Beinn nan
Chaorach
TRAVERSE A
500 N
TRAVERSE B
400 NE
Baseline
Baseline
255 m
270 m
Carn Dearg
282m
710
710
BH 2
BH1
215 m
400 SW
300 S
LEGEND
Tertiary Dyke
Dacitic Porphyry
(Dacite with felspar megacrysts)
Tonalite/Granodiorite
(undifferentiated)
Breccia
Hornfelsed metasediment
Caledonian
Dalradian
Solid
Fault
Fault (inferred)
Dip arrow
Drill-site
BH1
255 m Height AMSL in metres
300 Traverse line
SCALE
0 100 200 300 400
metres
182
Geology compiled from photogeological interpretation, Geological Survey Six-Inch sheets and surface mapping



GRAPHIC LOG. BH. 1



GRAPHIC LOG. BH. 2



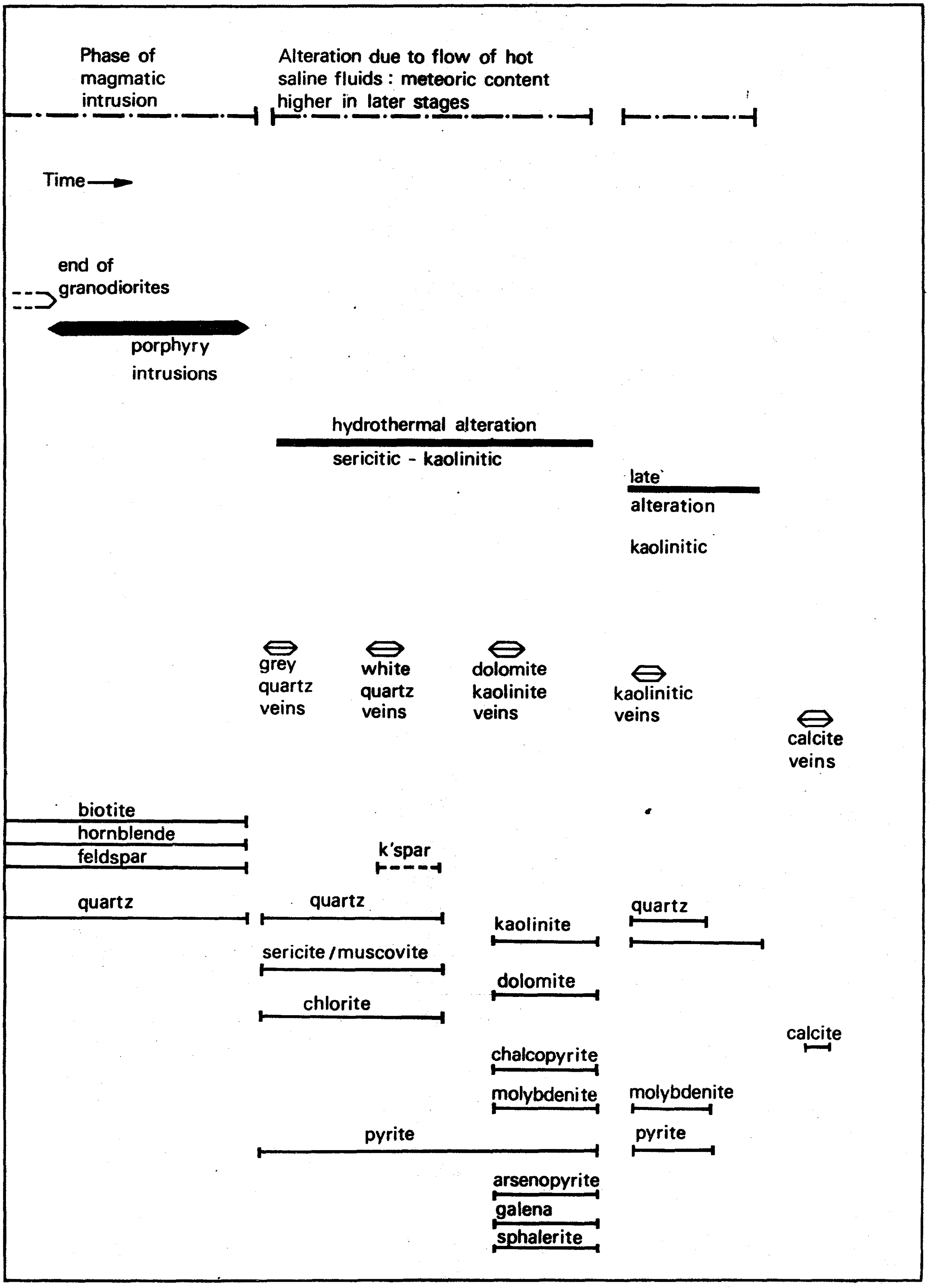


Fig. 23 Schematic diagram of alteration and mineralisation

Figure 22.

Sketches illustrating zonal arrangement of alteration about quatz veins (q) in specimens from drill-hole 1; 76.05m (part a) and 94.74m (partb). Part (a) shows a mosaic reconstruction based on two thin-sections in which the dark ornament represents Cu-Mo rich sulphides. Part (b) is a full size sketch of a core specimen in which the dashes represent biotites and the rectangular ornament represents plagioclases or their alteration products. The alteration zones are labelled as follows:-

1. - Porphyry showing mild hydrothermal alteration.
2. - Zones of increasing kalinite + Dolomite growth.
3. - Zones of composite sericite / kalinite alteration (which carry most of the Cu and Mo).
4. - Zones of intense sericitic alteration adjacent to quartz veins.

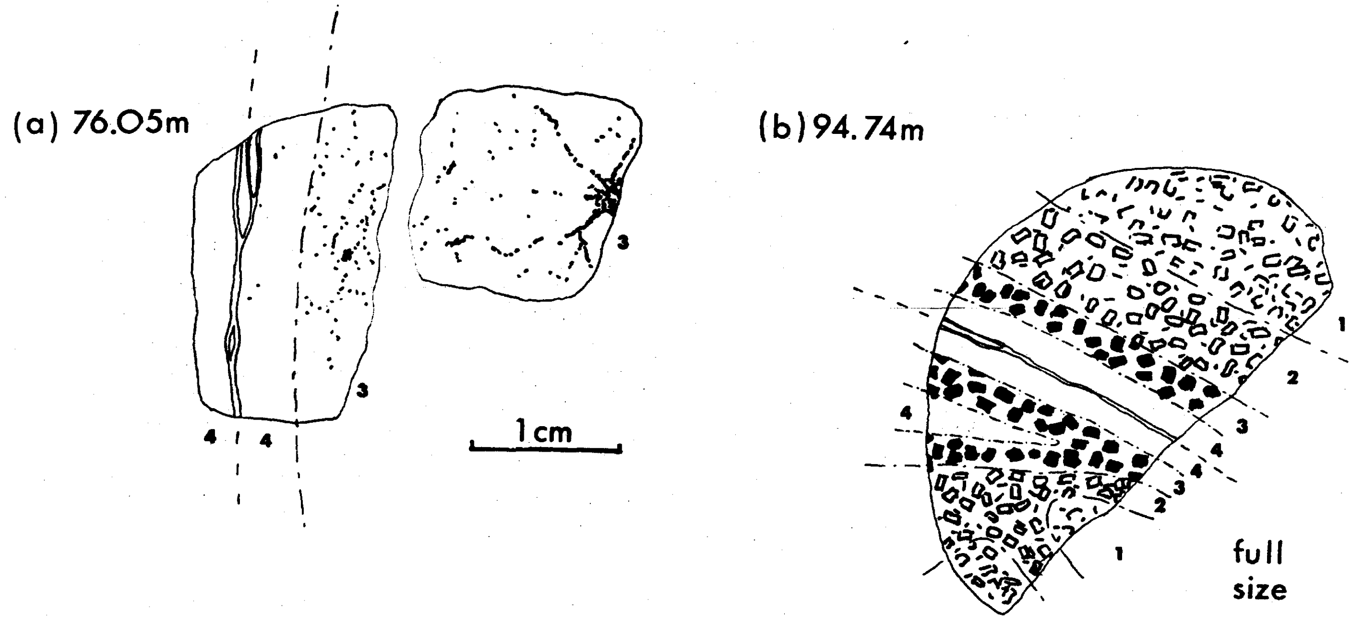


Fig. 22 Pictorial representation of petrographic thin-section from BH 1

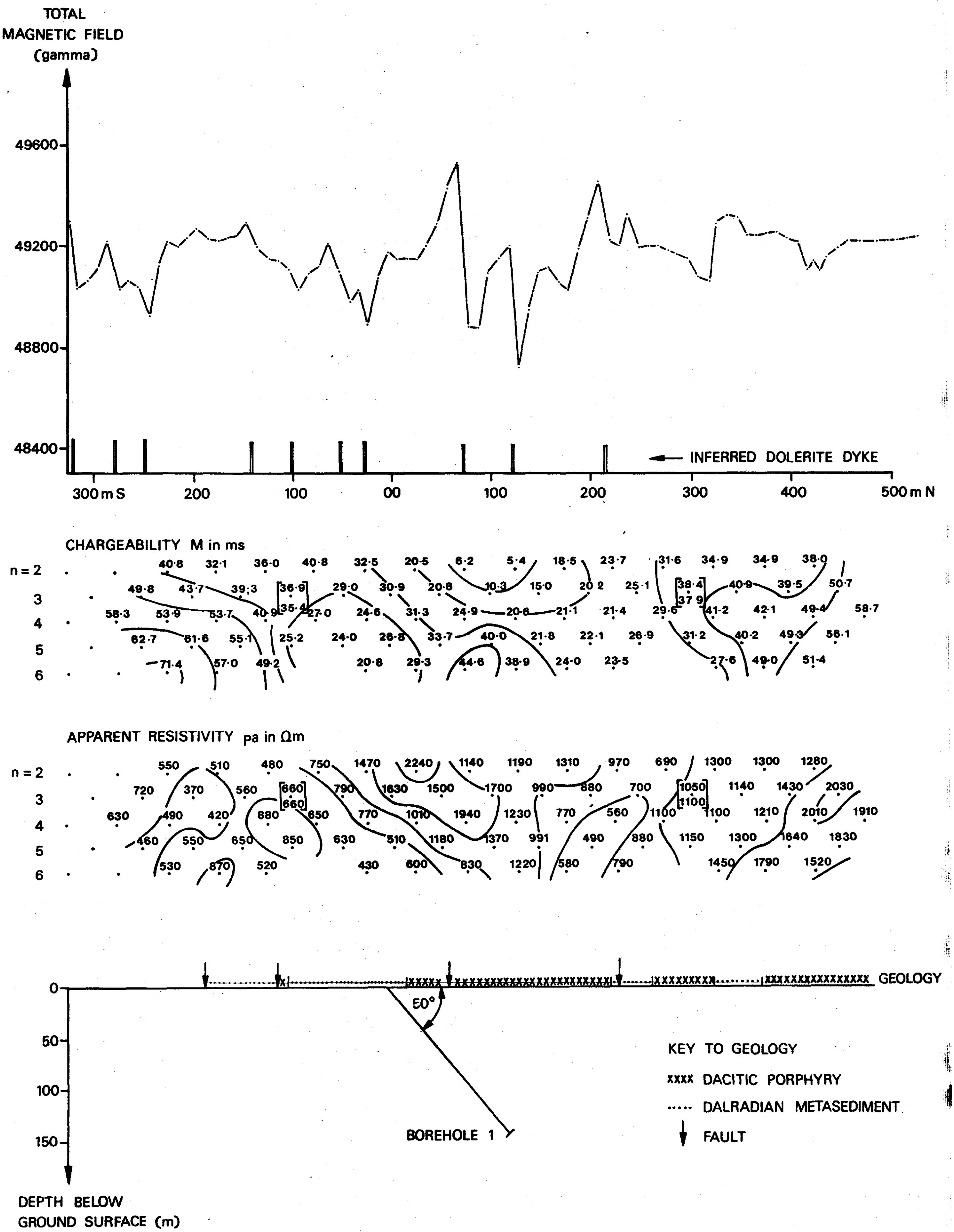


Fig. 24 Total magnetic field and IP pseudo-sections for line A

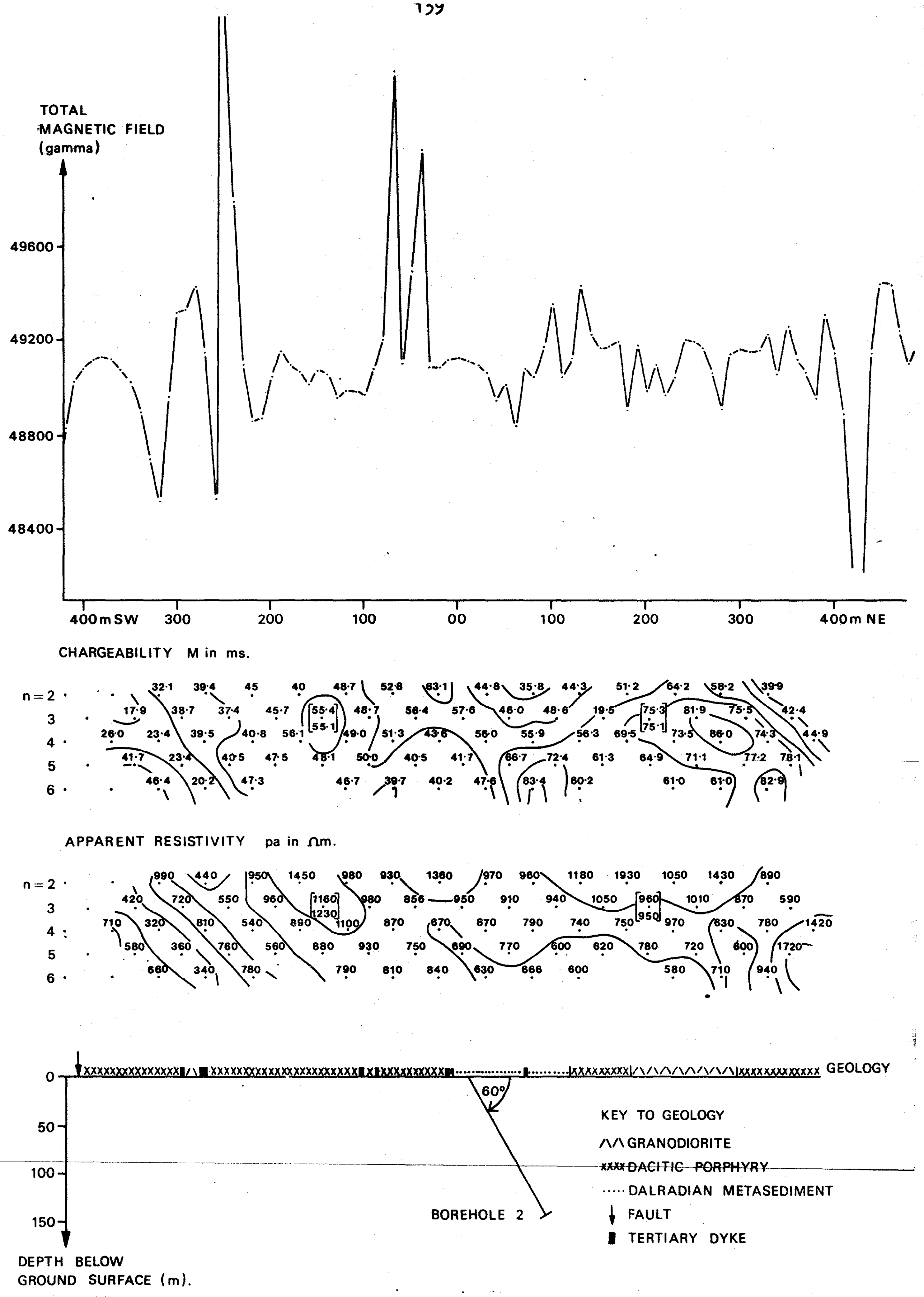


Fig. 25 Total magnetic field and IP pseudo-sections for line B

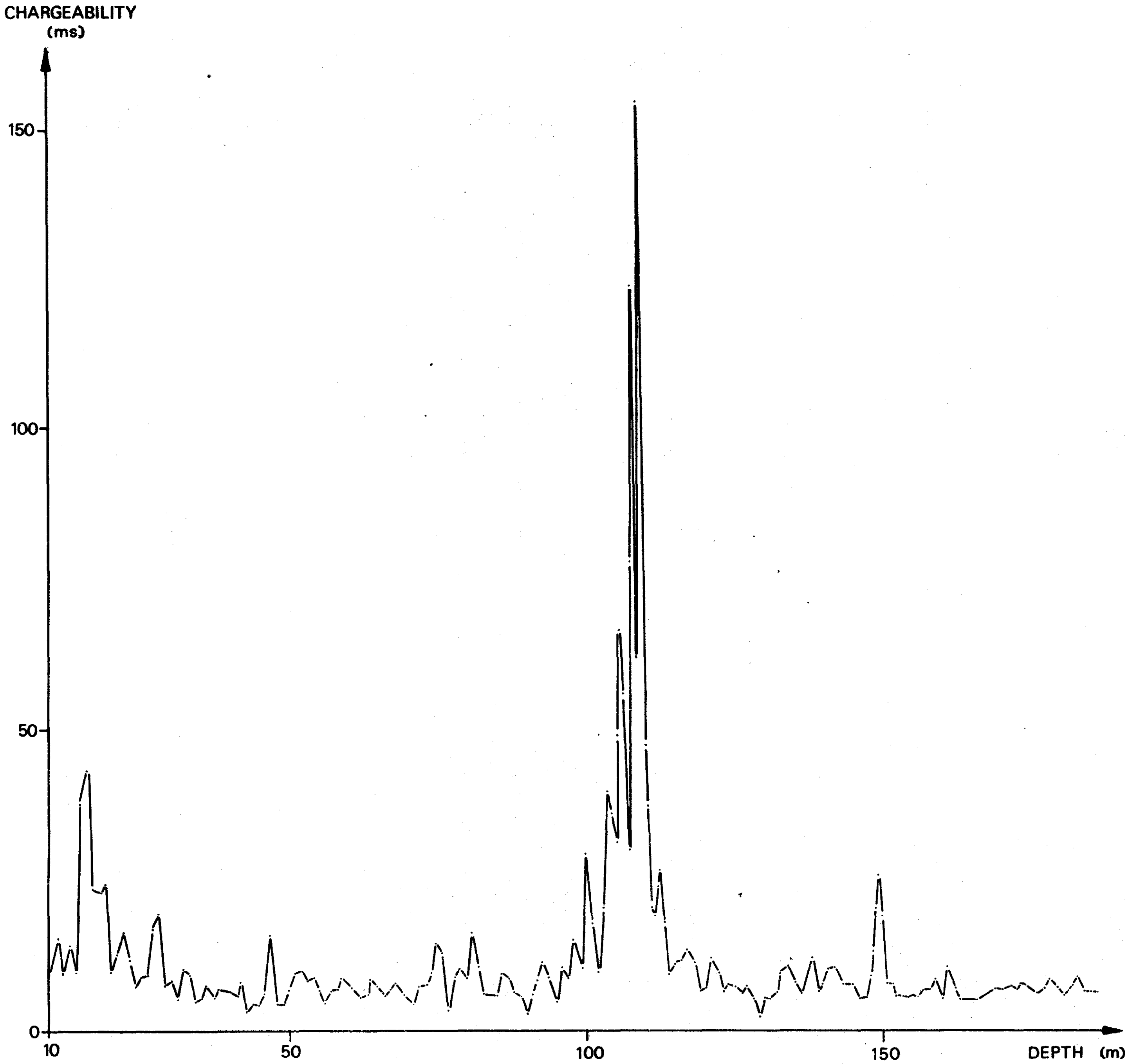


Fig. 26 Chargeability log for BH 1

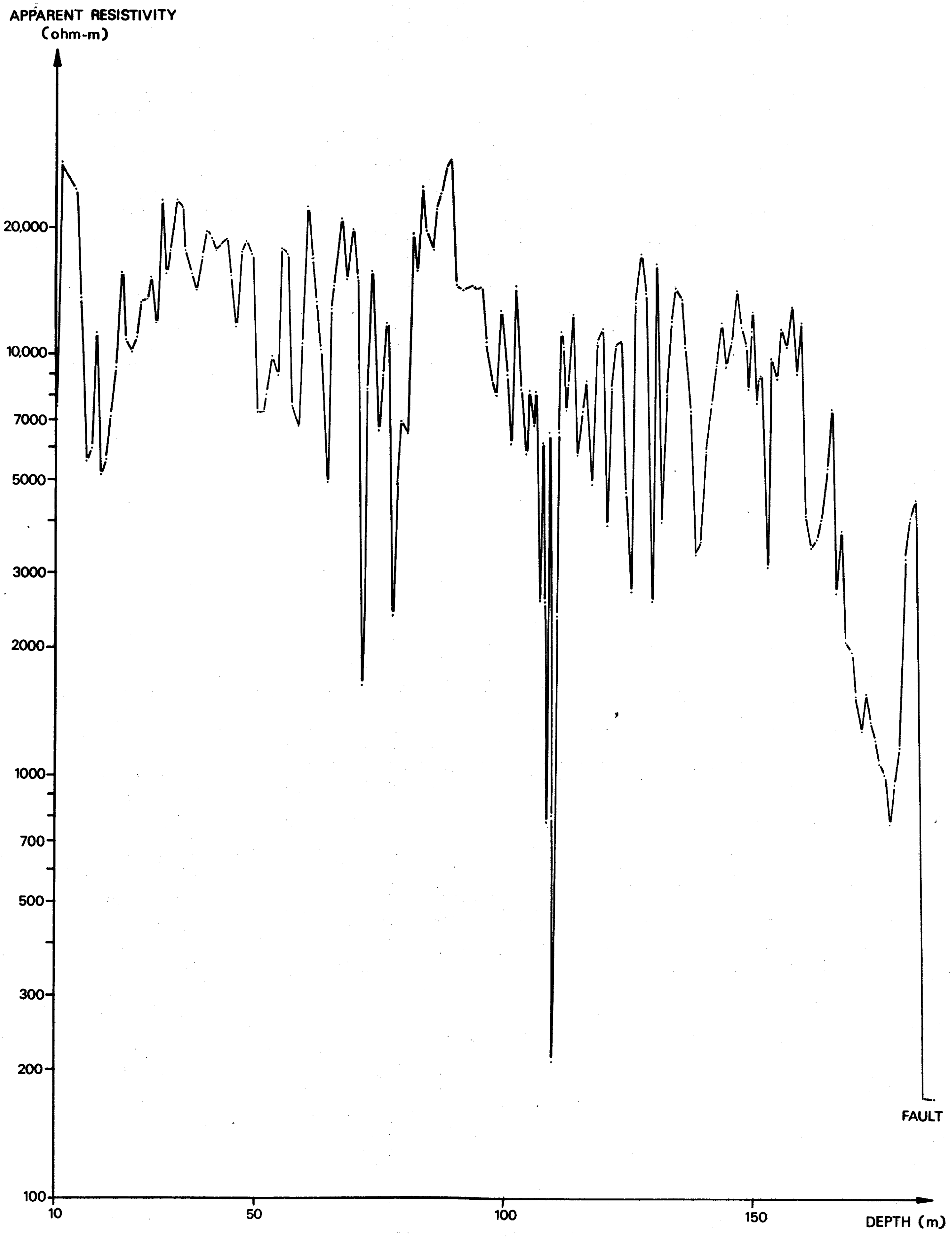


Fig. 27 Resistivity log for BH 2

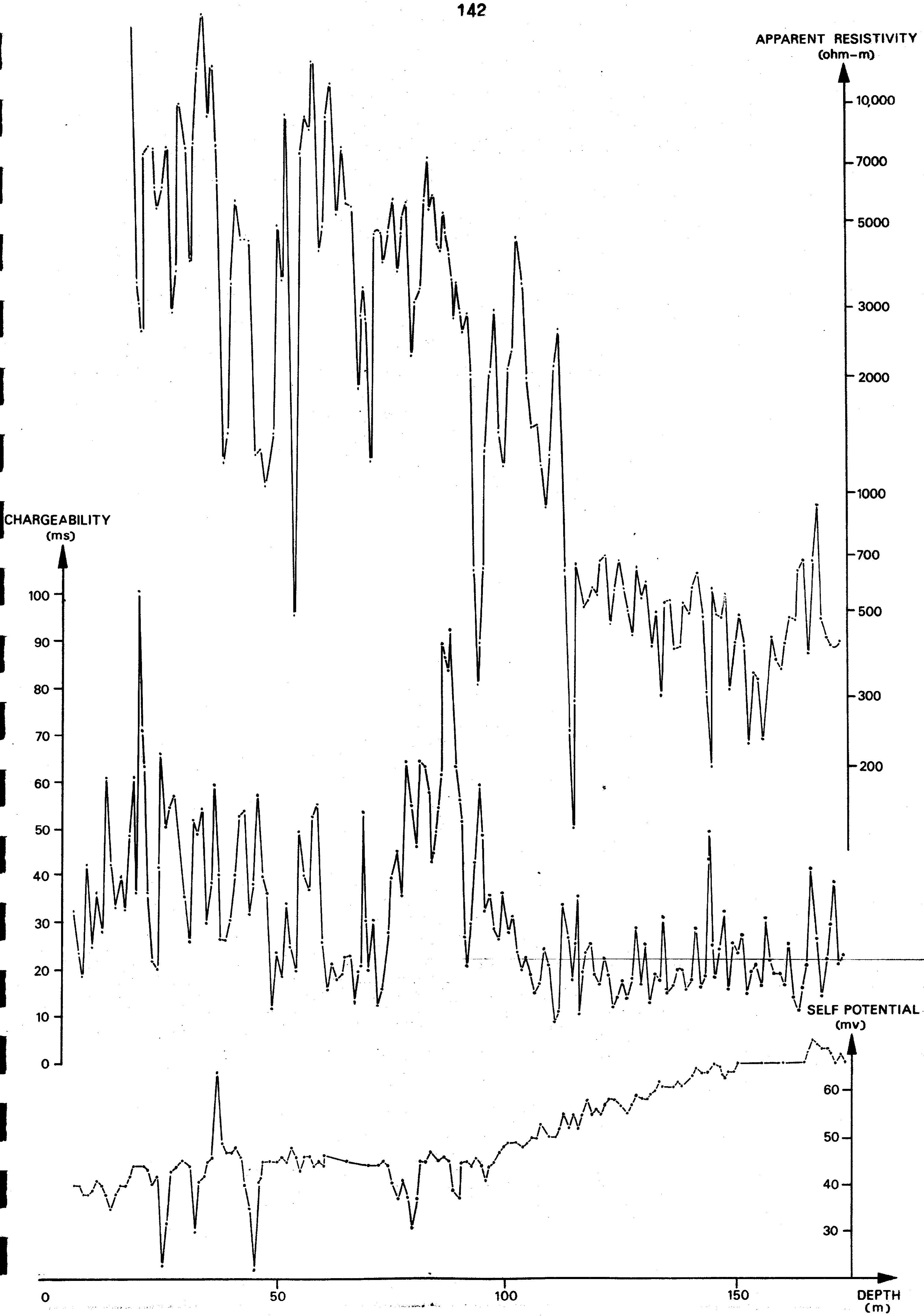


Fig. 28. Chargeability, resistivity and self-potential logs for BH 2