Natural Environment Research Council

Institute of Geological Sciences

# Mineral Reconnaissance Programme Report

*A report prepared for the Department of Industry*

# No. 4
# Investigation of copper mineralisation at Vidlin, Shetland

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 The information contained herein must not be published without reference to the Director, Institute of Geological Sciences.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 copper mineralisation at Vidlin, Shetland

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**Summary**

A co-ordinated geological-geochemical-geophysical investigation of copper mineralization in the area from Vidlin Ness to Dury Voe, Shetland was carried out in late 1974 and in 1975, followed by a drilling programme in early 1976. The mineralization which occurs within an amphibolitic belt (possibly metamorphosed tholeiitic lavas) consists of a strata-bound sulphide horizon outcropping at four localities at Vidlin Ness within a Dalradian succession of dominant calc-silicate granulites and minor marbles and semipelitic gneisses. The massive sulphides comprise mainly pyrrhotite and interesting amounts of chalcopyrite, sphalerite and galena associated with sulphide-bearing quartz-rock and tremolite-rock.

A southern extension of the known mineralization is indicated by linear geophysical anomalies and occasional outcrops of sulphide-bearing amphibolite, and at the northern end well-defined EM and magnetic anomalies suggest that the belt of massive sulphides at Vidlin Ness has a strike length of at least 1000m. A geochemical base of till anomaly, south of the outcropping massive sulphides at Vidlin Ness, strengthens the case for this strike length, and a second anomaly for copper, lead and zinc just north of Dury Voe on the line of weakly conductive and magnetic anomalies may indicate leakage from an additional body of subsurface massive sulphides.

An extension of the sulphide horizon to the north is indicated by a pronounced magnetic anomaly in Vidlin Voe on strike with the northernmost outcrop of the sulphide horizon (Dr D Flinn, pers. comm.)

Six drill-holes penetrated the sulphide horizon at Vidlin Ness confirming that it persists laterally for at least 500m and in depth to probably at least 100m. The horizon increases in thickness from just under 2m in the southern drill-holes to about 10m in the most northerly drill-holes. Average values across the sulphide intersection range from 0.46% Cu and 0.12% Zn in the south to 1.19% Cu and 1.27% Zn in the north.

The sulphide horizon at Vidlin is of comparable grade and thickness to strata-bound sulphide depoits mined in Scandinavia which commonly form deposits of from 1,500,000 to 10,000,000 tonnes of ore.

Investigation of copper mineralization at Vidlin, Shetland

## INTRODUCTION

Vidlin Ness was geologically surveyed in 1930 by D Haldane who noted sulphide mineralization (termed a "pyrites bed") at three localities on the Ness itself, and an additional occurrence east of Skeo Taing on Dury Voe to the south (Fig. 1). The sulphide occurrences were re-examined by R F Powner (1961) and the possibility that these might be of economic interest was pointed out by Dr D Flinn in 1974 during his co-operative work with the Institute of Geological Sciences in the production of Sheet 128. Dr S H U Bowie considered that it would be worth following up these occurrences and in June 1974, he collected seventeen samples of mineralized rock and country rock from Vidlin Ness for mineralogical and chemical studies. His field examination confirmed the possible economic potential of the area, and analyses of his mineralized samples showed values of 0.13% to 12.2% copper, 0.01% to 1.7% zinc, up to 0.23% lead, and small amounts of cobalt, chromium and nickel. These results were considered to be of sufficient interest to warrant carrying out a co-ordinated geological/geochemical/geophysical investigation of the area from Vidlin Ness to Dury Voe during 1975, followed by a drilling programme in early 1976.

### Location and Topography

The area investigated consists of a strip of country about 0.5km wide extending over a distance of 4km south-southwestwards from Vidlin Ness to Skeo Taing on Dury Voe. The land consists of rough peat moor, largely covered with heather, and indifferent grass pasture on which there is poor grazing for sheep. The rocky coastal sections on the north headland of Vidlin Ness and at Skeo Taing give way locally to small deeply-indented cliffs.

The area is poorly drained with virtually no streams in the northern part from Vidlin Ness to Vidlin village. Further south there is an ill-defined pattern of minor streams and channels which carry the drainage from the peat moors to a small loch south of Vidlin village and then into Vidlin Voe. North of Skeo Taing there is one well-defined stream course with minor tributaries rising in the Hill of Vidlin. The main topographic features are the low ridge (20-40m above sea-level) formed of calc-silicate granulites which extend from just west of Vidlin Ness northwards to the Ness, and the rounded hill of resistant coarse-grained pelitic schists which rises to about 50m north-northeast of Skelberry.

The population consisting of a few scores of people is concentrated mainly in Vidlin village which has a deep harbour for small boats and in scattered

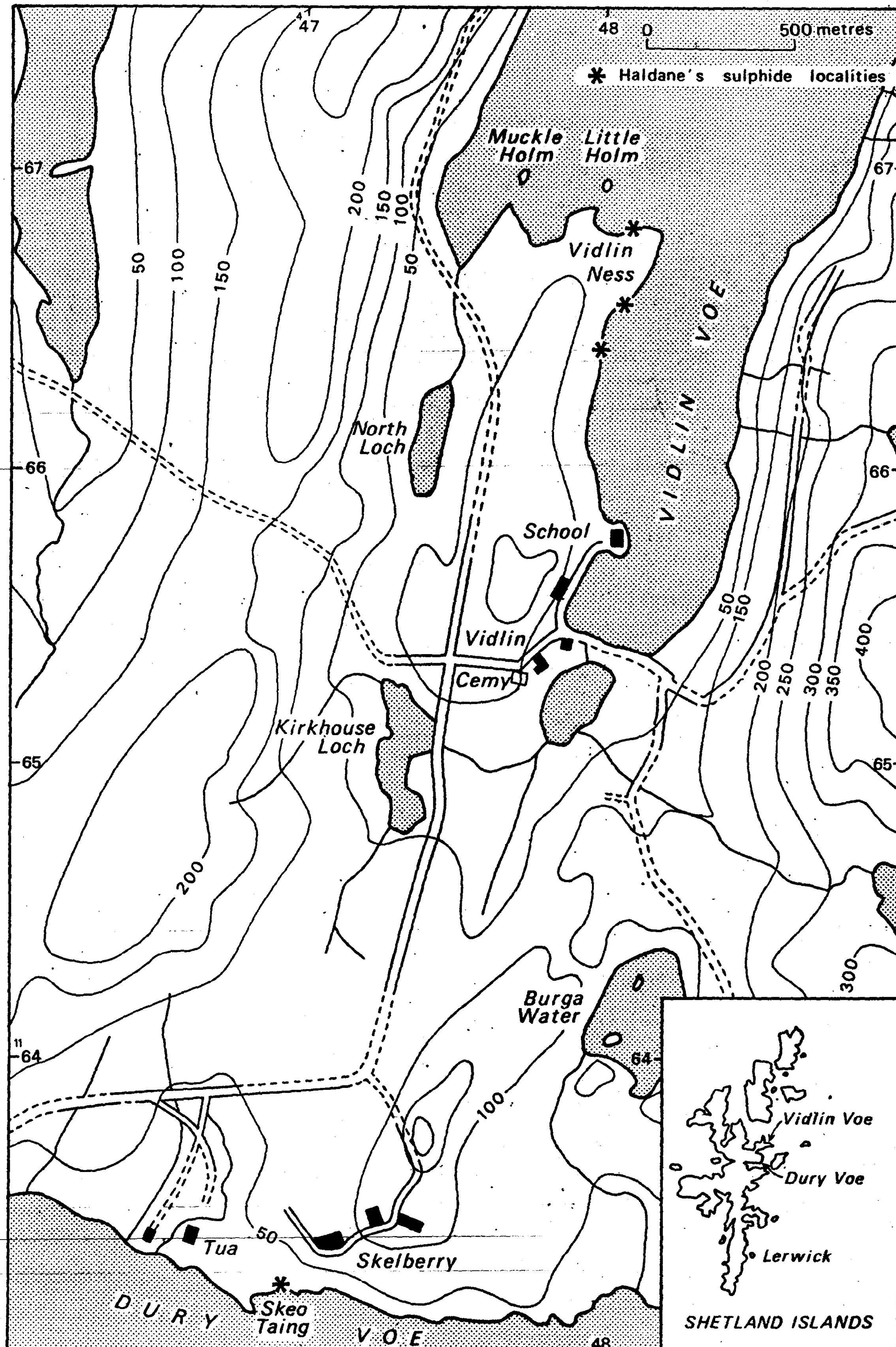



Fig. 1. Map showing location of sulphide mineralization noted by D. Haldane in the Vidlin District, Shetland

farms in the Skelberry area. There are no habitations in the immediate area of the mineralization at Vidlin Ness.

GEOLOGY

Preliminary geological mapping was carried out by Dr G C Clark in early 1975 (Report dated 11/4/75), and this was followed by more detailed mapping in October, 1975 by Dr F May (Report dated 5/1/76).

The preliminary mapping indicated that the four northern outcrops formed part of a single stratabound zone stretching for at least 500m and that the Skeo Taing pyritiferous zone was not part of a southern extension of the Vidlin Ness mineralization. Descriptions of the mineralization at each locality are included with more detail in the section on the sulphide horizon below. An aeromagnetic anomaly on the promontory east of Vidlin Voe noted by Dr A J Burley and M E Parker was considered to be due probably to staurolite-schist bands in permeation gneiss.

Photogeology

The object of the photogeological investigation (Report dated 21/5/75 by J H Bateson) was to identify and plot the main linear features of the area with a view to providing information for use in the further exploration of the mineralization on Vidlin Ness and at Skeo Taing.

The panchromatic photography (scale 1:10,000) available for this interpretation comprised:- Run 67-181, photos 604, 607, 610; Run 67-240, photos 6-576 to 6-578 and 6-583 to 6-585.

Linear features (Fig. 2) are of two main types. The majority (pecked-lines) have been identified with the aid of the stereoscope; a smaller number (dotted lines) were inserted from a direct study of the photographs without the use of stereoscopic images.

The precise nature of these features is not clear from the photographic evidence but it seems that the main "grain" of the area is indicated by the continuous lineation pattern from Vidlin Voe to Skeo Taing which is in general accord with the stated strike of the rocks. Many of the lineations with an approximate E-W orientation could be faults but the data are inconclusive.

There are areas in which a relatively high density of lineations are recorded - these are interpreted as areas of rock outcrop and also areas in which bedrock is obscured by relatively thin overburden.

Limited observations on the rocky coastal areas indicate that the bedrock contains many lineations with NW-SE, N-S and approximately E-W being the most frequent directional trends.

Attempts to trace the known mineralized zone (extending from A to B on Fig.2) were not very successful. This study does however identify similar trending features which cross the road westwards from Vidlin and which could be related to the main features extending to the general area of Skeo Taing

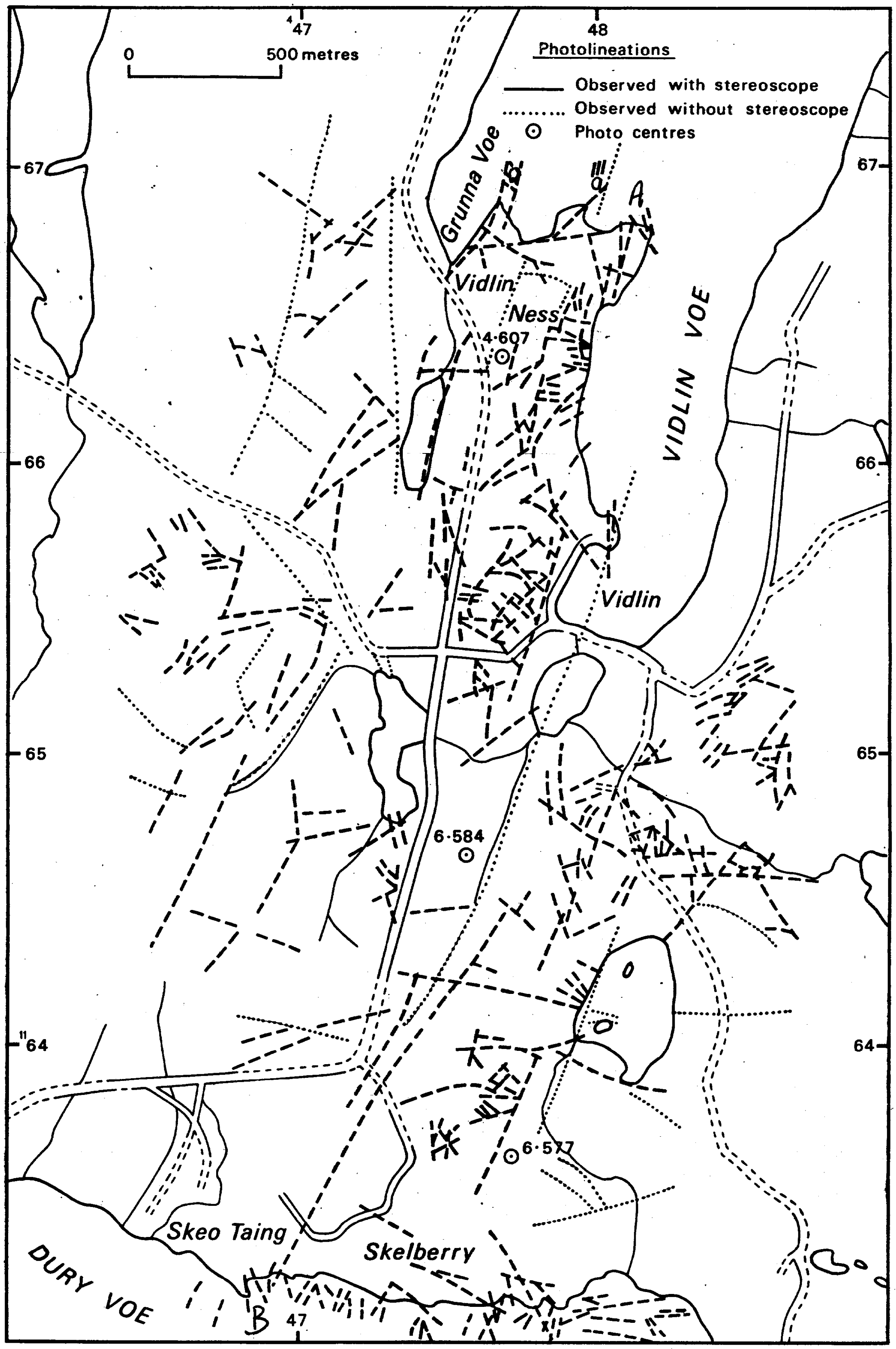



Fig. 2. Photogeological lineations in the Vidlin District

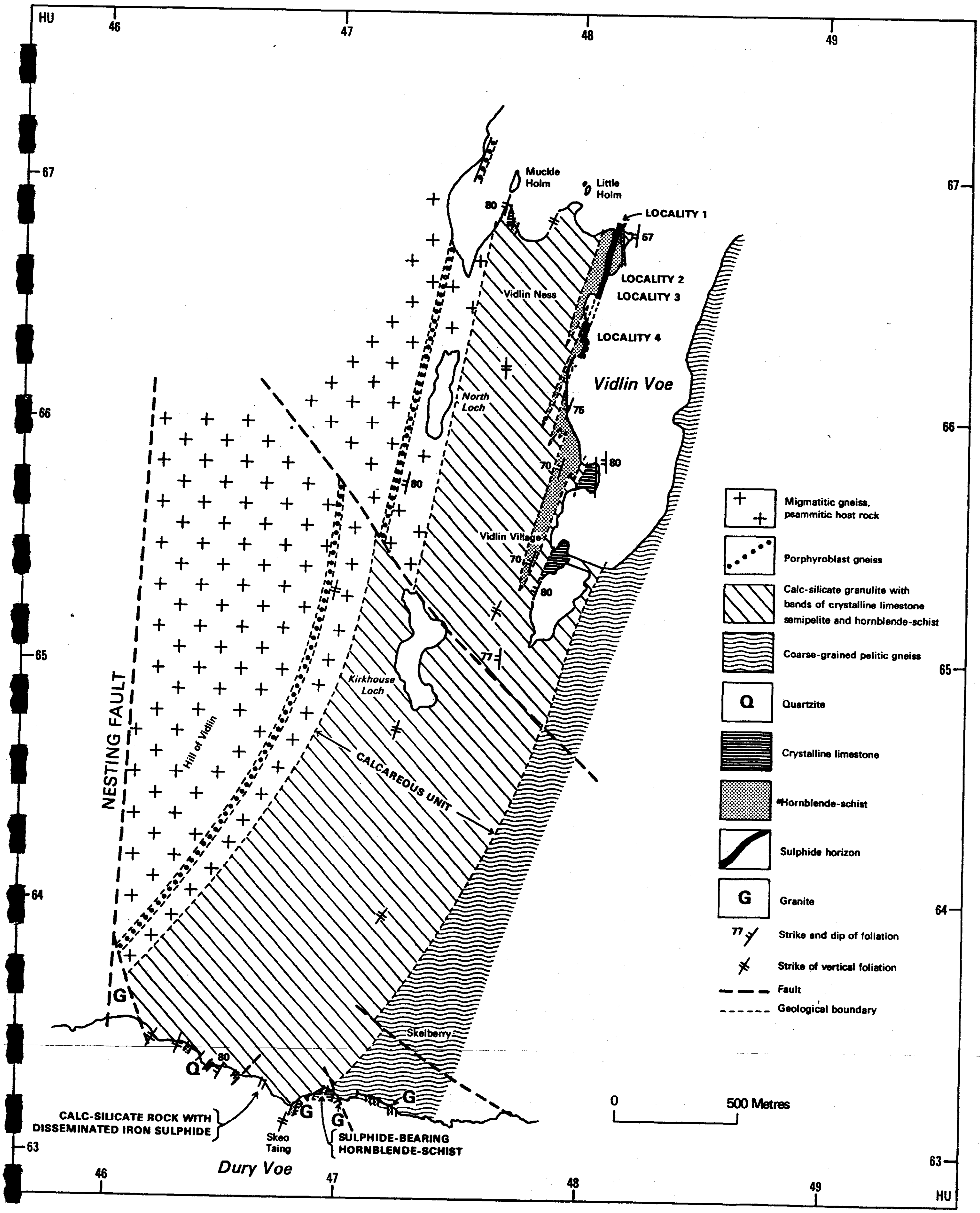



Fig. 3. Geological map of the Vidlin District by F. May (based in part on the work of Dr D. Flinn)

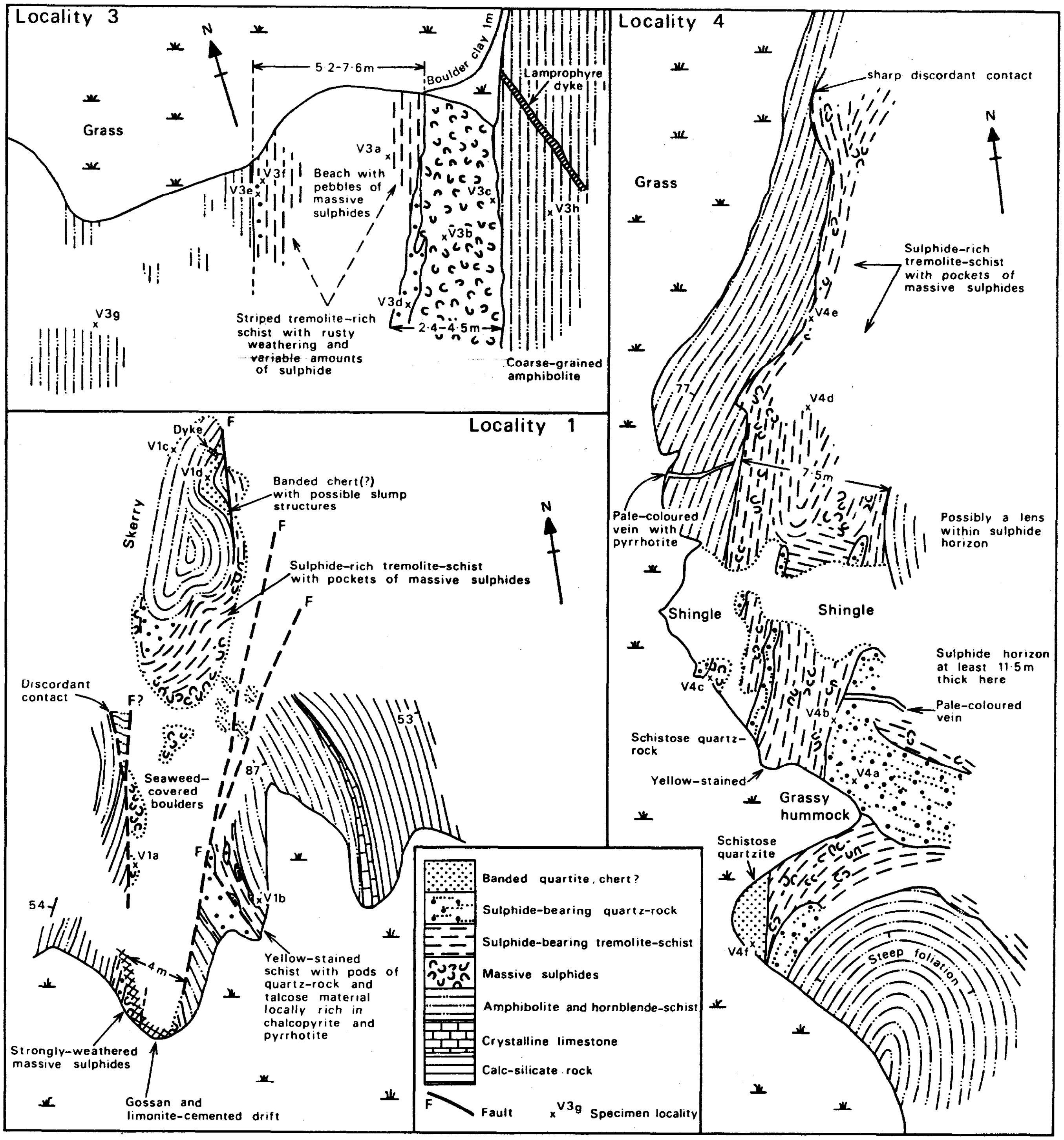



Fig. 6. Sketch maps of mineralized localities at Vidlin Ness

where other mineralization has been reported (C on Fig.2).

From this examination it was apparent that further geophysical surveys to trace this mineralization were required in traverses up to 750m long extending eastwards from the road between Grunna Voe and Skelberry.

## General Geology

The general geology of the area is shown in Fig.3. In Figs.4 and 5 the coast section of Vidlin Ness, the inland area around Vidlin village and part of the coast of Dury Voe are treated in detail. Sketch plans of the main exposures of the mineralized zone are shown in Fig.6.

The coast sections are only interrupted by a few shingle beaches but inland there is an almost continuous cover of boulder clay and peat. A number of small inland exposures known to occur north of Dury Voe were not examined during the present survey because it was thought advisable to concentrate most of the time available on the coast sections. Field identification of the rock types has been supplemented by petrographic examination of 14 thin sections.

The mineralized horizon lies within a steeply-inclined succession of medium to high grade metamorphic rocks lying to the east of the Nesting Fault which has a dextral displacement of 15 to 16km (Flinn, 1967). The rocks immediately east of the fault are migmatites in which the host rock is of psammitic aspect. These have been correlated with the Moine of the Scottish Mainland (Flinn et al, 1972). The porphyroblast gneiss (see Fig. 3) which forms the most easterly unit of the Moine migmatites is a distinctive rock containing rounded microcline porphyroblasts up to several centimetres across. The rocks to the east of the porphyroblast gneiss are considered to be Dalradian and to young in an easterly direction. A basal psammitic unit up to 140m thick is succeeded by a thick calcareous unit consisting mainly of flaggy calc-silicate rocks interbanded with semipelite, crystalline limestone, hornblende-schist and very minor pelite. The rocks are medium to fine-grained and the degree of migmatisation is generally low although towards the east, particularly on the shore of Dury Voe; narrow pelitic bands carry feldspar microaugen. The calcareous unit is succeeded to the east by coarse-grained micaceous gneiss of pelitic to semipelitic aspect containing a few bands of hornblende-schist. Certain bands within the gneiss give rise to the magnetic anomalies observed on the eastern extensions of the geophysical traverses south of line 1600S.

The metamorphic rocks are cut by a number of intrusions of pegmatite, granite, felsic porphyrite and lamprophyre.

## The Calcareous Unit

A tectonite fabric which is evident in most of the rocks shows that the area has been affected by plastic deformation and that the present thickness of the calcareous unit of approximately 800m is not necessarily the original stratigraphic thickness. The fabric consists mainly of a schistosity.

A linear element can be detected in most places but except in the limestone at Vidlin village it is not conspicuous. The schistosity lies parallel to the lithological layering, the two planar structures forming the foliation shown on the maps and sketch plans (Figs. 3-6). Folds associated with the fabric are uncommon but later brittle-style folds occur for example on the headland south of Little Holm. Minor faults with a throw of a few metres are fairly common. Zones of intense crushing and shattering occur up to 170m east of the Nesting Fault on the shore of Dury Voe.

More than half of the calcareous unit consists of striped calc-silicate rock and semipelite. Hard ribs 2 to 20cm thick alternate with easily weathered carbonate-bearing ones of similar thickness. Individual ribs generally maintain a constant thickness for several metres along the strike but in the section south west of Little Holm the layers are lenticular, probably the result of more intense deformation in that area. The rocks have a dull greyish or greenish colour and it is not always easy to distinguish calc-silicate-bearing layers from semipelitic ones. Calc-silicate rock associated with hornblende-schist on the north coast of Vidlin Ness at HU 48126678 has been examined in thin section and found to contain abundant tremolite together with some plagioclase, phlogopite and zoisite. A band, 5m thick, exposed on the shore of Dury Voe at locality B (Fig.5) contains, in addition, a colourless pyroxene, potash feldspar and disseminated iron sulphide. This band is of particular interest because it is probably responsible for the I.P. anomaly located along the strike to the north.

A few thin but well-defined pelitic bands are exposed on the shore of Dury Voe. They contain single-crystal microaugen of oligoclase and potash-feldspar, the former being the most abundant.

Crystalline limestone is particularly abundant in the Dury Voe section. Most of it is very impure owing to the presence of layers rich in calc-silicate minerals. It is interbanded on all scales with calc-silicate rock and semipelite and many of the bands have transitional boundaries. A thick limestone showing intense internal folding runs through Vidlin village. Only two bands of limestone are exposed on Vidlin Ness. East of locality 1 (Figs. 4 and 6) a band of limestone averaging 1m in thickness can be followed along the strike for 150m and used to demonstrate the discordant nature of the sulphide horizon described below. The decrease in the amount of limestone when the calcareous unit is traced northwards from Dury Voe to Vidlin Ness is probably a sedimentary facies variation.

Quartzose bands are found among the calc-silicate rocks and semipelites. Well-bedded quartzite about 30m thick and containing feldspar grains which are probably of detrital origin is exposed on the shore of Dury Voe at locality C (Fig.5). Quartzite is also a constituent of the sulphide horizon.

At Vidlin Ness there is an important development of hornblende-schist. It is intimately interbanded with calc-silicate rock and it is this interbanded sequence which contains the sulphide horizon. West of locality 1 (Fig.4) the hornblende-schist bands, making up about 50% of the total rock, vary from a metre or so down to a few centimetres in thickness but to the east and south individual bands are much thicker. Much of the hornblende-schist probably dies out a short distance south of Vidlin village, and on the shore of Dury Voe although bands up to 5m thick are common they constitute less than ten per cent of the calcareous unit.

The hornblende-schist is generally homogeneous but an internal foliation caused by variations in the proportions of hornblende and feldspar has been noted in places. Small garnets are present and in thin section the hornblende crystals are seen to have a characteristic pale-brown core and a narrow greenish rim. Minor amounts of iron sulphide occur and a band about 8m thick on the shore of Dury Voe at locality A (Fig.5) contains about four to five per cent of the material, sufficient to cause a rusty-weathering crust.

Coarse-grained amphibolite, apparently unique in the calcareous unit, lies along the eastern side of the sulphide horizon between localities 2 and 3 and faulted lenticles of it are found at locality 1. In hand specimen it is black in colour with conspicuous randomly-orientated crystals of hornblende, biotite and chlorite. It has an ultrabasic appearance although in thin section it is found to have about 5% plagioclase and quartz.

The Sulphide-Rich Horizon

A sulphide-rich zone reaching more than 10m in thickness is exposed at several localities on the coast of Vidlin Ness (Figs. 3, 4 and 6). It runs approximately parallel to the regional strike for at least 550m. In the north it extends under the sea for an unknown distance and in the south there is geophysical evidence to suggest that it may continue inland (Burley, July 1975). The contacts against the adjacent country rock are sharply defined but on the skerry at locality 1 (Fig. 6) the sulphide-bearing rocks appear to grade into hornblende-schist. In places the contact is discordant with respect to the foliation in the country rock although there is very little of the crushing that might be expected if this was due to faulting. At the south end of locality 4 the sulphide horizon abuts against a "nose" of hornblende-schist and appears to split into two branches. The western branch appears to pass inland where is covered by a thin deposit of drift but it could probably be exposed by trenching. The eastern branch follows the coast line just below low tide level and reappears 70m south of locality 4 where it is at least 3m thick. It probably dies out some distance further south because there are no indications of it where it would be expected to intersect the coast again at HU 47956609.

The foliation within the "nose" of hornblende-schist runs parallel to the contact which, superficially at least, resembles a fold closure.

Determination of the angle of dip presents a problem because all the exposures are at sea level and the sulphide horizon is only seen for a maximum of 2m in a vertical direction. However it is reasonable to assume that it is sub-parallel to the foliation which dips to the west at $70^{o}$ to $80^{o}$. Confirmation of this is provided in the six drill-holes.

The sulphide horizon is made up of massive sulphides, sulphide-bearing tremolite-schist and quartz-rock. The internal relationships are difficult to determine owing to the presence of a thin ferruginous crust produced by weathering. The massive sulphides usually have gradational boundaries against the tremolite-schist but the quartz-rock has fairly sharp contacts. There are vague fold structures particularly at localities 1 and 4 and the quartz-rock bands are discontinuous.

The massive sulphides are non-foliated and have a patchy granular texture due to the uneven distribution of iron sulphide, chalcopyrite, carbonate, amphibole and quartz. Locally there are small amounts of sphalerite and galena, particularly at locality 3. The tremolite-schist varies from fine-grained and well-foliated to coarse-grained and non-foliated. In addition to the tremolite it also contains quartz, muscovite, phlogopite, plagioclase and sulphides. The quartz-rock consists of parallel-orientated blades of tremolite in a matrix of granular quartz. Minor amounts of phlogopite, sulphides and elongated aggregates of plagioclase are also present. A well-bedded siliceous rock exposed on the skerry at locality 1 has been identified as chert by M S Garson (October, 1975) but whatever its origin it is now in the condition of quartzite. Similar cherty material occurs at locality 4 where there are also some siliceous rocks of probable sedimentary origin.

Weathering of the sulphide-rich rocks and the consequent release of iron into water percolating downhill has led to the formation of limonite-cemented drift preserved as erosion-resistant patches at localities 1, 2 and 3.

Two mineralized bands are exposed on the shore of Dury Voe. At locality A (Fig.5) hornblende-schist contains more than the average amount of iron sulphide but because it has not been detected geophysically to the north it is probably only of local significance. A band of calc-silicate rock 5m thick at locality B (Fig. 4) contains disseminated iron-sulphide, and geophysical evidence (Burley,July 1975) suggests that it may be a southerly extension of the Vidlin Ness sulphide-rich horizon.

The mapping has shown that the copper-bearing sulphides at Vidlin Ness occur within an interbanded sequence of calcareous metasediments and basic rocks (hornblende-schist) which may be of contemporaneous volcanic origin.

Locally at least the sulphide horizon is associated with an unusual coarse-grained amphibolite which has ultrabasic affinites. The sulphide horizon trends approximately parallel to the regional strike and is probably continuous between locality 1 and locality 4 where it appears to split into two branches, the easterly one pinching out within 250 metres. The internal folds and foliation show that it has suffered fairly intense plastic deformation and the local discordances noted along the margin are probably the result of shearing movements under deep-seated conditions during the regional metamorphism although later faulting under brittle conditions may also be a factor particularly at locality 1. The presence of tremolite-schist and quartzite show that the horizon is of sedimentary origin although the sulphides were not necessarily introduced at the time of deposition.

Much of the hornblende-schist wedges out south of Vidlin and in the same direction the proportion of crystalline limestone increases. These variations probably represent original facies changes and are significant in connection with possible extensions of the sulphide horizon. If the sulphides are genetically related to the basic rocks, which seems likely, then the sulphide horizon probably dies out towards the south. Conversely it would be expected to be more strongly developed under the sea to the north of Vidlin Ness. The line of I.P. anomalies stretching from Vidlin to the shore of Dury Voe may be caused by the sulphide horizon in a diminished condition. However on the shore of Dury Voe (locality B) it appears to contain only iron sulphides.

The geology of Vidlin resembles, in some respects, that of the recently investigated area of mineralization near Loch Tay where sulphides are associated with striped calcareous schists containing metavolcanic beds although at Loch Tay the rocks (Ben Lawers Schist) are much higher in the Dalradian Succession (North of Scotland Project, Central Perthshire Report).

Intrusive Igneous Rocks

Several dykes of lamprophyre (spessartite) trending south-south-east and generally less than 1m thick cut the metamorphic rocks at the north end of Vidlin Ness.

Numerous minor intrusions are exposed on the coast of Dury Voe. In order of emplacement the rock types are foliated pegmatite, felsic porphyrite and granite. There is also a later generation of pegmatite veins which cut the felsic porphyrite but their relation to the granite is not clear.

The felsic porphyrite is fine-grained with small oligoclase phenocrysts and occurs as discordant veins usually only a few centimetres thick. A weak internal foliation is evident in places and at Skeo Taing the veins have been folded and tectonically disrupted into lenticles.

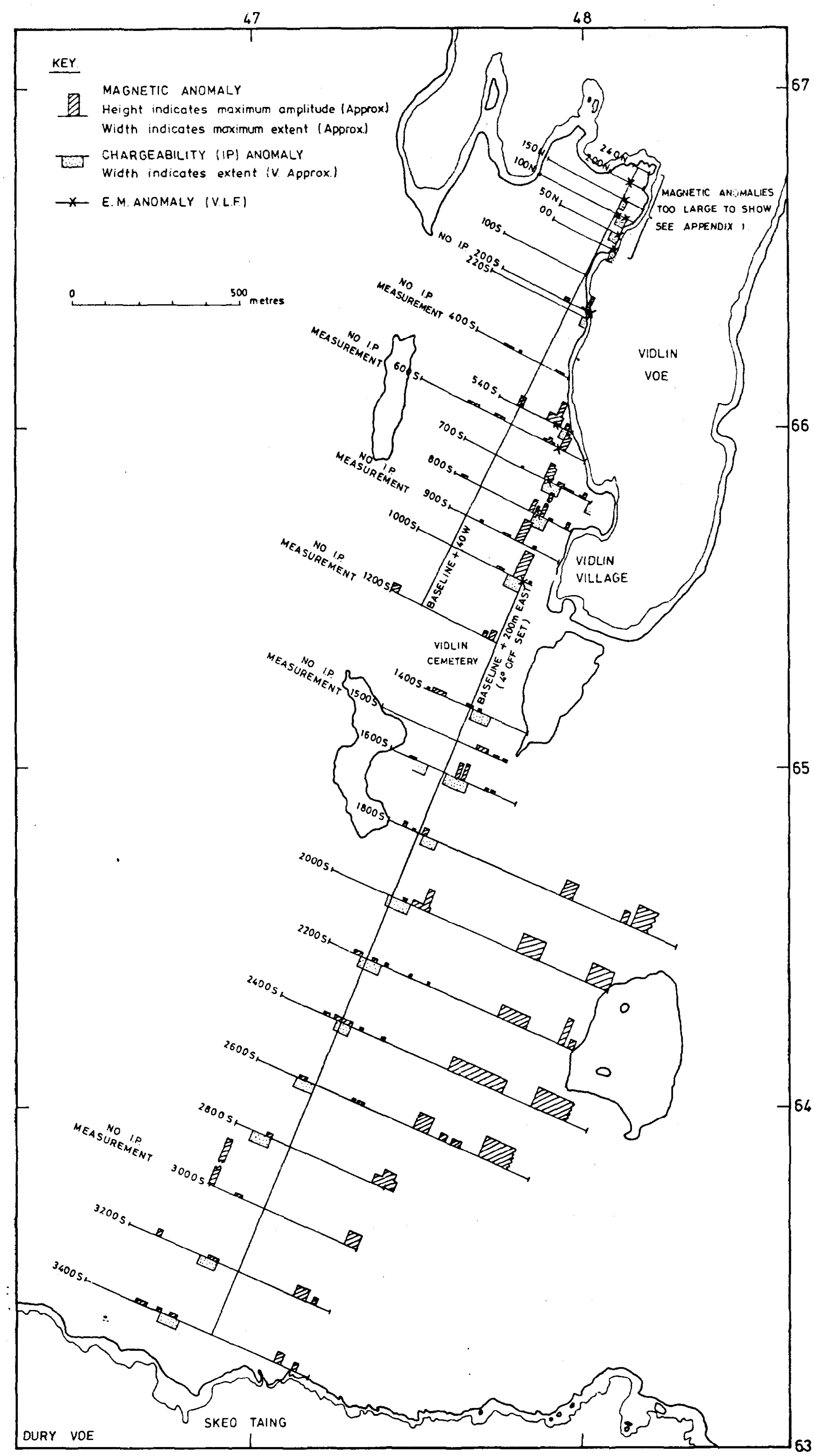



Fig. 7. Geophysical anomalies in the Vidlin District

The granite mass north-east of Skeo Taing (Fig. 5) is a gently-inclined sheet made up of two distinct varieties; a pale coarse-grained granite and a darker fine-grained granite. The coarser variety contains biotite and hornblende and shows the effects of some granulitisation and recrystallisation. The faulted wedge of granite alongside the Nesting Fault is extensively shattered. The granite masses are associated with a plutonic complex (The Graven Complex) situated on the south side of Dury Voe.

All the intrusions probably post-date the mineralization. At locality A, felsic porphyrite veins which cut the sulphide-bearing hornblende-schist are not mineralized.

GEOPHYSICAL SURVEYS

The first geophysical surveys, including measurements of magnetic field, conductivity and induced polarisation (I.P.) effect were carried out by A J Burley and M Parker over the northern part of Vidlin Ness (Report dated October 1974). The results indicated the location of the sulphide zone beneath peat cover and showed a strike length of at least 460 metres. After the detailed geological examination of the area and the photogeological interpretation by J H Bateson (described in the previous chapter) the geophysical surveys were extended to the coast of Dury Voe in June 1975.

The Measurements

Measurements of magnetic field, chargeability (I.P. effect), resistivity and electromagnetic (E.M) response were made along the lines shown in Fig. 7. A Hunter Mark 3 I.P. equipment was used to measure chargeability and resistivity, using 30 metre dipoles (20 metres in the north) in the 'dipole-dipole' configuration. The chargeability parameter measured in this case was the time integral of the secondary decay voltage between 240 and 1140 milliseconds after termination of a 2 second square wave transmitted pulse: it has been normalised with respect to the primary (transmitted) voltage and is expressed in milliseconds.

Magnetic measurements at Vidlin Ness where steep magnetic gradients were encountered were of the vertical field using a Jalander magnetometer; elsewhere a proton magnetometer was used to measure the total magnetic field. E.M. measurements were made using a Geonics V.L.F. E.M.16 equipment, and on certain lines (e.g. 150N) using an A.B.E.M. demigun.

Description of Results

The results of interest are presented in detail in Appendix I and summarised in Fig.7. In this section the results are described, starting in the north and working southwards.

The earlier measurements in the extreme north of the area show a linear zone of very high conductivities (i.e. low resistivities giving large, well-defined E.M. anomalies) coincident with prominent magnetic anomalies: these indicate the continuity of mineralization between the exposure on the north shore, near line 240N, and the outcrop on line 00. The 'double' anomalies (both E.M. and magnetic) on line 100N suggest a sinistral displacement of the mineralized zone at this point of just over 20 metres. The highest conductivities of over 1 mho $m^{-1}$ (corresponding to resistivities of less than 1 ohm m.) were measured on the most northerly line and the anomalies become progressively less pronounced southwards. The results for line 100S do not show comparable anomalies but the V.L.F. E.M. results on this line (see Appendix I) suggest that the structure is not far off shore. On line 200S the magnetic anomaly over the exposed mineralization on the shore is smaller than those in the north, corresponding to its reduced width; the absence of anomalies on 220S suggests that the mineralization does not extend inland at this point. Broad zones of high chargeability increasing with depth coincide with the other geophysical anomalies, but they are poorly defined and may be affected by sea water.

Similar anomalies were recorded on line 540S approximately on strike with the mineralization further north, and continue with greatly varying amplitude to line 1000S: this variability implies corresponding changes in the width and composition of the source. Conductivities are generally lower than in the north. The anomalous zone follows a steep bank running parallel to the shore immediately west of the village. Magnetic results on some lines are complicated by additional anomalies to the west which are not apparently associated with conductive material.

On line 1200S no clearly defined EM anomalies were recorded and it was not possible to make IP or resistivity measurements. Two magnetic anomalies lie almost on strike with those to the north.

From line 1400S southwards there is a series of chargeability anomalies approximately on strike with those to the north. Associated resistivities are typically of a few hundred ohm metres and provide an insufficiently sharp contrast with the surrounding rocks to give rise to significant EM anomalies: the EM profiles for these lines are therefore omitted from the appendix. The anomalous chargeabilities extend to near the coast of Dury Voe, but are less pronounced on the most southerly lines (3200S and 3400S). Associated magnetic anomalies are generally weak, being of the order of 100nT compared to a few thousand nT in the north. Towards the eastern ends of lines 1800S to 3400S, larger magnetic anomalies were recorded, but these are not associated with high conductivity or chargeability and are believed to arise from magnetite-rich pelitic gneiss (see section on the aeromagnetic anomaly east of Vidlin.)

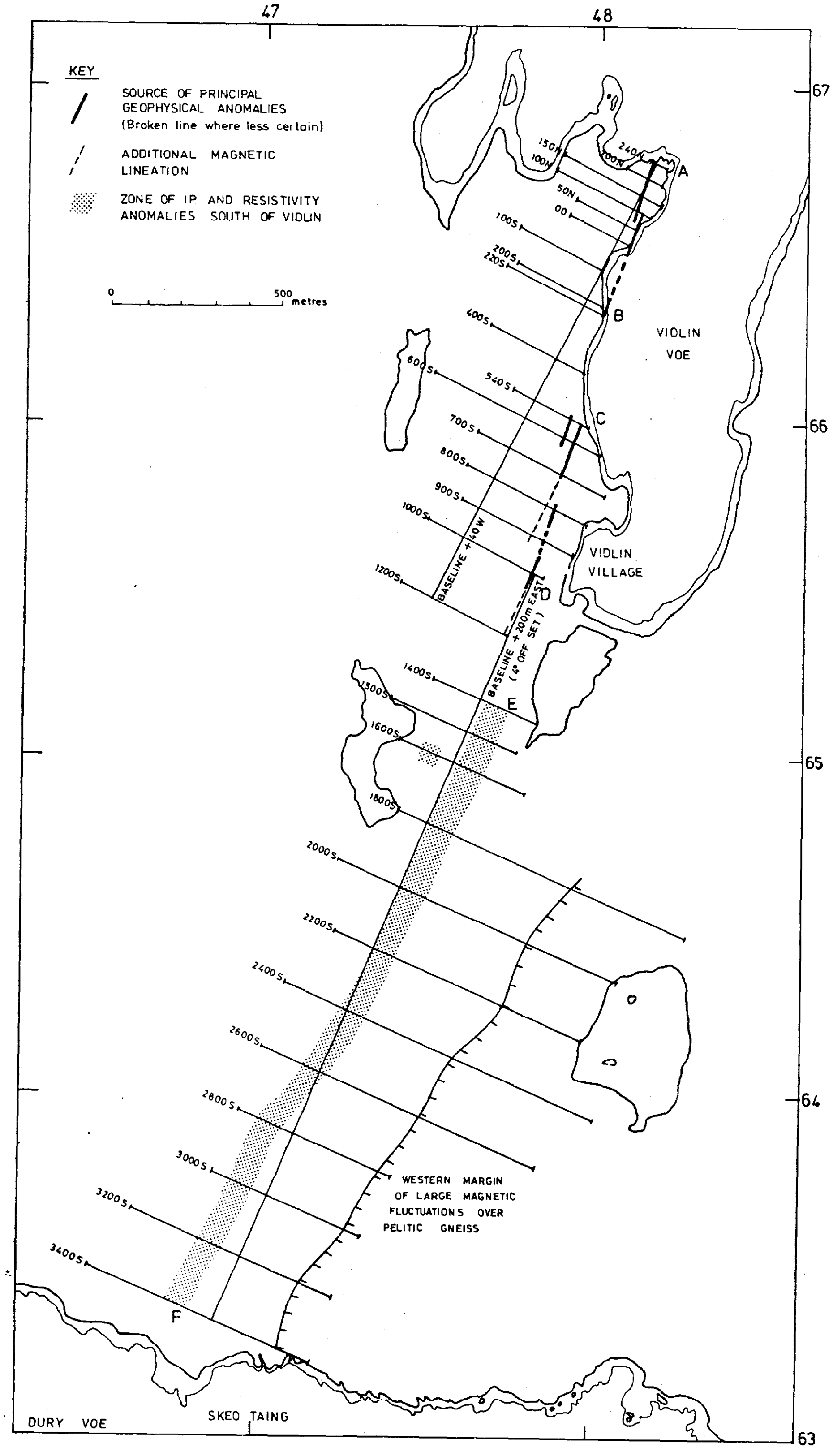



Fig. 8. Positions of sources of geophysical anomalies

## Assessment of Results

Fig 8 indicates the estimated positions of the sources of the principal geophysical anomalies which can be divided into 3 groups. Those in the north (A B) are the most pronounced and well-defined and result from massive sulphides extending close to the surface. The greatest thickness of mineralization coincides with the most prominent anomalies, close to the north shore. At B the thickness is greatly reduced and there is no evidence of substantial mineralization on line 400S.

The second group of anomalies, CD, show considerably greater variation but they could arise from an extension of the mineralization in the north. They coincide with the western margin of the hornblende-schist (see Fig. 3) which forms a ridge parallel to the shore. Between points D and E the amount of geophysical evidence obtained was limited by interference from artificial structures. The postulated continuation of the horizon to the coast of Dury Voe, EF, is based primarily on IP and resistivity results, reflecting a source which is only weakly conductive and magnetic. It should be remembered that differential weathering to clays can also cause IP and resistivity anomalies.

The positions of possible faults in the area, deduced from the magnetic and IP results, are shown in Fig. 8.

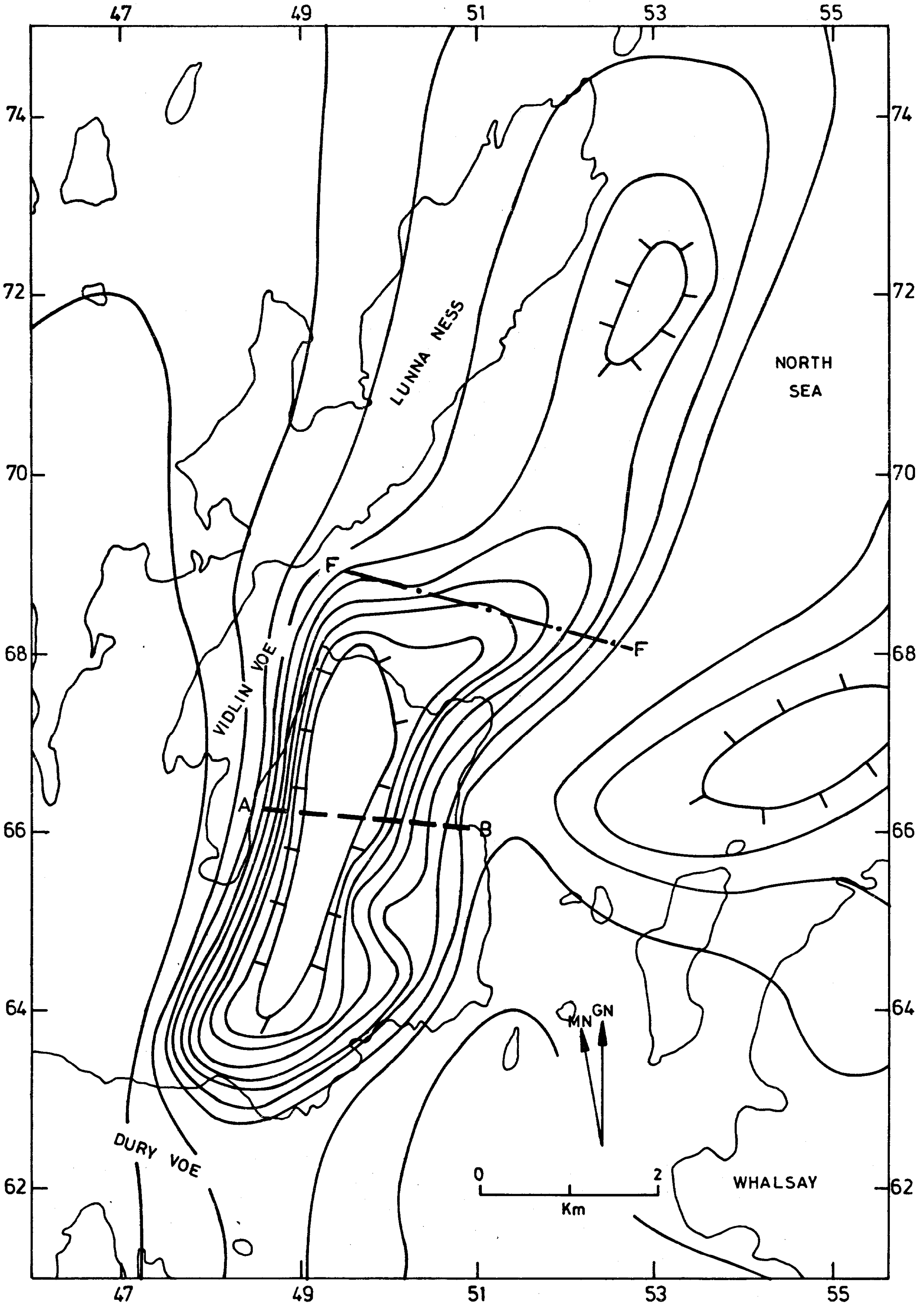
## The Aeromagnetic Anomaly East of Vidlin

An elongated aeromagnetic anomaly running parallel to the geological strike lies over the promontory between Vidlin Voe and Lunning Sound (Fig.9). This was investigated on the ground by G Marsden (Fig.10). The results show a series of short wavelength (typically 50metres) fluctuations superimposed on a positive anomaly approximately 2 kilometres wide with an amplitude of 700 nT. The body causing the major anomaly is about 6km long and extends near to the surface. To the north lies a weaker anomaly whose axis is displaced from the main ore: if the source is a continuation of the body to the south, it is probably downthrown and displaced eastwards by a fault (as indicated in Fig. 9).

Dr D Flinn (pers. comm.). has identified the source of the main aeromagnetic anomaly as a band of magnetite-rich pelitic gneiss: the shorter wavelength anomalies must, then, represent outcropping or near-surface bands containing a higher proportion of magnetite. An EM traverse using VLF equipment showed no appreciable anomalies of the kind measured west of Vidlin Voe.

## GEOCHEMICAL SURVEYS

Geophysical work undertaken in June 1975 by A. Burley and M Parker outlined a linear group of IP and magnetic anomalies stretching south from Vidlin Ness to Dury Voe. In order to investigate the cause of these anomalies and find if the exposed copper mineralization at Vidlin Ness continued southwards under the drift, it was decided to carry out a geochemical survey by sampling the




CONTOUR INTERVAL 50 nT SCALE 1:63360

A — — — B GROUND TRAVERSE F —— · —— · ——F POSSIBLE FAULT

Fig. 9. The aeromagnetic anomaly east of Vidlin

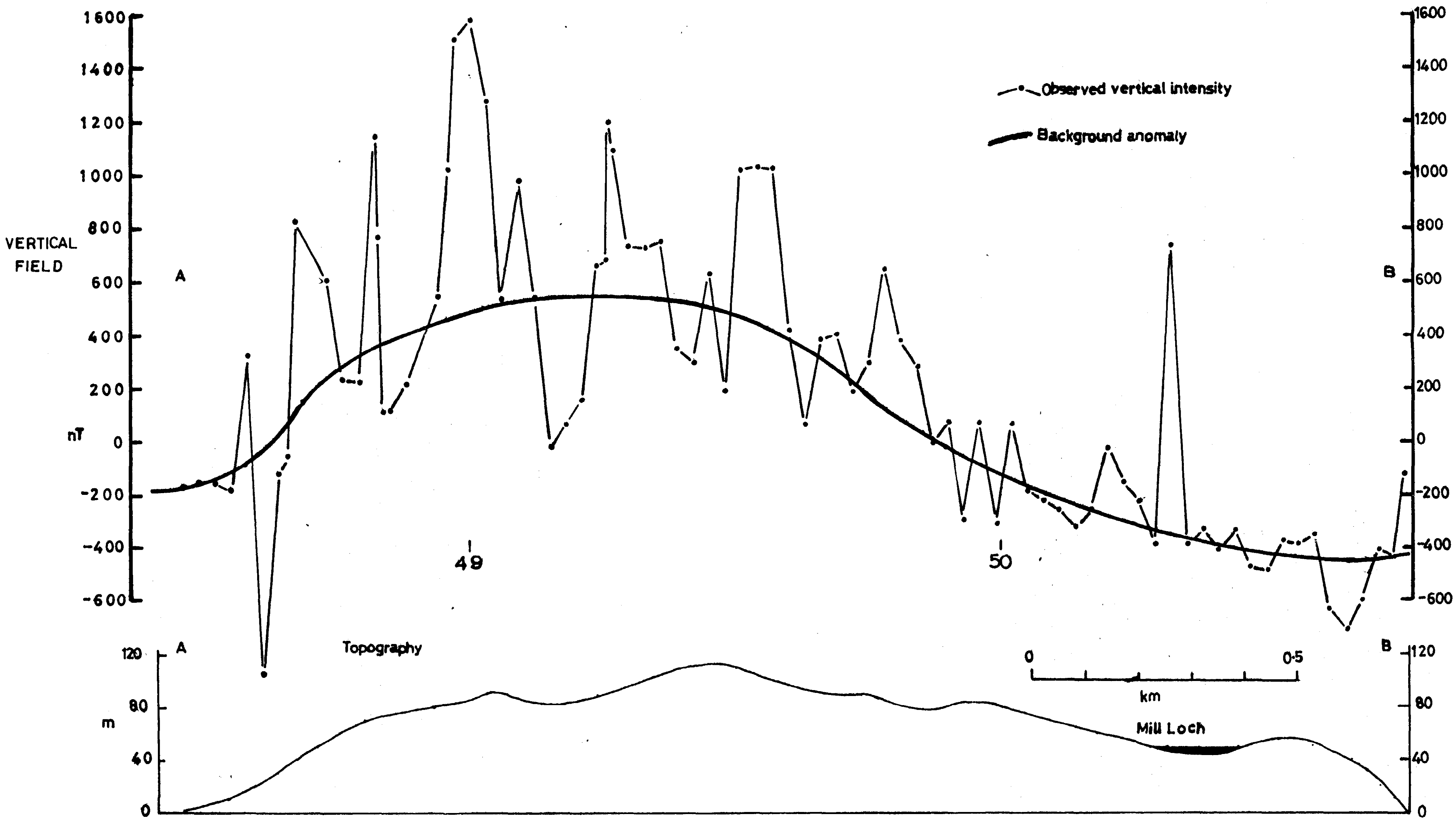



Fig. 10. Ground profile across the aeromagnetic anomaly

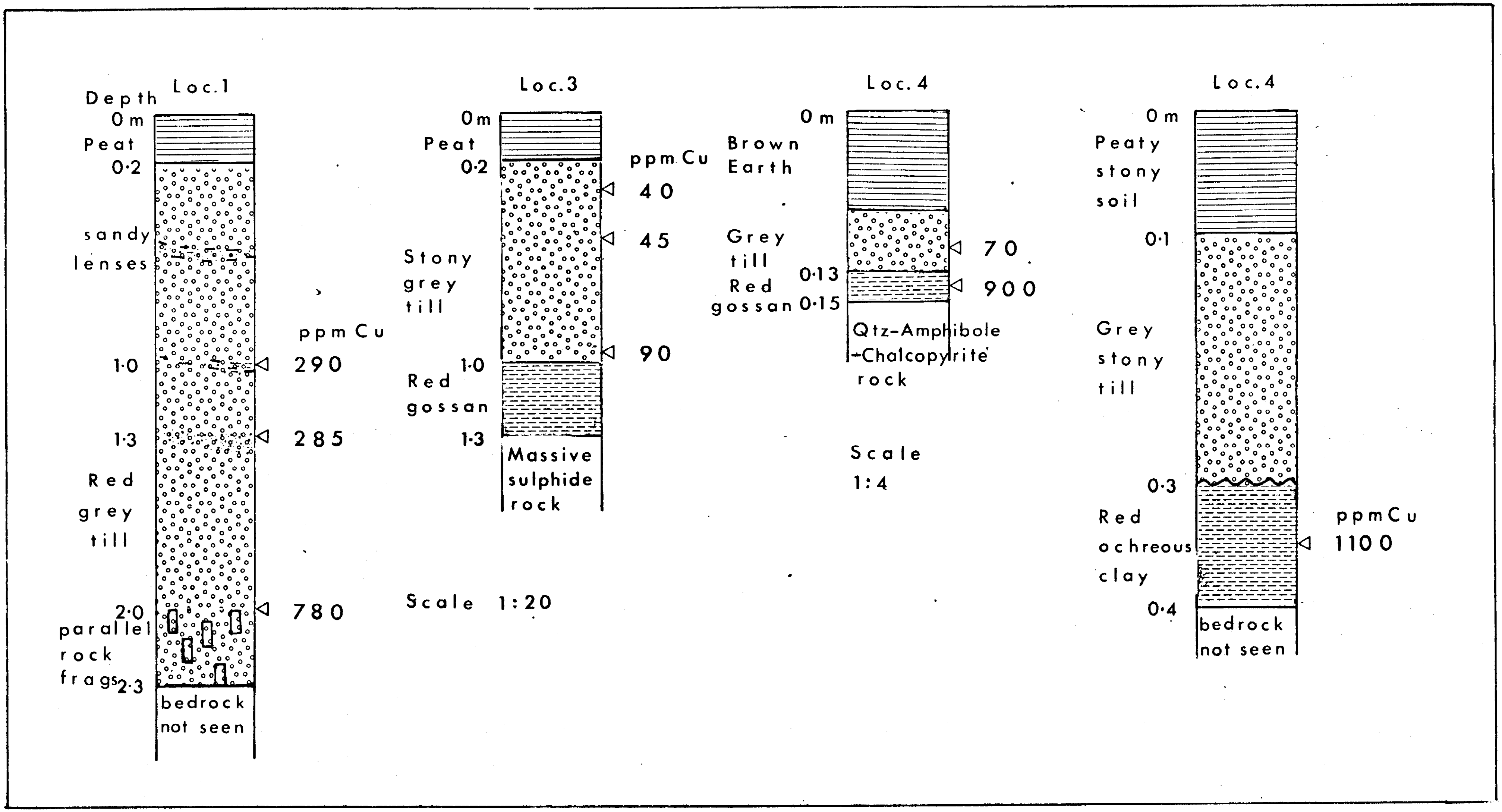



Fig. 11. Soil profiles at localities 1, 3 and 4 on Vidlin Ness with copper concentrations

bottom of the till with a power auger.

The relief of the area is generally low, rising steeply only on the pelitic geneisses to the east of Vidlin. Vegetation is mainly heather and moor grass, with some small areas of improved grassland near Vidlin and Skelberry. There are numerous small boggy pools and depressions but little active erosion by the small streams.

The drift covering the area varies from zero to 6m in thickness, averaging about 2m. The top 0.5-2.7m consists of peat, thicker in the depressions in the landscape but being reduced in other parts by cutting for fuel. The underlying drift is a clay/silt with occasional sandy layers containing frequent clasts about 1 cm size whilst boulders up to 0.5m are also seen in the few visible sections. This boulder clay is ice-deposited and contains boulders of granite, gneiss and schist that cannot be matched locally. At Vidlin Ness locality 3 (HU48076651) the grey, stony, exotic till overlies the hard, iron-cemented gossan, but at locality 1 (HU48166676) the till is red in colour and contains orientated fragments that appear to be bedrock rotted in situ. Generally however the grey, stony till that overlies the mineralization is exotic and not derived from the underlying bedrock.

<u>Orientation Sampling</u>

In order to define the anomalies that were likely to occur over the mineralization, samples were collected from the drift profiles at localities 1, 3 and 4 (Grid Reference HU48016634). Fig.11 shows the distribution of copper within the profiles and it can be seen that the grey, stony till overlying the red gossan gives only background values for copper (background = 47 ppm Cu as calculated from the survey traverses). The red ochreous till, immediately above the gossan, contains anomalous copper values up to 1100ppm. The hard iron-cemented gossan was perhaps formed during an interglacial period and covered by a later re-advance which deposited the grey till.

The section at locality 1 is unusual in that all the profile, below the peat, is red in colour, has sandy layers within it, and is anomalous in copper throughout. This could be due to either percolation of copper-bearing, iron-rich solutions into the till or local preservation in a deep hallow of a soil developed <u>in situ</u> during an interglacial period.

In general the orientation work showed that there is little upward geochemical dispersion and that it is reasonable to expect that the mineralization is overlain by exotic till. It was therefore decided to sample the base of the till wherever possible.

As part of the orientation work a study was made of the regional geochemical map of the Shetland Islands which is now on open file at the London and Scottish offices of the Institute. The area of the geophysical anomalies is, however, not drained by many streams and all the streams sediments in the area from Vidlin to Dury Voe had less than 20ppm Cu, except for the stream draining south from Burga Water (HU479640) which contained 45ppm. This stream was resampled every 200 metres upstream of the original site. The original result could not be repeated, all the stream sediment copper values being 20ppm or below. Pan concentrate samples also were low in copper with a peak value of 23ppm and it must be assumed that the original sample was contaminated or its analysis was in error.

Stream sediment sampling therefore did not help to locate this mineralization and it would probably have been missed if the area had not been geologically mapped. The reasons for this failure were lack of significant geochemical dispersion into the till, the small number of streams crossing it, and the low-lying nature of the terrain with little active erosion.

Method

The choice of sample interval was made on the basis of the relatively sharp, linear geophysical anomalies, the small across-strike width of the mineralization (about 5m), the lack of dispersion, and the need to reduce the number of sample sites and the distance of movement between auger sites. Accordingly samples were collected at 10m intervals along the 400m spaced geophysical lines and also along intervening 200m lines where possible (Fig. 12). Three sites were also selected on geophysical line 2400S to investigate the magnetic anomalies over the pelitic gneiss.

Sites were sampled using an Atlas-Copco 'Minuteman' power auger, which has a small petrol-engine driving a set of spiral auger flights. It is capable of collecting soil samples from depths up to 9 metres. It lacks the power to penetrate large stones but can shoulder aside smaller ones. Samples were taken at about every metre through the profile until the bit reached bedrock. The main uncertainty of the method lies in deciding whether the auger has reached the bottom of the till or just hit a large boulder.

Each till sample of about 100 gms was placed in a kraft paper bag and sent to the field laboratory, where it was dried and sieved through 80 mesh. A 5 gm split of the fine fraction was ground to -200 mesh in an agate planetary ball mill. This sub-sample was analysed for Cu, Pb, Zn, Co and Ni by atomic absorption spectrometry using a hot nitric acid attack, and for total Cr, Mn, Fe, Co, Ni and Ba by emission spectrography.

In an attempt to locate the mineralisation in the field a few till samples were panned and the heavy minerals visually identified. These pan concentrate samples were then ground and analysed by X-ray fluorescence for Ba, Pb, Zn, Cu, Ni, Fe, Mn and Ti.

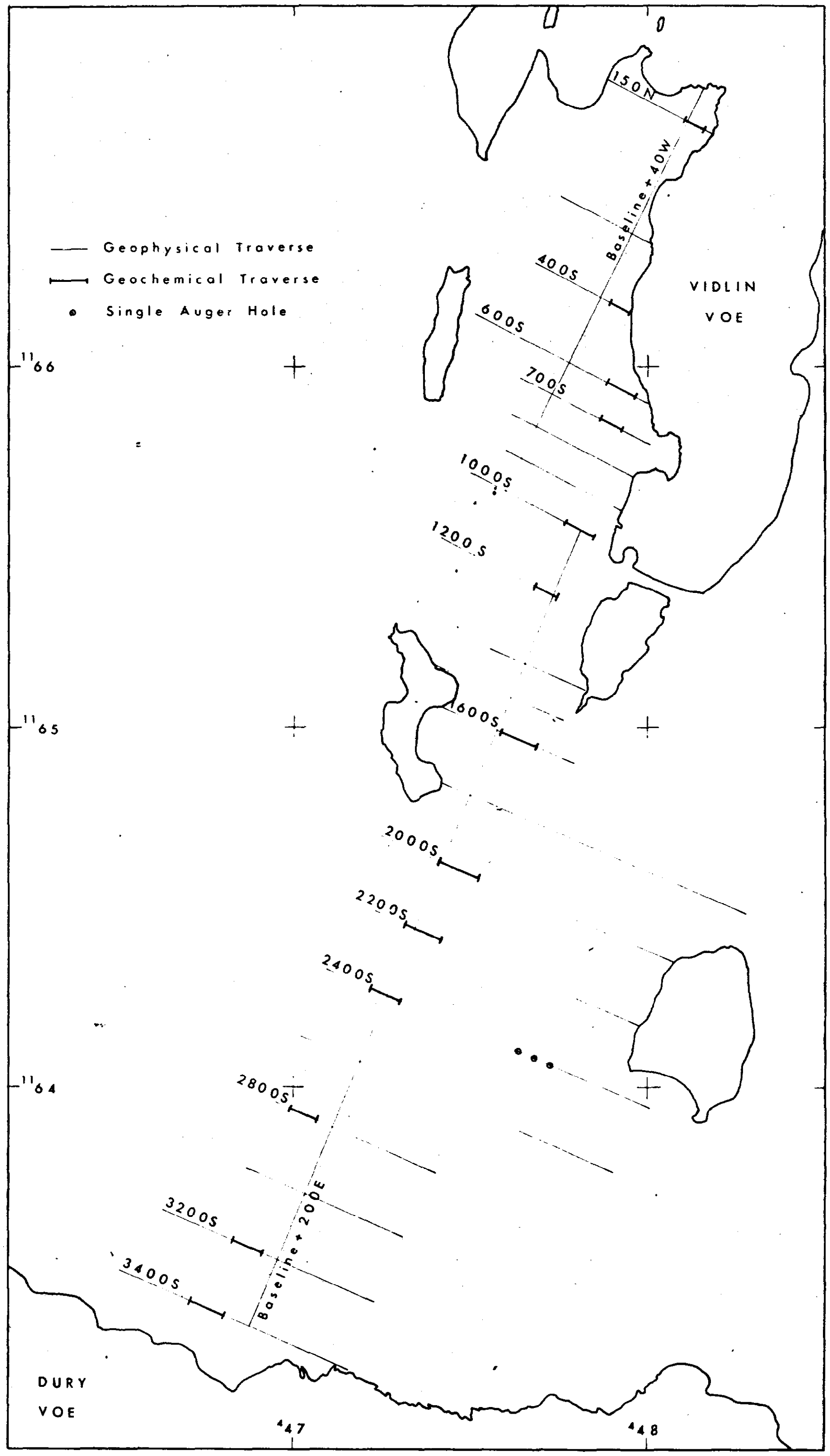



Fig. 12. The location of geochemical and geophysical traverses at Vidlin

## Results

The geochemical traverses are shown on Fig. 12. and the number, location, depth and chemical analysis of each sample given in Appendices II and III.

The results of the pan concentrate method were not encouraging. No chalcopyrite or other copper-bearing mineral was identified in the field and there was thus no visual check on the presence of the mineralization. The summary statistics for the panned till samples are presented in table 1. Samples CHP5 and 7 from over the Vidlin Ness mineralized horizon do not contain noticeably higher values for Cu or other base metals. The only anomalous samples (greater than the threshold) are CHP 119 (Zn 140 ppm, Cu 70 ppm), CHP 145 (Pb 38 ppm, Zn 139 ppm, Ni 52 ppm) and CHP 180 (Pb 28 ppm, Cu 51 ppm, Ni 78 ppm). CHP 119 is situated on traverse 2800S and the base of till sample at the same location is also anomalous in copper and zinc. Sample CHP 145 is from one of the auger holes which investigated the large magnetic anomalies east of Vidlin. It is very iron-rich (25%) and the anomalous zinc, nickel and, possibly lead, may be present in magnetite; although this has not been confirmed mineralogically. Sample CHP 180 is probably contaminated by metallic swarf from the auger flights. This was noted in the field but the possibility again needs further mineralogical confirmation.

### TABLE 1

Mean, standard deviation and geochemical threshold on panned till samples from Vidlin, Shetland (N = 29)

| Element | Mean, $\bar{x}$ | Standard Deviation, $\sigma$ | Threshold, $\bar{x} + 2\sigma$ |
|---|---|---|---|
| Ba (ppm) | 333.8 | 84.0 | 501.8 |
| Pb (ppm) | 7.8 | 8.6 | 25.0 |
| Zn (ppm) | 68.0 | 24.8 | 117.6 |
| Cu (ppm) | 19.0 | 13.4 | 45.8 |
| Ni (ppm) | 24.8 | 12.8 | 50.4 |
| Fe (%) | 5.85 | 4.03 | 13.91 |
| Mn (%) | 0.104 | 0.063 | 0.230 |
| Ti (%) | 0.553 | 0.442 | 1.437 |

The summary statistics for the analyses of the base of the till samples are given in Table 2. These are all carried out on untransformed data; a log-transformation has been done and this produces little or no difference in the interpretation except where mentioned.

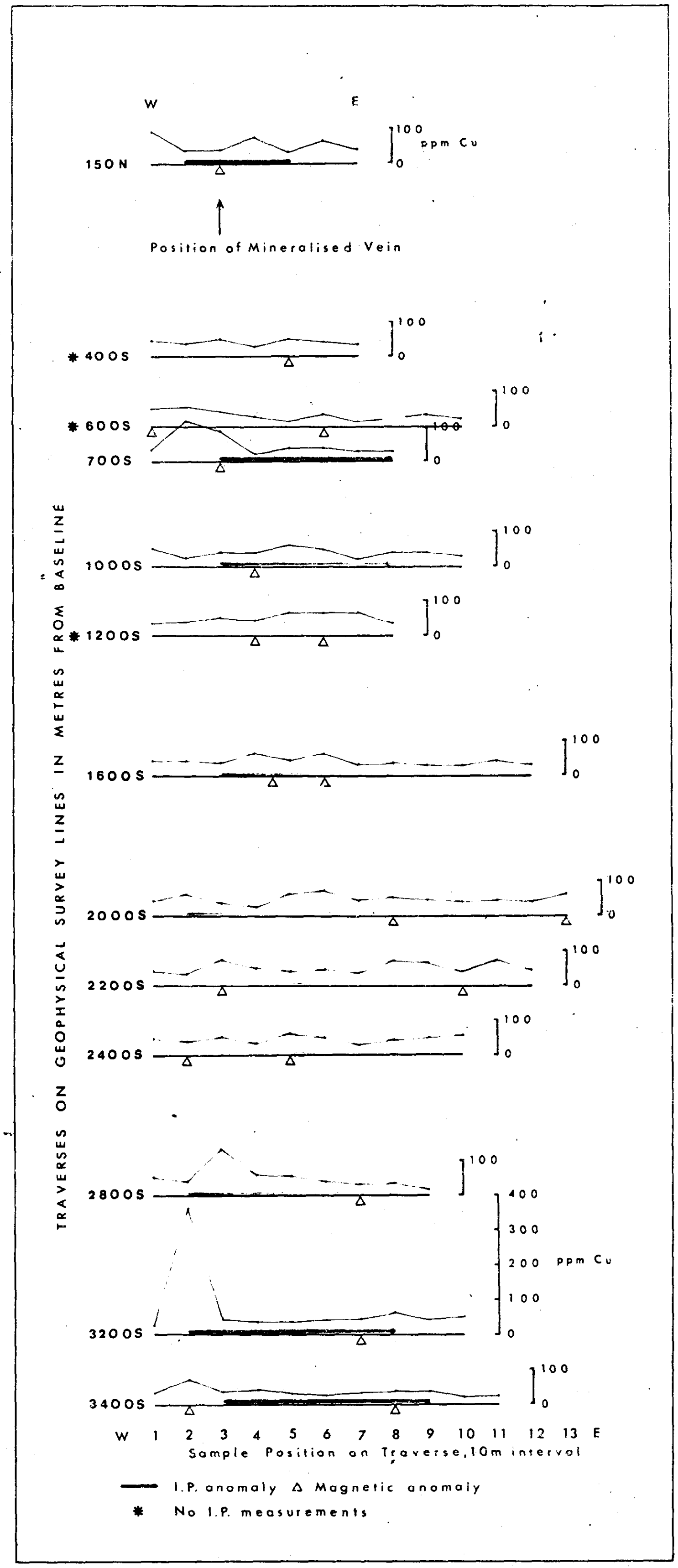



Fig. 13. Copper in base of till samples, Vidlin

TABLE 2

Mean, standard deviation and geochemical threshold on base of till samples from Vidlin, Shetland (N = 122)

| Element | Method | Mean, $\bar{x}$ | Standard Deviation, $\sigma$ | Threshold, $\bar{x} + 2\sigma$ |
|---|---|---|---|---|
| Cu | A.A.S. | 47.3 | 33.4 | 114.1 |
| Pb | " | 50.2 | 149.0* | 348.2 |
| Zn | " | 121.9 | 172.5* | 466.9 |
| Co | " | 20.0 | 6.2 | 32.4 |
| Ni | " | 39.0 | 14.8 | 68.6 |
| Cr | E.S. | 82.6 | 72.4 | 227.4 |
| Mn | " | 876.4 | 570.6 | 2017.6 |
| Fe(%) | " | 4.46 | 0.89 | 6.24 |
| Co | " | 17.7 | 5.3 | 28.3 |
| Ni | " | 46.4 | 17.1 | 80.6 |
| Ba | " | 504.9 | 171.4 | 847.7 |

All elements are in ppm, except Fe which is in %

A.A.S. = atomic absorption spectrometry

E.S. = emission spectrography

*Distribution markedly positively skewed

The variation of copper in the base of the till samples is displayed in Fig.13, which shows that only three samples exceed the threshold of 114 ppm and these lie on traverses 700S, 2800S and 3200S. Traverse 150N over the sub-outcrop of the mineralized horizon on Vidlin Ness is only slightly anomalous with values up to 90 ppm. This low geochemical response is possibly due to insufficient auger penetration. Traverse 700S is more strongly anomalous with a peak value of 115 ppm Cu and several values above 80 ppm. On the Cu-Zn plot (Fig. 14) these samples plot near to the orientation samples from the Vidlin Ness mineralized horizon, with copper greater than zinc. Thus the Vidlin Ness mineralized horizon is believed to extend as far as these anomalous samples on line 700S. Massive or disseminated pyrrhotite bodies may continue further south at this horizon but there is no geochemical evidence for the continuation of the copper mineralization. The lack of response on lines 400S and 600S is puzzling unless the sulphide horizon lies offshore and is faulted back inland between traverses 600S and 700S. The other anomalous traverses 2800S (Fig.13) and 3200S, NW of Skelberry, have a sharp copper peak at their western ends, and

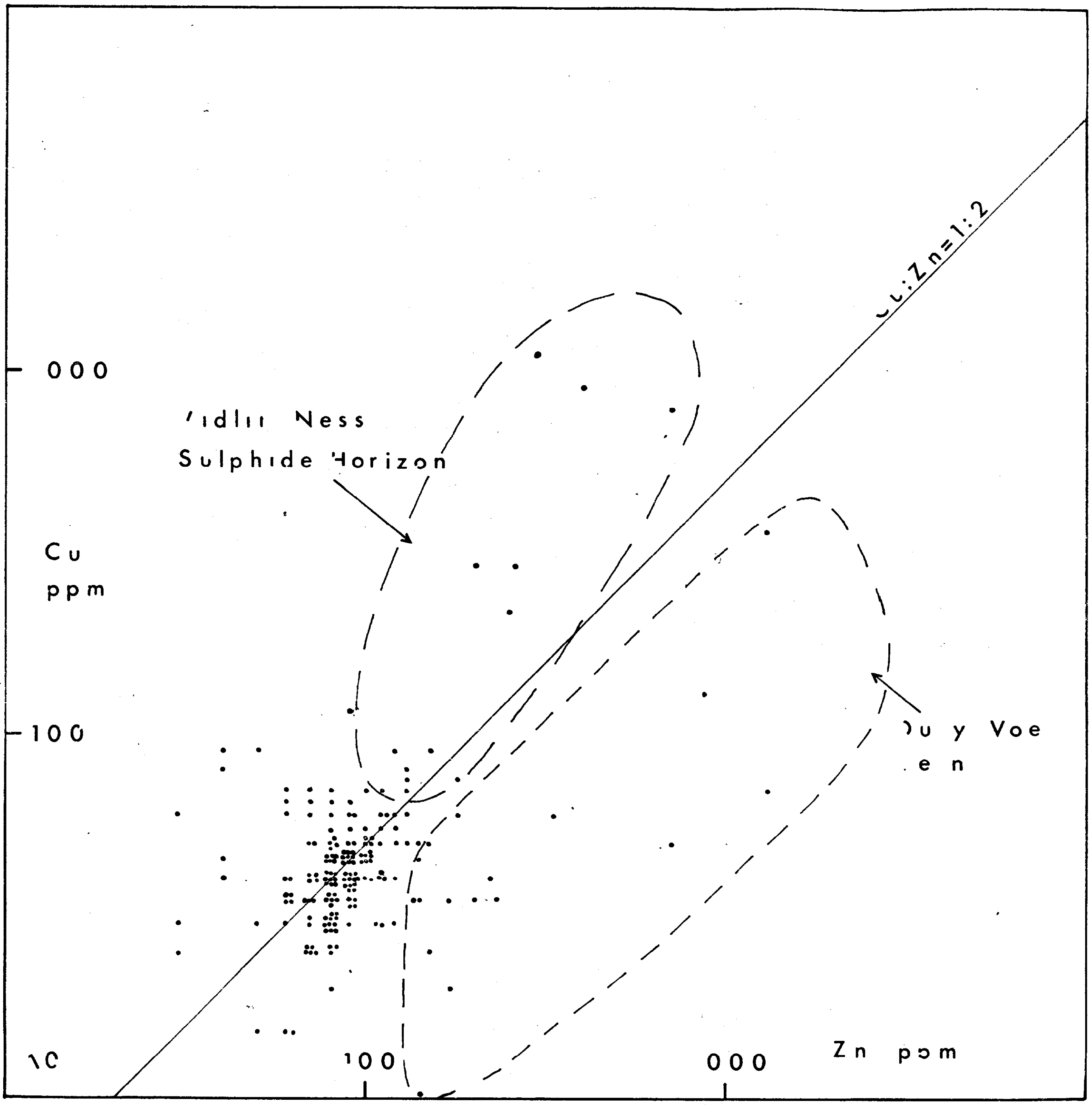



Fig. 14. Cu - Zn in till samples from Vidlin

this is paralleled by high lead and zinc, for example CHS 123 with Cu 360 ppm, Pb 1500 ppm, Zn 1300 ppm, Co 40 ppm and Ni 65 ppm. On the Cu-Zn plot (Fig. 14) all the samples from this 'Dury Voe' vein form a distinct field with Cu/Zn less than 0.3 and there is no overlap with the Vidlin Ness samples. There is a similar relationship between copper and lead (not shown). In the Dury Voe coast section on strike with this line of anomalies is a 3 m wide outcrop of 'Fault breccia' with galena and sphalerite (Fig. 5) and this is probably the cause of the geochemical and geophysical anomalies. Although galena and sphalerite are recorded in the Vidlin Ness mineralisation (Powner 1961, and Cope 1975) they are subordinate to pyrrhotite and chalcopyrite. The Dury Voe 'vein' is believed to be a slightly different type of mineralisation to that at Vidlin Ness with Pb and Zn being more important Cu. The depth of the till overlying the 'vein' is less than 2m and could be investigated by trenching.

Using the method of factor analysis, the eleven elements which have been determined in the base of till samples can be grouped into three factors; I - Co, Ni (by both methods), Cr and Fe; II - Cu, Pb, Zn and Mn; and III - Ba. The first grouping is consistent with the occurrence of basic rocks and these probably extend as far as traverse 2400S as shown by the high Co, Ni and Cr in sample CHS 107. Basic, or possibly ultrabasic, rocks appear to occur west of the mineralized horizon as shown by traverse 700S (Fig.15), where high Cr occurs west of the high Cu sample. Cu, Pb, Zn and Mn are associated as seen from Figs 14 and 15. This does not seem to be due to a secondary oxide concentration effect as some samples have high Mn without concentrating Cu, Pb or Zn. The Pb and Zn distributions are also log-normal because of the high values associated with this mineralization. If all the orientation samples are included in the factor analysis, then Cu is contained in a factor with Fe, and this is obviously due to the effect of the high Fe and Cu-rich samples collected directly over the Vidlin Ness mineralization. The third factor in the base of till sample matrix, the variation of Ba, cannot be readily related to any of the mineralization and none of the high Ba samples coincide with other high element values. Barium is probably contained in feldspar or trace amounts of barite in the metamorphic rocks.

## Conclusions

1. The copper mineralization at Vidlin Ness extends to traverse 700S but has not been detected further south. Basic rocks continue beyond the mineralization
2. The Cu, Pb and Zn anomalies on traverse 2800S and 3200S, NW of Skelberry, although different in geochemical character, are worthy of further investigation by trenching or drilling.
3. The linear geophysical features, which extend from Vidlin to Dury Voe, are not geochemically anomalous, with the exceptions noted above, and are probably caused by disseminated pyrrhotite within basic rocks.

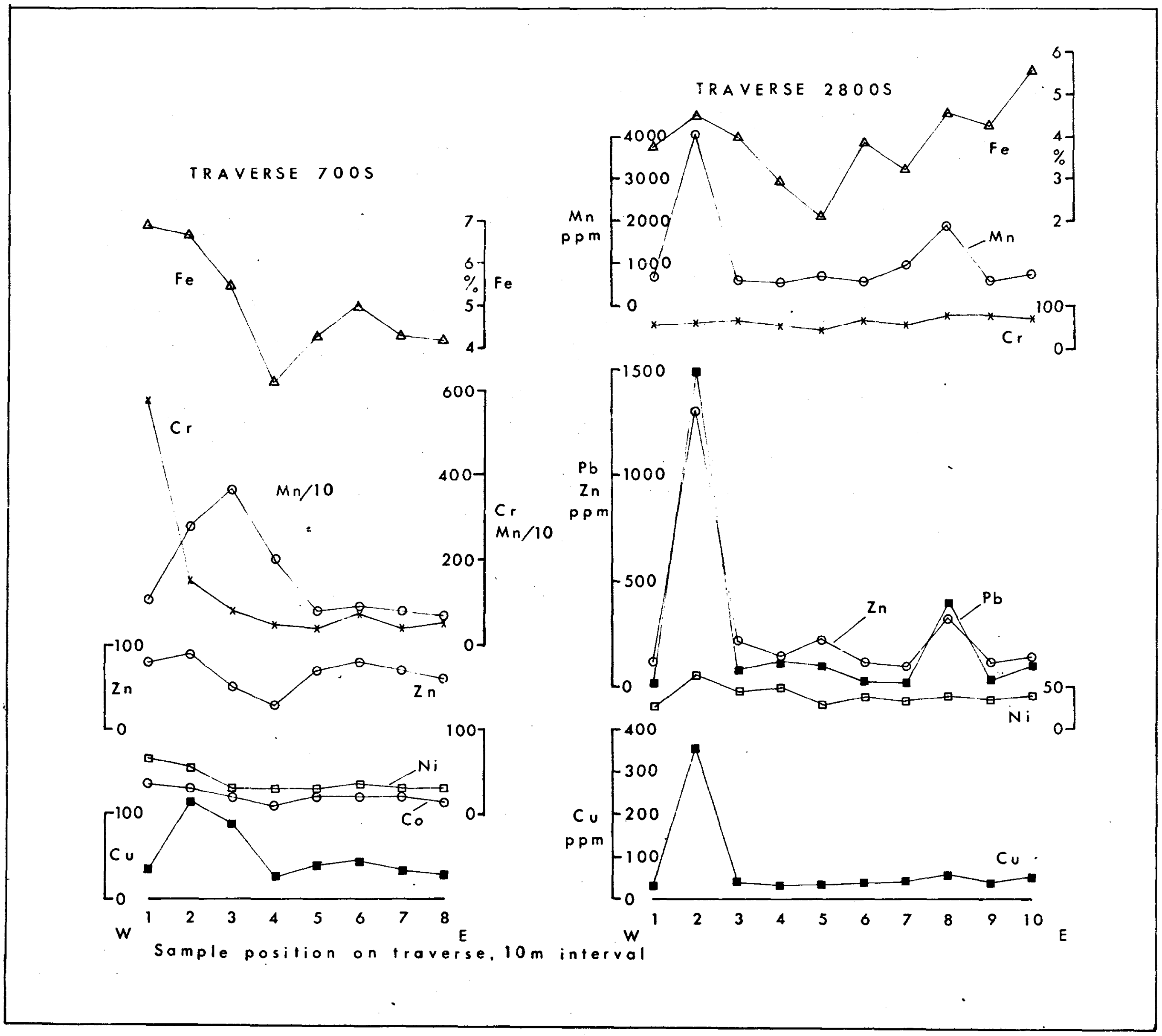



Fig. 15. Geochemical variation on selected traverses, Vidlin

## MINERALOGY

Mineralogical studies were carried out by P R Simpson and M Cope of the Mineralogy Unit on specimens from outcrops of the sulphide horizon and from sulphide-bearing hornblende-schists from Vidlin Ness and Dury Voe (Reports dated 27th November 1974 and November, 1975).

### Mineralogy of Outcrop Specimens

The massive sulphide rocks are non-foliated and have a patchy granular texture due to the uneven distribution of iron sulphides, chalcopyrite and amphibole. Chalcopyrite and local sphalerite and galena are enriched at the margins of amphibole-rich patches and quartz-rocks. In thin section there is seen to be a gradation from virtually silicate-free sulphide-rocks to heavily altered sulphide-rich amphibolites in which cavity fillings of colloform pyrite and marcasite with cores of granular pyrrhotite are truncated by a mixed assemblage of chalcopyrite, sphalerite and minor amounts of galena. The chalcopyrite exploits cleavage traces of the host amphibole and forms veinlets cutting across earlier stockworks of pyrite and marcasite.

The sulphide-bearing tremolite-rocks are dominantly recrystallized amphibole rocks that display stellate aggregates of tremolite, together with Mg-rich chlorite or talc, patches of altered plagioclase and some ilmenite grains. The opaque sulphide minerals are again the same as those in the massive sulphide-rocks with similar late cross-cutting sulphide veins. The sulphide-tremolite-rocks on the western edge of the massive sulphide horizon at locality 3 carry also calcite, mica and quartz, and elsewhere these rocks pass into quartz-rocks with disseminated pyrite and occasional aggregates of stellate tremolite.

The sulphide-bearing hornblende-rocks that form thin bands up to a few metres across at Dury Voe and the much more extensive hornblende-rocks that enclose the sulphide horizon at Vidlin Ness are amphibolites comprising colourless or greenish amphiboles with brownish green cores, plagioclase, quartz, epidote, ilmenite and sphene. Some of these rocks are altered with a development of tremolite. All have cavity fillings of pyrite and marcasite, together with disseminated pyrrhotite; but, in general, only minor amounts of disseminated chalcopyrite are present. Disseminated chalcopyrite is slightly more abundant in coarse-grained amphibolitic rocks on the eastern edge of localities 2 and 3, now altered to tremolite-chlorite rocks with only minor quantities of quartz and plagioclase. Eleven specimens from outcrops were analysed for a range of metals. Average values for each of the three types of specimen are given in ppm (Table 3).

TABLE 3.

| Specimen type | No analysed | Cu | Pb | Zn | Ag | Co | Ni |
|---|---|---|---|---|---|---|---|
| | | Parts per million | | | | | |
| Copper-rich massive sulphide | 5 | 49,160 | 270 | 6,650 | 30 | 130 | 35 |
| Sulphide-tremolite-quartz rock | 2 | 1,440 | 150 | 280 | 3 | 45 | 35 |
| Amphibolite | 4 | 210 | 30 | 80 | 1 | 50 | 65 |

Analyst, S Chaumoo, Analytical and Ceramics Unit. XRF analyses by D Bland, Mineralogy Unit, show that small amounts of chromium are also present in the massive sulphides.

Electron Microprobe Analyses

In order to provide information which could prove useful in any assessment of compositional controls acting on the various mineral assemblages, the nature of the green and colourless amphiboles was determined by EMPA of mineral grains in two selected samples (ST2 and V4c respectively). The quantities of Cu and Zn present in each phase were also determined. Analytical results are reported as oxide analyses together with calculated atomic proportions (Tables 4 and 5).

TABLE 4

Electron microprobe analyses of amphibole in specimen V4c (PTS 2264) tremolite-quartz-rock with chalcopyrite and sphalerite.

Weight Percent

| | Anal.1 | Anal.2 |
|---|---|---|
| $SiO_2$ | 55.55 | 55.09 |
| $TiO_2$ | 0.06 | 0.14 |
| $Al_2O_3$ | 2.30 | 4.96 |
| MgO | 21.04 | 21.63 |
| FeO | 3.92 | 2.22 |
| CaO | 13.25 | 13.24 |
| $Na_2O$ | 0.25 | 0.61 |
| $K_2O$ | 0.02 | 0.10 |
| CuO | 0.09 (6950ppm Cu) | 0.00 (nd.) |
| ZnO | 0.00 (nd.) | 0.00 (nd.) |
| $H_2O$* | 3.51 | 2.03 |
| TOTAL* | 100.00 | 100.00 |

Atomic Proportions

| | | | | |
|---|---|---|---|---|
| Si | 7.57 | | 7.51 | |
| Ti | 0.07 | 8.00 | 0.13 | 8.00 |
| Al | 0.36 | | 0.36 | |
| Al | 0.01 | | 0.44 | |
| Mg | 4.28 | 4.74 | 4.43 | 5.13 |
| Fe | 0.45 | | 0.26 | |
| Ca | 1.94 | | 1.95 | |
| Na | 0.07 | 2.01 | 0.16 | 2.13 |
| K | - | | 0.02 | |
| OH* | 3.20 | | 1.86 | |

*Percent $H_2O$ was calculated by difference.

Anal. 1 was carried out on amphibole crystal surrounded by chalcopyrite.

Anal. 2 was carried out on large amphibole crystal bearing chalcopyrite stringers along (001) cleavage traces.

**TABLE 5**

Electron microprobe analyses of green amphibole in specimen ST 2 (PTS 1256), ilmenite-quartz-feldspar-amphibolite with iron sulphides, from Skeo Taing Skerry.

| | Anal. 1 | Anal. 2 | Anal. 3 | Anal. 4 |
|---|---|---|---|---|
| $SiO_2$ | 43.60 | 43.37 | 41.63 | 42.93 |
| $TiO_2$ | 1.60 | 1.30 | 1.44 | 1.40 |
| $Al_2O_3$ | 11.60 | 11.23 | 11.92 | 11.73 |
| MgO | 8.06 | 8.28 | 7.27 | 7.44 |
| FeO | 19.26 | 19.33 | 20.60 | 20.74 |
| CaO | 11.26 | 11.49 | 1.16 | 10.89 |
| $Na_2O$ | 1.86 | 1.64 | 1.84 | 1.85 |
| $K_2O$ | 0.45 | 0.77 | 0.59 | 0.65 |
| CuO | 0.00 (236ppm Cu) | 0.04 (2795ppm Cu) | 0.04 (2955ppm Cu) | 0.04 (3036ppm Cu) |
| ZnO | 0.00 (nd.) | 0.00 (nd.) | 0.00 (nd.) | 0.04 (2892ppm Zn) |
| $H_2O$* | 2.31 | 2.55 | 3.53 | 2.29 |
| TOTAL* | 100.00 | 100.00 | 100.00 | 100.00 |

Atomic Proportions

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Si | 6.53 | | 6.51 | | 6.22 | | 6.49 | |
| Ti | 0.18 | 8.00 | 0.15 | 8.00 | 0.16 | 8.00 | 0.15 | 8.00 |
| Al | 1.29 | | 1.34 | | 1.62 | | 1.36 | |
| Al | 0.88 | | 0.65 | | 0.48 | | 0.73 | |
| Mg | 1.80 | 5.09 | 1.85 | 4.93 | 1.62 | 4.62 | 1.68 | 5.03 |
| Fe | 2.41 | | 2.43 | | 2.58 | | 2.62 | |
| Ca | 1.81 | | 1.87 | | 1.79 | | 1.77 | |
| Na | 0.54 | 2.44 | 0.48 | 2.50 | 0.53 | 2.45 | 0.54 | 2.44 |
| K | 0.09 | | 0.15 | | 0.13 | | 0.13 | |
| OH* | 2.30 | | 2.56 | | 3.52 | | 2.31 | |

*Percent $H_2O$ was calculated by difference.

All analyses were carried out on large unzoned, generally inclusion free, crystals.

The green amphiboles in ST2 were determined as Hornblende (SS) of the calcium amphibole group and the light - coloured species in V4c as Mg-rich members of the Tremolite-Ferro-actinolite series of the same amphibole group.

Mineralogy of Drill-Cores

Examination of the drill-cores from drill-holes 1-6 showed that the sequence of rock-types encountered in each drill-hole is very similar. It was decided therefore to undertake detailed mineralogical studies through hanging wall to the foot-wall of sulphide mineralization in drill-hole 1 in which there is the greatest development of massive sulphides (see Appendix IV - Drill-hole 1). These studies were carried out by P R Simpson (Reported dated 21/5/76).

Calc-silicate country rock comprises most of the first 46m of drill-hole 1. A specimen from 45-85m (Section No SN 2581) is tremolite-rich with about 95% tremolite imparting a strong schistosity to the rock. It is colourless and biaxial negative with a large axial angle of 20°. The identification is confirmed by X-ray Diffraction Photograph No. Ph 5385 - D Atkin, 21/5/76. Calcite is an important constituent in the groundmass, and graphite noted in reflected light is present in sub-parallel bands with traces of pyrite.

Below this there is a sharp contact with impure quartz-rock (SN 2582-47.7m) comprising 80% quartz grains cross-cut by several sets of inclusion trails and 15% partly chloritized tremolite. In reflected light, chalcopyrite is the dominant phase intergrown with minor amounts of pyrrhotite, sphalerite, pyrite and galena. The sulphide exhibit cross-cutting relationships in places similar to those in the sulphide-bearing quartz-rocks at locality 4. This quartz-rock continues downhole to SN 2583-47.9m in which there are equal amounts of chalcopyrite and pyrrhotite with minor amounts of sphalerite as an interstitial intergrowth.

At 48.0m there is a sharp contact (SN 2584) between quartz-rock above and tremolite-rock with individual crystals engulfed in massive pyrrhotite with traces of sphalerite and chalcopyrite. This gives away again to quartz-rock (SN 2586-49.15m) with 95% quartz and only minor, partly chloritized tremolite and interstitial disseminations of dominant chalcopyrite intergrown with minor pyrrhotite.

At 49.6m (SN 2585) the rock consists of 95% tremolite partly replaced by intergrowths of dominant chalcopyrite, minor pyrrhotite, sphalerite and galena. The sulphides are developed interstitially to the silicates and also cross-cut and replace discrete tremolite crystals. Two euhedral crystals of arsenopyrite were observed. Again at 52.1m (SN 2587) and 52.3m (SN 2588), tremolite-rock has individual tremolite crystals embedded in a matrix of pyrrhotite with lesser amounts of chalcopyrite, sphalerite and traces of galena. Nodular inclusions of impure quartz-rock occuring within the tremolite-rock (SN 2588) contain much less sulphide than the tremolite-rock. However the sulphide within and rimming the nodules is dominantly chalcopyrite whereas the sulphide in the tremolite-rock is dominantly pyrrhotite.

At 53.3m there is a fault breccia (SN 2589) consisting of angular breccia fragments of massive pyrrhotite with minor sphalerite and traces of chalcopyrite. The massive pyrrhotite has distinctive single crystals of tremolite embedded within it. The fault is invaded and cemented by calcite associated with chlorite and limonitic staining.

Below the fault breccia at 54.2m there is tremolite-calcite rock (SN 2590) with massive pyrrhotite, minor chalcopyrite and sphalerite. A late cross-cutting carbonate vein has a marginal development of chalcopyrite. This gives way to a rock (SN 2591-54.9m) consisting of 50% quartz and 50% tremolite much rounded and replaced by sulphides consisting largely of pyrrhotite with major amounts of sphalerite and chalcopyrite. These predominate over pyrrhotite in the quartz-rich portions of the rock whereas massive pyrrhotite predominates in the tremolite-rich areas which appear more succeptible to replacement.

At 55.0m there are quartz-rock nodules in tremolite-rich rock (SN 2592) similar to those at 52.3m while at 55.2m (SN 2593) there are coarse-grained, rounded albite crystals in a groundmass of biotite with interstitial major pyrrhotite, minor chalcopyrite, sphalerite and ilmenite.

The massive pyrrhotite-rock (SN 2594-56.7m) carries minor sphalerite and chalcopyrite with clasts of tremolite-calcite-rock. There are cross-cutting quartz-calcite veins and a partial development of secondary marcasite/pyrite in pyrrhotite.

At 57.2m there is a contact (SN 2595) between massive pyrrhotite with subrounded tremolite crystals and amphibolite consisting of amphibole with green hornblendic cores to crystals with tremolitic contacts against the sulphide. Chalcopyrite and sphalerite predominate over pyrrhotite as the disseminated sulphide phase in the amphibolite.

Below this there are rare euhedral crystals of arsenopyrite (SN 2597-58.5). Quartz-rock (SN 2596-57.9m) within the massive pyrrhotite-rock has minor chlorite, tremolite and pyrrhotite. At 58.85m, massive pyrrhotite, chalcopyrite and sphalerite occurs in sheared tremolite-quartz-rock (SN 2598). The sulphides apparently form a matrix in which sheared and rounded clasts are embedded.

In contrast to the outcrop exposures of sulphides which consist largely of pyrite/marcasite, the massive sulphides in the drill-cores are mainly pyrrhotite, and pyrite/marcasite is rarely developed. No evidence of primary structures remains and it is evident that there has been considerable shearing and redistribution of minerals along the sulphide horizon. Cross-cutting and replacement textures show that there has been a later mobilization with the more mobile copper, zinc and lead phases being concentrated in veinlets and at the margins of, and within the quartz-rocks whereas pyrrhotite has preferentially replaced tremolite crystals. It is possible that this mobilization occurred in Hercynian times as galena from a small vug at locality 1 (grid ref. 482668) has been dated at this age by Dr S Moorbath (1962).

A study of the drill-cores by C G Smith has shown that sphalerite is present at several horizons above the mineralized zone in drill-holes 6 and to a lesser extent in drill-hole 3. It is most common (up to 3%) in zones of brecciated calc-silicate granulite occurring as isolated patches or as a limited stockwork. Chalcopyrite and pyrrhotite, although also present within the breccia occur separately to the sphalerite. Sphalerite was only once noted in undisturbed calc-silicate granulite where it occurs with galena. Finally sphalerite occurs as scattered grains infilling small shears and quartz-calcite veinlets which cut both amphibolite and calc-silicate granulite. In these shears and veinlets the sphalerite is associated with pyrite and more rarely with pyrrhotite.

DRILLING RESULTS

A contract for drilling at Vidlin Ness was awarded on the 16th January, 1976 to Messrs Drill Sure Limited of Warwick. The drilling equipment arrived at the first site on the 20th February, 1976 and the drilling programme of six drill holes totalling 513.31m was completed on the 30th March, 1976. An Atlas Copco Diamec 700 drilling machine was used with coring bits of NQ size for broken and weathered near-surface rock, and 56mm size for the remaining parts of the drill-holes. The angle of each drill-hole was measured every 50m and at the bottom of the hole using a Tropari survey instrument.

The six drill-holes were planned to penetrate the sulphide horizon extending from locality 1 to locality 4 (Figs. 3,4) at depths of 40-50m in drill-holes 1-4 and to depths of 70-100m in drill-holes 5 and 6. Core recovery apart from overburden and highly weathered near-surface rock was virtually 100%. Intersections with the sulphide horizon were successfully made at each site. Details of the six drill-holes are given in Table 6.

**TABLE 6**

Details of drill-holes at Vidlin Ness

| DH No. | NGR | Distance from West edge of sulphides | Azimuth and Inclination: Start | 50m | Bottom | Total depth |
|---|---|---|---|---|---|---|
| 1 | 48156677 | 36m | N110°/60° | N113.5°E/59° | N113.5°E/58° | 75.48m |
| 2 | 48106660 | 37m | N120°/60° | N120°E/59° | | 62.91m |
| 3 | 48076652 | 40m | N120°E/60° | N120°E/57° | N115°E/55° | 84.83m |
| 4 | 48006631 | 36m | N115°E/60° | N113°E/57° | N115°E/55° | 80.22m |
| 5 | 48156677 | 35m | N110°E/75° | N110°E/75° | N115°E/74° | 88.69m |
| 6 | 48076652 | 44m | N120°E/70° | N120°E/69° | N120°E/66° | 121.18m |
| | | | | | Total metrage | 513.31m |

Section through the drill-holes illustrating simplified geology are shown in Figs. 16 and 17. Full details of the geology of the drill-cores and assay results for Cu, Pb, Zn, Co, Ni and Ag are given in Appendices IV and V. A summary of the sulphide intersections is given in Table 7.

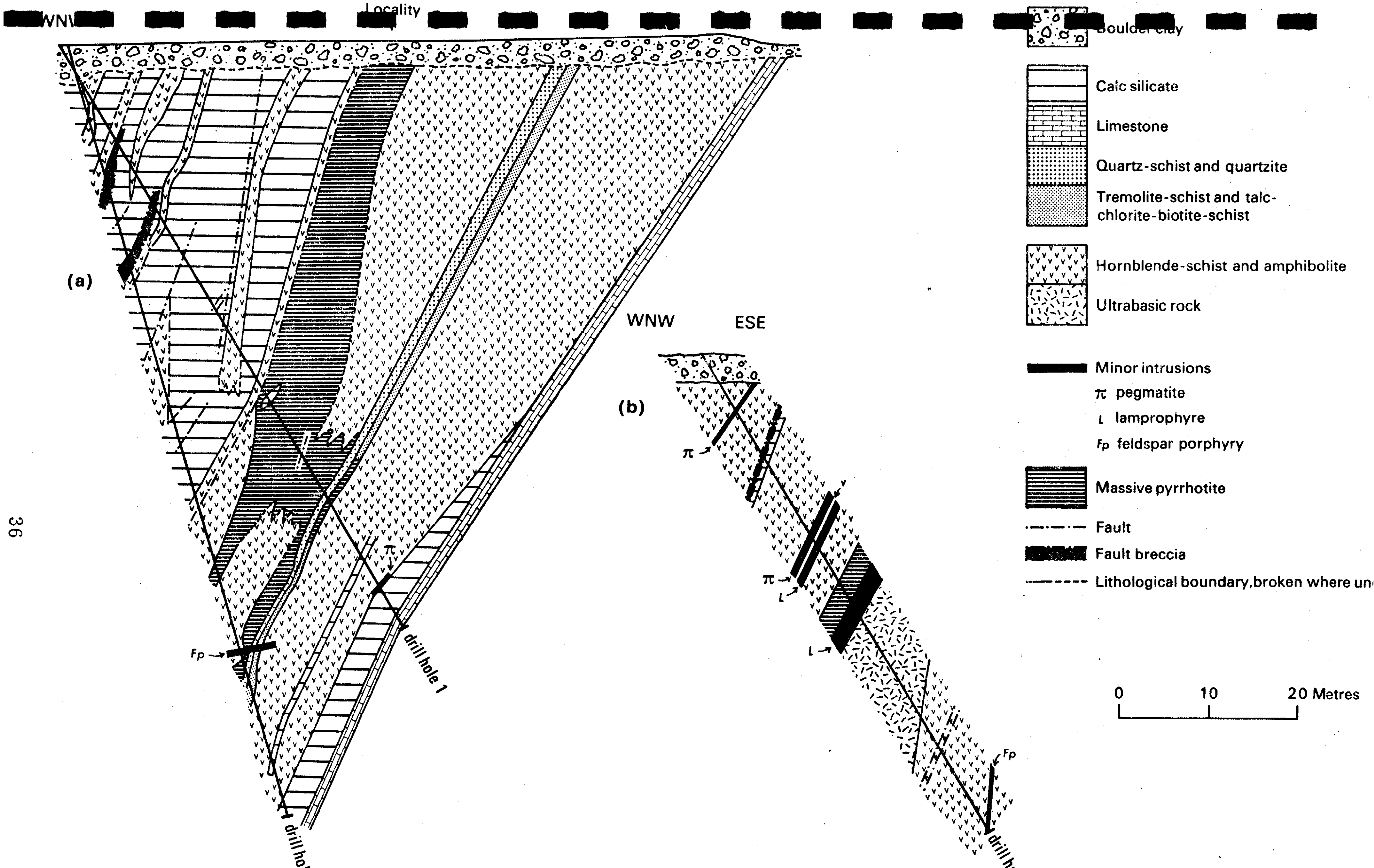
**TABLE 7**

Sulphide horizon intersections and assay results

| DH No. | Thickness of sulphide horizon at outcrop | Length of intersection of sulphide horizon | True thickness of sulphide horizon | Average assay values over sulphide horizon Cu% | Pb% | Zn% |
|---|---|---|---|---|---|---|
| 1 | 4m (loc.1) | 14m | 10m | 0.97 | 0.06 | 0.75 |
| 2 | about 4-5m (loc.2) | 2.4m | 2.2m | 1.19 | 0.06 | 1.27 |
| 3 | about 10m (loc.3) | 2.0m | 1.3m | 0.67 | 0.05 | 0.39 |
| 4 | up to 11.5m (loc.4) | 3.5m | 1.4m | 0.46 | 0.01 | 0.12 |
| 5 | 4m (loc.1) | 13.3m | 8m | 0.32 | 0.02 | 0.27 |
| 6 | about 10m (loc.3) | 2.1m | 1.5m | 0.46 | 0.01 | 0.14 |

Analyst, Miss B P Allen, Analytical and Ceramics Unit

The metals were determined by atomic absorption spectrophotometry.




**a** Section at locality 1 based on surface exposure and drill holes 1 and 5
**b** Section at locality 2 based on drill hole 2

Fig. 16. Drill-hole intersections at Vidlin Ness, localities 1 and 2

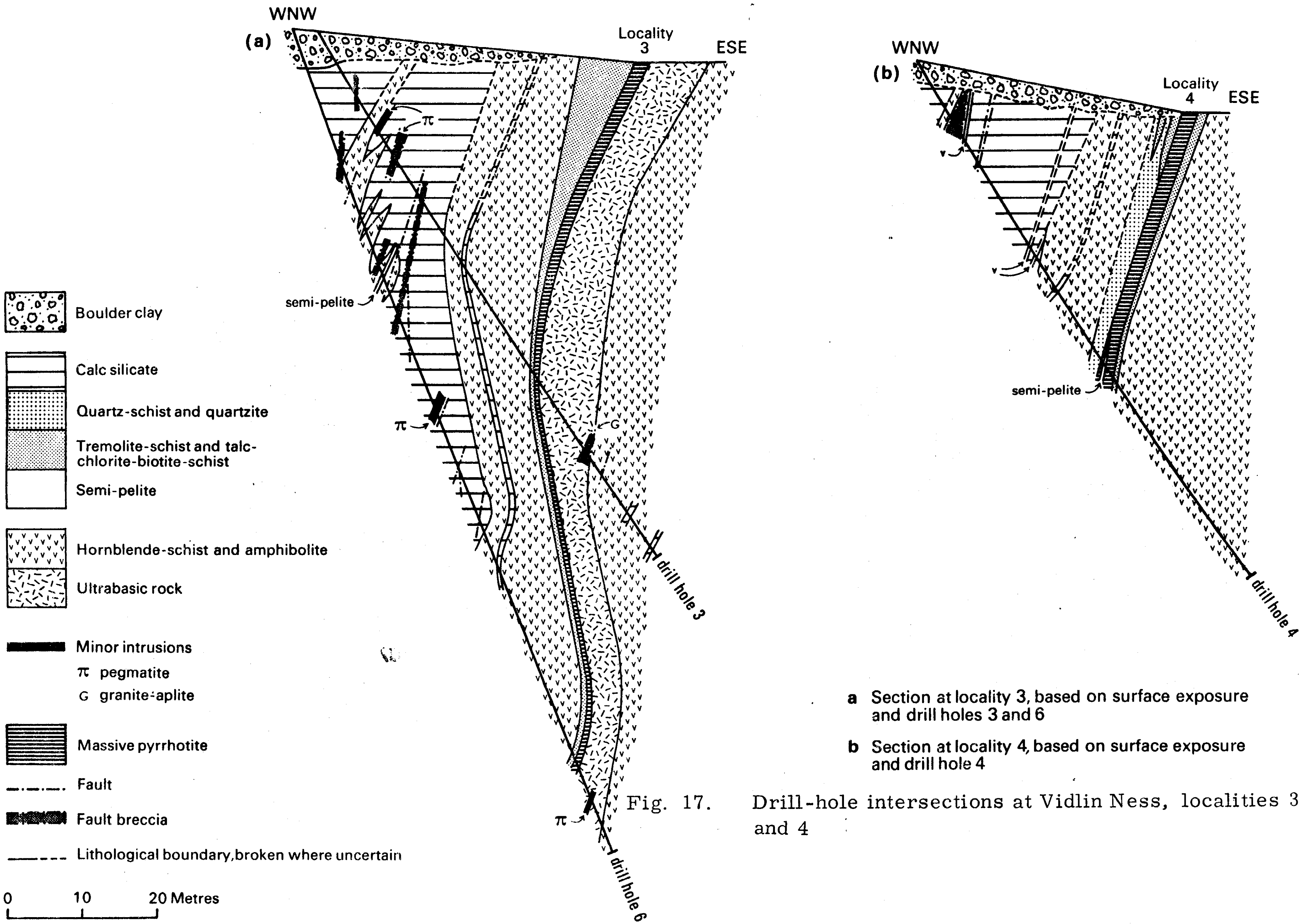



Fig. 17. Drill-hole intersections at Vidlin Ness, localities 3 and 4

The drill-hole intersection of the sulphide horizon were sampled every metre or at every obvious change of mineralization or of rock-type (see Appendices IV and V). Average values across the sulphide horizon were determined using all the values obtained. This means that in some of the drill-holes, and notably in drill-hole 5, some relatively barren ground included in the overall calculations has a strong lowering influence on the average metal values.

Fig. 16 shows that the thickness of the sulphide horizon outcropping at locality 1 increases to its intersection in drill-hole 1 and then slightly decreases in thickness to the intersection in drill hole 5 at a depth of 59.5m below surface. At outcrop the sulphide horizon consists of bands of massive sulphides up to 2m thick, separated by sulphide-bearing tremolite-quartz-rock and sulphide-bearing amphibolite, whereas in drill-hole 1 the massive sulphide portion is about 10m thick. Further down, in drill-hole 5, there is a decrease in massive sulphides and an increase in iron sulphide-bearing amphibolite, resulting in an overall decrease in grade. Removel of the comparatively barren samples would upgrade the ore to above 0.7% Cu.

At the other localities there is a decrease in thickness downwards from surface and the assay values in general diminish to the south. Because of strong weathering and leaching at surface outcrops it proved impracticable to sample across the sulphide horizon so that it is not known with the available data if grades differ much from surface to intersection in depth. At localities 1 and 3 however there is an apparent diminution in copper, lead and zinc values from the upper drill-hole intersection to the lower intersection.

The drilling results indicate that the sulphide horizon probably persists throughout the strike length from locality 1 to locality 4 indicated by geophysical measurements and outcrop mapping, and probably to depths of at least 100m.

DISCUSSION AND CONCLUSIONS

The first discovery in the Scottish Caledonides of strata-bound sulphide associated with metabasic rocks is of major significance and demonstrates that further work is desirable to establish if additional occurrences are present at this horizon in the Dalradian of Shetland and the mainland.

The probable volcanic origin of the metabasic rocks is indicated by analyses of a representative suite of five amphibolites from or close to the sulphide-bearing horizon in the Vidlin area, and for comparison the analysis of a supposed spilite from the Hawks Ness area, Shetland is also included. Analyses were carried out by direct electron excitation X-ray spectrometry (Table 8).

TABLE 8

| | V3g | HN1 | V1e | ST4 | CHD5/770 | V3h |
|---|---|---|---|---|---|---|
| $SiO_2$ | 49.9 | 49.3 | 48.7 | 47.5 | 46.9 | 43.5 |
| | 49.8 | 49.4 | 48.5 | 47.4 | 46.7 | 43.1 |
| $Al_2O_3$ | 13.9 | 14.3 | 14.6 | 15.7 | 13.4 | 12.1 |
| | 13.9 | 14.3 | 14.6 | 15.7 | 13.5 | 12.1 |
| Total Fe | 12.9 | 15.1 | 11.4 | 14.8 | 15.7 | 19.2 |
| as $Fe_2O_3$ | 12.8 | 15.2 | 11.9 | 14.8 | 15.7 | 19.1 |
| MgO | 7.79 | 5.75 | 8.74 | 5.90 | 7.62 | 13.3 |
| | 7.95 | 5.88 | 8.83 | 5.96 | 7.76 | 13.2 |
| CaO | 9.40 | 8.14 | 11.7 | 8.79 | 10.1 | 6.45 |
| | 9.27 | 8.19 | 11.8 | 8.69 | 10.2 | 6.41 |
| $Na_2O$ | 3.45 | 4.45 | 2.30 | 3.80 | 2.90 | 1.65 |
| | 3.50 | 4.55 | 2.35 | 3.90 | 3.00 | 1.65 |
| $K_2O$ | 0.47 | 0.21 | 0.55 | 0.55 | 0.58 | 0.57 |
| | 0.48 | 0.22 | 0.56 | 0.56 | 0.60 | 0.58 |
| $TiO_2$ | 1.46 | 2.43 | 1.04 | 2.44 | 1.98 | 1.54 |
| | 1.44 | 2.51 | 1.04 | 2.45 | 1.99 | 1.53 |

Results of duplicate determinations were obtained using a gabbro-basalt calibration curve for the Fe. Standard rocks were used for calibration. Analyst, A E Davis, Analytical and Ceramics Unit.

The localities of V3g and V3h are shown on Fig. 6; HN1 is from Hawks Ness (Nat. Grid Ref HU 472491); V1e is from the first exposure of hornblende-schist west of locality 1 on Fig.4; ST4 is from an outcrop of hornblende-schist in the stream east of Tua Farm (Nat. Grid. Ref. HU467634), north of B on Fig. 5; and CHD5/770 is a drill-core specimen from drill-hole 5 at 77.0 to 77.5m.

The Vidlin amphibolites apart from V3h are fairly similar and comparable in most respects to the slightly metamorphosed spilitic basalt from Hawks Ness. Chemically they fit roughly into the island-arc tholeiitic series (Baker, 1972) or oceanic tholeiite series from the mid-Atlantic ridge (Kay et al.1970) with low silica, potash and alumina. Total iron is however higher than the average tholeiitic basalt (Engel et al, 1965), and is more similar to total iron values in Scourie dykes from the Scottish Mainland (Dearnley, 1963). A perusal of analyses in the literature shows that the Vidlin amphibolites chemically resemble most closely tholeiites of Tertiary age paralleling the Red Sea coast of Egypt (Garson and Livingstone, 1973), and it is noteworthy that these Egyptian tholeiites also locally contain accumulations of iron sulphides, together with some chalcopyrite, similar to the massive sulphides at Vidlin.

Sample V3h contains much less $SiO_2$ and $Na_2O$ and much higher total iron and MgO than the other analysed rocks in Table 8. Sample V3h and CHD5/770 which has chemical similarities,are both from the eastern flank of the amphibolite belt i.e. east of the sulphide horizon. The low silica and soda and increase in mafic minerals may therefore be a reflection of differentiation within a volcanic flow or flows.

Mineralogical studies of the sulphide horizon have produced little evidence of the origin of these rocks. This is because any original sedimentary, depositional or replacement features in the massive sulphides have been almost totally removed or altered during metamorphism and tectonic movements through and along this undoubted incompetent horizon. It is also evident that there has been mobilization and recycling of the metals.

The amphibolites from south of Vidlin Ness, chemically identical to the presumed metabasic volcanic rocks at Vidlin Ness which are hosts to the sulphide mineralization are also comparatively rich in iron sulphides and locally contain chalcopyrite (Report by M S Garson dated 10/9/75). It would seem therefore that the volcanic rocks at this horizon were sufficiently rich in iron and copper to provide a source of these metals which could be concentrated by circulating brines in the manner proposed for the Cyprus-type mineralization associated with pillowed lavas (Robertson and Fleet, 1976).

The quartz-rocks perhaps provide some clues as to the original setting of the sulphide-rich horizon. At locality 1 there are quartzitic rocks which were probably deep-water (?) cherts showing slump features and at locality 4 similar cherty rocks are overlain by quartzites of detrital origin, the detrital grains possible coming from the cherts themselves. Speculatively, vague graded bedding features at both localities indicate that the rocks are the right way up stratigraphically, and this would be in line with the sparse evidence of gravitational differentiation to the east. If the massive sulphide horizon represents a volcanogenic-exhalative mineralization then the sulphide-bearing quartz-rocks which grade laterally into tremolite-rich varieties could have been siliceous exhalites. This would partly explain their localized occurrence and complex distribution, for example at locality 4 (see Fig. 6).

A comparison may be made with the Caledonide strata-bound sulphide deposits of Scandinavia (Vokes 1962, 1968), and, in particular, with the chalcopyrite-sphalerite-pyrrhotite ores of the Sulitjelma and Grong regions of Norway. There the deposits form horizons between calcareous schists and mafic lava, pyroclastics and amphibolites, and occur as strata-bound tabular or lens-shaped bodies, more than 1 km long, about 1.5-2m thick, with local thicknesses up to 5.8m. Production grades - for example, at Skorovas mine - range from

0.5 to 1.3% copper and 0.5 to 1.7% zinc.

The Norwegian examples provide a useful model for assessment of the potential of the Vidlin area. The strata-bound sulphide horizons there are of the same order of thickness as the Vidlin occurrence, and commonly form deposits of from 1 500 000 to 10 000 000 tonnes of ore. Drilling results show that the Vidlin occurrence thickens to the north, so there could be appreciable reserves beneath the sea. There is also an increase in copper and zinc grades from south to north with the grades at locality 1 being similar to those in many of the Scandinavian sulphide deposits.

Comparison with the Scandinavian sulphide deposits suggests also that other lens-shaped occurrences could be present in depth within the 4-km strike length of the presumed sulphide horizon intermittently developed between Vidlin Ness and Dury Voe.

Geophysical surveys show that the mineralization outcropping at Vidlin Ness has produced the most pronounced and well-defined EM and magnetic anomalies which extend as far as 540S, suggesting that the mineralization occurs over a strike length of about 800m. Some off-setting by faulting is also indicated within this stretch. Further south to traverse 1000S there is a considerably greater variation in anomalies but these could be due to an extension in depth of the Vidlin Ness mineralization, or to a change in mineralization.

The postulated continuation of the horizon to Dury Voe is based primarily on IP and resistivity results reflecting a source which is only weakly conductive and magnetic. There is therefore little evidence geophysically of significant near-surface mineralization in the area, but the possibility of mineralization in depth is not ruled out.

Stream sediment sampling failed to locate any mineralization along the line of geophysical anomalies from Vidlin Voe to Dury Voe mainly because of lack of significant geochemical dispersion into the till and the small number of streams crossing it. Base of till sampling revealed only three anomalies lying on traverses 700S, 2800S and 3200S (Fig. 13), but the low geochemical response along the line of the rest of the horizon is possibly due to insufficient auger penetration.

The peak value on traverse 700S is 115 ppm Cu with several values above 80ppm. This coincides with geophysical anomalies and the Vidlin Ness sulphide horizon is believed therefore to extend at least as far as this with possibly part of the horizon between traverses 400S and 600S faulted off-shore. This would give a strike length of about 1000m for the Vidlin Ness mineralization. The other anomalous traverses 2800S and 3200S, NW of Skelberry, have a sharp copper peak at their western ends, and this is parallelled by high lead and zinc.

In the Dury Voe coastal section, roughly on strike with this line of anomalies, there is a 3m wide outcrop of fault breccia with galena and sphalerite (Fig.5) and this is probably the cause of the geochemical anomalies. This surface mineralization however may be the result of mobilization of metals from an underlying sulphide body similar to that at Vidlin Ness and requires investigation.

The drilling results indicate that there is a general thickening of the sulphide horizon to the north and a corresponding increase in copper and zinc grades in this direction. Geophysical work carried out off-shore by Dr D Flinn (pers. comm.) has shown that there is a pronounced magnetic anomaly northwards along the strike of the sulphide horizon confirming the likelihood of the body extending some considerable distance under Vidlin Voe. A study of the aeromagnetic anomaly east of Vidlin suggests that the major anomaly is displaced eastwards by a fault trending WNW about 2km north of Vidlin Ness (Fig. 9). If the sulphide horizon persists this far then it also may be displaced to the east, and this would explain the lack of rock-types corresponding to the Vidlin Ness succession on Lunna Ness to the north.

Summary of the Conclusions

1. Strata-bound sulphide mineralization associated with amphibolites (possibly metamorphosed tholeiites) outcrops at four localities at Vidlin Ness in Shetland within a Dalradian succession dominantly of calc-silicate granulites and thin marbles. Outcrop thicknesses are obscured by till and beach deposits but reach 11.5m at one locality.

2. The mineralization comprises massive sulphides (dominantly pyrrhotite with lesser amounts of chalcopyrite, sphalerite and galena), sulphide-bearing quartz-rocks gradational into sulphide-bearing tremolite-rocks and sulphide-rich amphibolites.

3. Six drill-holes into the sulphide horizon confirm that it has a strike length of at least 500m and a vertical extent of at least 100m. The horizon is inclined at about 60° to 90° to the west, except between drill-holes 3 and 6 where it dips 80° to the east.

4. The sulphide horizon decreases in thickness from about 10m in drill-holes 1 and 5 in the north to just less than 2m in depth in drill-holes 3 and 6 in the south.

5. Average copper and zinc values across the sulphide intersections in the drill-holes range from 0.46% Cu and 0.12% Zn in the south to 1.19% Cu and 1.27% Zn in the northern part of the area. Removal of barren bands in the horizon would upgrade these values.

6. Disseminations of sphalerite and separately of chalcopyrite occur in patches and veinlets on the hanging wall of the sulphide horizon and amphibolite and in brecciated zones within the calc-silicate granulites to the west. These are possibly the expression of recycling of metals in Hercynian times and their economic importance is difficult to assess with the available data.

7. An extension southwards of the sulphide-bearing amphibolites to Dury Voe is indicated by linear geophysical anomalies and occasional outcrops of amphibolite. Well-defined EM and magnetic anomalies suggest the massive sulphides at Vidlin Ness may have a strike length of at least 1000m. This horizon may be present in depth towards Dury Voe but the source is only weakly conductive and magnetic.

8. Geochemical base of till sampling has located two anomalies for copper, one about 200 metrés south of the most southerly outcrop of mineralization at Vidlin Ness, and the second with high lead and zinc values just north of Dury Voe, on strike with breccia carrying galena and sphalerite. The latter may be a leakage from an additional body of massive sulphides in depth.

9. The likelihood of the sulphide horizon continuing northwards under Vidlin Voe is confirmed by geophysical work carried out by Dr D Flinn which outlined a pronounced magnetic anomaly extending northwards from the outcrop on the skerry at locality 1.

10. The copper-bearing sulphide occurrence at Vidlin is of similar type, grade and thickness to strata-bound sulphide occurrences mined in Scandinavia, e.g. the chalcopyrite-sphalerite-pyrrhotite ores of the Sulitjelma and Grong regions of Norway, which commonly form deposits of from 1,500,000 to 10,000,000 tonnes of ore. Further drilling is required at Vidlin to determine the size of this occurrence.

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# APPENDIX ONE

# GEOPHYSICAL SURVEY RESULTS

## SECTION 1: MAGNETIC FIELD PROFILES
## RESISTIVITY & INDUCED POLARISATION PSEUDOSECTIONS

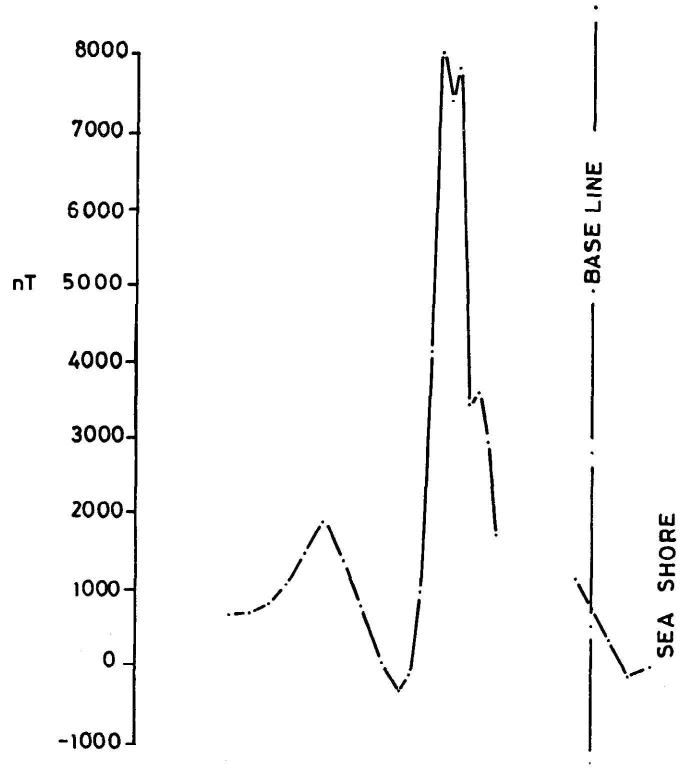
HORIZONTAL SCALE 1:2000

0 100 200 metres

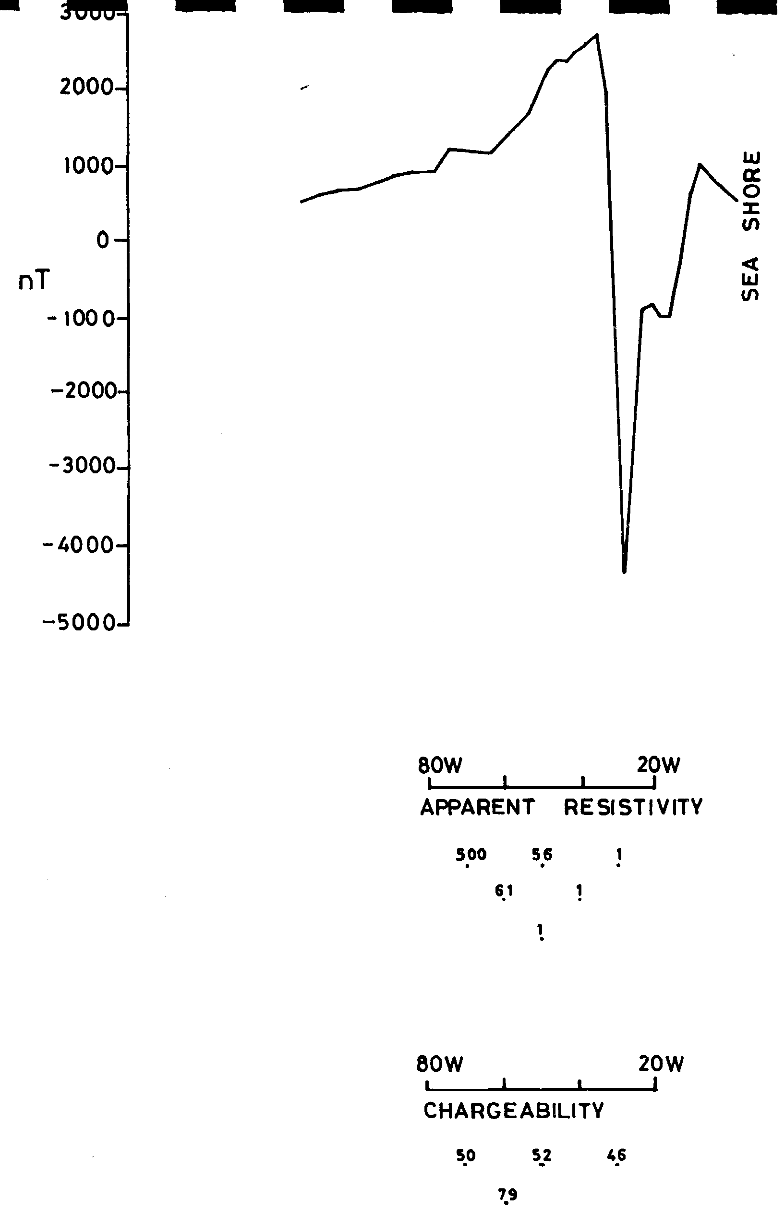
MAGNETIC FIELD PROFILES : On core lines in the northern part of the area (240N), 200N, 150N, 100N, 50N, 00, 100S, 220S, 540S) the vertical component of the field was measured relative to an arbitrary datum. On all other lines the total field was measured. Units of field are nanotesla (nT) where 1nT = 1 gamma.

RESISTIVITY AND I.P. SECTIONS : Pseudo-sections of apparent resistivity in ohm metres and chargeability ($M_{240}^{1140}$) in milliseconds are presented.

A1. 1. 2

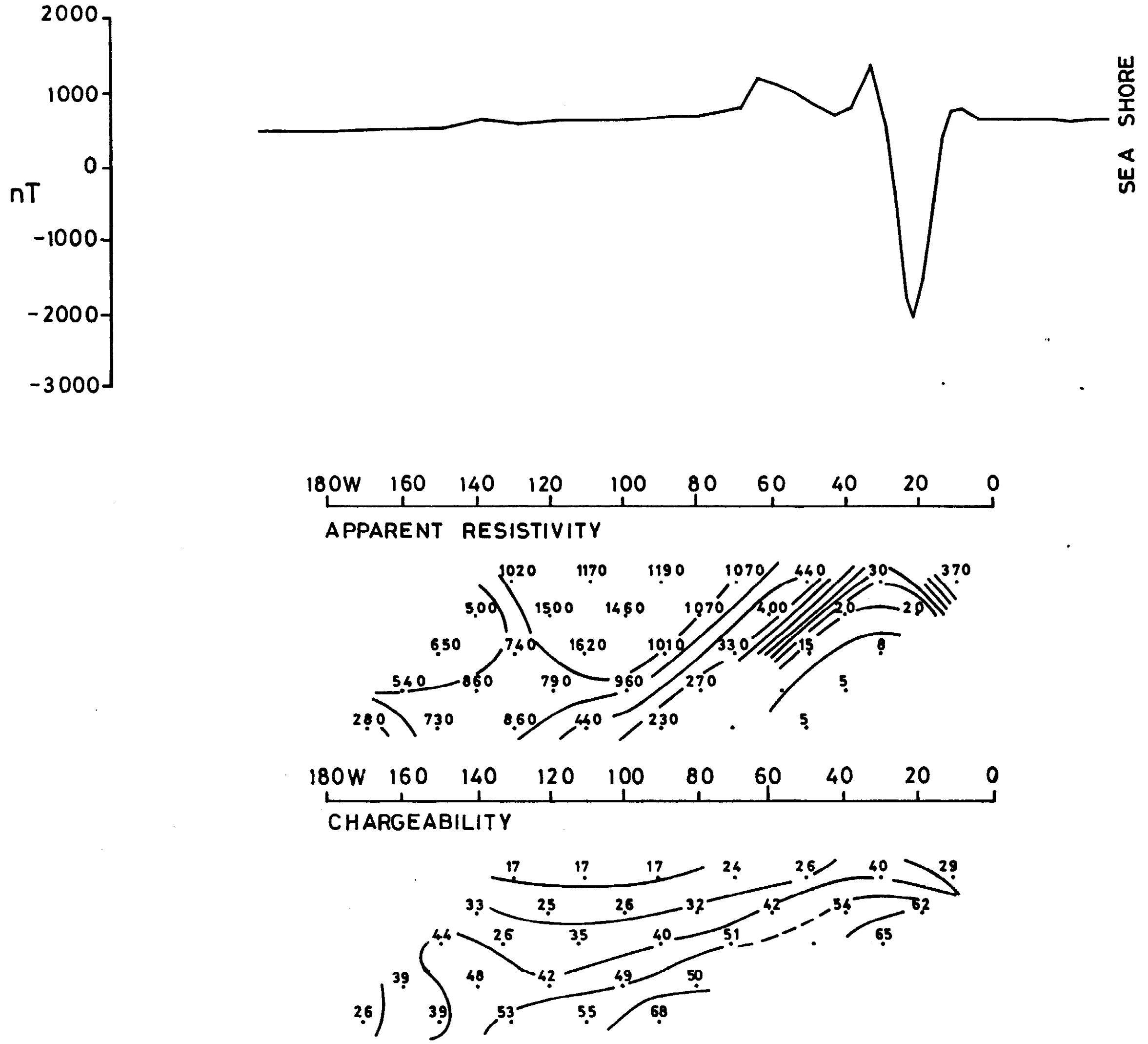



LINE 240 N VERTICAL MAGNETIC FIELD



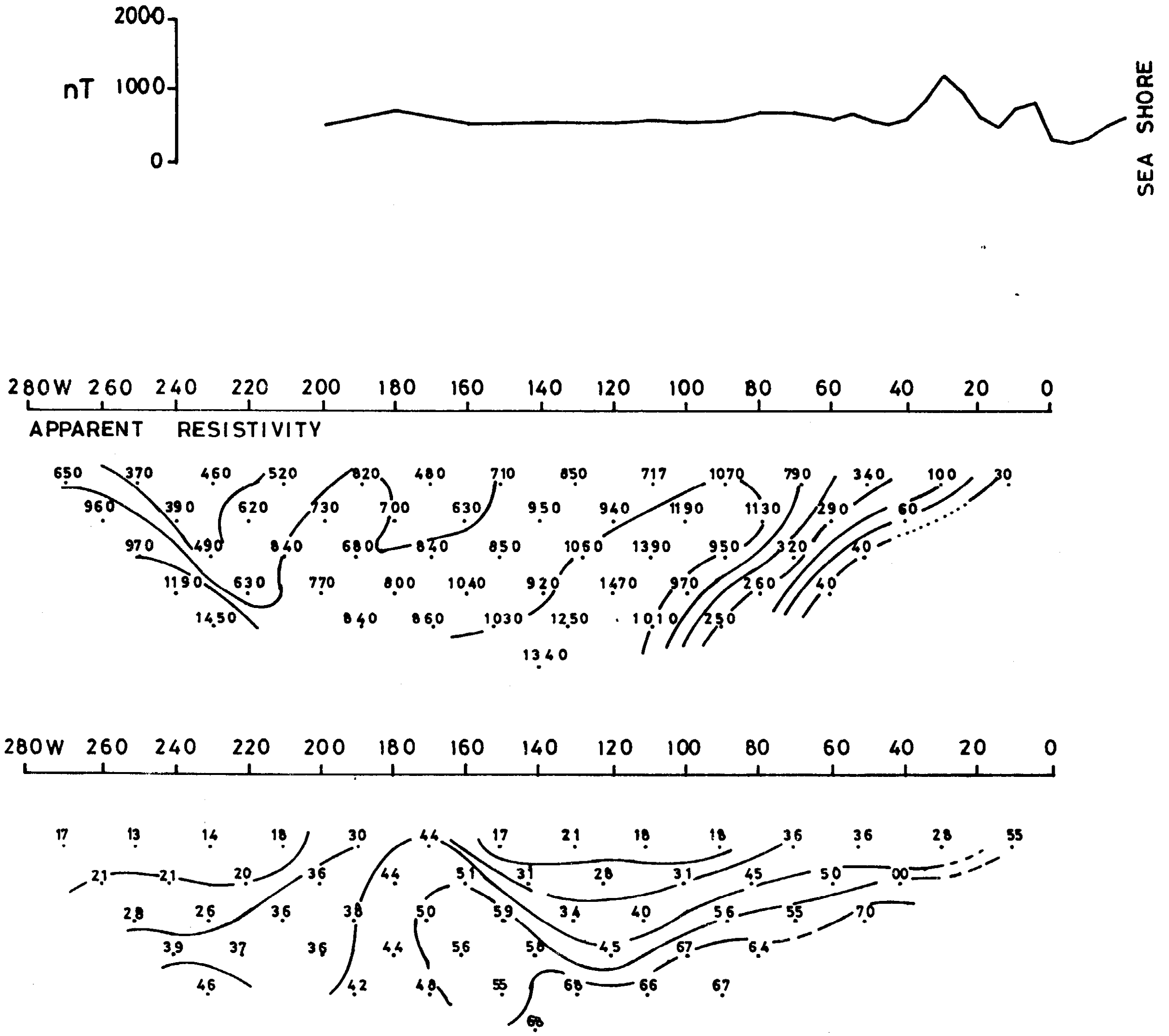

LINE 200N VERTICAL MAGNETIC FIELD, APPARENT RESISTIVITY AND CHARGEABILITY

A1. 1. 4

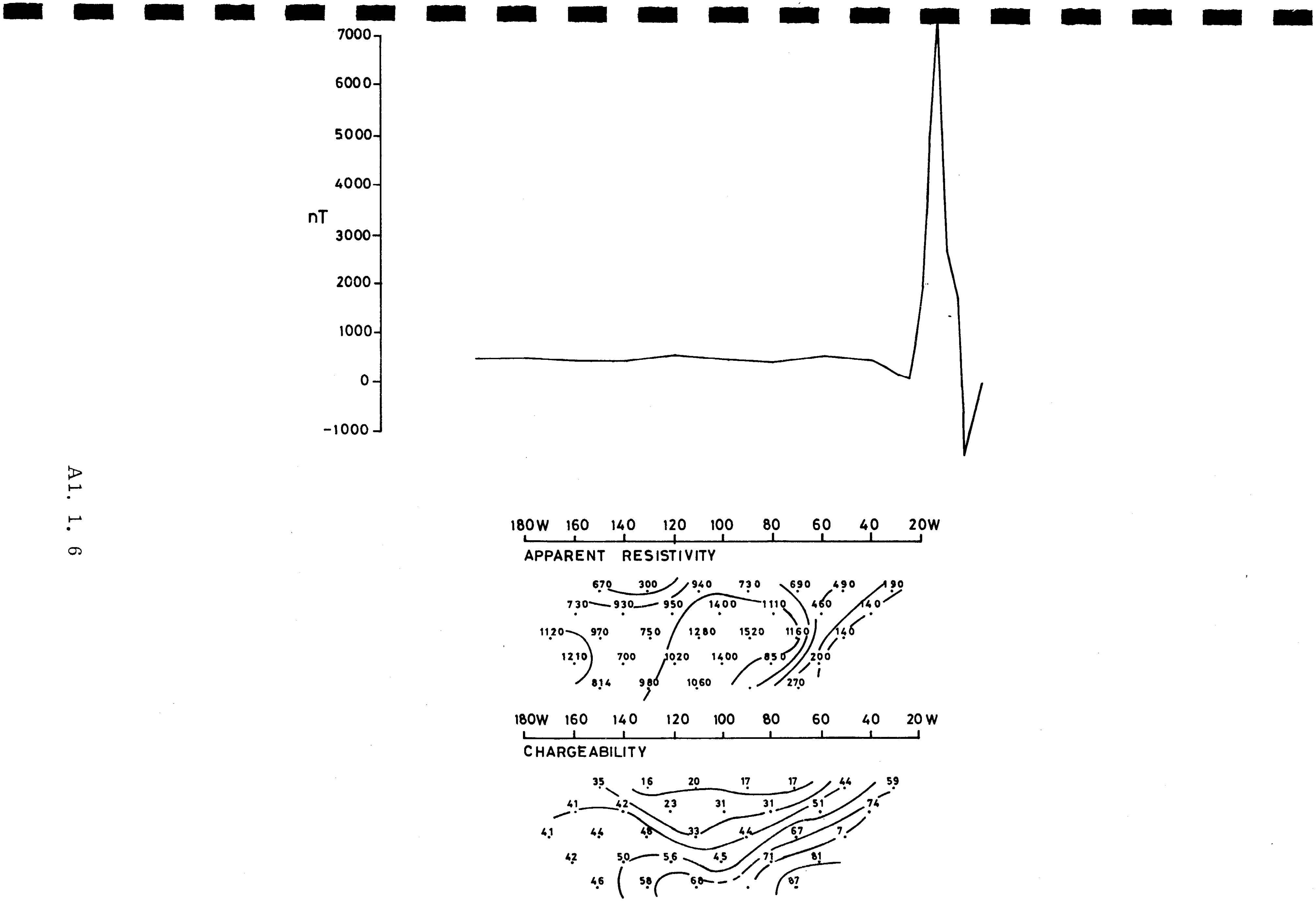



LINE 150 N VERTICAL MAGNETIC FIELD APPARENT RESISTIVITY AND CHARGEABILITY

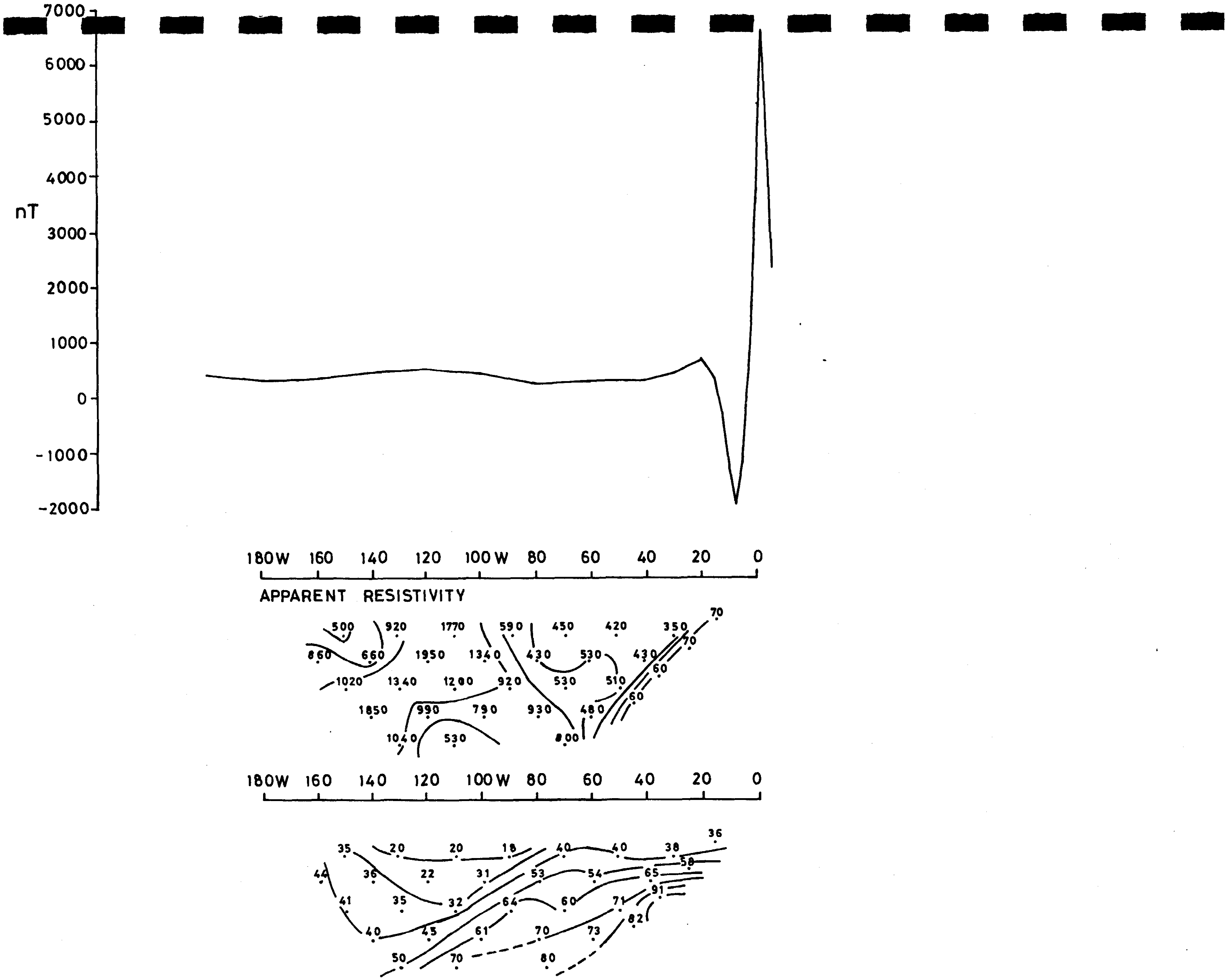
A1. 1. 5



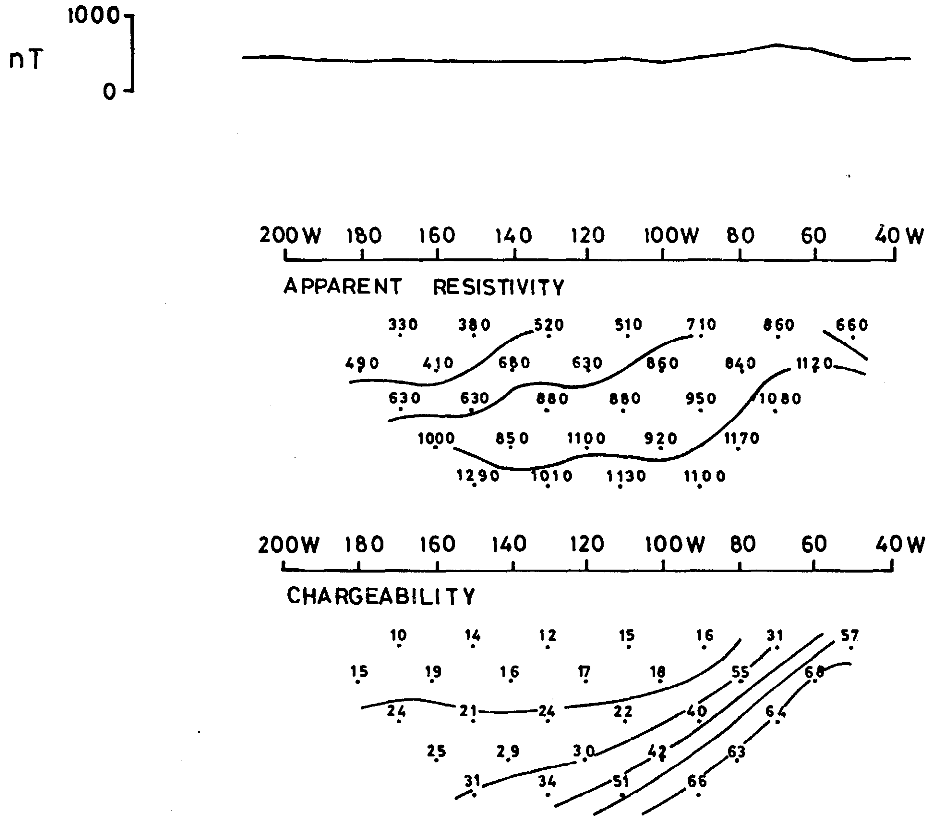

LINE 100N VERTICAL MAGNETIC FIELD, APPARENT RESISTIVITY AND CHARGEABILITY



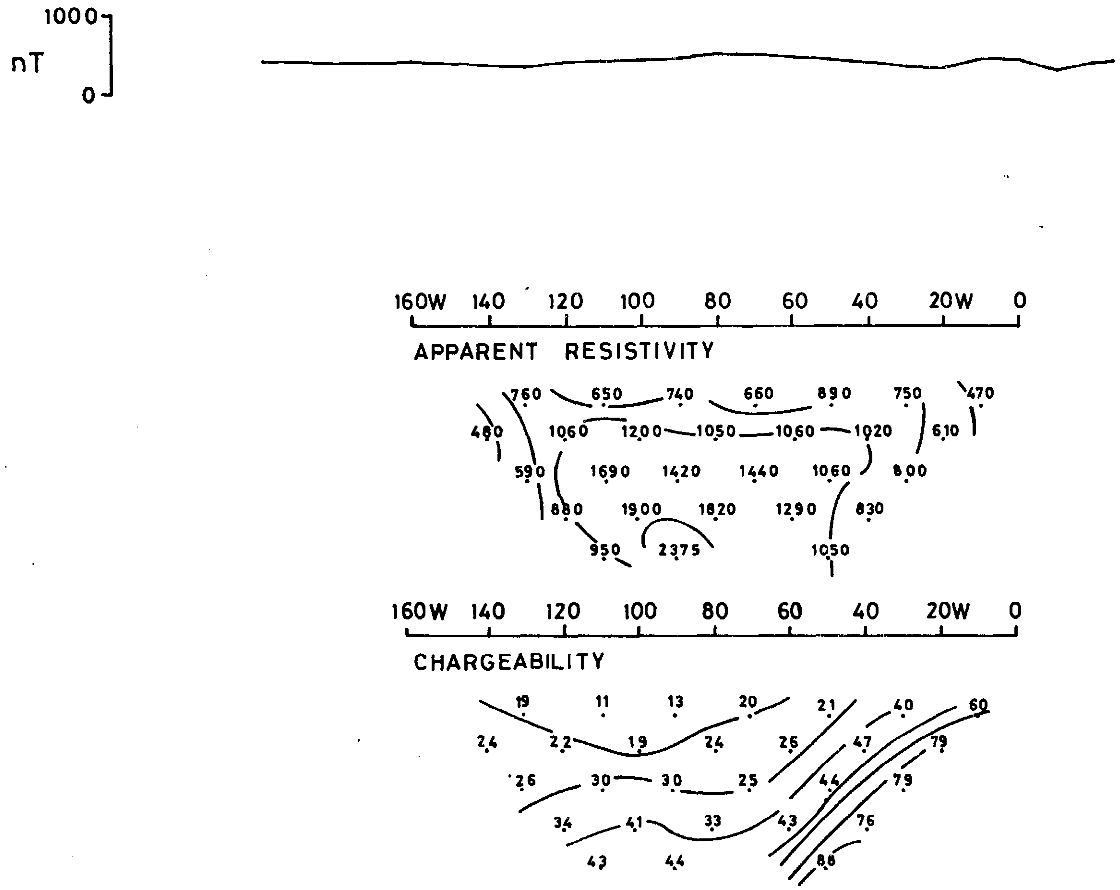

LINE 50N VERTICAL MAGNETIC FIELD, APPARENT RESISTIVITY AND CHARGEABILITY



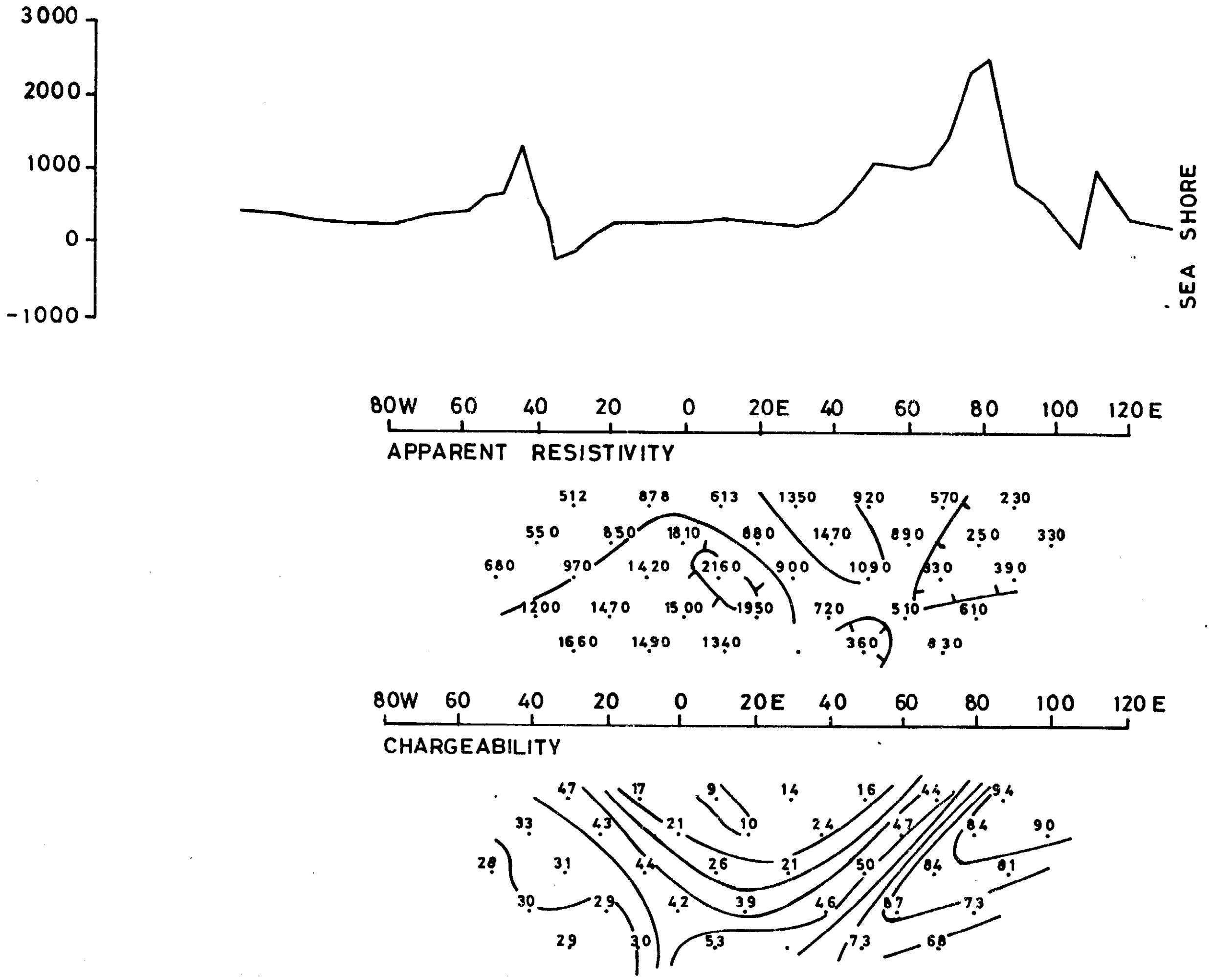

LINE 0 VERTICAL MAGNETIC FIELD , APPARENT RESISTIVITY AND CHARGEABILITY




LINE 100S VERTICAL MAGNETIC FIELD, APPARENT RESISTIVITY AND CHARGEABILITY

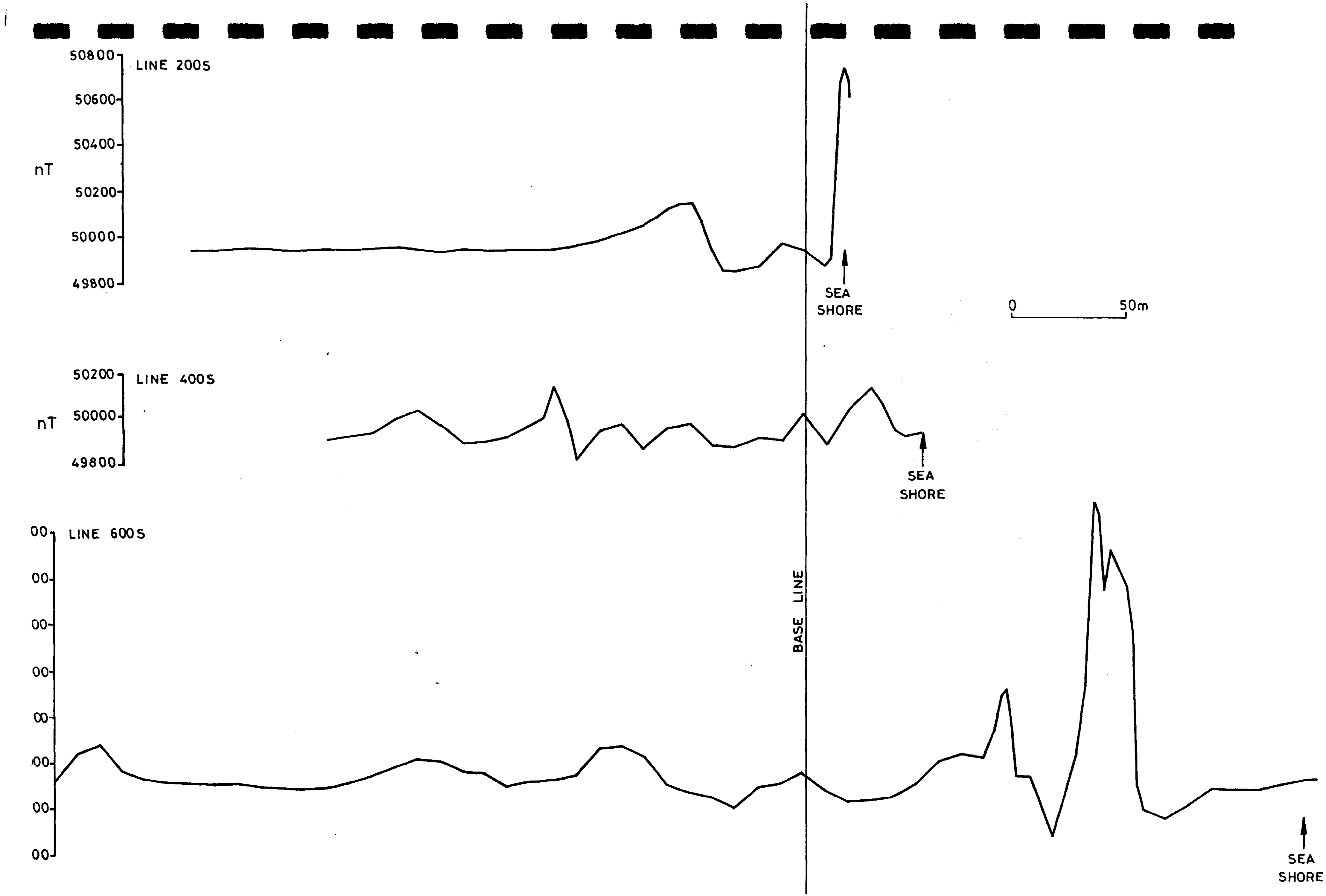



LINE 220 S VERTICAL MAGNETIC FIELD, APPARENT RESISTIVITY AND CHARGEABILITY

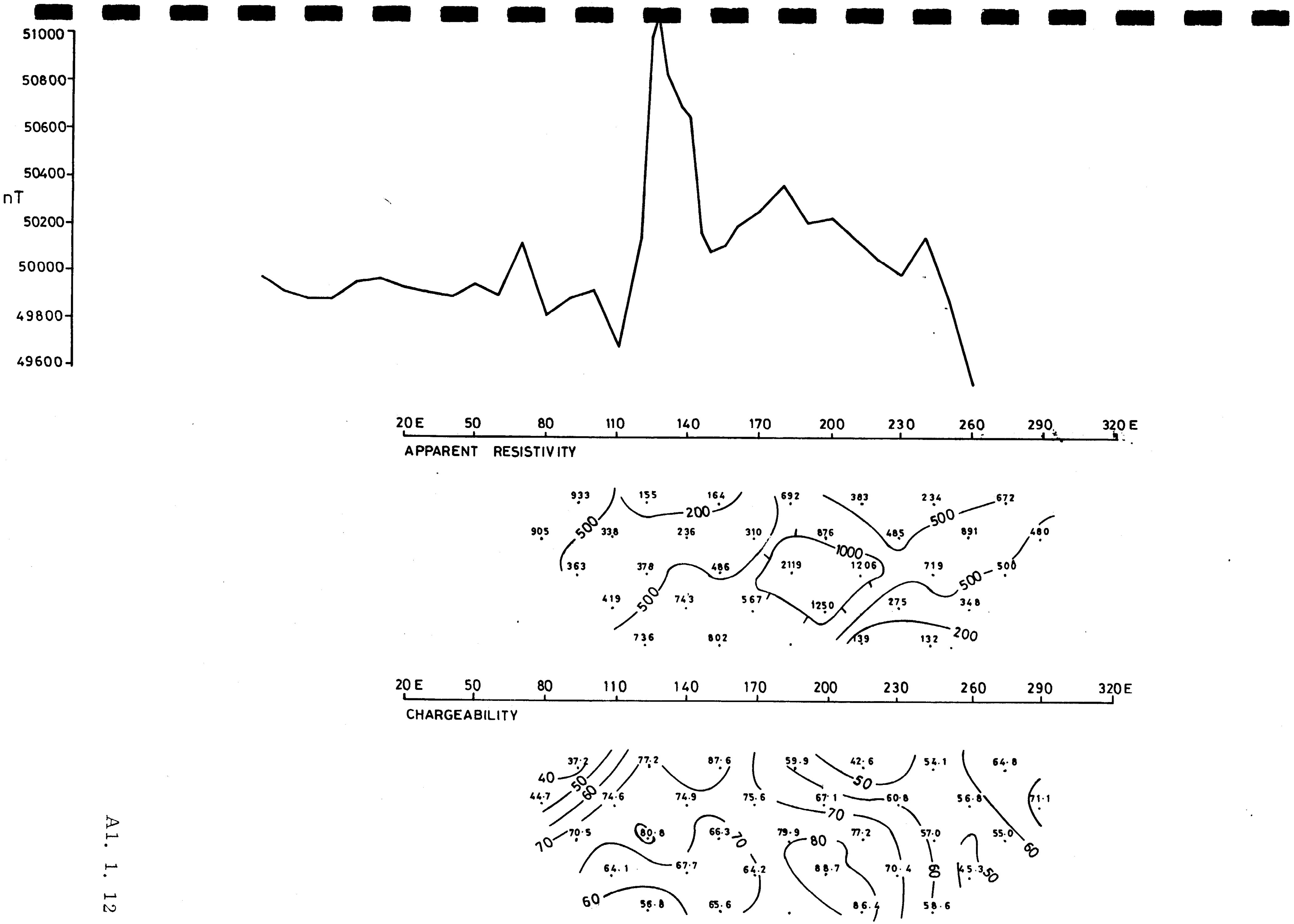



A1. 1. 10

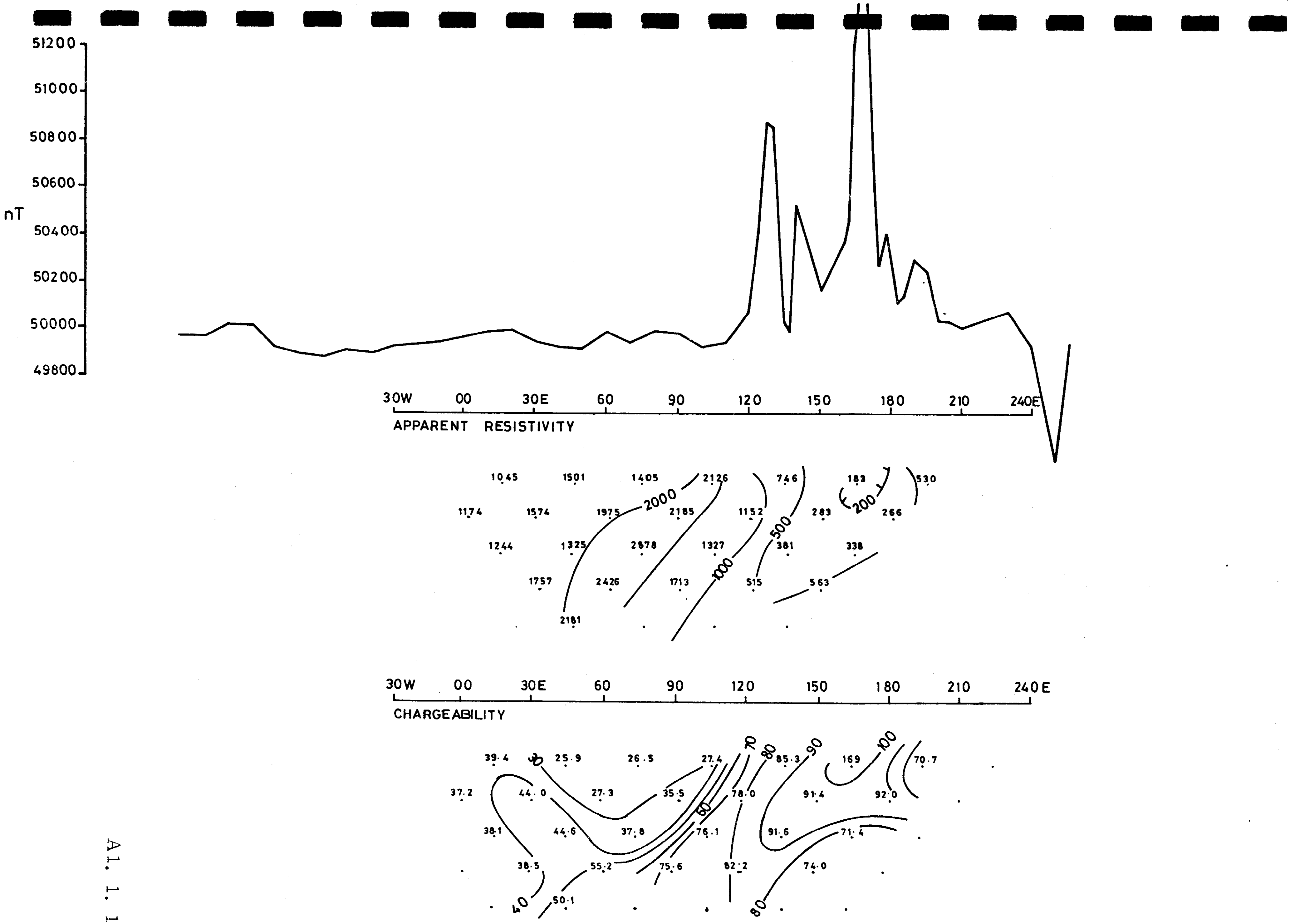
LINE 540S VERTICAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY



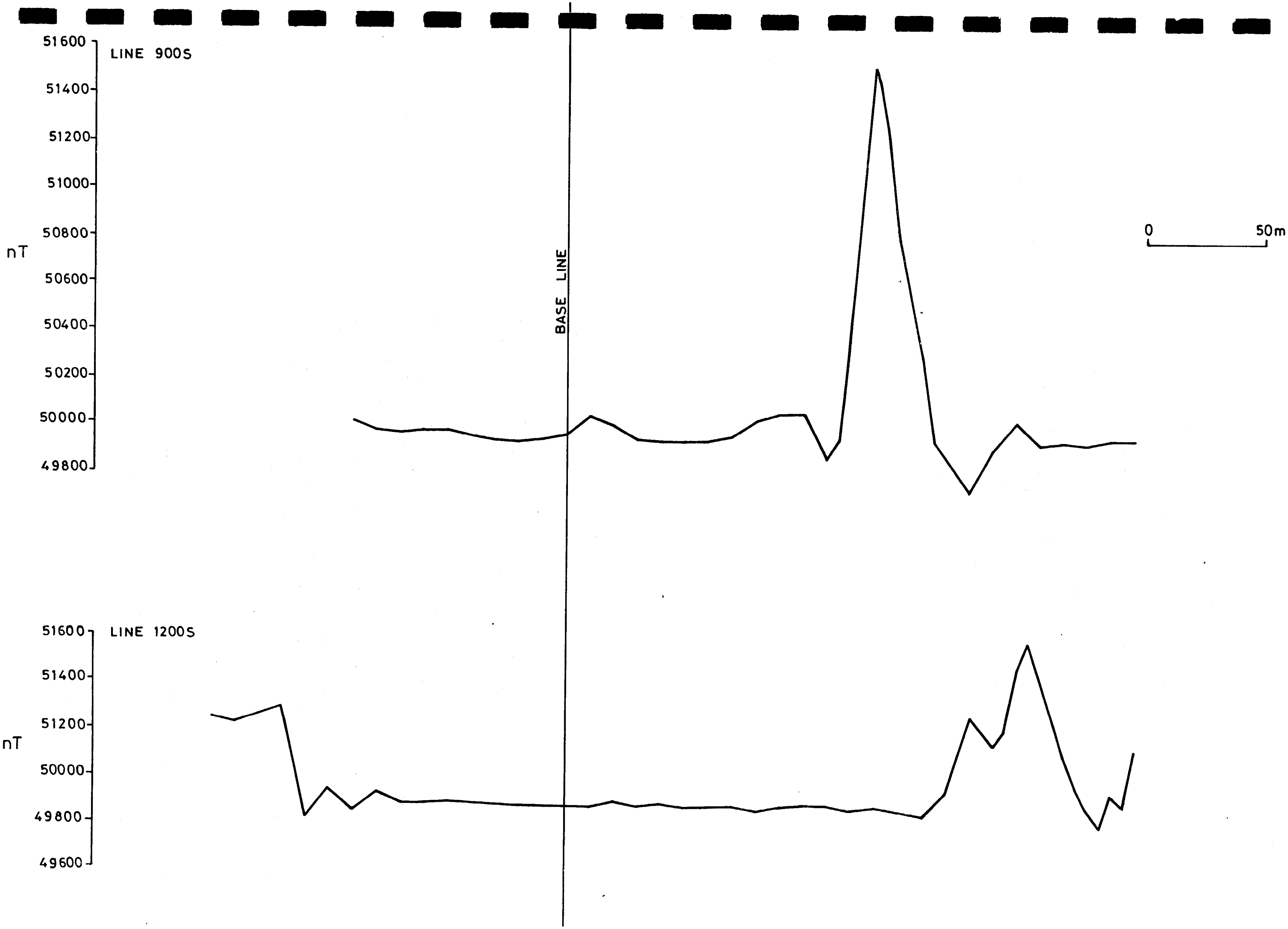

LINE 200S, 400S AND 600S TOTAL MAGNETIC FIELD




LINE 700S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

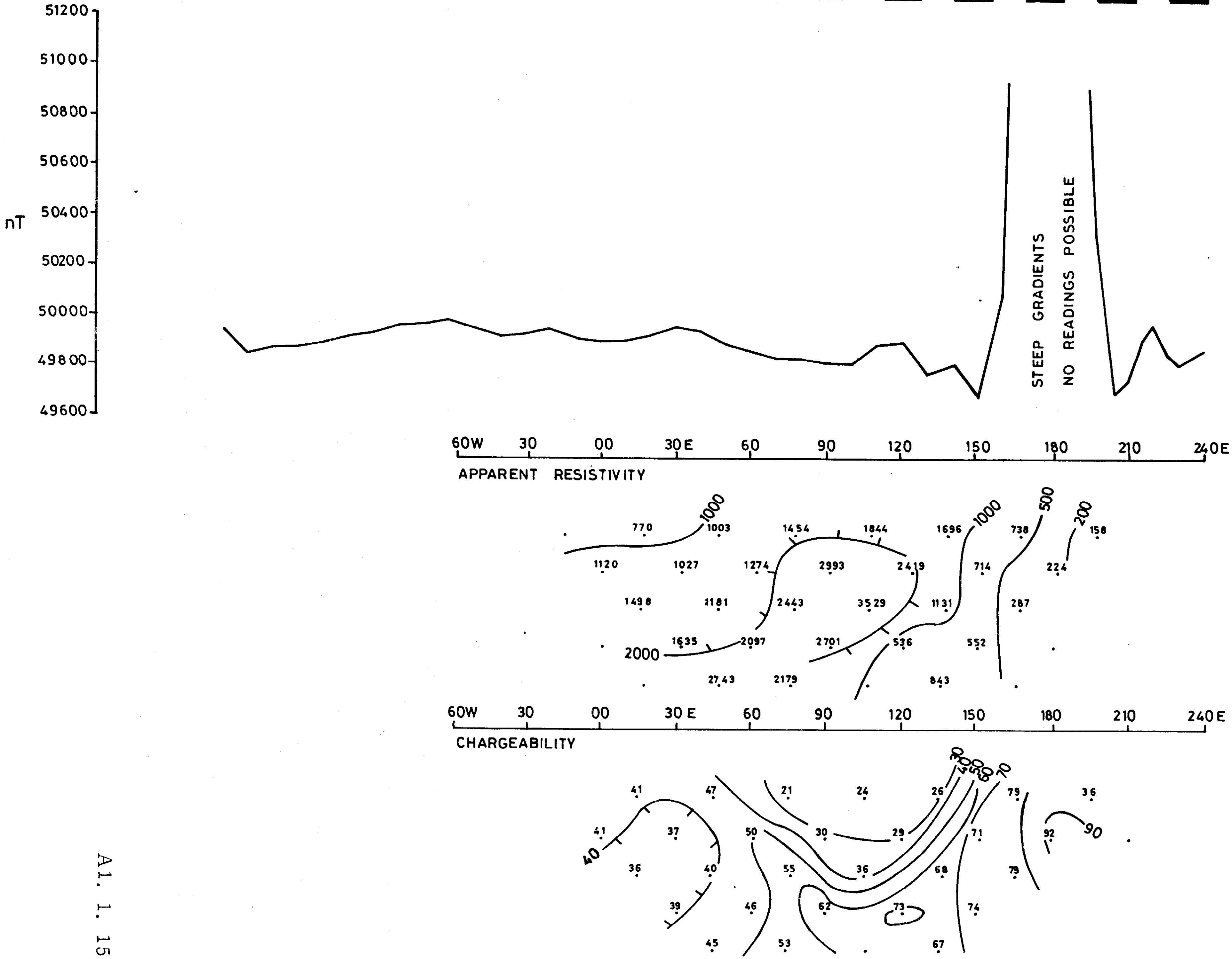



LINE 800S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY



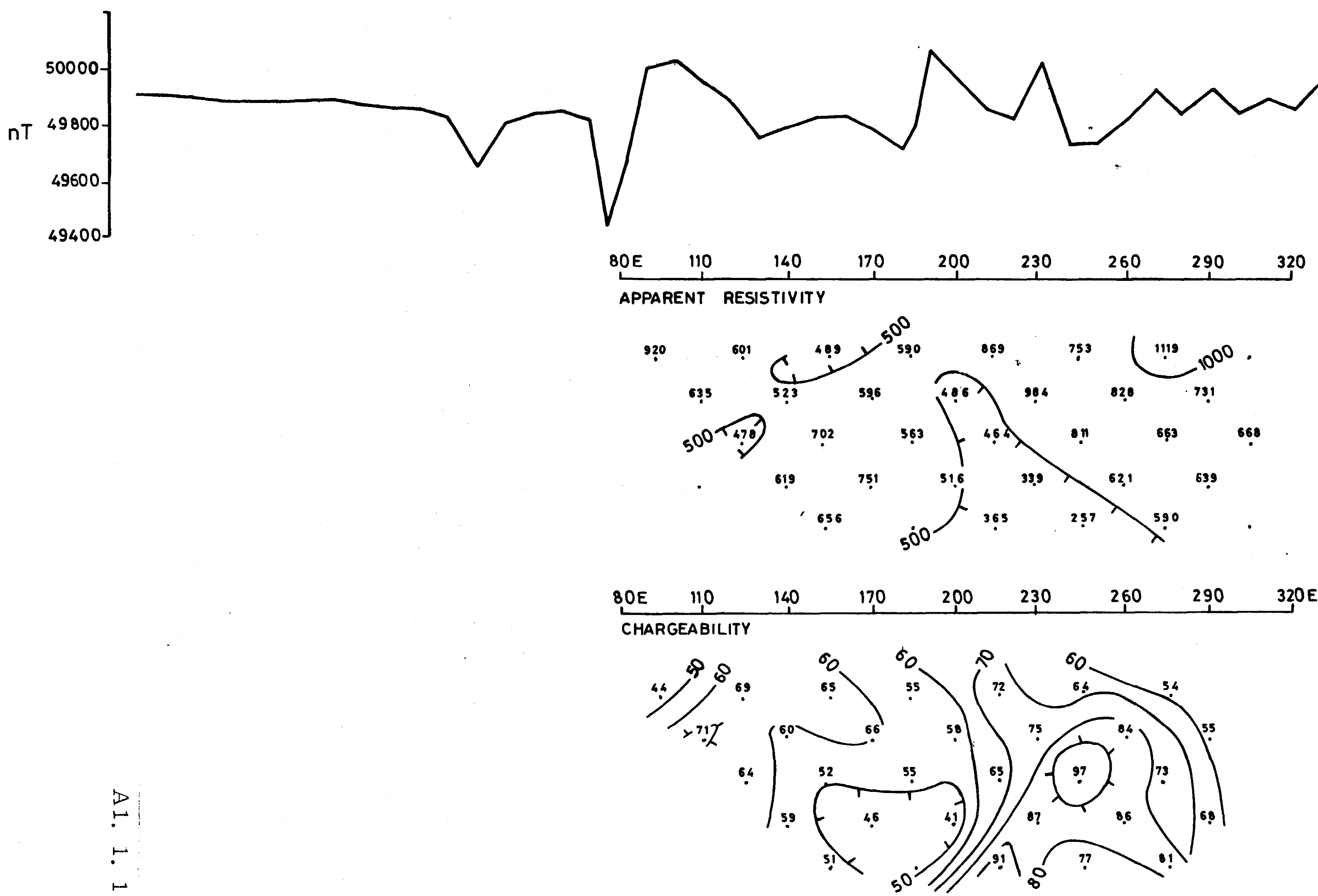

LINE 900S AND 1200S TOTAL MAGNETIC FIELD

A1. 1. 14

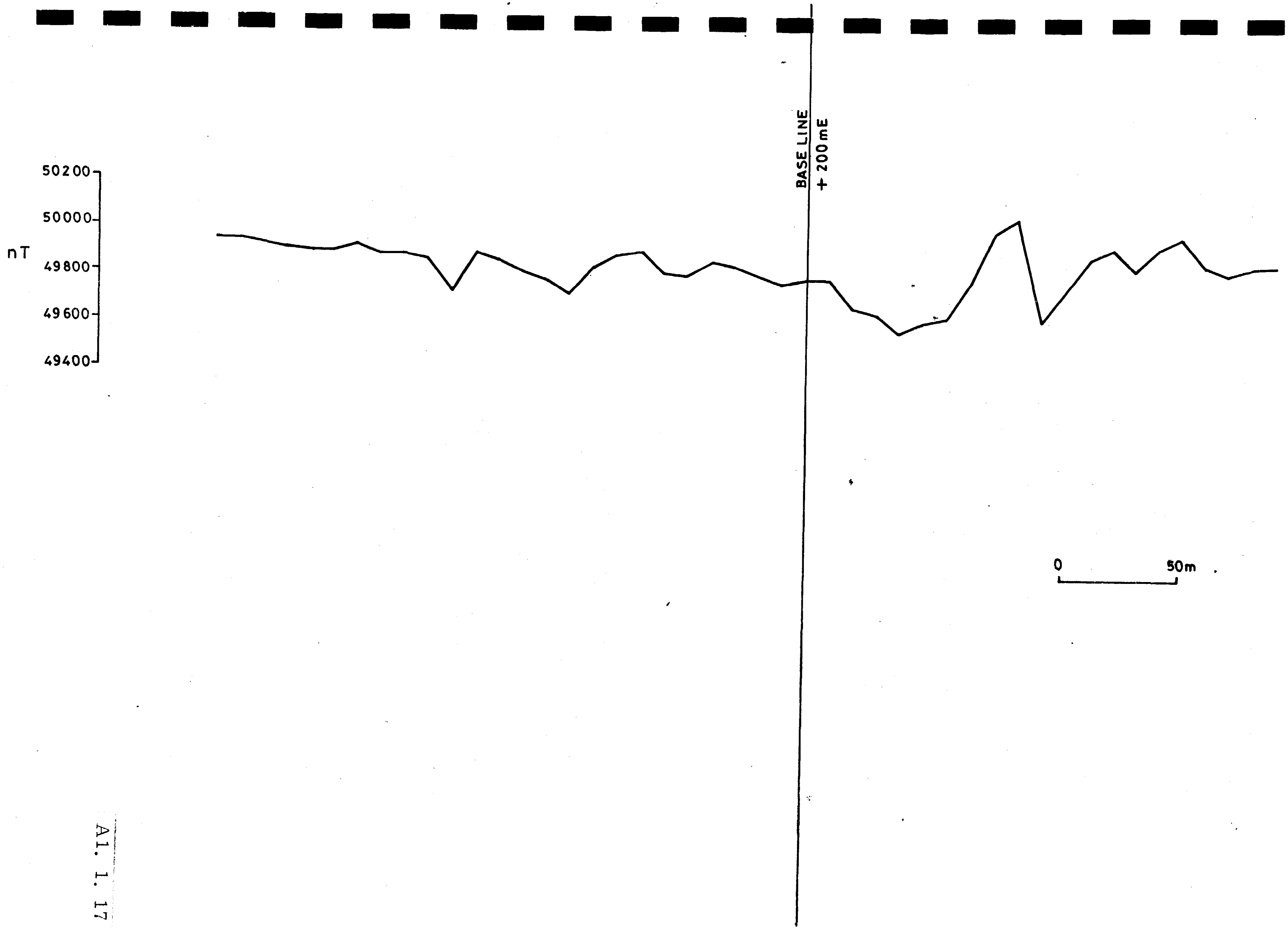



LINE 1000 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

A1. 1. 15

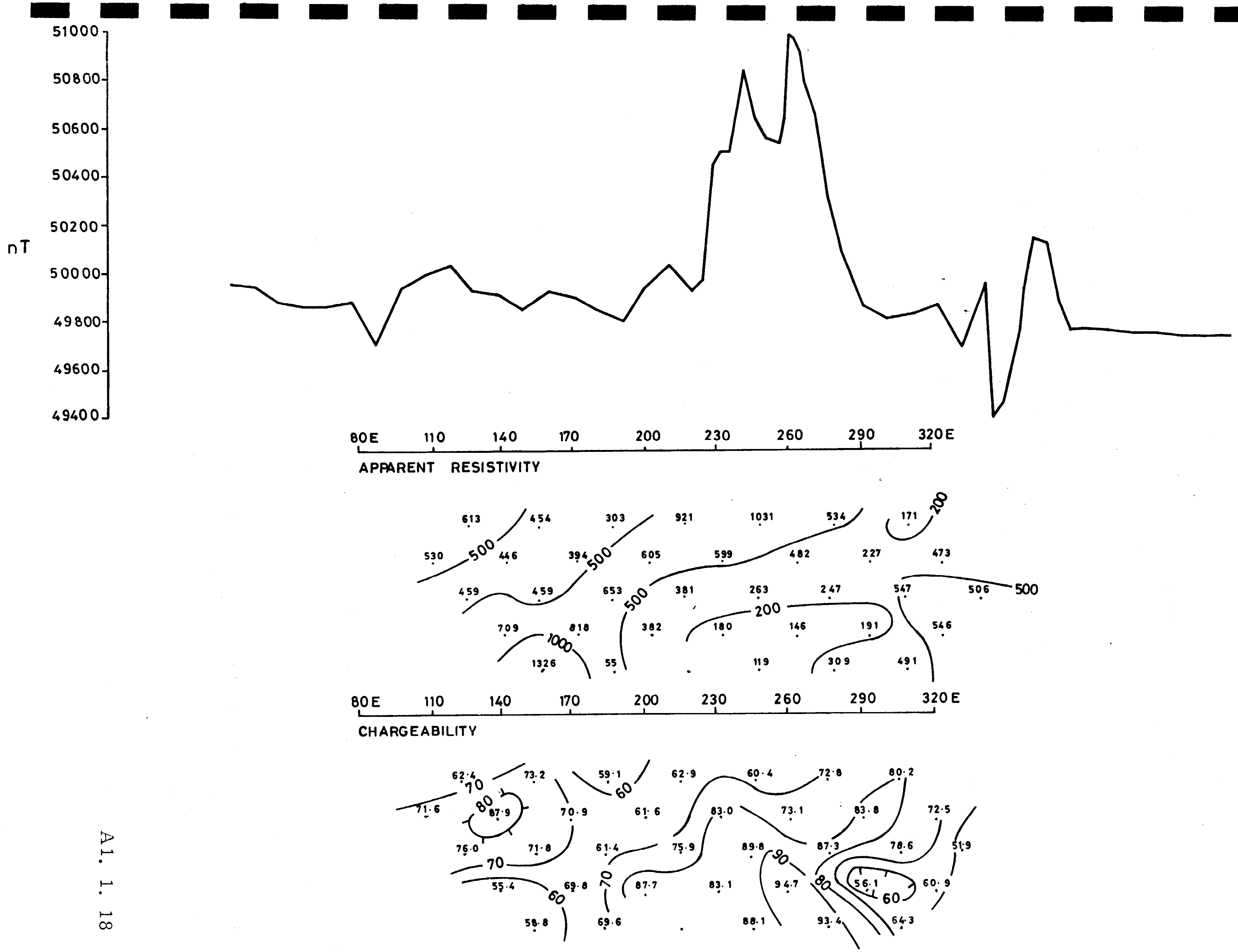



LINE 1400 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

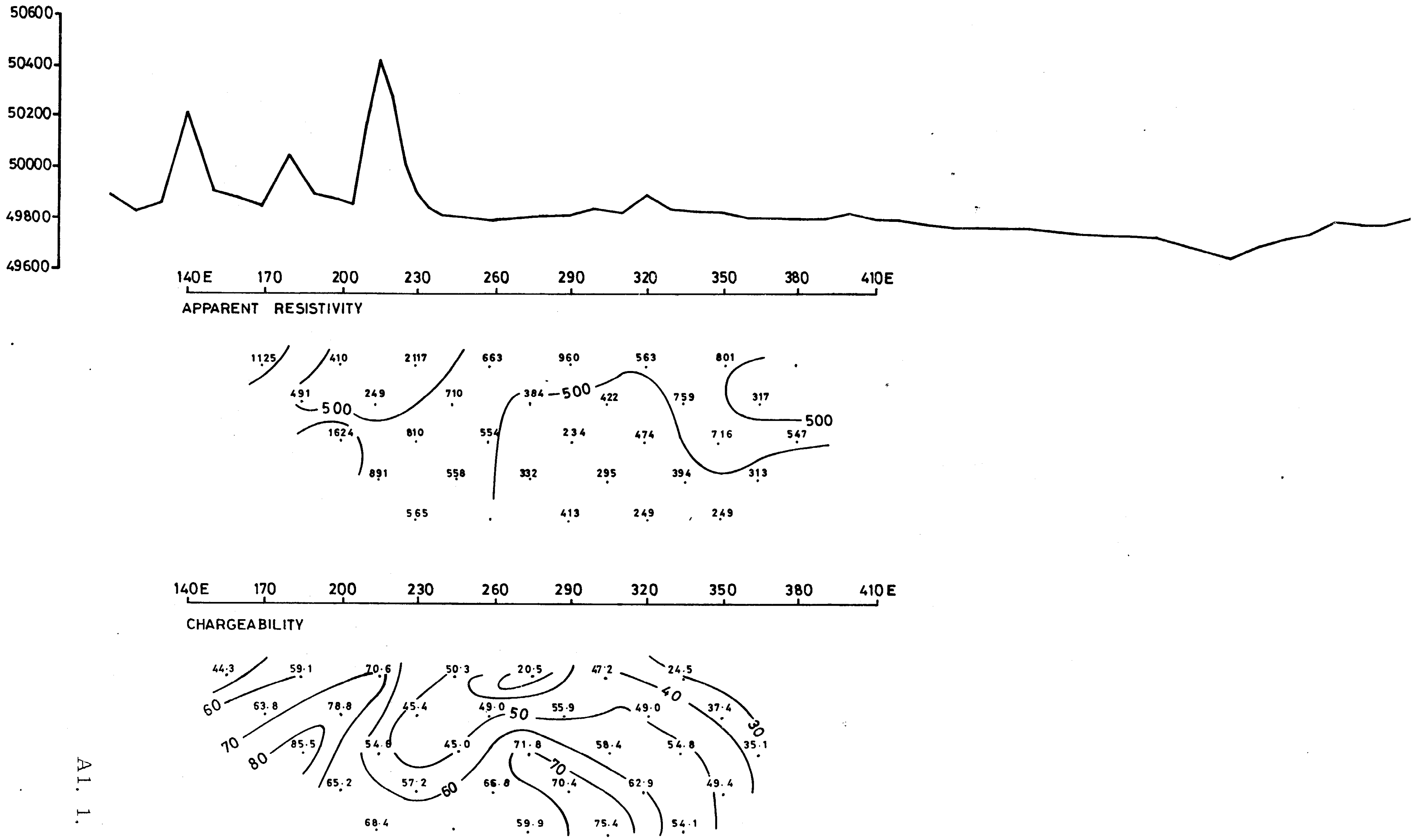



LINE 1500S TOTAL MAGNETIC FIELD

A1. 1. 17

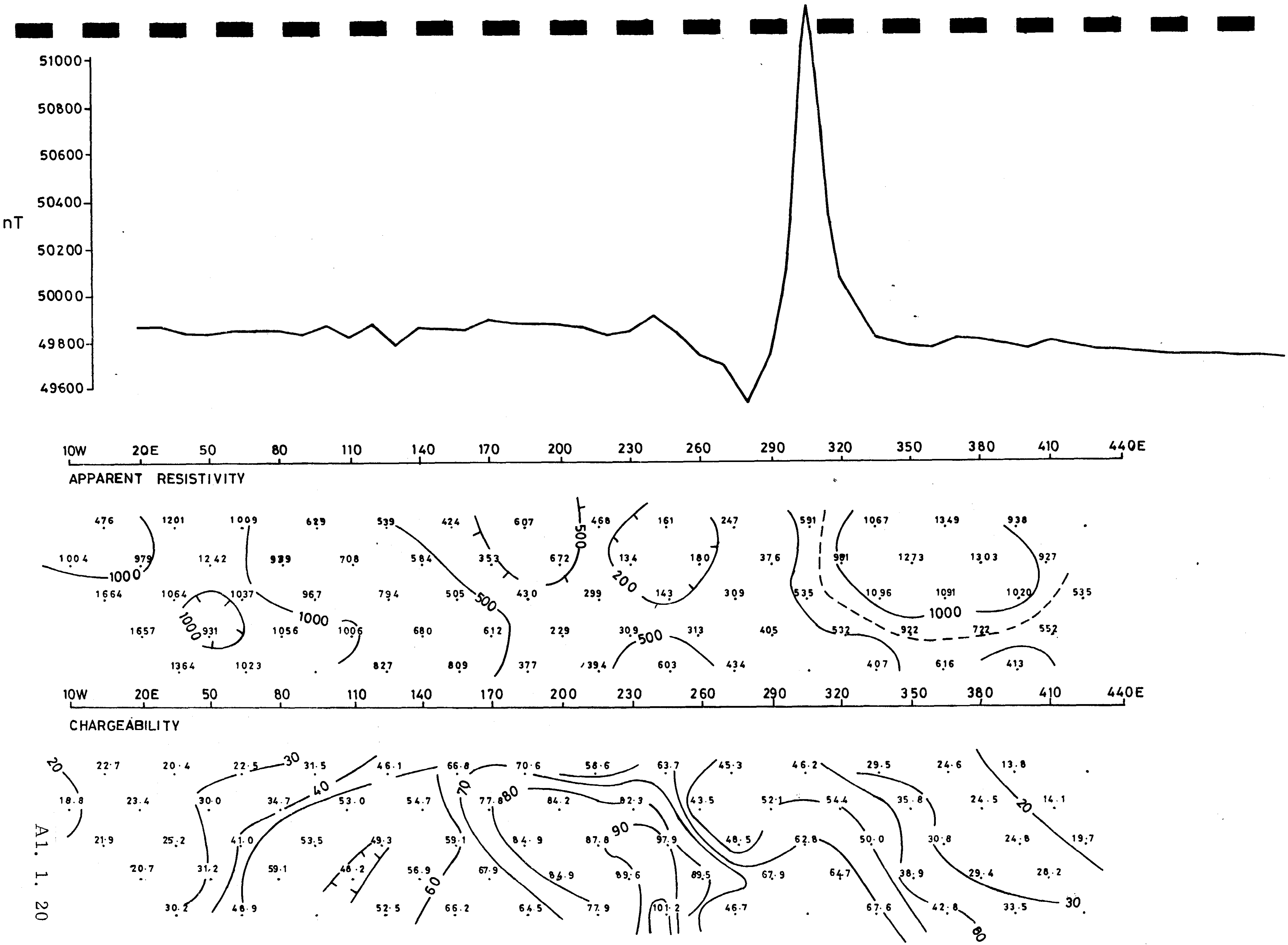



LINE 1600S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

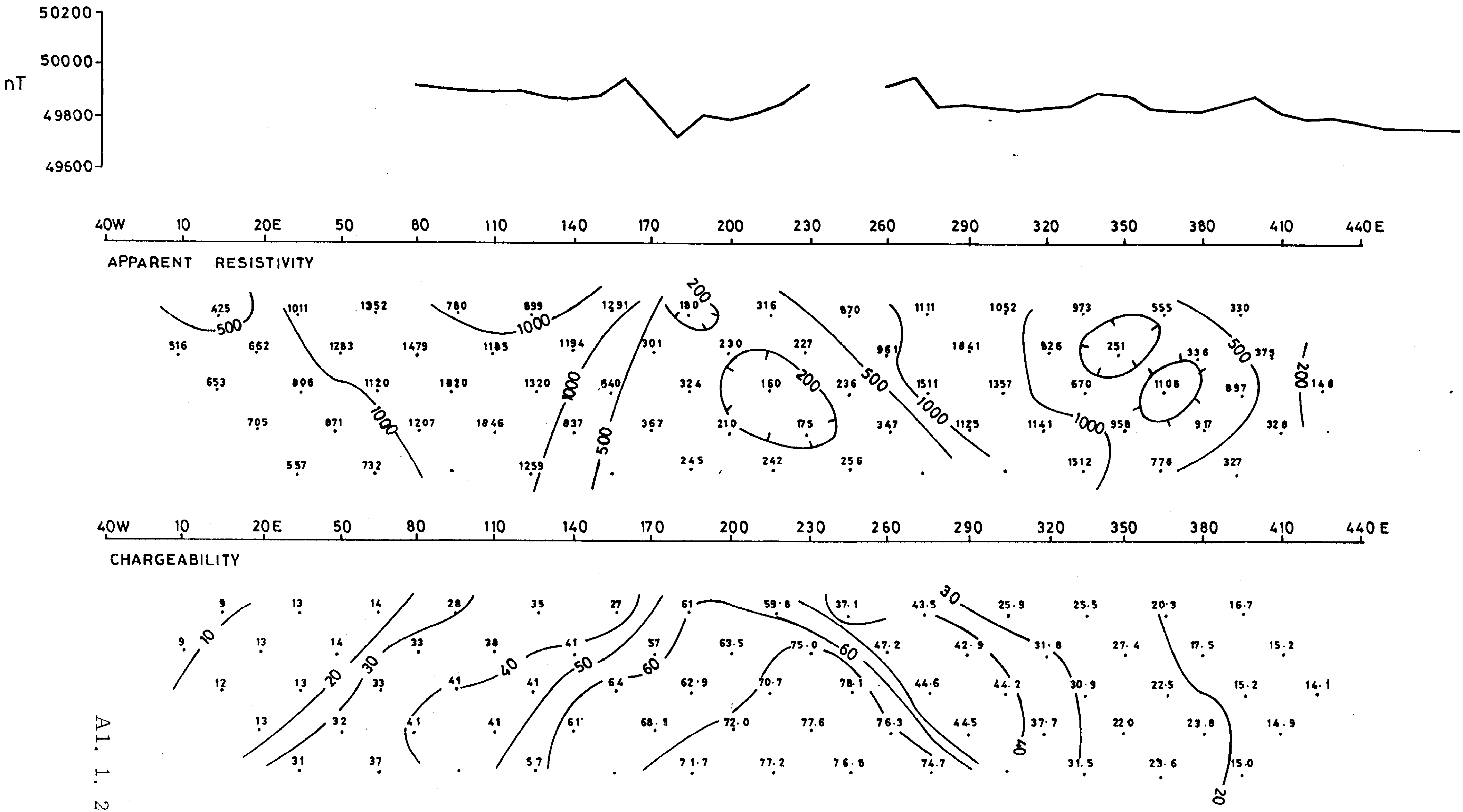



A1. 1. 19

LINE 1800S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

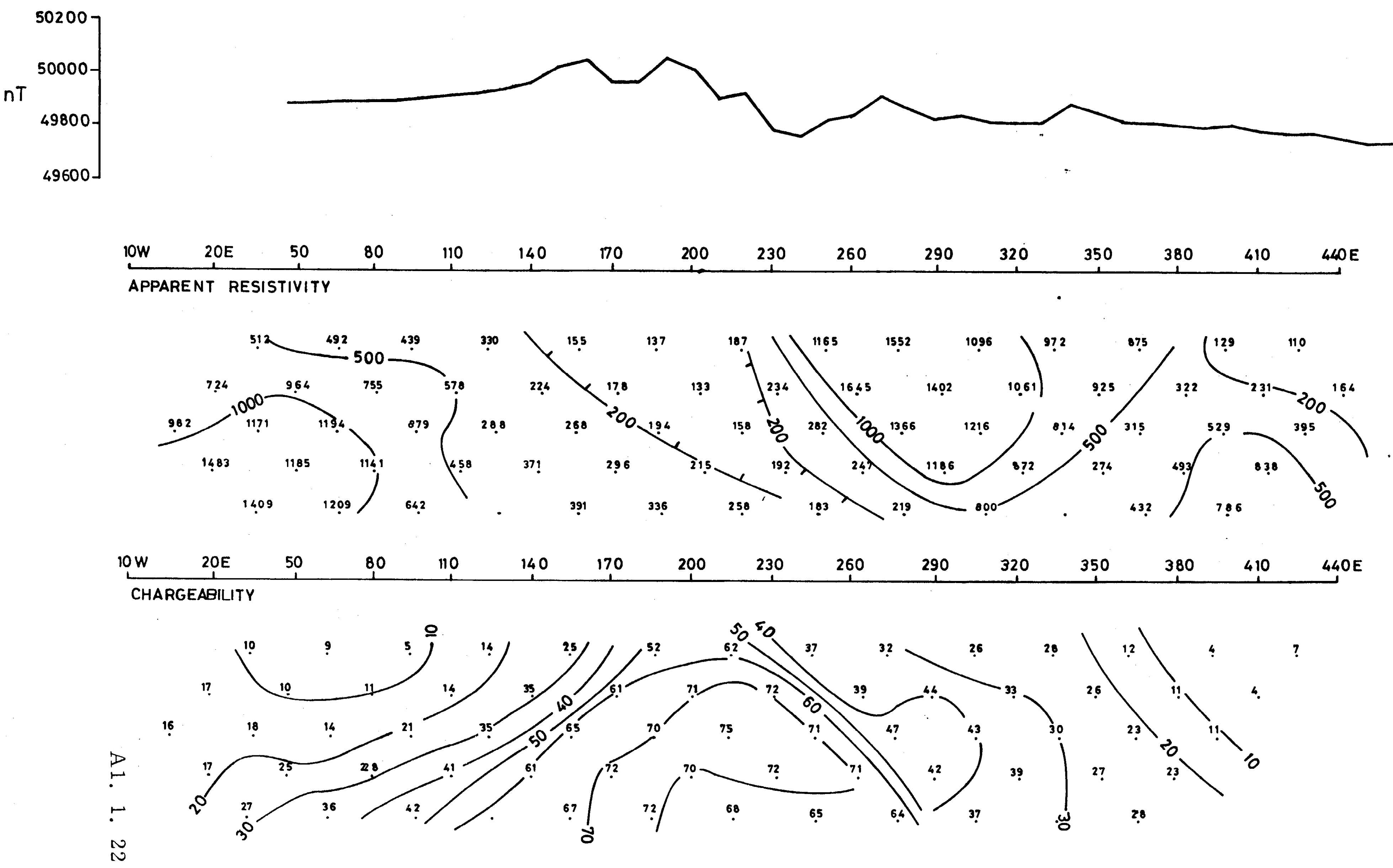



LINE 2000 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY



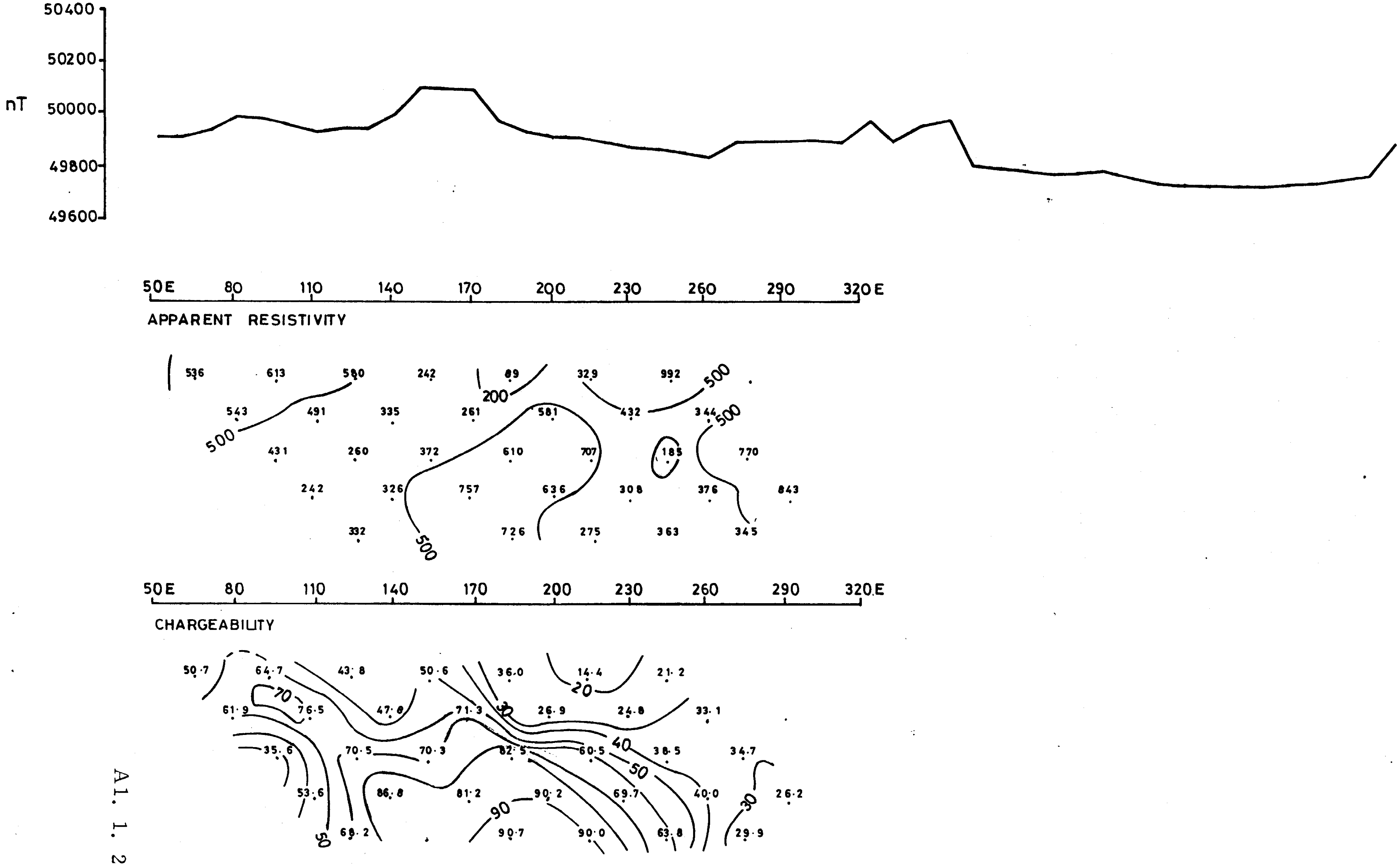

A1. 1. 21

LINE 2200 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

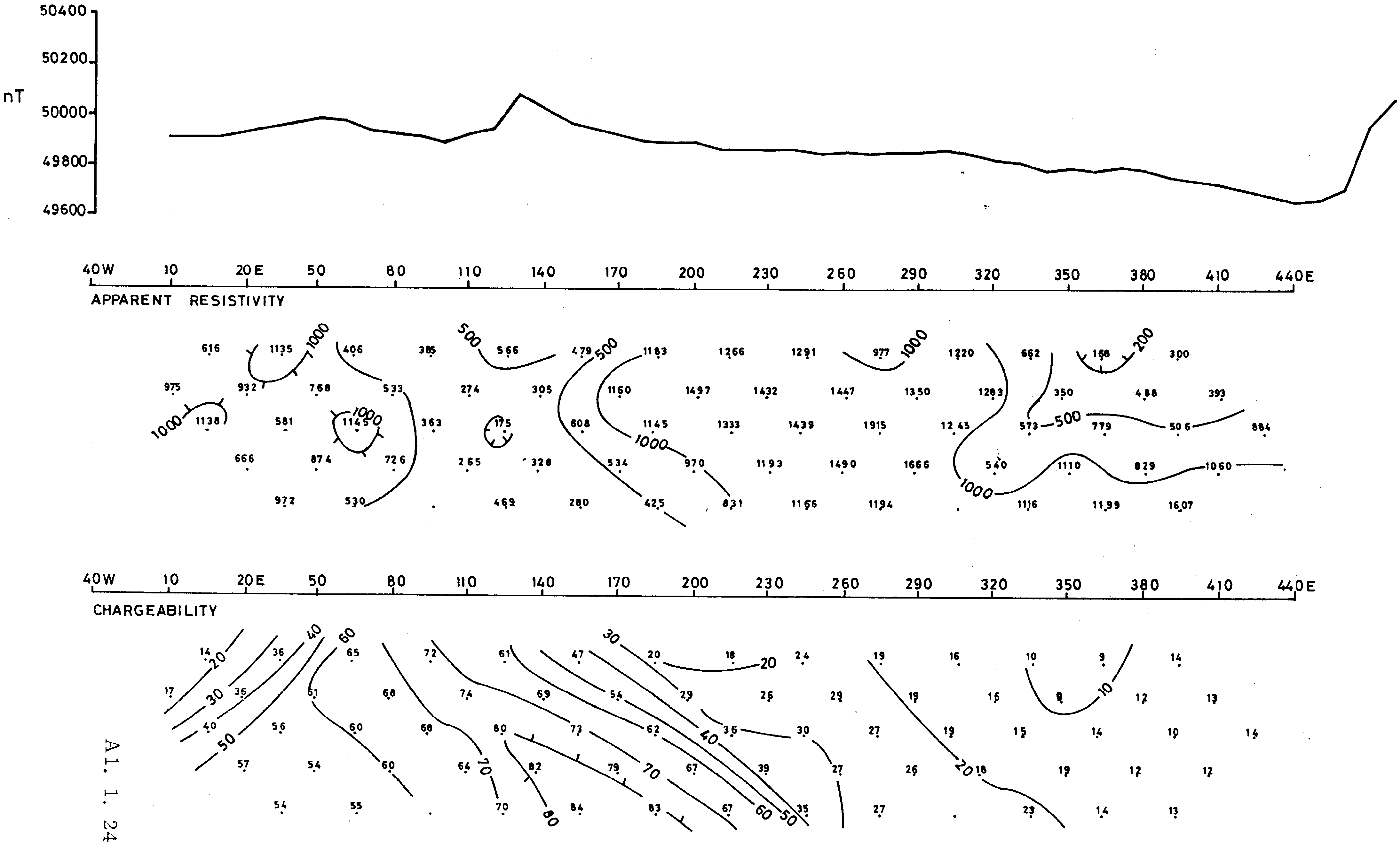



A1. 1. 22

LINE 2400S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

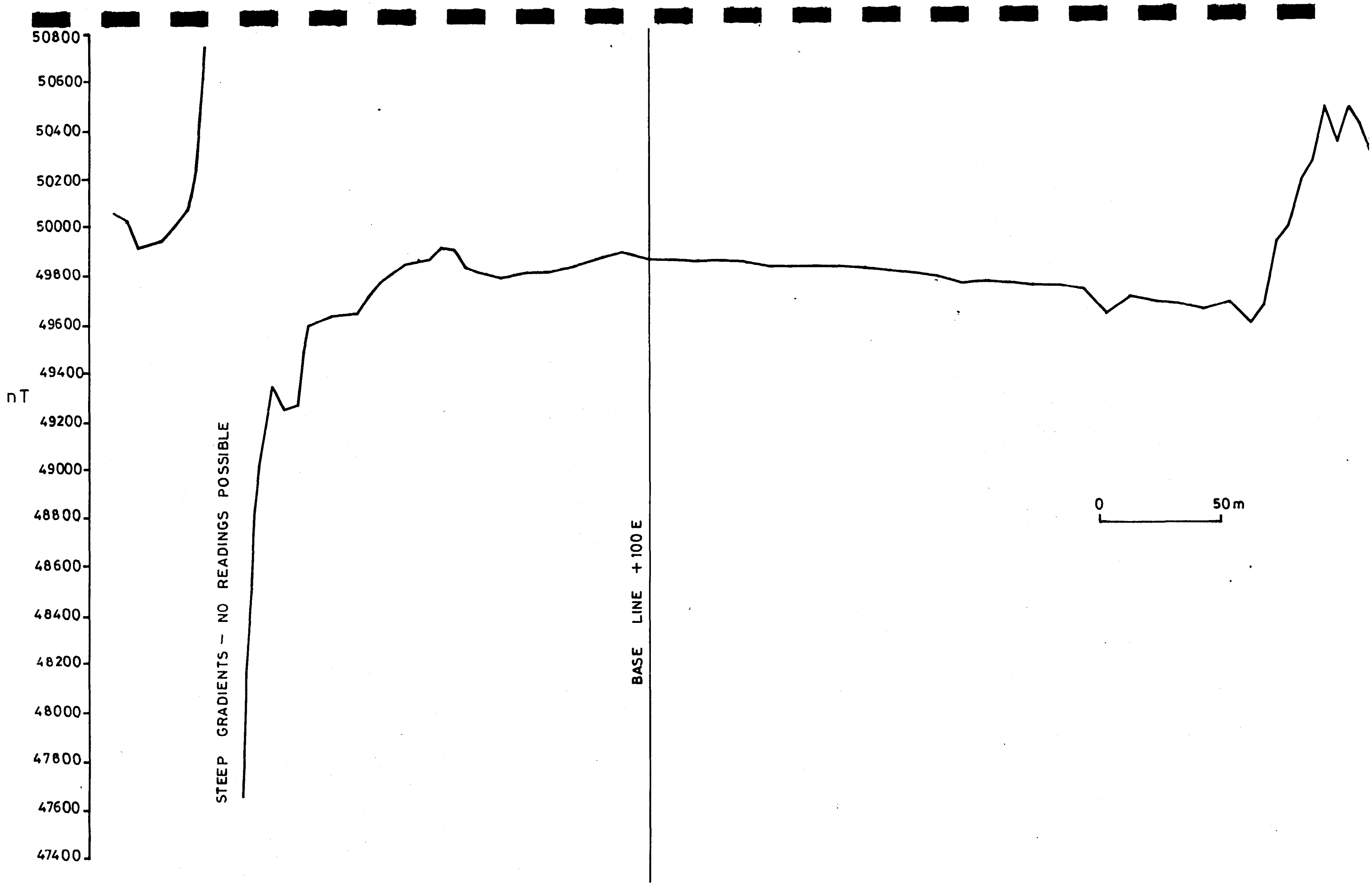



LINE 2600 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

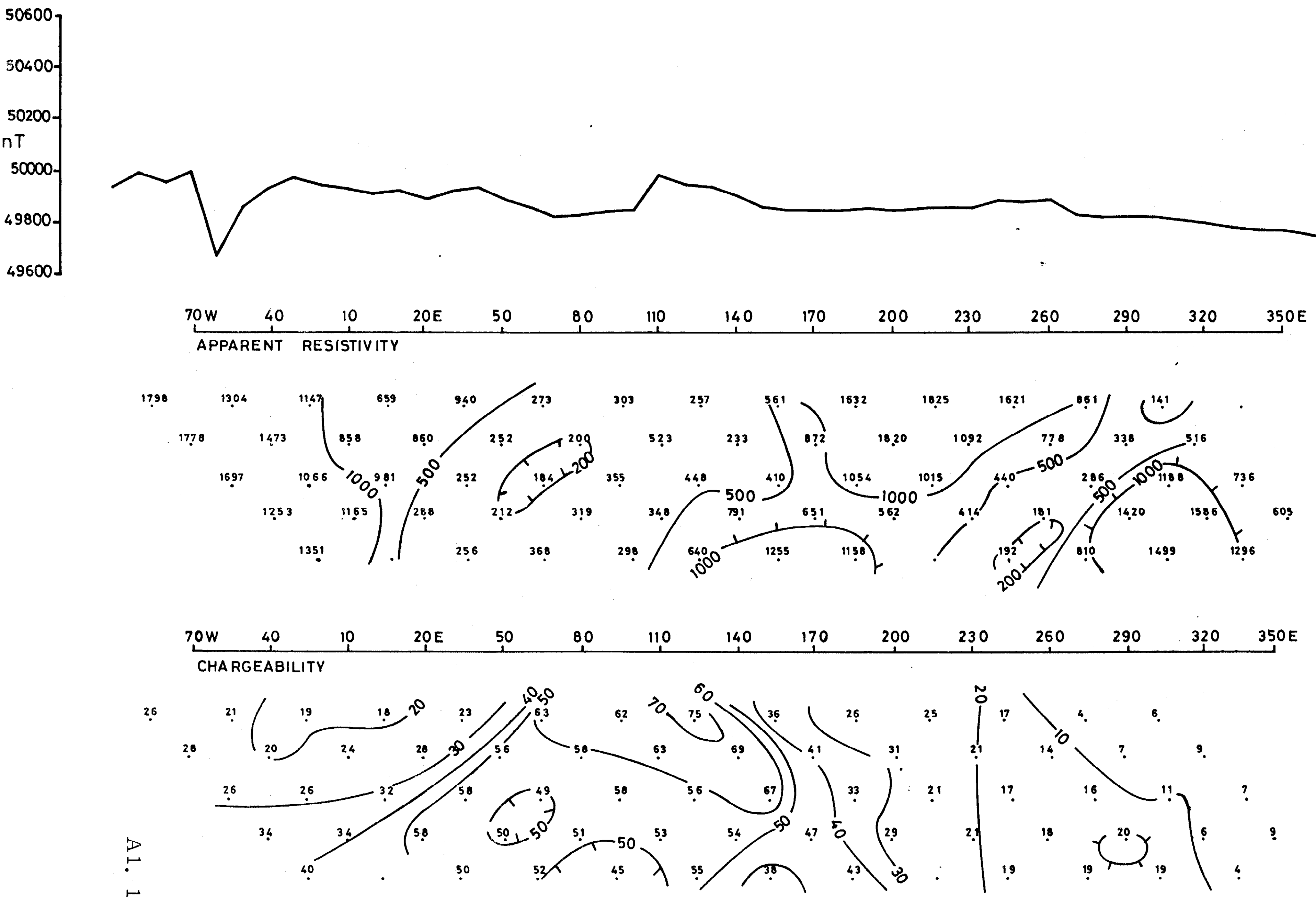



A1. 1. 24

LINE 2800 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

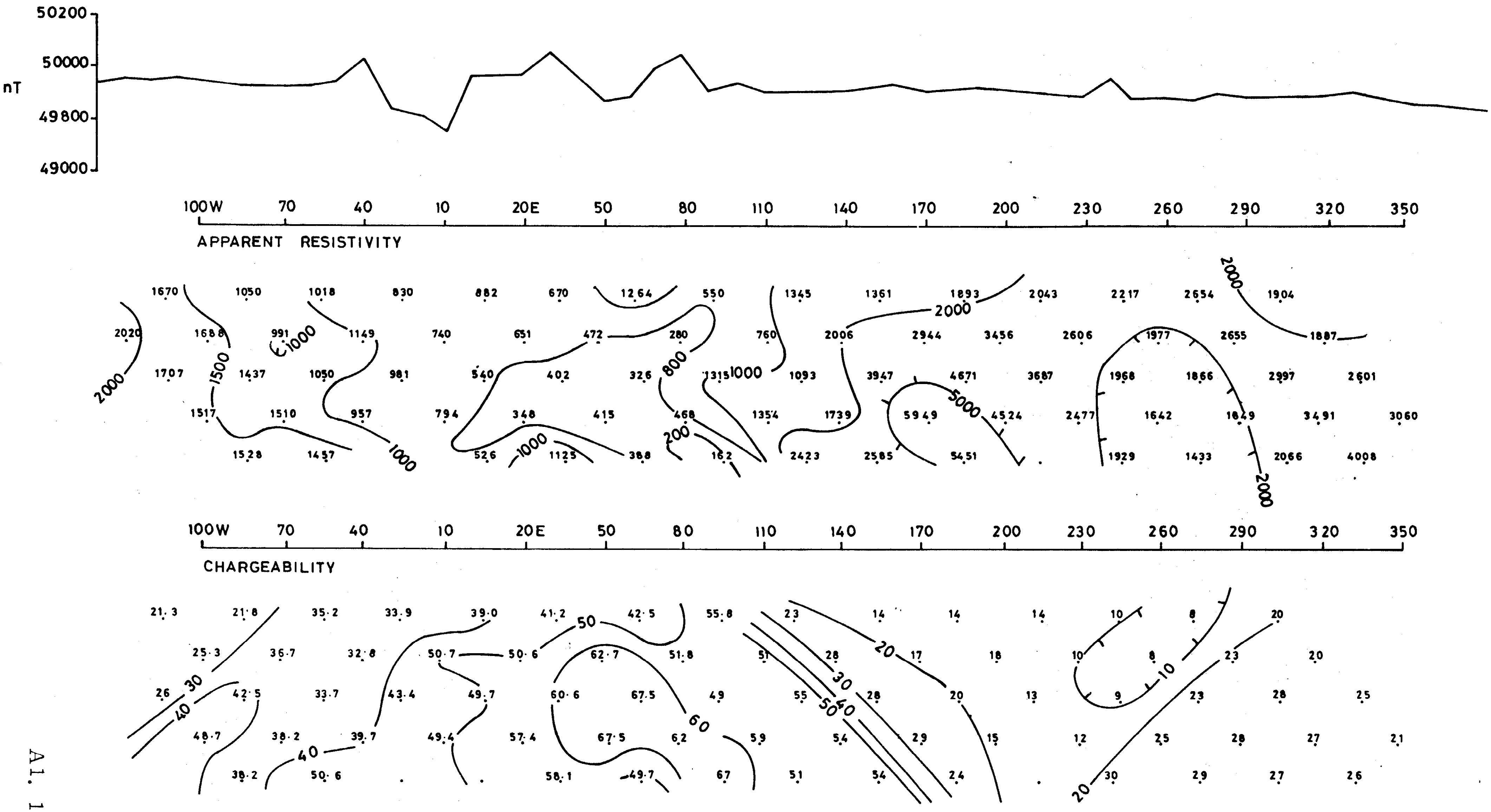



LINE 3000 S TOTAL MAGNETIC FIELD




A1. 1. 26

LINE 3200 S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY




LINE 3400S TOTAL MAGNETIC FIELD, RESISTIVITY AND CHARGEABILITY

A1. 1. 27

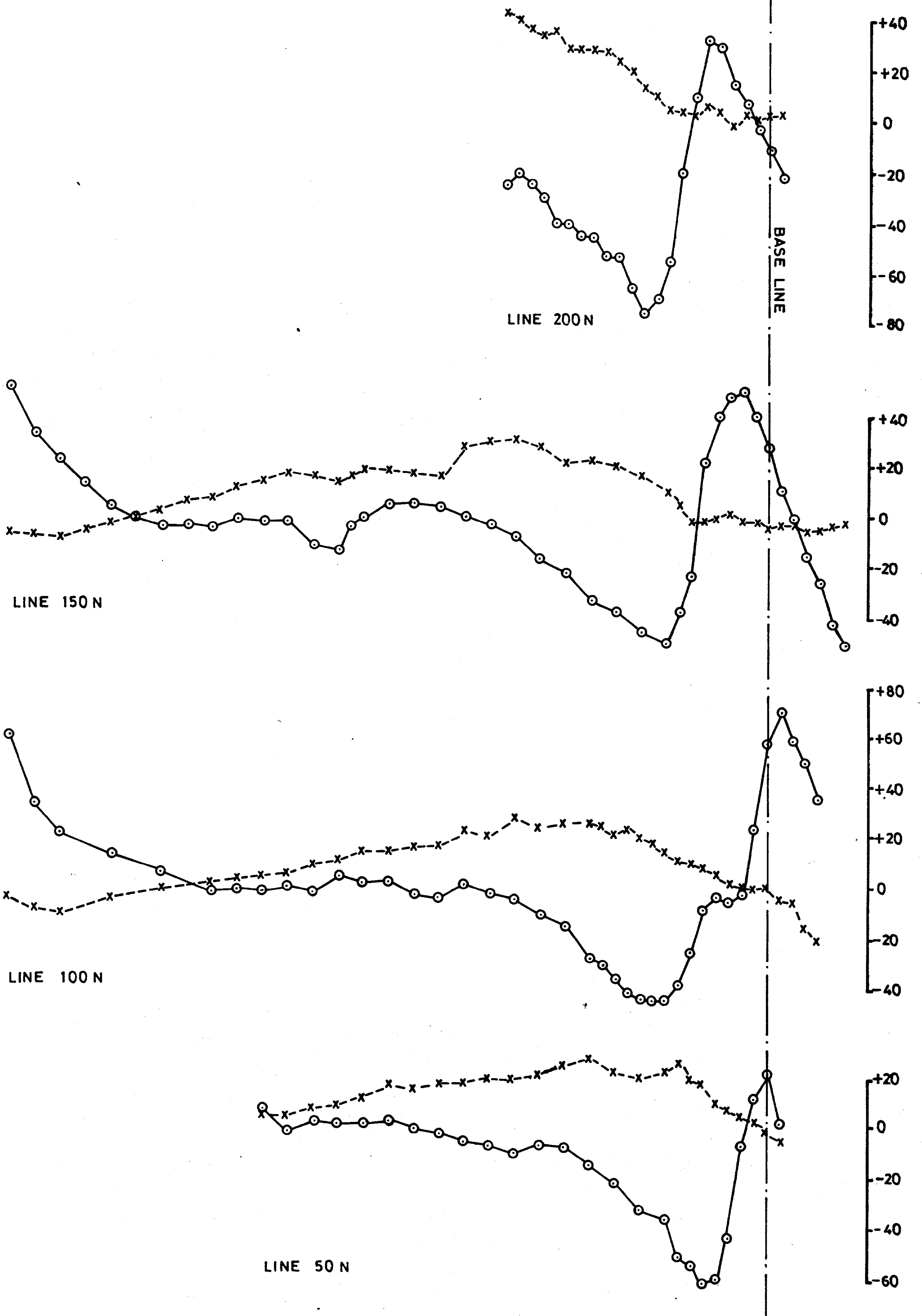
# GEOPHYSICAL SURVEY RESULTS

## SECTION 2: ELECTROMAGNETIC SURVEY, PROFILES

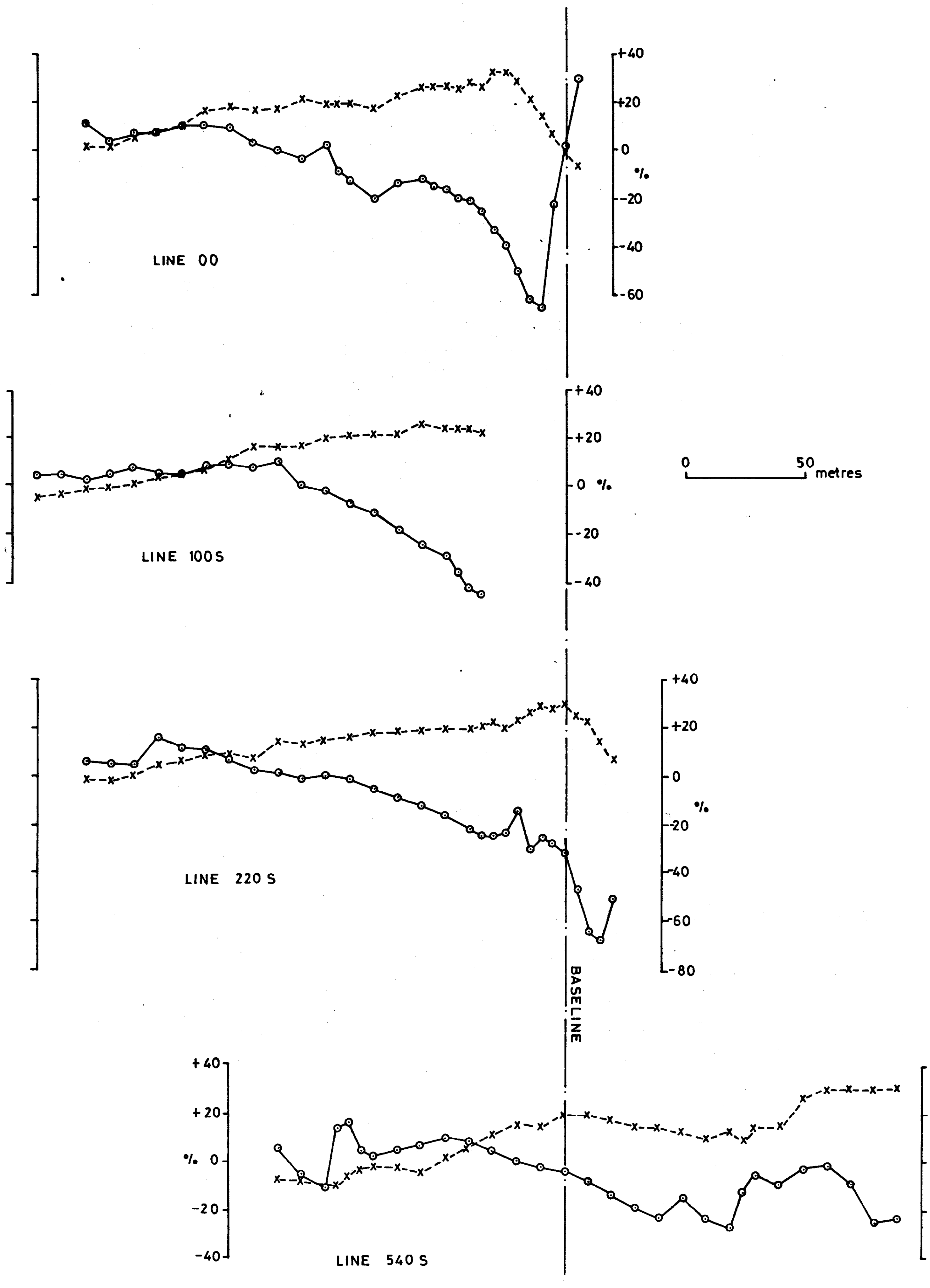
HORIZONTAL SCALE 1: 2000


o———o IN PHASE    x-----x OUT OF PHASE

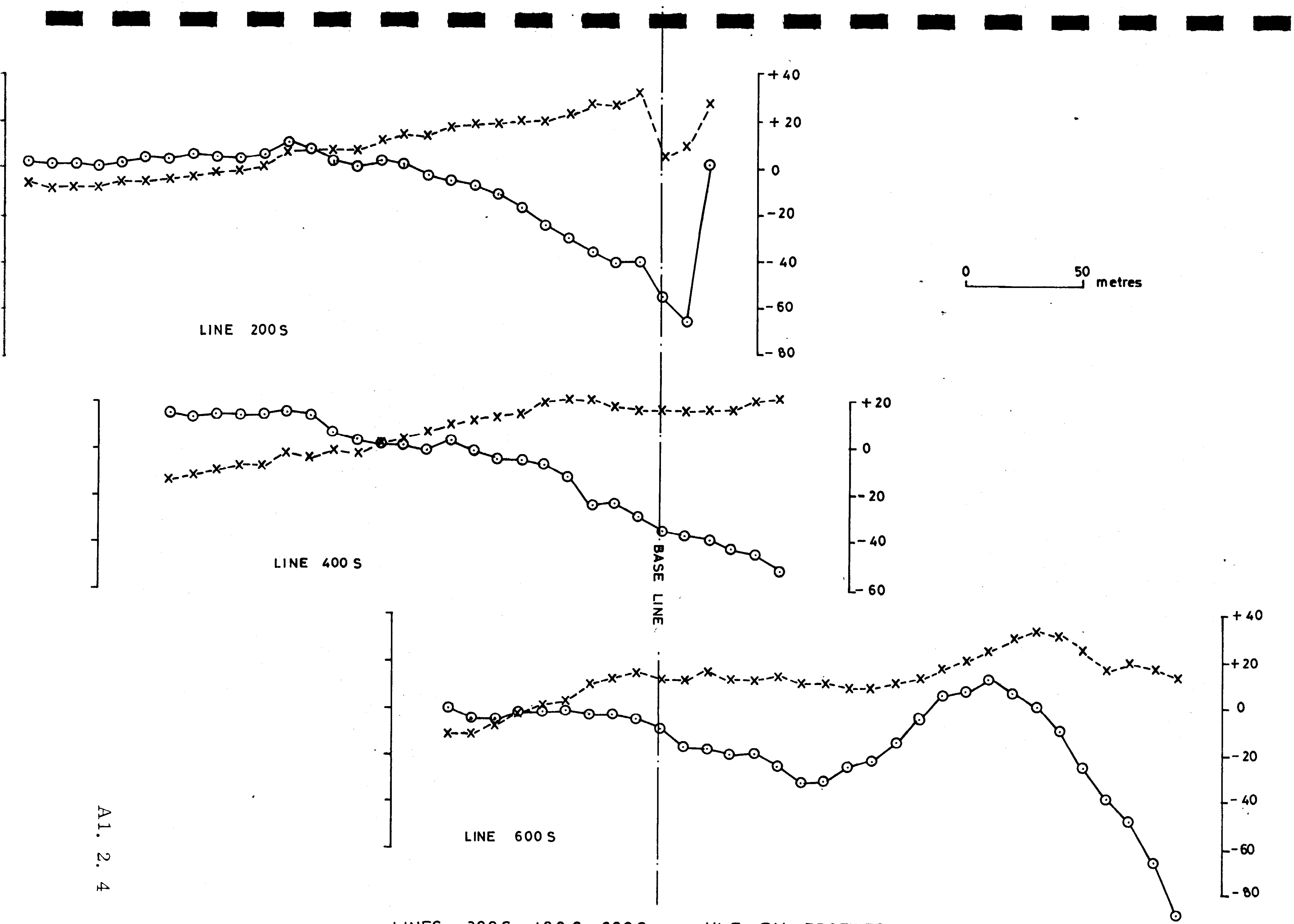
The VLF received was tuned to GBR at 16 KHz and the traverses were made from east to west.




LINES 200 N, 150 N, 100 N, 50 N VLF EM PROFILES

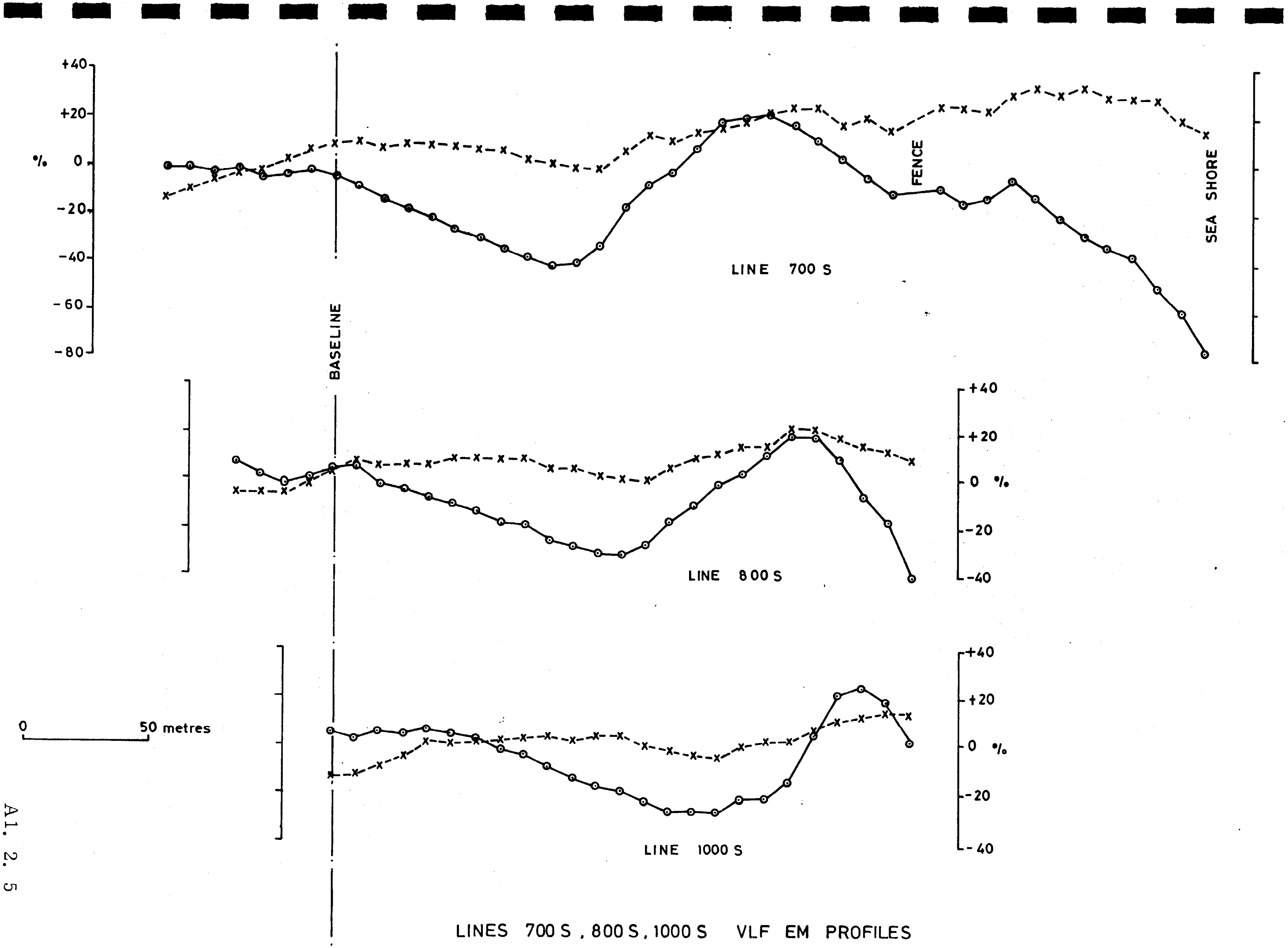



LINE 00, 100 S, 220 S, 540 S VLF EM PROFILES



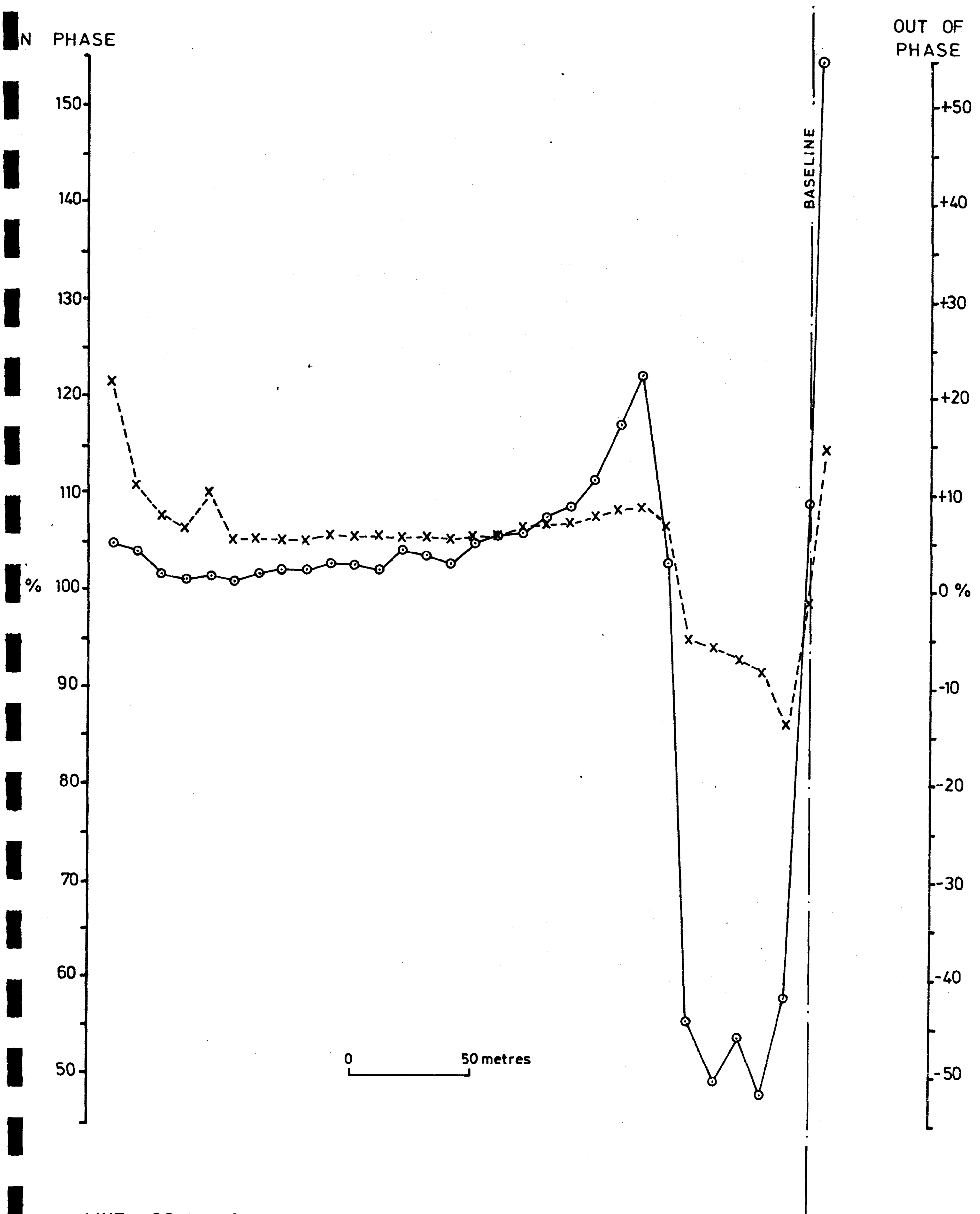

LINES 200 S, 400 S, 600 S : VLF EM PROFILES

A1. 2. 4




A1. 2. 5

LINES 700 S, 800 S, 1000 S VLF EM PROFILES




LINE 150N : SLINGRAM EM, AT 880 Hz, COIL SEPARATION: 60m

## APPENDIX TWO: GEOCHEMICAL SAMPLE NUMBERS AND LOCATIONS

| Traverse 150N | Position on Traverse | Panned Till Sample | Depth |
|---|---|---|---|
| CHS 1 | 10E | | 1.1m |
| CHS 2 | 0 | | 0.8 |
| CHS 3 | 10W | | 1.4 |
| CHS 4 | 20W | | 1.3 |
| CHS 5 | 30W | CHP 5 | 2.3 |
| CHS 6 | 40W | | 1.2 |
| CHS 7 | 50W | CHP 7 | 1.4 |
| **Traverse 700S** | | | |
| CHS 8 | 110E | | 0.9m |
| CHS 9 | " | | 1.8 |
| CHS 10 | " | | 2.5 |
| CHS 11 | " | | 2.7 |
| CHS 12 | 120E | | 1.8 |
| CHS 13 | " | | 2.7 |
| CHS 14 | " | | 3.5 |
| CHS 15 | 130E | | 0.8 |
| CHS 16 | " | | 1.3 |
| CHS 17 | 140E | | 0.7 |
| CHS 18 | " | | 1.4 |
| CHS 19 | " | | 1.8 |
| CHS 20 | " | | 2.0 |
| CHS 21 | " | | 2.6 |
| CHS 22 | 150E | | 0.9 |
| CHS 23 | " | | 1.7 |
| CHS 24 | " | | 2.4 |
| CHS 25 | 160E | | 0.9 |
| CHS 26 | " | | 1.7 |
| CHS 27 | " | | 2.6 |
| CHS 28 | " | | 3.0 |
| CHS 29 | 170E | | 0.9 |
| CHS 30 | 180E | | 0.5 |
| **Traverse 600S** | | | |
| CHS 31 | 170E | | 1.5m |
| CHS 32 | 160E | | 0.8 |
| - | 150E No sample | | - |
| CHS 33 | 140E | | 0.4 |

**Traverse 600S**

| | | | |
|---|---|---|---|
| CHS 34 | 130E | | 0.8m |
| CHS 35 | 120E | | 0.6 |
| CHS 36 | 110E | | 1.0 |
| CHS 37 | " | CHP 37 | 1.6 |
| CHS 38 | 100E | | 0.8 |
| CHS 39 | " | | 1.4 |
| CHS 40 | 90E | | 0.9 |
| CHS 41 | " | | 1.7 |
| CHS 42 | " | | 1.8 |
| CHS 43 | 80E | CHP 43 | 1.1 |
| CHS 44 | " | | 2.3 |
| CHS 45 | " | | 2.8 |

**Traverse 1000S**

| | | | |
|---|---|---|---|
| CHS 46 | 150E | | 0.5m |
| CHS 47 | 160E | | 0.4 |
| CHS 48 | 170E | | 0.4 |
| CHS 49 | 180E | | 0.3 |
| CHS 50 | 190E | | 0.3 |
| CHS 51 | 200E | | 1.8 |
| CHS 52 | " | | 2.5 |
| CHS 53 | 210E | | 0.4 |
| CHS 54 | 220E | | 0.2 |
| CHS 55 | 230E | | 0.1 |
| CHS 56 | 240E | | 0.2 |

**Traverse 1600S**

| | | | |
|---|---|---|---|
| CHS 57 | 320E | | 2.0m |
| CHS 58 | 310E | | 1.4 |
| CHS 59 | 300E | | 1.1 |
| CHS 60 | " | | 1.3 |
| CHS 61 | 290E | | 0.9 |
| CHS 62 | " | | 2.0 |
| CHS 63 | 280E | | 1.4 |
| CHS 64 | " | | 1.8 |
| CHS 65 | 270E | | 0.9 |
| CHS 66 | 260E | | 1.0 |
| CHS 67 | 250E | CHP 67 | 0.9 |
| CHS 68 | 240E | | 0.8 |
| CHS 69 | 230E | | 0.7 |

Traverse 1600S

| | | | |
|---|---|---|---|
| CHS 70 | 220E | CHP 70 | 0.7 CHR 70, CHD 70 |
| CHS 71 | 210E | CHP 71 | 1.6 |

Traverse 2000S

| | | | |
|---|---|---|---|
| CHS 72 | 310E | | 1.3m |
| CHS 73 | " | | 2.1 |
| CHS 74 | " | | 2.5 |
| CHS 75 | " | | 3.3 |
| CHS 76 | " | | 4.0 |
| CHS 77 | 300E | | 1.8 |
| CHS 78 | " | | 2.7 |
| CHS 79 | 290E | | 1.8 |
| CHS 80 | " | | 2.6 |
| CHS 81 | " | | 3.2 |
| CHS 82 | " | | 3.6 |
| CHS 83 | 280E | CHP 83 | 0.9 |
| CHS 84 | 270E | | 0.8 |
| CHS 85 | 260E | | 1.4 |
| CHS 86 | " | CHP 86 | 1.8 |
| CHS 87 | 250E | | 0.7 |
| CHS 88 | " | | 0.9 |
| CHS 89 | 240E | | 0.7 |
| CHS 90 | " | | 1.8 |
| CHS 91 | " | | 1.9 |
| CHS 92 | 230E | | 1.5 |
| CHS 93 | " | | 2.4 |
| CHS 94 | " | | 2.5 |
| CHS 95 | 220E | | 0.8 |
| CHS 96 | " | CHP 96 | 2.4 |
| CHS 97 | " | | 3.2 |
| CHS 98 | 210E | | 1.4 |
| CHS 99 | " | | 1.8 |
| CHS 100 | 200E | CHP 100 | 2.3 |
| CHS 101 | 190E | | 0.9 |

Traverse 2400S

| | | | |
|---|---|---|---|
| CHS 102 | 150E | CHP 102 | 4.5m |
| CHS 103 | " | | 5.4 |
| CHS 104 | 160E | CHP 104 | 5.4 |
| CHS 105 | 170E | | 6.0 |

**Traverse 2400S**

| | | | |
|---|---|---|---|
| CHS 106 | 180E | | 3.0m |
| CHS 107 | 190E | CHP 107 | 4.5 |
| CHS 108 | 200E | CHP 108 | 3.4 |
| CHS 109 | 210E | CHP 109 | 2.0 |
| CHS 110 | 220E | | 1.0 |
| CHS 111 | 230E | | 0.6 |
| CHS 112 | 240E | CHP 112 | 0.9 |

**Traverse 2800S**

| | | | |
|---|---|---|---|
| CHS 113 | 150E | | 0.4m |
| CHS 114 | 140E | | 0.6 |
| CHS 115 | 130E | | 0.9 |
| CHS 116 | 120E | | 0.8 |
| CHS 117 | 110E | | 2.4 |
| CHS 118 | 100E | | 1.8 |
| CHS 119 | 90E | CHP 119 | 1.9 |
| CHS 120 | 80E | | 1.5 |
| CHS 121 | 70E | | 1.4 |

**Traverse 3200S**
(4 samples)

| | | |
|---|---|---|
| CHS 122, A, B, C, | 60E | 2.0m |
| CHS 123 | 70E | 1.5 |
| CHS 124 | 80E | 0.7 |
| CHS 125 | 90E | 0.4 |
| CHS 126 | 100E | 1.6 |
| CHS 127 | 110E | 1.2 |
| CHS 128 | 120E | 2.2 |
| CHS 129 | 130E | 3.0 |
| CHS 130 | 140E | 1.3 |
| CHS 131 | 150E | 2.2 |

**Traverse 3400S**

| | | |
|---|---|---|
| CHS 132 | 120E | 1.4m |
| CHS 133 | 110E | 0.6 |
| CHS 134 | 100E | 1.1 |
| CHS 135 | 90E | 1.3 |
| CHS 136 | 80E | 1.0 |
| CHS 137 | 70E | 0.6 |
| CHS 138 | 60E | 0.6 |
| CHS 139 | 50E | 1.8 |

**Traverse 3400S**

| | | | |
|---|---|---|---|
| CHS 140 | 40E | | 0.8m |
| CHS 141 | 30E | | 2.7 |
| CHS 142 | " | | 3.0 |
| CHS 143 | 20E | | 0.6 |

**Traverse 2400S**

| | | | |
|---|---|---|---|
| CHS 144 | 700E | CHP 144 | 1.9m |
| CHS 145 | 650E | CHP 145 | 2.3 CHR 145 |
| CHS 146 | 600E | CHP 146 | 1.4 CHR 146 |

**Traverse 2200S**

| | | | |
|---|---|---|---|
| CHS 147 | 280E | | 2.4m |
| CHS 148 | 270E | | 2.3 |
| CHS 149 | 260E | CHP 149 | 1.8 |
| CHS 156 | 250E | | 2.5 |
| CHS 157 | 240E | CHP 157 | 2.2 |
| CHS 158 | 230E | | 0.6 |
| CHS 159 | 220E | | 1.5 |
| CHS 160 | 210E | | 1.1 |
| CHS 161 | 170E | CHP 161 | 1.1 |
| CHS 162 | 180E | | 2.0 |
| CHS 163 | 190E | | 1.7 |
| CHS 164 | 200E | | 2.2. |

**Sections above localities 4-1**

| | |
|---|---|
| Loc. 4 | |
| CHS 166 | 0.15m |
| CHS 167 | 0.11 |
| CHS 168 | 0.15 |
| CHS 169 | 0.35 |
| Loc. 3 | |
| CHS 170 | 0.3 |
| CHS 171 | 0.5 |
| CHS 172 | 1.0 |
| Loc. 1 | |
| CHS 173 | 1.0 |
| CHS 174 | 1.3 |
| CHS 175 | 2.0 |

**Traverse 400S**

| | | | |
|---|---|---|---|
| CHS 176 | 50E | | 1.2m |
| CHS 177 | 40E | CHP 177 | 2.7 |
| CHS 178 | 30E | | 2.1 |
| CHS 179 | 20E | | 1.0 |
| CHS 180 | 10E | CHP 180 | 3.0 |
| CHS 181 | 0 | | 0.9 |
| CHS 182 | 10W | | 1.7 |

**Traverse 1200S**

| | | | |
|---|---|---|---|
| CHS 183 | 210E | CHP 183 | 2.8m |
| CHS 184 | 200E | | 2.2 |
| CHS 185 | 190E | | 0.6 |
| CHS 186 | 180E | | 1.3 |
| CHS 187 | 170E | CHP 187 | 2.2 |
| CHS 188 | 160E | | 0.6 |
| CHS 189 | 150E | | 0.7 |
| CHS 190 | 140E | | 0.5 |

APPENDIX THREE

GEOCHEMICAL SURVEY RESULTS

TABLE I SOIL SAMPLES, VIDLIN

| | | CU | PB | ZN AAS | CO AAS | NI | CR | MN | FE | ES CO | ES NI | BA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHS | 1 | 45. | 20. | 40. | 10. | 25. | 311. | 1095. | 60059. | 28. | 96. | 160. |
| CHS | 2 | 65. | 20. | 60. | 15. | 30. | 80. | 711. | 45171. | 15. | 37. | 573. |
| CHS | 3 | 35. | 20. | 60. | 15. | 30. | 80. | 718. | 49276. | 16. | 37. | 442. |
| CHS | 4 | 75. | 50. | 130. | 20. | 35. | 70. | 834. | 47483. | 20. | 45. | 483. |
| CHS | 5 | 40. | 20. | 90. | 20. | 35. | 62. | 535. | 41538. | 13. | 47. | 393. |
| CHS | 6 | 35. | 20. | 70. | 20. | 35. | 74. | 699. | 45117. | 16. | 39. | 528. |
| CHS | 7 | 90. | 40. | 120. | 20. | 30. | 335. | 1771. | 50095. | 18. | 71. | 407. |
| CHS | 8 | 40. | 20. | 90. | 20. | 40. | 545. | 2294. | 50862. | 20. | 105. | 701. |
| CHS | 9 | 30. | 20. | 80. | 20. | 30. | 70. | 626. | 45748. | 17. | 55. | 650. |
| CHS | 10 | 50. | 10. | 80. | 35. | 70. | 171. | 994. | 71055. | 37. | 99. | 319. |
| CHS | 11 | 35. | 10. | 80. | 35. | 65. | 577. | 1075. | 68771. | 39. | 99. | 76. |
| CHS | 12 | 60. | 10. | 70. | 30. | 60. | 138. | 848. | 57017. | 30. | 69. | 511. |
| CHS | 13 | 90. | 10. | 40. | 15. | 20. | 57. | 3595. | 50856. | 12. | 28. | 259. |
| CHS | 14 | 115. | 30. | 90. | 30. | 55. | 148. | 2772. | 67256. | 29. | 63. | 381. |
| CHS | 15 | 25. | 30. | 40. | 10. | 20. | 61. | 5339. | 41456. | 14. | 28. | 215. |
| CHS | 16 | 90. | 30. | 50. | 20. | 30. | 80. | 3742. | 55175. | 17. | 40. | 272. |
| CHS | 17 | 30. | 10. | 50. | 15. | 30. | 79. | 769. | 45758. | 16. | 44. | 364. |
| CHS | 18 | 40. | 10. | 60. | 20. | 30. | 62. | 971. | 42272. | 18. | 44. | 366. |
| CHS | 19 | 80. | 10. | 40. | 30. | 40. | 106. | 1816. | 48496. | 27. | 50. | 138. |
| CHS | 20 | 30. | 10. | 30. | 15. | 25. | 41. | 1592. | 35105. | 13. | 25. | 32. |
| CHS | 21 | 25. | 50. | 30. | 10. | 30. | 52. | 1982. | 32871. | 11. | 31. | 44. |
| CHS | 22 | 40. | 20. | 80. | 20. | 35. | 61. | 848. | 45263. | 19. | 38. | 545. |
| CHS | 23 | 35. | 20. | 80. | 20. | 30. | 53. | 837. | 44476. | 18. | 38. | 558. |
| CHS | 24 | 40. | 10. | 70. | 20. | 30. | 42. | 753. | 43548. | 17. | 34. | 423. |
| CHS | 25 | 40. | 20. | 80. | 15. | 35. | 59. | 749. | 44965. | 16. | 41. | 550. |
| CHS | 26 | 40. | 20. | 80. | 20. | 30. | 61. | 1090. | 54362. | 22. | 43. | 601. |
| CHS | 27 | 50. | 20. | 90. | 25. | 35. | 81. | 804. | 49495. | 20. | 48. | 445. |
| CHS | 28 | 45. | 10. | 80. | 20. | 35. | 70. | 846. | 49721. | 24. | 46. | 475. |
| CHS | 29 | 35. | 20. | 70. | 20. | 30. | 43. | 830. | 42652. | 18. | 34. | 480. |
| CHS | 30 | 30. | 10. | 60. | 15. | 30. | 51. | 718. | 42183. | 14. | 32. | 456. |
| CHS | 31 | 25. | 10. | 80. | 15. | 30. | 49. | 672. | 39464. | 16. | 37. | 491. |
| CHS | 32 | 35. | 10. | 80. | 20. | 35. | 63. | 829. | 40474. | 19. | 44. | 601. |
| CHS | 33 | 15. | 10. | 60. | 10. | 20. | 49. | 593. | 37880. | 11. | 25. | 630. |
| CHS | 34 | 35. | 10. | 60. | 15. | 30. | 52. | 586. | 40821. | 15. | 33. | 492. |
| CHS | 35 | 15. | 10. | 50. | 10. | 20. | 38. | 464. | 28792. | 10. | 23. | 610. |
| CHS | 36 | 25. | 20. | 70. | 15. | 30. | 59. | 575. | 37645. | 15. | 32. | 652. |
| CHS | 37 | 30. | 20. | 80. | 15. | 30. | 72. | 714. | 38689. | 17. | 38. | 738. |
| CHS | 38 | 30. | 10. | 70. | 10. | 30. | 53. | 561. | 39542. | 11. | 35. | 588. |
| CHS | 39 | 40. | 20. | 80. | 20. | 35. | 57. | 618. | 44850. | 16. | 39. | 606. |
| CHS | 40 | 55. | 30. | 120. | 30. | 70. | 65. | 574. | 53127. | 20. | 57. | 442. |
| CHS | 41 | 45. | 20. | 90. | 20. | 40. | 57. | 676. | 47754. | 19. | 50. | 477. |
| CHS | 42 | 55. | 40. | 80. | 25. | 60. | 91. | 798. | 44733. | 19. | 50. | 498. |
| CHS | 43 | 35. | 20. | 80. | 20. | 40. | 72. | 817. | 52518. | 20. | 48. | 901. |
| CHS | 44 | 45. | 20. | 80. | 20. | 40. | 60. | 542. | 41079. | 18. | 41. | 490. |
| CHS | 45 | 50. | 20. | 90. | 20. | 50. | 67. | 600. | 46985. | 20. | 62. | 383. |
| CHS | 46 | 50. | 20. | 80. | 20. | 40. | 54. | 568. | 48320. | 19. | 47. | 348. |
| CHS | 47 | 25. | 20. | 80. | 25. | 40. | 57. | 667. | 40834. | 21. | 44. | 619. |
| CHS | 48 | 40. | 20. | 90. | 20. | 30. | 49. | 759. | 40583. | 14. | 32. | 426. |
| CHS | 49 | 40. | 20. | 80. | 15. | 35. | 53. | 715. | 46868. | 14. | 37. | 548. |
| CHS | 50 | 60. | 20. | 90. | 30. | 80. | 148. | 638. | 41274. | 21. | 64. | 388. |
| CHS | 51 | 75. | 30. | 180. | 15. | 40. | 49. | 1322. | 28782. | 10. | 40. | 247. |
| CHS | 52 | 50. | 30. | 70. | 10. | 30. | 54. | 1151. | 22389. | 10. | 26. | 382. |
| CHS | 53 | 20. | 20. | 90. | 20. | 30. | 44. | 630. | 42121. | 14. | 33. | 538. |
| CHS | 54 | 40. | 30. | 90. | 15. | 35. | 30. | 711. | 49377. | 14. | 36. | 633. |
| CHS | 55 | 40. | 20. | 80. | 15. | 30. | 55. | 614. | 42288. | 13. | 31. | 467. |
| CHS | 56 | 30. | 40. | 75. | 10. | 25. | 61. | 617. | 42787. | 11. | 29. | 468. |
| CHS | 57 | 30. | 30. | 90. | 15. | 25. | 56. | 666. | 44044. | 13. | 30. | 669. |
| CHS | 58 | 40. | 30. | 90. | 20. | 35. | 59. | 692. | 43256. | 16. | 36. | 629. |
| CHS | 59 | 35. | 30. | 90. | 20. | 30. | 68. | 812. | 44065. | 15. | 35. | 494. |
| CHS | 60 | 30. | 30. | 70. | 15. | 25. | 54. | 743. | 37770. | 14. | 35. | 507. |
| CHS | 61 | 40. | 20. | 110. | 20. | 45. | 77. | 692. | 47298. | 18. | 43. | 669. |
| CHS | 62 | 30. | 50. | 120. | 25. | 40. | 63. | 918. | 47670. | 16. | 39. | 397. |
| CHS | 63 | 45. | 30. | 90. | 20. | 35. | 73. | 720. | 49446. | 15. | 39. | 613. |
| CHS | 64 | 35. | 20. | 90. | 20. | 40. | 67. | 728. | 49015. | 14. | 39. | 582. |
| CHS | 65 | 30. | 20. | 80. | 20. | 30. | 64. | 897. | 50215. | 14. | 34. | 647. |
| CHS | 66 | 60. | 20. | 80. | 25. | 40. | 102. | 779. | 50104. | 17. | 42. | 542. |
| CHS | 67 | 45. | 20. | 80. | 25. | 40. | 87. | 894. | 52667. | 20. | 45. | 592. |
| CHS | 68 | 60. | 20. | 80. | 25. | 40. | 81. | 794. | 56810. | 18. | 42. | 454. |
| CHS | 69 | 35. | 30. | 70. | 20. | 30. | 63. | 571. | 59140. | 14. | 31. | 592. |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CHS 70 | 40. | 30. | 90. | 20. | 35. | 64. | 557. | 45252. | 14. | 36. | 703. |
| | CHS 71 | 40. | 20. | 90. | 20. | 35. | 66. | 702. | 42470. | 13. | 35. | 699. |
| | CHS 72 | 40. | 20. | 80. | 20. | 30. | 69. | 557. | 47651. | 16. | 60. | 678. |
| | CHS 73 | 40. | 20. | 80. | 20. | 35. | 76. | 674. | 55619. | 18. | 40. | 802. |
| | CHS 74 | 45. | 30. | 90. | 25. | 35. | 75. | 651. | 56728. | 18. | 44. | 741. |
| | CHS 75 | 50. | 30. | 100. | 20. | 40. | 71. | 643. | 50631. | 16. | 41. | 635. |
| | CHS 76 | 60. | 100. | 180. | 20. | 40. | 73. | 783. | 48438. | 19. | 45. | 668. |
| | CHS 77 | 45. | 30. | 80. | 20. | 35. | 81. | 672. | 49411. | 21. | 46. | 703. |
| | CHS 78 | 40. | 30. | 90. | 20. | 25. | 67. | 651. | 43733. | 18. | 43. | 569. |
| | CHS 79 | 40. | 30. | 90. | 20. | 30. | 66. | 693. | 46966. | 17. | 42. | 623. |
| | CHS 80 | 45. | 30. | 80. | 20. | 30. | 74. | 686. | 49208. | 19. | 42. | 646. |
| | CHS 81 | 45. | 30. | 100. | 20. | 25. | 70. | 757. | 50527. | 19. | 45. | 719. |
| | CHS 82 | 45. | 30. | 100. | 25. | 20. | 82. | 817. | 54926. | 21. | 47. | 858. |
| | CHS 83 | 40. | 30. | 90. | 15. | 30. | 66. | 735. | 43097. | 16. | 39. | 755. |
| | CHS 84 | 45. | 30. | 90. | 20. | 30. | 60. | 730. | 49306. | 20. | 40. | 630. |
| | CHS 85 | 45. | 30. | 90. | 20. | 35. | 75. | 778. | 53422. | 21. | 46. | 688. |
| | CHS 86 | 50. | 80. | 130. | 20. | 35. | 69. | 748. | 43681. | 17. | 38. | 588. |
| | CHS 87 | 40. | 20. | 80. | 15. | 30. | 57. | 641. | 38740. | 14. | 34. | 540. |
| | CHS 88 | 45. | 20. | 90. | 20. | 30. | 51. | 481. | 35748. | 15. | 31. | 39[illegible]. |
| | CHS 89 | 70. | 30. | 70. | 25. | 40. | 179. | 1047. | 52622. | 17. | 38. | 211. |
| | CHS 90 | 60. | 20. | 30. | 20. | 30. | 120. | 1042. | 46032. | 16. | 28. | 103. |
| | CHS 91 | 70. | 50. | 60. | 20. | 55. | 58. | 783. | 53048. | 19. | 44. | 864. |
| | CHS 92 | 80. | 20. | 130. | 30. | 45. | 58. | 2046. | 55180. | 30. | 58. | 262. |
| | CHS 93 | 60. | 20. | 110. | 25. | 35. | 40. | 1469. | 33928. | 14. | 26. | 453. |
| | CHS 94 | 60. | 20. | 110. | 25. | 35. | 65. | 2121. | 48960. | 25. | 54. | 527. |
| | CHS 95 | 50. | 20. | 80. | 20. | 35. | 141. | 706. | 61125. | 20. | 46. | 709. |
| | CHS 96 | 60. | 40. | 130. | 25. | 55. | 78. | 1038. | 54170. | 23. | 60. | 465. |
| | CHS 97 | 25. | 30. | 150. | 30. | 55. | 80. | 838. | 59777. | 22. | 61. | 565. |
| | CHS 98 | 40. | 30. | 100. | 20. | 35. | 64. | 580. | 41080. | 17. | 42. | 375. |
| | CHS 99 | 35. | 30. | 80. | 15. | 30. | 72. | 628. | 41316. | 21. | 53. | 384. |
| | CHS 100 | 60. | 30. | 90. | 10. | 30. | 59. | 553. | 41919. | 16. | 40. | 462. |
| | CHS 101 | 40. | 20. | 70. | 15. | 30. | 61. | 1079. | 28935. | 12. | 38. | 244. |
| | CHS 102 | 45. | 30. | 100. | 15. | 35. | 57. | 516. | 38037. | 16. | 34. | 499. |
| | CHS 103 | 45. | 30. | 100. | 15. | 30. | 101. | 1352. | 40446. | 18. | 55. | 188. |
| | CHS 104 | 40. | 20. | 100. | 20. | 35. | 58. | 607. | 47933. | 15. | 40. | 611. |
| | CHS 105 | 50. | 20. | 110. | 20. | 40. | 71. | 844. | 49010. | 19. | 48. | 658. |
| | CHS 106 | 35. | 10. | 90. | 15. | 35. | 65. | 573. | 40411. | 18. | 39. | 768. |
| | CHS 107 | 60. | 20. | 120. | 50. | 150. | 511. | 1022. | 68512. | 44. | 163. | 337. |
| | CHS 108 | 50. | 20. | 120. | 25. | 55. | 66. | 1152. | 51413. | 22. | 58. | 675. |
| | CHS 109 | 30. | 30. | 110. | 15. | 40. | 38. | 2634. | 29996. | 15. | 48. | 109. |
| | CHS 110 | 45. | 20. | 100. | 25. | 50. | 78. | 581. | 40967. | 18. | 53. | 483. |
| | CHS 111 | 50. | 20. | 100. | 30. | 40. | 71. | 601. | 55053. | 22. | 45. | 572. |
| | CHS 112 | 55. | 20. | 90. | 20. | 35. | 90. | 711. | 57144. | 23. | 55. | 410. |
| | CHS 113 | 15. | 10. | 60. | 10. | 25. | 43. | 529. | 40121. | 11. | 30. | 536. |
| | CHS 114 | 35. | 20. | 90. | 15. | 35. | 50. | 554. | 41047. | 12. | 33. | 529. |
| | CHS 115 | 30. | 20. | 80. | 20. | 35. | 75. | 492. | 35313. | 15. | 53. | 578. |
| | CHS 116 | 40. | 20. | 90. | 20. | 35. | 77. | 696. | 42715. | 16. | 39. | 853. |
| | CHS 117 | 55. | 40. | 110. | 25. | 55. | 46. | 2761. | 43593. | 19. | 64. | 146. |
| | CHS 118 | 55. | 30. | 100. | 25. | 75. | 73. | 791. | 39435. | 21. | 79. | 380. |
| | CHS 119 | 130. | 120. | 870. | 35. | 55. | 54. | 906. | 47327. | 24. | 45. | 210. |
| | CHS 120 | 40. | 10. | 40. | 15. | 35. | 49. | 804. | 23521. | 12. | 37. | 284. |
| | CHS 121 | 50. | 20. | 100. | 20. | 40. | 64. | 526. | 37533. | 14. | 45. | 613. |
| | CHS 122 | 30. | 20. | 80. | 15. | 25. | 56. | 657. | 37910. | 12. | 31. | 561. |
| A | CHS 122 | 25. | 20. | 70. | 10. | 20. | 52. | 569. | 36169. | 15. | 30. | 556. |
| B | CHS 122 | 25. | 20. | 80. | 15. | 25. | 47. | 600. | 35858. | 13. | 29. | 436. |
| C | CHS 122 | 25. | 20. | 70. | 10. | 20. | 43. | 455. | 27524. | 10. | 23. | 386. |
| | CHS 123 | 360. | 1500. | 1300. | 40. | 65. | 62. | 4105. | 45412. | 27. | 62. | 499. |
| | CHS 124 | 40. | 80. | 220. | 25. | 45. | 70. | 602. | 40009. | 19. | 52. | 525. |
| | CHS 125 | 35. | 120. | 140. | 20. | 50. | 55. | 571. | 29594. | 15. | 39. | 716. |
| | CHS 126 | 35. | 110. | 230. | 15. | 30. | 42. | 715. | 21605. | 12. | 25. | 394. |
| | CHS 127 | 40. | 30. | 120. | 20. | 40. | 66. | 584. | 39097. | 18. | 49. | 894. |
| | CHS 128 | 45. | 20. | 100. | 15. | 35. | 57. | 940. | 32810. | 15. | 44. | 560. |
| | CHS 129 | 60. | 390. | 330. | 20. | 40. | 77. | 1930. | 45705. | 18. | 49. | 436. |
| | CHS 130 | 40. | 30. | 110. | 20. | 35. | 77. | 632. | 43771. | 18. | 53. | 791. |
| | CHS 131 | 50. | 100. | 140. | 20. | 40. | 73. | 757. | 56632. | 22. | 55. | 513. |
| | CHS 132 | 25. | 20. | 70. | 10. | 25. | 59. | 486. | 32773. | 13. | 33. | 532. |
| | CHS 133 | 20. | 50. | 170. | 20. | 30. | 56. | 748. | 48900. | 18. | 38. | 460. |
| | CHS 134 | 35. | 90. | 200. | 20. | 40. | 54. | 588. | 38265. | 14. | 48. | 321. |
| | CHS 135 | 35. | 30. | 140. | 15. | 30. | 55. | 916. | 34928. | 12. | 37. | 311. |
| | CHS 136 | 30. | 30. | 80. | 15. | 35. | 74. | 571. | 44120. | 14. | 43. | 649. |
| | CHS 137 | 25. | 20. | 70. | 20. | 40. | 66. | 668. | 39038. | 16. | 39. | 541. |
| | CHS 138 | 30. | 30. | 80. | 15. | 30. | 55. | 636. | 34137. | 11. | 34. | 537. |
| | CHS 139 | 40. | 30. | 70. | 20. | 50. | 164. | 1075. | 52197. | 20. | 74. | 232. |
| | CHS 140 | 35. | 40. | 180. | 15. | 30. | 50. | 667. | 34164. | 11. | 29. | 411. |
| | CHS 141 | 50. | 290. | 700. | 30. | 40. | 50. | 2570. | 76210. | 24. | 48. | 140. |
| | CHS 142 | 70. | 650. | 1300. | 10. | 55. | 52. | 1479. | 36730. | 10. | 60. | 64. |
| | CHS 143 | 30. | 40. | 110. | 15. | 35. | 55. | 538. | 30374. | 11. | 34. | 453. |
| | CHS 144 | 30. | 20. | 80. | 15. | 30. | 53. | 595. | 40020. | 15. | 39. | 586. |
| | CHS 145 | 10. | 10. | 140. | 35. | 45. | 50. | 827. | 45868. | 21. | 44. | 632. |
| | CHS 146 | 20. | 10. | 80. | 20. | 30. | 34. | 428. | 29879. | 13. | 26. | 429. |
| | CHS 147 | 45. | 20. | 140. | 20. | 45. | 86. | 947. | 47102. | 17. | 49. | 597. |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHS 148 | 70. | 20. | 80. | 20. | 50. | 157. | 1036. | 57245. | 23. | 61. | 406. |
| CHS 149 | 40. | 20. | 90. | 15. | 35. | 71. | 492. | 39036. | 15. | 37. | 576. |
| CHS 156 | 65. | 20. | 80. | 20. | 45. | 93. | 817. | 51024. | 20. | 58. | 475. |
| CHS 157 | 70. | 30. | 110. | 25. | 45. | 78. | 733. | 43629. | 19. | 50. | 417. |
| CHS 158 | 35. | 20. | 80. | 15. | 30. | 69. | 684. | 41179. | 16. | 37. | 734. |
| CHS 159 | 45. | 30. | 90. | 20. | 35. | 70. | 667. | 40766. | 17. | 40. | 676. |
| CHS 160 | 40. | 30. | 90. | 15. | 30. | 48. | 468. | 29236. | 11. | 26. | 454. |
| CHS 161 | 40. | 20. | 90. | 20. | 30. | 79. | 908. | 49826. | 22. | 46. | 715. |
| CHS 162 | 35. | 20. | 60. | 15. | 30. | 66. | 665. | 41229. | 12. | 40. | 512. |
| CHS 163 | 70. | 40. | 100. | 25. | 50. | 138. | 1007. | 63321. | 24. | 60. | 606. |
| CHS 164 | 50. | 120. | 150. | 20. | 40. | 62. | 1065. | 37575. | 10. | 34. | 437. |
| CHS 166 | 215. | 40. | 250. | 25. | 30. | 92. | 1083. | 59652. | 25. | 39. | 564. |
| CHS 1ε7 | 70. | 50. | 130. | 20. | 40. | 85. | 1202. | 46503. | 21. | 51. | 452. |
| CHS 168 | 900. | 100. | 400. | 40. | 25. | 123. | 606. | 238294. | 28. | 23. | 414. |
| CHS 169 | 1100. | 130. | 300. | 15. | 15. | 132. | 775. | 137697. | 15. | 31. | 569. |
| CHS 170 | 40. | 20. | 80. | 25. | 30. | 77. | 868. | 51472. | 21. | 45. | 712. |
| CHS 171 | 45. | 20. | 90. | 25. | 35. | 80. | 845. | 52241. | 22. | 49. | 704. |
| CHS 172 | 90. | 30. | 150. | 35. | 35. | 72. | 919. | 55889. | 30. | 41. | 594. |
| CHS 173 | 290. | 60. | 200. | 25. | 35. | 82. | 914. | 65928. | 25. | 46. | 568. |
| CHS 174 | 285. | 120. | 260. | 15. | 25. | 58. | 953. | 62540. | 16. | 33. | 302. |
| CHS 175 | 780. | 320. | 700. | 30. | 30. | 52. | 1150. | 54107. | 29. | 40. | 176. |
| CHS 176 | 40. | 20. | 90. | 30. | 40. | 75. | 866. | 59686. | 24. | 49. | 613. |
| CHS 177 | 45. | 20. | 90. | 20. | 35. | 82. | 666. | 54125. | 22. | 52. | 554. |
| CHS 178 | 50. | 20. | 80. | 25. | 40. | 89. | 751. | 46253. | 22. | 48. | 377. |
| CHS 179 | 30. | 30. | 80. | 20. | 35. | 64. | 613. | 43645. | 19. | 41. | 556. |
| CHS 180 | 50. | 30. | 100. | 25. | 40. | 88. | 759. | 56046. | 21. | 53. | 534. |
| CHS 131 | 40. | 20. | 90. | 20. | 35. | 69. | 691. | 48721. | 19. | 45. | 546. |
| CHS 182 | 45. | 30. | 100. | 25. | 40. | 69. | 687. | 52352. | 22. | 54. | 488. |
| CHS 183 | 40. | 20. | 60. | 10. | 30. | 59. | 935. | 25744. | 9. | 29. | 152. |
| CHS 184 | 65. | 30. | 90. | 30. | 55. | 115. | 799. | 51132. | 26. | 75. | 356. |
| CHS 185 | 65. | 30. | 70. | 25. | 50. | 192. | 750. | 58617. | 28. | 84. | 562. |
| CHS 186 | 65. | 20. | 60. | 20. | 45. | 123. | 800. | 57056. | 21. | 66. | 353. |
| CHS 187 | 45. | 30. | 80. | 25. | 45. | 77. | 729. | 48203. | 23. | 57. | 481. |
| CHS 188 | 50. | 20. | 70. | 20. | 40. | 91. | 686. | 51159. | 19. | 58. | 429. |
| CHS 189 | 40. | 20. | 70. | 15. | 30. | 66. | 654. | 48002. | 16. | 42. | 443. |
| CHS 190 | 35. | 20. | 60. | 15. | 35. | 79. | 513. | 39101. | 14. | 40. | 782. |

TABLE II

PANNED TILL SAMPLES FROM VIDLIN

| | BA | PB | ZN | CU | NI | FE | MN | TI |
|---|---|---|---|---|---|---|---|---|
| CHP 5 | 359 | 3 | 44 | 13 | 11 | 3.332 | 0.054 | 0.322 |
| CHP 7 | 327 | 16 | 80 | 29 | 19 | 4.431 | 0.079 | 0.372 |
| CHP 37 | 358 | 7 | 45 | 12 | 16 | 3.719 | 0.052 | 0.371 |
| CHP 42 | 246 | 7 | 70 | 20 | 27 | 6.440 | 0.164 | 0.733 |
| CHP 67 | 195 | 0 | 45 | 11 | 23 | 5.205 | 0.117 | 0.695 |
| CHP 70 | 400 | 6 | 24 | 7 | 17 | 3.907 | 0.067 | 0.385 |
| CHP 71 | 339 | 5 | 61 | 6 | 20 | 5.191 | 0.108 | 0.530 |
| CHP 83 | 411 | 2 | 55 | 12 | 18 | 3.447 | 0.046 | 0.301 |
| CHP 86 | 398 | 0 | 57 | 13 | 15 | 3.575 | 0.050 | 0.297 |
| CHP 91 | 398 | 0 | 69 | 24 | 21 | 3.359 | 0.089 | 0.345 |
| CHP 96 | 345 | 2 | 81 | 28 | 26 | 5.352 | 0.072 | 0.352 |
| CHP 100 | 276 | 1 | 75 | 19 | 20 | 4.254 | 0.096 | 0.311 |
| CHP 102 | 379 | 18 | 67 | 18 | 30 | 6.720 | 0.151 | 0.795 |
| CHP 104 | 420 | 11 | 78 | 20 | 26 | 5.741 | 0.104 | 0.552 |
| CHP 105 | 431 | 3 | 39 | 14 | 24 | 5.023 | 0.080 | 0.459 |
| CHP 107 | 375 | 3 | 66 | 19 | 26 | 5.418 | 0.094 | 0.504 |
| CHP 108 | 358 | 4 | 60 | 21 | 22 | 5.296 | 0.115 | 0.569 |
| CHP 109 | 428 | 10 | 60 | 16 | 21 | 4.180 | 0.074 | 0.402 |
| CHP 112 | 389 | 6 | 37 | 9 | 10 | 2.836 | 0.044 | 0.330 |
| CHP 119 | 306 | 7 | 140 | 70 | 24 | 4.523 | 0.062 | 0.342 |
| CHP 145 | 115 | 38 | 139 | 13 | 52 | 25.014 | 0.362 | 2.732 |
| CHP 146 | 409 | 9 | 72 | 9 | 21 | 5.487 | 0.059 | 0.393 |
| CHP 149 | 436 | 5 | 66 | 13 | 24 | 4.981 | 0.075 | 0.489 |
| CHP 157 | 311 | 16 | 60 | 12 | 21 | 4.592 | 0.078 | 0.366 |
| CHP 161 | 386 | 1 | 60 | 12 | 21 | 4.551 | 0.061 | 0.341 |
| CHP 177 | 264 | 10 | 71 | 16 | 23 | 7.573 | 0.190 | 0.924 |
| CHP 180 | 208 | 28 | 81 | 51 | 78 | 12.425 | 0.181 | 0.649 |
| CHP 183 | 199 | 5 | 86 | 25 | 34 | 6.829 | 0.140 | 0.608 |
| CHP 187 | 215 | 3 | 79 | 17 | 29 | 6.223 | 0.135 | 0.578 |

# APPENDIX FOUR

# DRILL-CORE LOGS

SECTION OF Drillhole No. 4 Vidlin Ness, Vidlin, Shetland

Surface Level ............ O.D.

Communicated June 1976 by Institute of Geological Sciences

Date of boring or sinking 9.3.76 Borer Drillsure Ltd

One-inch Map 128 Six-inch Map HU 46 NE

958116 4M 2/75 J.F.&S. 275

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| PEAT, No recovery. | | | | |
| BOULDER CLAY, fragments only of granite, vein quartz and acid gneiss. 10% recovery | 2 | 78 | 2 | 78 |
| BOULDER CLAY, fragments only - upper 10cm of granite remainder of migmatitic gneiss with quartz vein <10% recovery | 0 | 35 | 3 | 13 |
| BOULDER CLAY, fragments only of acid gneiss, vein quartz and amphibolite. 3% recovery. | 1 | 20 | 4 | 33 |
| CALC SILICATE, off-white massive rock composed of quartz and subordinate calcite with widely spaced dark green amphibolitic + ? chloritic partings with occasional bands of the darker more usual striped calc silicate The latter is dominant between 6.00 and 6.70m. Microfaulting at 6.95 and carbonate vein between 7.00 and 7.06m. Rock is unusually calcite-rich between 7.09 and 7.23 - almost a limestone - with quartz and calcite veining. Inclination at top 38° increasing to 90° between 4.72 and 5.00m and then lessening to 45° at 5.50m. Core all quite broken. | 3 | 16 | 7 | 49 |
| AMPHIBOLITE, medium to fine grained with foliation only apparent below 8.00m. Probably altered as actinolite seems dominant over hornblende. Inclination 33° at 8.55m. Pyrrhotite disseminated throughout with associated minor chalcopyrite at 7.85m Joints and cracks frequently have film of pyrite and at 8.50m disseminated ? molybdenum. 20cm missing, probably between 8.17 and 8.37 as are very broken there. | 1 | 27 | 8 | 76 |
| CALC SILICATE with quartz vein | 0 | 06 | 8 | 82 |
| BRECCIA upper 13cm of quartz vein with minor calcite and angular fragments of dark ? calc silicate. Trace of pyrite | | | | |

(249/1589) D. No. 248420 5,000 7/72 M. & St., Ltd. G249

SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| passes down into breccia containing angular dark fragments within quartz matrix in which calcite seems to occur as shear infilling. | 0 | 54 | 9 | 36 |
| QUARTZ-FELDSPAR-PEGMATITE cut by network of cracks infilled with chlorite and more rarely calcite. | 0 | 27 | 9 | 63 |
| BRECCIA principally small angular fragments of quartz and carbonate in fine-grained dark matrix. 38% recovery | 0 | 67 | 10 | 30 |
| QUARTZ VEIN with dark angular fragments and irregular cracks infilled with calcite and dark ? chlorite | 0 | 23 | 10 | 53 |
| BRECCIA as above. Lower 10cm reduced to small pieces. 40% recovery. | 0 | 75 | 11 | 28 |
| CALC SILICATE, mid to pale grey and thinly laminated. Inclination 52° at top. Graphite and a trace of <u>pyrite</u> on joints. | 0 | 29 | 11 | 57 |
| HORNBLENDE-SCHIST, dark and fine grained. Mostly broken into small pieces which include parts of a quartz-feldspar-vein. Graphite and <u>pyrite</u> common. About 10cm lost. | 0 | 31 | 11 | 88 |
| CALC-SILICATE, finely laminated with well developed striping between 12.65 and 12.98m and between 13.30 and 13.76m. 1.5cm thick quartz-albite vein with calcite in centre. <u>Pyrrhotite</u> forms a very limited stockwork and is ocasionally seen in small patches. Inclination 15° at 14.00m. Below 15.06m darker (? hornblendic) bands seldom >2cm become noticeable. | 3 | 66 | 15 | 54 |
| APLITE, with flecks of biotite.Upper margin concordant, but lower cross-cutting in parts. | 0 | 24 | 15 | 78 |
| CALC SILICATE, upper 20cm. quite dark and probably contain hornblende. Many more bands of this rock type in the underlying pale grey calc silicate, so that between 16.35 and 18.35m the rock has a distinct banded appearance. <u>Pyrite</u> common on joints. Inclination 45° at 16.00m and 50° at 18.00m. Between 18.67 and 19.01m darker bands with biotite common. Below this settles into alternating | | | | |

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SECTION OF Drillhole No.4 Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| pale calc-rich striped - and dark calc-poor ? hornblendic units. Dark units die out below 21.80m Below this some pale massive calc-rich bands particularly between 21.99 and 22.28m. Several smaller bands between 22.45 and 22.55m and again between 23.40 and 23.50m. Inclination 40° at 20.00, 22.00 and 24.00m. Calcite + epidote-filled cracks generally parallel to core axis are common between 25.81 and 26.05m. Below 26.05m darker units again obvious and between 26.95 and 28.26m This is the dominant rock. Inclination 30° at 26.10 and 40° at 28.00m. Pyrite common on joints. | 12 | 99 | 28 | 77 |
| BIOTITE-HORNBLENDE-SCHIST, fine grained and compact with poorly-discernible schistosity. Pyrite on joints. | 0 | 22 | 28 | 99 |
| CALC SILICATE upper 6cm dark, almost providing a transition between calc silicate and the above rock. Above 29.54m comprises a well banded rock with typical light and dark units. Below this there is a more massive pale rock with only thin mafic partings. Also rock has a more disturbed look with chlorite-filled cracks. Patchy pyrrhotite. | 0 | 94 | 29 | 93 |
| APLITE, pale greenish-grey, dominantly of ? albite with possibly some pale amphibole and coarse feldspathic top. | 0 | 10 | 30 | 03 |
| CALC SILICATE, finely banded, with some weathering out of calcite-rich units. Inclination 33° at 30.10m. | 0 | 21 | 30 | 24 |
| GARNETIFEROUS HORNBLENDE-SCHIST with diffuse margins and finely disseminated pyrrhotite. | 0 | 12 | 30 | 36 |
| CALC SILICATE pale grey with well-developed striping - frequently wavy - and near base is disrupted by small shears. | 0 | 60 | 30 | 96 |
| AMPHIBOLITE, composed principally of pale green quite fibrous amphibole in upper 1m, the remainder comprising hornblende. Of variable appearance | | | | |

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SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| probably due to difference proportions of plagioclase and garnets. Some coarse plagioclase-amphibole segregations between 31.00 and 31.20m. Pyrrhotite present as a fine dissemination with larger patches developing occasionally. Quartz veinlets throughout and between 31.00 and 31.20m patches of pyrrhotite with associated minor chalcopyrite. Feldspathic segregations: 34.27-34.45m. Upper margin is discordant being marked by thin horizon of pale green ? chlorite. However band of amphibolite within with concordant upper margin. Pyrrhotite disseminated throughout (2-3%) and rare chalcopyrite: 35.06-35.09m, concordant, seems to have a greater % of fibrous paler amphibole but pyrrhotite lacking. Inclination 40° at 22.70 and 42° at 34.60m. Calcite common on joints in lowest 25cm with pyrite. | 5 | 04 | 36 | 00 |
| CALC SILICATE, finely laminated with little or no free calcite. Inclination 20° at base where rock has more definite banding. | 0 | 61 | 36 | 61 |
| ALTERED AMPHIBOLITE, alteration not quite so pronounced in upper 25cm. Below this rock also shows indication of tectonism viz small shears infilled with pyrite. Carbonate on joints with pyrite. Pyrrhotite common both as a dissemination and as isolated patches. Chalcopyrite patches between 37.12 and 37.20m and at 37.58m. | 1 | 83 | 38 | 44 |
| AMPHIBOLITE, medium grained with occasional garnets Some plagioclase - coarse amphibole segregations with associated thin irregular (feldspar) veinlets. Inclination 30° at 38.90m. Pyrrhotite, occasional specks<1% with slightly larger grains in quartz (+ rare carbonate) veinlets. Carbonate on joints. Between 42.55 and 42.80m several unusual alteration zones comprising alternating stripes of pale quartz + | | | | |

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SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| feldspar + amphibole-rock and chlorite rock - the latter generally form the margins. Pale rock has up to 10% pyrrhotite with minor chalcopyrite. Prominent plagioclase + amphibolite segregation between 42.80 and 42.86m. Garnets more common between 43.00 and 43.78m. Bronzy mica common between 44.23 and 45.06m. Quartz feldspar veins particularly common between 44.00 and 44.86m, invariably with finely divided pyrrhotite. Inclination 35° at 41.00, 28° at 43.00 and 25° at 45.00m. | 6 | 96 | 45 | 40 |
| QUARTZITE, granular with flecks of biotite and chlorite which are occasionally present in sufficient quantity to form laminae. Core quite broken. Inclination 50° at 45.90. | 0 | 55 | 45 | 95 |
| CHLORITE-TALC-TREMOLITE-SCHIST with disseminated pyrrhotite and minor chalcopyrite.. | 0 | 20 | 46 | 15 |
| QUARTZITE, darker and finer grained than above Distinct increase in micaceous partings below 46.52m These comprise mostly chlorite but muscovite is visible near base. | 1 | 20 | 47 | 35 |
| CHLORITE-TALC-SCHIST with minor tremolite. Includes massive pyrrhotite (up to 70%) and associated chalcopyrite (up to 0.5%) | 0 | 52 | 47 | 87 |
| SEMI PELITE dominantly of fine grained feldspar with tremolitic bands particularly prominent towards base. Patches of course green feldspar. Massive pyrrhotite (20%) above 47.97m but below is restricted to a fine dissemination with only occasional coarse patches (generally less than 5%). Sporadic showing of chalcopyrite but always less than 1% | 0 | 73 | 48 | 60 |
| TALC-CHLORITE-SCHIST - reduced to small fragments | 0 | 26 | 48 | 86 |

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SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| MASSIVE PYRRHOTITE | | | | |
| Estimated volume % — Pyrr / Chpy | | | | |
| 48.86 - 48.96 · Pyrr 30 · Chpy <1 · Angular and rounded chlorite + tremolite | | | | |
| 48.96 - 49.06 · Pyrr 50 · Chpy 2 · Tremolite | | | | |
| 49.06 - 49.16 · Pyrr 50 · Chpy 1 · Chlorite + talc + tremolite | | | | |
| 49.16 - 49.26 · Pyrr 35 · Chpy ≤5 | | | | |
| 49.26 - 49.36 · Pyrr 40 · Chpy ≤5 · Tremolite + chlorite + talc + quartz | | | | |
| 49.36 - 49.46 · Pyrr 50 · Chpy <1 · Tremolite | | | | |
| 49.46 - 49.56 · Pyrr 45 · Chpy <0.1 · Talc + chlorite | | | | |
| 49.56 - 49.66 · Pyrr 60 · Chpy <0.5 | | | | |
| 49.66 - 49.76 · Pyrr 65 · Chpy <0.1 · Talc | | | | |
| 49.76 - 49.86 · Pyrr 60 · Chpy <0.1 · " | | | | |
| 49.86 - 49.96 · Pyrr 55 · Chpy 0.5 · " | | | | |
| 49.96 - 50.06 · Pyrr 50 · Chpy - · Talc + tremolite | | | | |
| 50.06 - 50.16 · Pyrr 10 · Chpy 15 · Tremolite | | | | |
| 50.16 - 50.26 · Pyrr 40 · Chpy ≤5 · Tremolite + feldspar | | | | |
| 50.26 - 50.36 · Pyrr 40 · Chpy 1-2 · Tremolite + talc + chlorite | 1 | 50 | 50 | 36 |
| TREMOLITE SCHIST with disseminated pyrrhotite (2-3%) and chalcopyrite (1%) | 0 | 10 | 50 | 46 |
| TREMOLITE-PLAGIOCLASE-SCHIST (? semipelite) with disseminated pyrrhotite (2-3%) and chalcopyrite (1%) | 0 | 10 | 50 | 56 |
| TREMOLITE-SCHIST with 5-10% disseminated pyrrhotite and less than 1% chalcopyrite in upper 10cm. Below the chalcopyrite dies out and pyrrhotite increases to 15%. Below 50.76 pyrrhotite decreases to 1-2% and rare patches of massive chalcopyrite form up to 2%. | 0 | 30 | 50 | 86 |
| AMPHIBOLITE, medium to fine grained with abundant bronzy mica. Occasional patches of pyrrhotite (less than 1%) with rare chalcopyrite. | 0 | 24 | 51 | 10 |

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SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | | Thickness | Depth from Surface |
|---|---|---|---|
| | | Metres | Metres |
| | ALTERED PLAGIOCLASE-AMPHIBOLITE, dominated by greenish plagioclase with only irregular patches of fibrous amphibole. However below 51.60m amphibole dominant. Pyrrhotite in strings and patches and as fine dissemination throughout, generally less than 2%.<br>AMPHIBOLITE, upper 40cm medium grained; below, fine grained with garnet porphyroblasts. A few alteration segregations viz. 52.27 - 52.32m - quartz + plagioclase + carbonate + pyrrhotite ; 52.93 - 52.96m - plagioclase + pale amphibole + pyrrhotite + chalcopyrite. Pyrrhotite present throughout to a greater or lesser extent, occasionally having much chalcopyrite. Between 52.35 and 52.65m there is vertical alteration zone 0.5cm thick with pyrrhotite. Alteration is prominent below 53.80m although in parts it looks like original banding. Zone containing massive pyrrhotite (generally less than 10%) between 54.96 and 55.05m. The pyrrhotite content of the rock seems to increase in these alteration zones but is seldom more than 1.2%. It may be accompanied by chalcopyrite particularly at 55.20, 55.50 and 56.20m. Between 57.02 and 57.29m many quartz-feldspar veins some with marginal pyrite, and the core is reduced to small pieces. Trace of chalcopyrite in plagioclase + amphibole + pyrrhotite segregation at 57.65m. At 59.45m lens of dark blue-black amorphous ? chlorite. Surrounded by thin film of quartz-albite. Specs of chalcopyrite and pyrrhotite close by. Quartz veins common between 59.65 and 59.90m many having patchy pyrrhotite. Chalcopyrite associated with almost massive pyrrhotite at 59.90m<br>Inclination 32° at 53.80, 25° at 55.75 30° at 57.80, 25° at 59.93 and 32° at 61.70m. | | |

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SECTION OF Drillhole No.4, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46NE

| | Thickness | Depth from Surface |
|---|---|---|
| | Metres | Metres |

Alteration Zones

60.05 - 61.25. Massive nonfoliated slightly paler green rock with occasional quartz - feldspar segration. Between 60.56 and 60.65m is a band of the massive pale green rock which occurs at the top of this unit. This seam of massive pyrrhotite at 61.05m. otherwise sulphide lacking in this zone. Reverts to more typical fine grained amphibolite around 61.25.

62.65 - 62.92m with patchy sphalerite mainly in quartz feldspar segregations.

64.37 - 64.80. Consists principally of bands up to 18cm thick of massive white rock (plagioclase + calcite + ? quartz) containing bands and whisps of amphibolite. Impression is that whole rock is replacing the amphibolite.

65.07 - 65.87m similar to above but bands generally smaller averaging 1-10mm with a maximum of 10cm. With one exception these are parallel to the folia-tion - though deviations occur where they are ptygmatically folded. Are occasionally cut by quartz - feldspar veins carrying pyrrhotite and minor chalcopyrite 66.14 - 66.59m. Similar with pyrrhotite as rare patches and disseminations.

68.43 - 68.87m - more typical of usual type (viz. 60.05 - 61.25m) but lacks coarse feldspar and amphibol and has calcite. 69.18 - 69.23, 70.98 - 71.38 and 71.89 - 71.93m all typical with coarse plagioclase, quartz, amphibole and patchy pyrrhotite. Latter is unique in having lensoid core of amphibolite surrounded by pale green amphibole and marginal quartz - feldspar.

Below 67.51m pyrrhotite is only rarely present as a dissemination being mostly a vein mineral. Minor chalcopyrite in vein at 70.17m. A fairly coarse

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SECTION OF Drillhole No.4 Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| grained rock predominates between 74.42 and 75.14m which below 74.55m is cut by many quartz-feldspar veinlets. Calcite and minor pyrite on joints, garnets common between 76.80 and 79.84m<br>**Alteration Zones**<br>75.14 - 75.43m Coarse developments of plagioclase + quartz + pale green amphibole. Cut by veinlets of quartz + purplish grey mineral (see DH2-56.24m) ranging in thickness from 1mm to 1cm. Similar vein (0.5 - 1cm) at 75.86m which is affected by movement along foliation planes. Associated veinlets have patchy pyrrhotite.<br>78.28 - 78.50. A few minor quartz-feldspar bands with pale green amphibole and rare pyrrhotite.<br>79.10 - 79.95m. Upper 40cm consists of fine development of quartz and feldspar in irregular patches - only rarely coarse grained with disseminated pyrrhotite throughout not exceeding 1-2%. In lower part development of paler green amphibole which often disguises the foliation and which contains large irregular quartz-feldspar bands and lenses some showing ptygmatic folds. Single grain of sphalerite at 79.65m<br>Inclination 30° at 63.70, 45° at 65.80, 40° at 67.80, and at 69.60, 30 at 71.60, 35° at 73.60, 40° at 75.50, 65° at 77.25 and 42° at 79.35m.<br>END OF HOLE | 29 | 12 | 80 | 22 |

SECTION OF Drillhole No.5, Vidlin Ness, Vidlin, Shetland

Surface Level ............ O.D.

Communicated June 1976 by Institute of Geological Sciences

Date of boring or sinking ............ Borer Drillsure Ltd

One-inch Map 128 Six-inch Map HU 46 NE

958116 4M 2/75 J.F.&S. 275

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| PEAT, no recovery | | | | |
| BOULDER CLAY, fragments only of semi pelite, feldspathic gneiss, granite, vein quartz and more rarely amphibolite. 10% recovery. | 1 | 98 | 1 | 98 |
| BOULDER CLAY, two large fragments of granite, one gneissose, with smaller fragments of granite, amphibolite and migmatites. 7% recovery. | 0 | 96 | 2 | 94 |
| BOULDER CLAY, fragment of migmatite. 12% recovery. | 0 | 50 | 3 | 44 |
| BOULDER CLAY, fragments of semi pelite, migmatite and granite. | 0 | 4 | 3 | 48 |
| BOULDER CLAY, fragments of quartz vein, amphibolite, semi pelite and granite-gneiss. 20% recovery. | 0 | 75 | 4 | 23 |
| BOULDER CLAY, fragments of amphibolite, granite and quartz. 30% recovery. | 0 | 40 | 4 | 63 |
| BOULDER CLAY, fragments of pelite. 17% recovery | 0 | 64 | 5 | 27 |
| BOULDER CLAY, fragments of brecciated quartz and semi pelite. 30% recovery. | 0 | 31 | 5 | 58 |
| BOULDER CLAY, comprising large piece of micaceous psammite and small fragments of semi pelite and granite | 0 | 22 | 5 | 80 |
| EXOTIC, large fragment of dark, very fine grained siliceous rock cut by quartz vein | 0 | 48 | 6 | 28 |
| CAVE-IN - fine fragments | 3 | 47 | 9 | 75 |
| CALC SILICATE pale and dark bands consisting almost entirely of amphibole. Inclination 65-90° | 0 | 30 | 10 | 05 |
| HORNBLENDE-SCHIST with occasional garnets. Between 10.15 and 10.48 dominated by pale plagioclase - ? actinolite alteration zones sharing fairly intimate interbanding and probably containing sedimentary laminae. Quartz veins and pyrite on joints. | 0 | 50 | 10 | 55 |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| CALC SILICATE, well developed light and dark striping consisting principally of amphibole. Partly brecciated between 10.65 and 10.73m, cracks being infilled with pale green mineral. Also many quartz segregations and irregular patches. Large quartz-feldspar patch at 10.80. Inclination 58° at 10.50m | 1 | 28 | 11 | 83 |
| CAVE-IN | 0 | 23 | 12 | 06 |
| CALC SILICATE with pale and dark amphibole bands and thin, often discontinuous quartz laminae Graphite on joints between 12.40 and 12.43m. Inclination 65° at 12.80. ? ALTERED AMPHIBOLITE, essentially or pale green tremolite/actinolite rock with closely spaced, often discontinuous and folded quartz-feldspar laminae. Occasional patches of darker amphibolite In general rock lacks the well-developed planar structure of the calc silicate. Pyrrhotite disseminated throughout, up to 1-2% with minor chalcopyrite and sphalerite. Mineralization tends to die out below 14.50m. Below 14.73 quartz-feldspar laminae decrease markedly and rock gradually loses structure. Some evidence of tectonism. Single quartz-feldspar vein. | 2 | 94 | 15 | 00 |
| ? ALTERED AMPHIBOLITE, massive pale greenish-white rock (probably plagioclase + tremolite + calcite) with wisps of darker amphibole. Gradually passes down into schist comprising alternating units of the above. Occasional traces of pyrrhotite. Inclination 50° | 0 | 35 | 15 | 35 |
| PLAGIOCLASE-TREMOLITE-CALCITE-SCHIST, finely striped Inclination about 80°. | 0 | 40 | 15 | 75 |
| QUARTZ-FELDSPAR-PEGMATITE with chlorite filled cracks and rare specks of pyrite. | 0 | 22 | 15 | 97 |
| CALC SILICATE with well developed cleavage parallel to mineral striping. Large pale green alteration | | | | |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| patch at top. Abundant free carbonate. Some late brittle folds with inclination ranging from 50-90° | 0 | 18 | 16 | 15 |
| FAULT GOUGE, reduced to very small fragments. 44% recovery. | 0 | 53 | 16 | 68 |
| BRECCIATED CALC SILICATE, composed of fragments of underlying rock with patches and veinlets of calcite with chlorite in shears and graphite on joints | 0 | 10 | 16 | 78 |
| CALC SILICATE with well developed banding, comprising alternating tremolitic and felsic/calcite layers, generally in 50:50 ratio but between 18.11 and 18.50m lighter units definitely dominant. Brecciated zone 19.12 to 19.22m pyrrhotite patch up to 1cm with smaller grains of sphalerite in quartz blob at 19.59m. Inclination 50° at 16.90 steepening to 85° at 17.00 and then lessening to 65° at 17.55 and to 25° and 18.60m. Graphite on joints throughout. Brittle folds between 20.10 and 20.20m with attendant brecciation. | 3 | 42 | 20 | 20 |
| BRECCIA ZONE, core reduced to small fragments principally of calc silicate with abundant graphite and rock-polish. | 0 | 09 | 20 | 29 |
| CALC SILICATE, reduced to quite small pieces but no evidence of strong brecciation. | 0 | 38 | 20 | 67 |
| CALC SILICATE, strongly disrupted but not brecciated | 0 | 25 | 20 | 92 |
| CALC SILICATE, composed of alternating pale green and dark grey-black bands with irregularly developed pale buff/pale green massive bands, particularly in upper metres. Banding in general quite irregular with frequent lensing and not always very well developed. Many cross cutting quartz veins and pods and smaller calcite veinlets. Inclination 40° at 20.95 and 45° at 23.15m. Specs of sphalerite around calcite-quartz lens at 21.38m. Slightly darker rock between 22.30 and 22.60m but as core reduced to small fragments in the zone, colour change | | | | |

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SECTION OF Drillhole. No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| may be due to increase in chlorite content. Pyrite frequently developed in small shears in thin section. Further small disturbances between 22.90 and 23.00m, being particularly noticeable in the quartz-feldspar areas (common below 22.70m) with a network of chlorite-filled shears. | 2 | 38 | 23 | 30 |
| DISTURBED ZONE, calc silicate strongly disrupted but not brecciated with brittle folds in evidence. Quartz vein containing angular fragments of country rock between 23.55 and 23.75m parallel to core axis. | 0 | 40 | 23 | 70 |
| BRECCIA ZONE, consisting principally of ground up calc silicate - massive pale and dark green rock (patch colouration) with irregular quartz blebs. Brecciation particularly apparent where pegmatite veins are present (24.20 - 24.25; 25.55 - 25.65; 25.95 - 26.00; 26.03 - 26.05). Despite brecciation foliation is apparent below 25.65. Small patch of chalcopyrite and sphalerite at 24.80. Dissemination of ? pyrrhotite 25.65 - 25.73m. Molybdenum on joints at 25.73m. | 2 | 34 | 26 | 04 |
| AMPHIBOLITE, rather altered with garnets almost completely replaced. Cut by a network of carbonate veinlets some of which carry pyrrhotite and chalcopyrite. | 1 | 16 | 27 | 20 |
| BRECCIATED PEGMATITE, cut by epidote-filled shears. Lower 3cm of quartz with angular fragments of calc silicate. | 0 | 10 | 27 | 30 |
| CALC SILICATE - upper 23cm pale grey then mid grey until lowest 8cm. Well developed striping throughout Inclination at top 50°. Calcite content generally very low. Calcite veinlet at 26.42m. 0.5 - 1cm thick. Several quartz veinlets. Pyrite with occasional graphite on joints | 0 | 17 | 27 | 47 |

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SECTION OF Drillhole. No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU.46.NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| HORNBLENDE-SCHIST, fine-grained with disseminated pyrrhotite. | 0 | 03 | 27 | 50 |
| CALC SILICATE, pale grey with occasional mid grey (hornblendic) bands, particularly between 29.58 and 29.70. ? metavolcanic horizons. Similar zone between 33.15 and 33.40m some having disseminated pyrrhotite and rare chalcopyrite. Two bands of massive pale buff/off white (? plagioclase + calcite) with thin pale green laminae between 32.69 and 32.73 and 32.91 - 33.00m. Inclination at top 57°, 53° at 29.50, 42° at 31.50m. 38° at 33.50°. Minor shearing at base. | 6 | 22 | 33 | 72 |
| BRECCIA ZONE, crushed and chloritised calc silicate with large irregular calcite patches and abundant graphite | 0 | 17 | 33 | 89 |
| AMPHIBOLITE, fine grained and slightly altered. Many shears filled with calcite and occasional pyrite | 0 | 31 | 34 | 20 |
| CALC SILICATE, sheared at top with many irregular calcite veinlets, dying out downwards. Abundant graphite and occasional patches of pyrite | 0 | 15 | 34 | 35 |
| AMPHIBOLITE, fine grained with graphite and fine pyrite on joints. | 0 | 6 | 34 | 41 |
| CALC SILICATE with fine light and dark banding and occasional quartz-feldspar bands. Then discontinuous pyrite seams in what could be alteration zones. | 0 | 6 | 34 | 47 |
| AMPHIBOLITE with sharp top. Slightly altered look with some parallel greenish bands. Cut by irregular quartz veins in lower part. | 0 | 19 | 34 | 66 |
| ALTERATION ZONE pale green, fine grained rock with irregular quartz blebs and lenses cut by calcite veinlets. Sharp lower contact. | 0 | 03 | 34 | 69 |
| CALC SILICATE, mid grey with irregular quartz lenses. | 0 | 03 | 34 | 72 |
| AMPHIBOLITE, 3cm alteration zone, 4cm below top, comprising quartz-feldspar rock with pale green | | | | |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| laminae. Below this rock is sheared, altered and cut by irregular and discontinuous quartz veinlets. Pyrrhotite with minor chalcopyrite is present in a quartz-calcite patch between 35.00 and 35.02m whilst isolated grains of pyrite occur nearby. Below 35.27 rock becomes more leucocratic and medium grained and seems quite fresh. Strongly sheared again below 36.10m with accompanying increase in quartz veining. Prominent quartz-calcite veins 0.5 - 1cm thick between 36.47 and 36.87m containing cavity growth of transparent quartz needles. Intensity of shearing deminishes suddenly at 37.00m with a return to the plagioclase amphibolite having the conspicuous veining. This is particularly noticeable between 37.40 and 37.60m where the veins may be up to a cm thick. Pyrite and rare chalcopyrite are associated with these veins whilst pyrrhotite occurs in the smaller veinlets. Shearing and veining die out below 37.60. Inclination 72° at 37.95m<br>Alteration zones<br>38.00 - 38.15 pale green with rare quartz-feldspar patches, minor pyrrhotite and pyrite and rare chalcopyrite. Below 38.30m patchy pale green alteration with rare lenses of coarse quartz + plagioclase + actinolite + calcite and rare pyrrhotite. Pyrrhotite is present as a fine dissemination throughout this zone with larger grains in veinlets with chalcopyrite.<br>39.30 - 39.40m. Pale green amphibole-plagioclase with pink feldspar lenses and pyrite on joints. Below 39.40 patchy alteration persists forming in places continuous stripes and by 40.00 whole core is affected. Pyrrhotite is disseminated throughout, also in blebs and lenses which on occasion have chalcopyrite. Pyrite on joints + quartz veins, | 6 | 00 | 40 | 72 |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| SHEARED PEGMATITE with stockwork of <u>pyrrhotite</u> (1-2%) and <u>chalcopyrite</u> (<1%) | 0 | 14 | 40 | 86 |
| MASSIVE PYRRHOTITE forming over 90% of core between 40.86 and 40.94m tapering towards base. Specks of <u>chalcopyrite</u> (<0.1%). Remainder consists of plagioclase, quartz, tremolite, chlorite and calcite. Lower margin a dark shear zone with occasional <u>pyrite</u> cubes, specks of chalcopyrite. | 0 | 18 | 41 | 04 |
| ALTERED AMPBIBOLITE, intensely sheared at base. <u>Pyrrhotite</u> probably about 10% in lowest 2cm with disseminated <u>chalcopyrite</u> 2-3%. Below 41.30m both less than 1%. Intensely disrupted pegmatite at base | 0 | 31 | 41 | 35 |
| ? CALC SILICATE, possibly containing some altered amphibolite. Specks and streak of <u>chalcopyrite</u> | 0 | 35 | 41 | 70 |
| BRECCIA, dominated by angular pieces of calc silicate but upper part contains plagioclase fragments which may have been derived from the altered amphibolite Angular <u>pyrrhotite</u> pieces also common in upper part forming approximately 60% between 41.76 and 41.82. Calcite veinlets very common lower half. <u>Chalcopyrite</u> patches and stringer occasionally present but overall less than 10%. Matrix of dark ? chlorite. | 0 | 32 | 42 | 02 |
| CALC SILICATE, midgrey, striped. Sheared with calcite and quartz veining. Brecciated between 42.17 and 42.26 and 42.51 - 42.63m. <u>Chalcopyrite</u> in shears at 42.27. | 0 | 61 | 42 | 63 |
| CALC SILICATE, pale grey, and finely striped in upper part but below 43.46m reverts to darker rock similar to that above 42.62m. Below 46.40m paler calcite rich rock until well developed striping at 46.82m passes down into darker rock with finer striping and little calcite Band of paler rock as above 47.15 - 47.20m. Fairly homogeneous dark rock with only faint striping and variable calcite between 47.20 and 47.81m. Cut by many calcite veinlets. | | | | |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HY 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Pyrite common particularly in shears with graphite on joints. 47.89 - 48.21m paler rock, devoid of calcite which in lower 15cm is paler green and quite disrupted with clay gouge in narrow shears and many irregular calcite veinlets. Some small specks of pyrite. Below 48.21m slightly darker rock with very regular striping, becoming lighter below 48.30m with bands of hornblende-schist (green-bed type) up to 6cm thick - noticeably finely banded - possibly dominant rock between 49.38 and 49.68m. Some bands of the coarser (irregularly banded) pale calcite-rich rock. Irregular vein and patches of calcite between 48.70 and 48.80. Two thin pegmatites (<1cm thick) between 49.94 - 49.99m. Impure limestone bands, greenish white, 52.04 - 52.07 and 52.10 - 52.16m. Inclination $38^{\circ}$ at 42.75, $80^{\circ}$ at 43.70, $90^{\circ}$ at 44.47 $42^{\circ}$ at 44.80, $44^{\circ}$ at 45.70, $40^{\circ}$ at 48.30 and at 50.30 and $45^{\circ}$ at 52.10m. Brittle folds, frequently accompanied by shearing, brecciation and graphite coating common particularly at 43.04 - 43.14, 43.30 - 43.46, 46.45 - 46.49 and 46.85 - 46.90. Breccia zone between 45.15 and 45.20m. Strongly disrupted and brecciated between 45.96 and 46.30m with graphite and clay infilling shears. Numerous irregular calcite (+minor quartz) patches. Between 46.30 and 46.40m inclination $90^{\circ}$ with gentle flexures. Returns abruptly to $30^{\circ}$ at 46.40. | 9 | 53 | 52 | 16 |
| AMPHIBOLITE, medium grained, mostly altered to palish grey coarse grained rock in upper 68cm composed dominantly of tremolite/actinolite. Below 52.84m although rock is generally fresher (some alteration zones do occur) core is badly broken. Some brecciation between 53.39 and 53.49. Alteration again below 54.27 with occasional quartz-feldspar pegmatites and calcite | | | | |

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SECTION OF Drillhole No.5, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| veins. 31cm. missing between 53.29 and 54.27m and between 54.67 and 55.10m where the core is reduced to small fragments 14cm are absent. Similarly between 55.33 and 55.69m, with intense calcite veining below 55.64m. <u>Pyrrhotite</u> not often seen in the more broken sections but in other parts it occurs as a fine dissemination ($\leq$3%). <u>Pyrite</u> particularly common between 55.80 and 56.20, some being associated with calcite veins. 12cm missing between 56.38 and 56.50m. Below 56.50m core in larger pieces with irregular quartz veinlets. | 4 | 44 | 56 | 60 |
| PLAGIOCLASE-AMPHIBOLITE, mostly a granular intergrowth but between 57.20 and 57.40m the plagioclase is streaked parallel to the foliation. Foliation generally more evident than in above unit - inclination 60° at 56.75m and 50° at 57.35m. Finely disseminated <u>pyrrhotite</u> generally less than 1%. Calcite + minor quartz veins common between 56.66 and 57.06m forming up to 50% of core between 56.75 and 56.95m and containing patches and streaks of <u>pyrrhotite</u> (up to 2cm) + rare pyrite. Specks of <u>chalcopyrite</u> with <u>pyrrhotite</u> associated with very thin quartz-feldspar veinlets (similar to the underlying pegmatite) at 57.47m. | 0 | 98 | 57 | 58 |
| QUARTZ-FELDSPAR-PEGMATITE, crosscutting with stockwork of <u>pyrrhotite</u> (up to 10%) with irregular distribution of <u>chalcopyrite</u> (up to 1%) + ? molybdenite. | 0 | 28 | 57 | 86 |
| AMPHIBOLITE with garnet-and plagioclase rich zones, the latter probably associated with alteration in the upper 30cm. Some finely divided <u>pyrrhotite</u> generally less than 1% but probably nearer 10% in the alteration zones. <u>Pyrite</u> common on joints. Pegmatite 1.5cm thick between 58.18 and 58.38m with <u>pyrrhotite</u> and <u>pyrite</u>. Also between 58.62 and 58.80m. | | | | |

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SECTION OF Drillhole No.5, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| **Alteration zones** 59.10 - 59.40m. generally of coarse lighter amphibole with stockwork of pyrrhotite (≤2%) and minor chalcopyrite (<0.5%). Minerals may be concentrated in quartz-feldspar veins. 59.65 - 59.75m. Rather more feldspathic with finely disseminated pyrrhotite and carbonate-quartz vein containing specks of galena. Inclination 50° at 59.00m. | 1 | 89 | 59 | 75 |
| MASSIVE PYRRHOTITE (50%) - CALCITE (30%) VEIN crosscutting with khaki coloured gossan (20%). | 0 | 15 | 59 | 90 |
| AMPHIBOLITE, medium or occasionally coarse grained, depending on the state of alteration. Pyrrhotite very finely disseminated (<1%) but more common in veinlets and in shears where it is often accompanied by chalcopyrite. Chalcopyrite is common below 60.25m mainly as irregularly distributed tiny streaks and blebs occasionally up to 6mm. Overall distribution about 1%. | 0 | 70 | 60 | 60 |
| MASSIVE PYRRHOTITE with minor pyrite and traces of chalcopyrite containing irregularly shaped pieces of tremolite, calcite, chlorite and rare talc. (see estimated volumes below) | 0 | 42 | 61 | 02 |
| AMPHIBOLITE, medium grained, with an irregular distribution of pyrrhotite and chalcopyrite (<1%) | 0 | 15 | 61 | 17 |

| | Estimated volume % Pyrr | Chpy | Py | Inclusions and remarks |
|---|---|---|---|---|
| 60.60 - 60.70 | 80 | - | Trace | Tremolite, calcite, chlorite |
| 60.70 - 60.80 | 75 | - | 3-5 | Tremolite |
| 60.80 - 60.90 | 85 | Trace | 5 | Pyrite occurs mainly in veinlets calcite and chlorite. |
| 60.90 - 61.02 | 65-70 | Trace | 5-10 | Talc, chlorite with calcite in upper half |

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |

MASSIVE PYRRHOTITE

| | Estimated volume % | | | Inclusions and Remarks | Thickness (Metres) | | Depth from Surface (Metres) | |
|---|---|---|---|---|---|---|---|---|
| | Pyrr | Chpy | py | | | | | |
| 61.17 - 61.27 | 85 | 2-3 | - | Tremolite and calcite mainly rounded. Chalcopyrite preferentially in tremolitic areas. | | | | |
| 61.27 - 61.37 | 90 | trace | <0.5 | Tremolite, calcite, chlorite. Some pyrite + calcite in thin veinlets cutting pyrrhotite | | | | |
| 61.37 - 61.47 | 80-85 | 1 | 1 | Subrounded calcite ≤1cm with smaller chlorite. Chalcopyrite associated with calcite | | | | |
| 61.47 - 61.57 | 65-70 | <0.5 | - | Rounded calcite ≤2cm + tremolite. | | | | |
| 61.57 - 61.67 | 75 | <0.5 | 1-2 | Tremolite, calcite, chlorite | | | | |
| 61.67 - 61.77 | 60 | <1 | - | Calcite, all fragments show intergrowth with pyrrhotite. Chalcopyrite has patchy distribution | | | | |
| 61.77 - 61.95 | 65-70 | <0.5 | - | Calcite | 0 | 78 | 61 | 95 |

| | Thickness (Metres) | | Depth from Surface (Metres) | |
|---|---|---|---|---|
| AMPHIBOLITE, strongly altered in parts. ? Talcose bands in upper 2cm. Calcite veins and segregations above 62.80m. Below this rock is coarser grained probably due to its more altered state. Massive pyrrhotite (up to 40%) between 62.36 and 62.46m branching out into stockwork with associated pyrite (1-2%). Also present between 62.80 and 62.87m. Otherwise pyrrhotite and chalcopyrite disseminated throughout with irregular concentrations forming 10% and 50% respectively + chalcopyrite also frequently in the form of a stockwork. | 1 | 85 | 63 | 80 |

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| AMPHIBOLITE, mid grey, medium grained, possibly lighter and more granular than usual ? ultrabasic.<br>Alteration zones<br>64.18 - 64.40m with shearing.<br>65.20 - 65.60m with pyrrhotite and chalcopyrite occurring as stockwork and in patches + rare pyrite - generally ≤1-2% Otherwise pyrrhotite present as fine dissemination <1% - slight increase in lowest 20cm. | 2 | 4 | 65 | 84 |
| AMPHIBOLITE, showing textural variations from massive to highly schistose. Consists of hornblende, actinolite, bronzy biotite and talc. Irregular distribution of pyrrhotite seldom less than 1% and more than 10%, minor chalcopyrite | 2 | 76 | 68 | 60 |
| TALC-CHLORITE-BIOTITE-SCHIST. Inclination $55^{o}$ - $90^{o}$. Pyrrhotite disseminated throughout - 10-20%. Irregularly distributed chalcopyrite patches up to 2% | 1 | 06 | 69 | 66 |
| ALTERED, AMPHIBOLITE, with patchy pyrrhotite and chalcopyrite - latter particularly common in upper 5cm (≤5%) | 0 | 60 | 70 | 26 |
| FELDSPAR-PORPHYRY-DYKE, cross-cutting and fingering into surrounding amphibolite. Contains finely divided and patchy pyrite. | 0 | 44 | 70 | 70 |
| ALTERED AMPHIBOLITE, as above but with higher sulphide content and occasional development of coarse amphibole Pyrrhotite generally 5-10% with chalcopyrite less than 5% but in lowest 10cm both about 15%. Sphalerite in calcite vein at 70.90m | 0 | 50 | 71 | 20 |
| MASSIVE PYRRHOTITE with minor chalcopyrite and inclusions of chlorite, calcite, tremolite, biotite and talc. | | | | |

| | Estimated volume % | | Inclusions |
|---|---|---|---|
| | Pyrr | Chpy. | |
| 71.20 - 71.30 | 70 | Trace | Chlorite, calcite, minor tremolite |
| 71.30 - 71.40 | 70 | Trace | " |

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SECTION OF Drillhole No.5, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| **Estimated Volume %** **Inclusions**<br>Pyrr Chpy | | | | |
| 71.40 - 71.50 80 Trace ___ " ___ | | | | |
| 71.50 - 71.60 60 Trace Chlorite, tremolite talc | | | | |
| 71.60 - 71.70 35 5 Tremolite, chlorite, biotite, talc | | | | |
| 71.70 - 71.80 65 2 Tremolite, talc in upper part calcite in lower. | 0 | 60 | 71 | 80 |
| CHLORITE-TALC-SCHIST with massive and disseminated chalcopyrite probably about 20% | 0 | 15 | 71 | 95 |
| MASSIVE PYRRHOTITE | | | | |
| **Estimated volume %** **Inclusions**<br>Pyrr Chpy | | | | |
| 71.95 - 72.05 60-65 <0.1 Actinolite, chlorite | | | | |
| 72.05 - 72.15 60-65 <0.1 Actinolite, chlorite | 0 | 20 | 72 | 15 |
| TREMOLITE-CHLORITE-TALC-SCHIST with patchy pyrrhotite (≤20%) with occasional patches of chalcopyrite 4cm missing. | 0 | 24 | 72 | 39 |
| MASSIVE PYRRHOTITE | | | | |
| **Estimated volume %** **Inclusions and remarks**<br>Pyrr Chpy | | | | |
| 72.39 - 72.49 40 2-3 Actinolite, chlorite, talc more as a fine intergrowth than individual fragments. | | | | |
| 72.49 - 72.59 50-55 2-3 talc, actinolite, chlorite. Pyrrhotite concentrated in upper half. Chalcopyrite in lower half. | | | | |
| 72.59 - 72.69 50-60 ≤5 Actinolite, chlorite, biotite, talc. Chalcopyrite in streaks and blebs. Core quite broken with much rock polish which tends to hide sulphide | | | | |
| 72.69 - 72.79 40-50 2-3 Actinolite, talc, chlorite, much as above with rock polish obscuring sulphides. | | | | |
| 72.79 - 72.86 20 2-3 Coarse actinolite rock with quartz segregations. | | | | |

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Pyrite (15%) concentrated in veins | 0 | 47 | 72 | 86 |
| COARSE-TREMOLITE-ACTINOLITE - Rock with thin band of bronzy biotite at upper margin. | 0 | 04 | 72 | 90 |
| QUARTZ-TREMOLITE-ROCK, pale off-white medium to coarse grained with vertical or steeply inclined lineation in parts. Sporadic development of very coarse actinolite. | 0 | 95 | 73 | 85 |
| AMPHIBOLITE (coarse actinolite rock) with quartz bands and blebs. Patchy pyrrhotite locally up to 5%. | 0 | 15 | 74 | 00 |
| BIOTITE-CHLORITE-PLAGIOCLASE-AMPHIBOLITE, very compact and quite fine grained in parts. Bronzy biotite conspicuous Pyrrhotite throughout, 10-15%. | 0 | 30 | 74 | 30 |
| TALC-CHLORITE-BIOTITE-SCHIST. Pyrrhotite occurs throughout generally as a fine dissemination, 5-10% but in parts may be up to 50%. Chalcopyrite associated - overall probably less than 0.5% but locally blebs and streaks may form about 2-3%. Inclination ranges from 50-90°. | 2 | 53 | 76 | 83 |
| MASSIVE PYRRHOTITE enclosing large fragments of underlying amphibolite and more rarely irregular quartz segregations | 0 | 07 | 76 | 90 |
| AMPHIBOLITE, upper 50cm. almost fine grained with poorly developed foliation. Passes down into medium grained garnet-amphibolite. Very finely disseminated throughout with occasional concentrations. Present also in quartz veinlets and in alteration segregations. Rare specks of chalcopyrite at 76.93m. Pyrite common with quartz on joints. Alteration zones 77.68 - 77.73m - coarse plagioclase and amphibolite with pyrrhotite blebs. 78.60 - 79.70m. Many narrow segregations - overall slightly paler green. Inclination 60° at 77.10, 50° at 77.40 and 45° at 79.70m. | 3 | 00 | 79 | 70 |

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SECTION OF Drillhole No.5, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| QUARTZ-FELDSPAR-VEIN quartz tends to be in patches enclosing and invading pieces of amphibolite. Probably a sweat - out. Irregular patches and stockwork of pyrrhotite. | 0 | 30 | 80 | 00 |
| AMPHIBOLITE, altered in upper 30cm, then freshening downwards with decrease in pyrrhotite content from 2.3% to a fine dissemination $<1\%$. Between 81.18 and 81.29m dominated by bronzy mica and consequently quite schistose. Also thin partings of dark ? chlorite. Pyrite conspicuous in certain bands, generally as irregular blebs, $\leq 3\%$. Quartz-feldspar lenses and irregular patches which also feature in underlying amphibolite. 81.25 - 81.37m. very pale khaki bands with fine stripes and irregular patches of quartz and feldspar. Also has less common thin hornblendic bands. Pale rock probably comprises tremolite and may be a sweat-out. Bronzy mica common between 81.37 and 81.70m. The lowest 30cm very finely banded with increased pyrrhotite content ($>1\%$) and quartz veins parallel to the foliation. Thought to be an alteration feature but may be some sedimentary bands. Inclination 58° at 81.50. | 2 | 80 | 82 | 80 |
| CALC SILICATE, alternating stripes and bands of pale grey and pale khaki with thin dark ? hornblendic laminae - Banding often wavy and discontinuous. Khaki bands disappear below 83.05m where rock becomes darker and presumably more hornblendic. Also slightly more micaceous and with aligned quartz lenses. Khaki bands reappear and predominate between 83.10 and 83.21m where rock is disturbed and veined with calcite and has irregular quartz lenses. Very similar to the rock between 81.25 and 81.37m. Below this there appear irregular patches and then seams of pale buff limestone which rapidly | | | | |

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| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| expand to occupy most of the core between 83.45 and 83.65. Inclination 60° at 83.45m. | 0 | 95 | 83 | 75 |
| ALTERED AMPHIBOLITE striped and similar to that above the calc silicate. Conspicuous quartz veins with brecciation between 83.80 and 84.05m. 84.05 - 84.45m. Zone of plagioclase-quartz segregation including pinkish plagioclase which is also aligned. 84.62 - 84.97m. 20-50% of core consents of quartz-feldspar pegmatite. Although it appears to be cross-cutting, mafics + occasional amphibolite xenoliths have original orientation. <u>Pyrrhotite</u> common principally in shears with associated minor <u>pyrite</u>. | 1 | 22 | 84 | 97 |
| AMPHIBOLITE, granitiferous with some bronzy biotite. Alteration band - 85.22 - 85.25m. Finely divided <u>pyrrhotite</u> up to 5%. Inclination 50° at 85.45. In lowest 8cm gives way to a massive off-white rock with minor calcite and slivers and bands of amphibolite cut by thin discontinuous quartz-veins. | 1 | 06 | 86 | 03 |
| CALC SILICATE, almost completely masked by the above rock. | 0 | 10 | 86 | 13 |
| ALTERED AMPHIBOLITE, upper 7cm of calc. off-white rock with amphibolite slivers. Gives way downwards to pale and dark green banded rock with numerous feldspathic segregations. Some more massive and obviously veinlets but are parallel to the foliation. Between 86.57 and 86.75m calc. off-white band (possibly this zone contains some meta-sediments). Inclination 48° at 86.25m. | 0 | 57 | 86 | 70 |
| ALTERED AMPHIBOLITE, more homogeneous than above 86.87 - 86.94m - coarse plagioclase-amphibole segregation with very limited <u>pyrrhotite</u> stockwork. Finely divided <u>pyrrhotite</u> <1% with odd specks of <u>chalcopyrite</u> - concentrated in veinlets. | 0 | 43 | 87 | 13 |
| AMPHIBOLITE, with some concordant and cross-cutting quartz and quartz-calcite veins with rare pyrrhotite. | | | | |

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SECTION OF Drillhole No.5, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Finely divided pyrrhotite in rock <1% | 0 | 57 | 87 | 72 |
| ALTERED AMPHIBOLITE - finely banded pale and dark units with quartz-feldspar laminae and bands 87.87 - 87.90. Khaki coloured bands with very thin quartz lens. | 0 | 40 | 88 | 12 |
| CALC SILICATE, with wavy striping and occasional quartz-feldspar lens. Lowest 50cm reduced to small fragments with ubiquitous graphite and slickensiding. | 0 | 57 | 88 | 69 |

END OF HOLE

SECTION OF Drillhole No.6, Vidlin Ness, Vidlin, Shetland

Surface Level ......... O.D.

Communicated June 1976 by Institute of Geological Sciences

Date of boring or sinking ......... Borer Drillsure Ltd

One-inch Map 128 Six-inch Map HU 46 NE

958116 4M 2/75 J.F.&S 275

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| PEAT, no recovery | | | | |
| BOULDER CLAY, fragments only of porphyroblastic semi pelite. 2% recovery. | 4 | 38 | 4 | 38 |
| BOULDER CLAY, fragments only of amphibolite, migmatite and porphyroblastic gneiss. 4% recovery. | 2 | 06 | 6 | 44 |
| CALC SILICATE, essentially tremolite-schist with thin, often discontinuous bands of pale green ? actinolite and speckled with darker hornblende crystals up to 6mm. Inclination 80°. 14cm. missing. | 0 | 71 | 7 | 15 |
| CALC SILICATE, mid grey with distinctive striping often very wavy and commonly disrupted. Inclination dominantly 90° but lessens to 60° below 10.00m. Cut by closely spaced shears, generally parallel to bedding, which contain dark ? chlorite and graphite. | 3 | 22 | 10 | 37 |
| CALC SILICATE as above, but below 10.40m almost totally replaced, in a nebulous sort of way by massive off-white to pale green calc rock with occasional flecksof tremolite. Inclination 80-90°. Lower margin seems quite conformable and does not have the look of replacement. | 0 | 63 | 11 | 00 |
| CALC SILICATE, dominantly amphibolitic with no calcite Pale calc-rich bands between 11.45 and 11.86m. upper part associated with quartz-feldspar pegmatitic lens. Inclination generally 80-90° but strongly folded between 11.86 and 11.93. Specks of pyrite common, particularly on joints. | 1 | 32 | 12 | 32 |
| CALC SILICATE, mid grey, striped with abundant calcite. Above 12.63m and below 13.20m irregular patches and smears | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| of calcite, some with associated pyrite. Inclination dominantly 90° and strongly folded at 13.40m. Closely spaced shears with dark ? chlorite, graphite and occasional pyrite specks. Strongly folded between 14.15 and 14.35m with minor brecciation. | 2 | 68 | 15 | 00 |
| CALC SILICATE, darker and more compact than above - probably mainly amphibole, together with a little mica but no calcite. Pyrite common and a little finely divided pyrrhotite. Closely spaced shears as above. | 0 | 55 | 15 | 55 |
| CALC SILICATE, mid grey banded with much calcite. Inclination dominantly 90° with brittle folds occasionally reducing inclination to 45°. Graphite common in shears with specks of pyrite. Irregular calcite veinlets common below 16.00m. Becomes slightly darker below 16.21m but calcite still evident. | 1 | 59 | 17 | 14 |
| BRECCIATED CALC SILICATE, traversed by network of small shears with graphite and rock polish. Degree of disturbance not great as in most parts vertically inclined bedding still visible. More intensely disrupted parts have irregular calcite patches. Minor amounts of pyrite generally as single crystals. | 1 | 22 | 18 | 36 |
| BRECCIA. Similar to above but more strongly deformed. Foliation obliterated over most of section and a dark matrix (previously confined to small shears) much more evident. Below 19.00m volume of calcite increases markedly to give blotchy pale green-white rock. Some of calcite looks original. Also some quartz-feldspar patches. Specks of chalcopyrite at 18.98m. ? sphalerite between 19.11 and 19.59m - scattered grains occasionally showing crude stockwork - probably 1-2%. Marked change at 19.68 to pale green with dark angular fragments and interstitial calcite. Dark fragments disappear after first 8cm and calcite content increase. Patches of pyrrhotite up to 9mm. | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Original rock probably an amphibolite. | 1 | 52 | 19 | 88 |
| VERY ALTERED AMPHIBOLITE, a very friable and in parts quite clayey pale green rock consisting probably of chlorite and calcite. Some evidence of brittle folds but no brecciation. | 0 | 62 | 20 | 50 |
| AMPHIBOLITE. very coarse grained with white plagioclase porphyroblasts between 20.70 and 20.90m. More fine grained paler green bands between 21.02 and 21.06 with patches of sphalerite up to 2mm. Core frequently reduced to small fragments in lowest 10cm. | 0 | 63 | 21 | 13 |
| ALTERED AMPHIBOLITE, core noticably broken,cut by very closely spaced shears, seemingly parallel to the foliation. Strongly chloritised. A few thin stringers of sphalerite at 21.50m. Inclination 50° at 21.40m. Alteration again pronounced below 22.00m with the rock frequently reduced to small pieces. Rare specks of pyrite. | 1 | 57 | 22 | 70 |
| APLITE gentle intrusion with no disturbance of amphibolite lamellae within margins of dyke. Occasional patches of sphalerite both in aplite and in adjacent amphibolite. Also pyrite on joints | 0 | 16 | 22 | 86 |
| AMPHIBOLITE, sheared and chloritised as above. | 0 | 34 | 23 | 20 |
| AMPHIBOLITE, slightly altered but not sheared. Medium grained but below 23.58m. very coarse amphibolite with some pale pink feldspar and interstitial quartz (alteration zone) with rare patchy pyrite. | 0 | 52 | 23 | 72 |
| PLAGIOCLASE - AMPHIBOLITE, medium grained dark green with distinctive speckled textures due to common feldspar porphyroblasts. Also some coarser feldspar segregations in lower part. Finely disseminated pyrrhotite throughout less than 0.5% with pyrite and rare molybdenite on joints. Inclination 50° at 23.90m. | 0 | 48 | 24 | 20 |
| AMPHIBOLITE, medium grained fairly typical with numerous alteration-type segregations, very few, | | | | |

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SECTION OF Drillhole No.6, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| however, having pyrrhotite. Sporadic garnetiferous bands. However below 25.80m studded with garnets up to 3mm. Finely divided ? pyrrhotite throughout (<0.5%). Pyrite on joints and very abundant in calcite veins between 26.05 and 26.07m. | 2 | 30 | 26 | 50 |
| ALTERED AMPHIBOLITE, upper 7cm very closely jointed. consists of irregularly interbanded dark slightly altered amphibolite and massive greenish white ? feldspathic rock. Shot through with irregular dark cracks and occasional dark ? chlorite. Isolated patches of sphalerite between 26.87 and 26.95m. | 0 | 50 | 27 | 00 |
| CALC SILICATE, upper 9cm amphibolitic with no calcite, and hence may represent a transitional junction. More calcic part has a few hornblendic laminae. Occasional lens of dark blue-black ? chlorite. Pyrite on joints. Inclination 52°. | 0 | 28 | 27 | 28 |
| AMPHIBOLITE. After initial 8cm of fine pale altered rock with coarse feldspar-quartz-segregations the rock consists of dark green amphibolite peppered with garnets up to 5mm. The latter are also concentrated at certain horizons. Further segregations at 27.43 - 27.47m, otherwise relatively homogeneous with only a few quartz-feldspar and calcite veins. The latter commonly have pyrite. Specks of pyrrhotite throughout with pyrite on joints. | 1 | 83 | 29 | 11 |
| CALC SILICATE. Alternating bands of pale green-white calc. rock and dark hornblendic parts, with a few quartz-feldspar laminae (could be an altered amphibolite but quite calcareous). Inclination 35°. | 0 | 21 | 29 | 32 |
| AMPHIBOLITE, upper 60cm. altered with occasional plagioclase segregations and locally intense calcite veining. Passes down into fresher rock, studded with pale pink garnets which are occasionally replaced by white 'chlorite'. Garnets disappear between 30.00 and 30.32m where alteration is again evident. Bronzy biotite laminae common 30.15 - 30.22m. | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Inclination 48° at 30.10m. Core broken and chloritised between 31.00 and 31.08m with calcite veining. Altered again below 31.32m with occasional bands of bronzy mica. Finely disseminated pyrrhotite occasionally present with rare larger patches. Also patchy sphalerite associated with calcite-quartz veining between 31.25 - 31.30m. | 2 | 36 | 31 | 68 |
| ALTERED AMPHIBOLITE, rather heterogeneous pale grey rock with occasional pale green - off white bands and irregular patches of quartz-feldspar and blue-black ? chlorite. Frequently traversed by network of small dark shears. Sphalerite in thin seams throughout and particularly common (2-3%) between 31.73 and 31.80m. Occasionally associated with chalcopyrite, more commonly pyrite. Pyrite well developed in calcite veins. | 0 | 70 | 32 | 38 |
| CALC-SILICATE, pale grey, striped with abundant calcite below upper 3-5cm. Inclination 45° with occasionally gentle folding. Strongly sheared below 32.57m with small fault gouge between 32.65 and 32.71m. Thin calcite veinlets also abundant. | 0 | 42 | 32 | 80 |
| FAULT GOUGE, fine dark greenish rock with calcite veinlets, traversed by thin shears. 10cm absent. | 0 | 28 | 33 | 08 |
| BRECCIA, upper 15cm comprises angular pale green ? calc silicate and quartz-calcite separated by dark chlorite occasional calcite and sphalerite (2-3%). Underlain by brecciated off-white limestone in which sphalerite is only rarely seen. Probably continues to the base though the core is badly broken below 33.41m. | 0 | 42 | 33 | 50 |
| PLAGIOCLASE-TREMOLITE-ACTINOLITE-CALCITE-ROCK Massive white with thin discontinuous actinolite laminae. Quartz veins present between 33.65 and 33.95m. Irregular thin dark shears throughout. In lowest 6cm. comprises alternating bands of white and pale green rock. | 0 | 86 | 34 | 36 |

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| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| ALTERED AMPHIBOLITE alternating bands of pale khaki to off-white - and quartz-plagioclase-tremolite rock with occasional crystals of actinolite and some pyrrhotite - rich bands. | 0 | 56 | 34 | 92 |
| SEMI-PELITE, fine grained dark grey with irregular quartz laminae. Includes 3cm band of pale massive rock with pyrrhotite disseminated throughout. | 0 | 80 | 35 | 72 |
| ALTERED AMPHIBOLITE, comprising massive pale off-white rock, as above, with thin amphibolitic bands and laminae. Pyrrhotite common between 36.04 and 36.09m. Below 36.09 darker rock predominates. Below 36.20 shearing more intense and pyrite occasionally present in cracks. Trace of ? molybdenite at 36.45m. | 0 | 85 | 36 | 57 |
| Steeply inclined contact. | | | | |
| BRECCIA mainly angular fragments of the above in a dark matrix (upper half) made up of rock in lower half. | 0 | 24 | 36 | 81 |
| PLAGIOCLASE-ACTINOLITE-CALCITE-ROCK, massive white to pale green, sheared and partly brecciated. Reduced to small fragments in lowest 13cm. | 0 | 59 | 37 | 40 |
| CALC SILICATE, dominantly white tremolite with irregular pale green actinolite partings + ? scapolite. | 0 | 30 | 37 | 70 |
| CALC SILICATE mid to pale grey with striping poorly developed in upper part but becoming more evident downwards. Frequently disrupted by shearing. Inclination 33° at 38.70m. 50° at 40.50m. Bedding very disturbed below 40.70m with some mild brecciation, graphite and rock polish on joints. Streaks of sphalerite with occasional associated galena, 40.89 - 40.97m. | 3 | 30 | 41 | 00 |
| BRECCIA - angular fragments of amphibolitic calc silicate with feldspar and little or no free calcite. | 0 | 50 | 41 | 50 |
| CALC SILICATE, upper 20cm. strongly disturbed with bedding only partly visible. Of the mid grey type with abundant calcite. Pale massive calc bands | | | | |

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SECTION OF Drillhole No.6, Vidlin Ness, Vidlin Shetland

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| between 42.50 and 42.58m. Disturbed zone 42.80 - 43.03m, in which calc silicate is cut by graphite-coated shears (up to 2mm) and a very limited zone of brecciation. Irregular calcite vein with some patchy dark ? chlorite + pyrite between 44.80 and 44.30m. Inclination 28° at 42.45m. Steepens to 65° at 45.45m concomitantly with onset of brecciation. This dies out again below 45.70m. Graphite conspicuous. Inclination lessens to 28° at 44.84m. | 4 | 40 | 45 | 90 |
| LIMESTONE, massive white rock with aligned bluish grey flecks similar in colour to surrounding schist. Top junction sharp but lower less well defined, giving the impression that this is a replacement rock. | 0 | 20 | 46 | 10 |
| CALC SILICATE, similar to above with a few thin micaceous horizons between 46.25 and 46.40m. Below the core is again in small pieces, graphite is common on joints and there is limited brecciation. Inclination 45° and 46.30m. Graphite on joints 47.16 - 47.18m. calcite dies out below 47.12m. Limestone bands as above. 48.25 - 48.30m. and 48.40 - 48.88m. Dark amphibolite bands with probably more actinolite than hornblende 48.80 - 48.83 and 48.86 - 48.88m. Minor shearing, irregular calcite veining and pyrite 49.11 - 49.35m. 1cm thick calcite-quartz vein at 49.40m with minor sphalerite. Between 49.40 and 49.71m graphite and pyrite common on joints. Pyrite common in rock between 49.80 and 50.06m. Micaceous partings between 50.06 and 50.20m. Coarse dark amphibolitic porphyroblasts appear at 50.03m and are widespread below 50.25m. Sphalerite in calcite-quartz vein at 50.23m. Coarse amphibole dies out below 52.50m but reappears below 53.50m. Inclination 50° at 54.50m. Intensive veining between 54.76m. - larger contain quartz and feldspar and are cut by later calcite veinlets. | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| Rock noticeably sheared in lowest 7cm. | 8 | 78 | 54 | 88 |
| QUARTZ-FELDSPAR-PEGMATITE with pyrite infilling shears. | 0 | 32 | 55 | 20 |
| CALC SILICATE, sheared and invaded by pegmatite veinlets, with later calcite veinlets. | 0 | 20 | 55 | 40 |
| QUARTZ-FELDSPAR-PEGMATITE, as above but much less pyrite. Includes many angular fragments of calc silicate. | 0 | 36 | 55 | 76 |
| CALC SILICATE, strongly sheared and quite clayey. | 0 | 07 | 55 | 83 |
| LIMESTONE, pale buff with thin closely spaced chloritic partings. | 0 | 10 | 55 | 93 |
| CALC SILICATE, strongly sheared and veined with calcite with only local brecciation. | 0 | 43 | 56 | 36 |
| BRECCIA, angular fragments of calc silicate up to 3-4cm in dark matrix with irregular calcite patches and veinlets. Between 56.38 and 56.48 and between 56.49 and 56.66m up to half the core is occupied by ? in situ calc silicate. | 0 | 34 | 56 | 70 |
| CALC SILICATE, much as above, ie pale grey with conspicuous striping and abundant calcite. Several thin ? hornblendic bands (up to 1cm thick) - 57.79 - 57.95m. Inclination 40° at 58.00m. Brittle folding 57.95 - 58.17m with graphite conspicuous on joints. Pyrite veinlet up to 6mm at 58.45m Irregular calcite veinlets occur locally. Local shear zone 58.81 - 58.87m with minor clay gouge, graphite and disseminated pyrite. Darker variety of calc silicate with only a few thin calcite-rich bands present between 60.13 and 60.63m. Inclination 57° at 58.90m. Bands of a similar rock appear again below 60.95 and by 61.60m are dominant. Total exclusion of paler stripes gives rise to much darker rock below 61.81m. Between 62.00 and 62.03m. quartz-calcite veins with angular fragments of country rock, thin film of pyrite and rare sphalerite. Cut by thin calcite veinlets. Shear zone - | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| 62.90 to 63.00m. with fault gouge, ? graphite and rock polish. <u>Pyrite</u> common at 60.90m aligned parallel to foliation whilst at 62.70m is common in veinlets. Inclination $35^{\circ}$ at 60.90, and $30^{\circ}$ at 62.70m but below 63.35m steepens to $70^{\circ}$ and the rock is slightly sheared. Some calcite veinlets generally with patchy <u>pyrite</u>. Between 63.68 and 63.80m core reduced to small fragments with abundant rock polish. Intense shearing and calcite veining 64.08 - 64.18m. Inclination $50^{\circ}$ at 64.20m. | 7 | 67 | 64 | 37 |
| DISTURBED ZONE, small pieces generally intensely sheared with abundant rock polish and local brecciat-ion. At 64.50m dark rock gives way to pale grey calcite-rich calc silicate. | 0 | 27 | 64 | 64 |
| CALC SILICATE, as above with a few fine calcite veins and some graphite on joints. Inclination $43^{\circ}$ at 65.00m. | 1 | 29 | 65 | 93 |
| BRECCIA, angular fragments of calc silicate in dark clayey matrix consisting principally of graphite. | 0 | 13 | 66 | 06 |
| CALC SILICATE, intensely disrupted but foliation (inclination $90^{\circ}$) still visible. Some disrupted quartz veins. Core reduced to small fragments between 66.30 and 66.51m. | 0 | 45 | 66 | 51 |
| CALC SILICATE, pale to mid grey with striping and abundant calcite. Small <u>pyrite</u> patches common between 67.00 and 67.05m. Very finely divided <u>pyrrhotite</u>. Inclination $35^{\circ}$ at 67.05. | 2 | 02 | 68 | 53 |
| AMPHIBOLITE, fine grained and probably altered. Also probably has lower proportion of quartz and feldspar. <u>Pyrrhotite</u> disseminated throughout. Cut by shears infilled with calcite, dark chlorite and <u>pyrite</u>.. | 0 | 28 | 68 | 81 |
| CALC SILICATE, with dark hornblende bands up to 6cm thick common below 69.78m. Finely disseminated <u>pyrrhotite</u> in both rock types. Below 72.00m dip | | | | |

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SECTION OF Drillhole No.6, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| suddenly steepens to 55° and then to 70° at 72.30m - the result of brittle folding. Minor local brecciation and lensed quartz-feldspar-pegmatite-vein. Numerous calcite veins and veinlets. Rock becomes very dark below 72.95m. almost like an amphibolite. Some fine banding (including calcite-rich units) between 72.38 and 72.58m. Below 74.25m return to more calcite-rich pale grey type. Inclination 40° and 74.30m. | 5 | 55 | 74 | 36 |
| AMPHIBOLITE, fairly sharp top with 1cm. alteration band just below top. Medium to almost fine grained, dark with occasional concordant quartz veinlets. Alteration type segregation - 74.75 to 74.83m. plagioclase, actinolite with occasional quartz patches. Pyrrhotite disseminated and in small patches up to 3%. Otherwise pyrrhotite finely disseminated through the rock. (<1%). | 1 | 07 | 75 | 43 |
| PLAGIOCLASE-AMPHIBOLITE, medium grained equigranular intergrowth of plagioclase and hornblende. Alteration type segregation 75.65 - 75.75m with pyrrhotite about 1%. Otherwise very finely divided. Concordant quartz veinlets common. Below 76.37m plagioclase porphyroblasts common. Inclination 38° at 76.30m. | 1 | 23 | 76 | 66 |
| AMPHIBOLITE, paler green altered rock with coarse actinolite developing in upper 38cm. Alteration type segregation - 77.07 - 77.10m, plagioclase + actinolite + calcite with rare pyrrhotite patch - cut by very thin veinlets containing pyrite and ? chalcopyrite. More extensive zone with aplite vein 77.22 - 77.29m. Further aplites at 77.35 and 77.42m displaced by small shear. Garnet bands common 77.50 - 77.60m. | 1 | 09 | 77 | 75 |
| ALTERATION ZONE, distinctly banded rock in upper 35cm. This gives way to a more massive pale green rock with many quartz-feldspar segregations and aplitic patches. Inclination 60° at top steepening | | | | |

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SECTION OF Drillhole No.6, Vidlin

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| to about 90° between 78.20 and 78.40m. | 1 | 11 | 78 | 86 |
| PLAGIOCLASE-AMPHIBOLITE with some plagioclase segregations and patchy, pyrrhotite. Inclination at 79.00 = 45°. | 0 | 58 | 79 | 44 |
| ALTERED-AMPHIBOLITE | 0 | 36 | 79 | 80 |
| CALC-SILICATE regularly banded, calc, pale and dark green. Inclination 70° with some folding. | 0 | 50 | 80 | 30 |
| PLAGIOCLASE-AMPHIBOLITE with finely divided pyrite | 0 | 45 | 80 | 75 |
| APLITIC SEGREGATION with thin flecks and laminae of amphibolite and patches of pyrrhotite. | 0 | 11 | 80 | 86 |
| ALTERED AMPHIBOLITE, between 81.10 and 81.45m up to one third of the core occupied by aplitic segregations and veins cut by thin shears. Brittle fold between 81.80 and 82.00m with inclination momentarily 90° but otherwise 60°. Pyrite common in joints. Finely divided pyrrhotite common in vein. | 1 | 34 | 82 | 20 |
| AMPHIBOLITE | 0 | 20 | 82 | 40 |
| ALTERED AMPHIBOLITE | 0 | 44 | 82 | 84 |
| FELDSPAR PORPHYRY SHEET | 0 | 08 | 82 | 92 |
| ALTERED AMPHIBOLITE, with feldspathic segregation | 0 | 23 | 83 | 15 |
| PLAGIOCLASE AMPHIBOLITE separated from above by 1-2cm feldspar-porphyry vein. Similar vein 2cm thick, sleeply inclined between 83.63 and 84.00m Pyrrhotite generally present throughout varying from fine disseminations (<0.5%) to thin films on joints. Inclination 73°. | 1 | 89 | 85 | 04 |
| ALTERED AMPHIBOLITE | 0 | 26 | 85 | 30 |
| AMPHIBOLITE | 0 | 30 | 85 | 60 |
| ALTERED AMPHIBOLITE with large patches and streaks of pyrrhotite between 85.77 and 85.91m. | 0 | 43 | 86 | 03 |
| PLAGIOCLASE AMPHIBOLITE, porphyroblastic in places. A few thin alteration zones. Some finely divided pyrrhotite common on joints along with pyrite | | | | |
| Quartz-feldspar vein/segregation with unidentified | | | | |

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| | Thickness | | Depth from Surface | |
|---|---|---|---|---|
| | Metres | | Metres | |
| amphibole laminae/bands and patchy pyrrhotite + minor chalcopyrite - 87.82 to 87.92m. Finely divided pyrrhotite generally less than 1% but very common in quartz veinlets. Inclination 80° at 88.36m 1-2m. Calcite veinlets with minor pyrite- between 88.60 and 89.50m. Similar veinlets - 89.80 - 90.05 and 90.14 to 90.65m. Inclination 57° at 89.45, 60° at 91.70 and 75° at 93.80m. | 9 | 19 | 95 | 22 |
| ALTERED AMPHIBOLITE upper 10cm of quite coarse grained amphibolite with irregular quartz-feldspar patchy segregations. Small patch of pyrrhotite with minor chalcopyrite. Remainder is of fine grained amphibolite with chloritic laminae and irregular, mostly concordant quartz veinlets. Pyrrhotite patches and minor chalcopyrite. | 0 | 31 | 95 | 53 |
| PLAGIOCLASE-AMPHIBOLITE, much as above. Plagioclase segregations with pyrrhotite die out below 96.60m. Inclination 60° at 95.70. Pyrite and less commonly pyrrhotite between 97.42 and 97.50m. Alteration zone 97.86 - 98.10m. Pale green rock with network of quartz veins - intensity of alteration and veining die out after upper 8cm. | 2 | 57 | 98 | 10 |
| AMPHIBOLITE with some vaguely defined alteration zones. Quartz-veinlets around 98.50 carry occasional pyrrhotite with minor chalcopyrite | 0 | 65 | 98 | 75 |
| GARNETIFEROUS AMPHIBOLITE a few plagioclase segregations and pale green alteration zones -100.30 to 100.55m with minor pyrrhotite. Outwith this zone only minor veining with pyrrhotite only recorded once. Finely divided pyrrhotite does appear to occur throughout. Inclination 50° at 99.50 and at 101.00m. Segregations - 103.35 to 103.60m - consist principally of chlorite but contain some large irregular plagioclase patches and pale grey quartz-calcite intergrowths. Occasionally contain highly garnetiferous patches. Garnets also occur | | | | |

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| | Thickness Metres | | Depth from Surface Metres | |
|---|---|---|---|---|
| irregularly in the amphibolite. Pyrite in small patches with rare chalcopyrite. Quartz-feldspar vein (segregation type) with patchy pyrrhotite and associated minor chalcopyrite between 104.05 and 104.10m. | 6 | 75 | 105 | 50 |
| AMPHIBOLITE with disseminated patchy chalcopyrite (up to - 2%) and minor pyrrhotite (<1%). Sulphides also occur in veinlets and in lowest 10cm chalcopyrite forms a stockwork. | 0 | 30 | 105 | 80 |
| MASSIVE PYRRHOTITE (55-60%) with 15-20% chalcopyrite and inclusion of talc, chlorite and actinolite | 0 | 10 | 105 | 90 |
| AMPHIBOLITE, generally medium grained but some coarse intergrowths with pyrite. In lowest 14cm vein development of pyrrhotite intergrown with actinolite and with 3-5% chalcopyrite. Vein of massive pyrrhotite between 106.35 and 106.52m occupying whole of core in lowest 8cm. Comprises 50-60%. pyrrhotite and 5-8% chalcopyrite with inclusions of coarse dark amphibole. Similar vein between 106.69 and 106.70m with probably about 50% pyrrhotite intergrown with coarse amphibole. No chalcopyrite within but patch below (about 5% over 2cm). Small chalcopyrite patch between 106.80 and 106.90m. | 1 | 00 | 106 | 90 |

MASSIVE PYRRHOTITE with minor chalcopyrite.

| | Estimated volume % Pyrr | Chpy | Remarks and inclusion |
|---|---|---|---|
| 106.90 - 107.00 | 80.85 | 1-2 | Sulphide concentrated at base. Tremolite matrix. |
| 107.00 - 107.10 | 80.85 | - | Tremolite/actinolite, calcite |
| 107.10 - 107.20 | No recovery. | | |
| 107.20 - 107.30 | 60 | 1-2 | Chalcopyrite in stringers chlorite + actinolite |

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SECTION OF Drillhole No.6, Vidlin

Six-inch Map (County and Quarter Sheet) HU 46 NE

| Estimated volume % | Pyrr | Chpy | Remarks and inclusion | Thickness (Metres) | | Depth from Surface (Metres) | |
|---|---|---|---|---|---|---|---|
| 107.30 - 107.40 | 75 | 1 | Tremolite, minor calcite, calcite, talc | | | | |
| 107.40 - 107.50 | 75 | $\leqslant 1$ | Calcite(occasionally forming fragments up to 2cm) tremolite, chlorite, talc. | | | | |
| 107.50 - 107.60 | 75 | $\leqslant 1$ | Generally rounded fragments of calcite with dark specks ( ? amphibole) and talc. | | | | |
| 107.60 - 107.73 | 70 | $\leqslant 1$ | Calcite, tremolite, talc, chlorite <u>Chalcopyrite</u> tends to be concentrated in lowest 3cm. | 0 | 83 | 107 | 73 |
| AMPHIBOLITE, with finely divided <u>pyrrhotite</u>. Quartz vein up to 1mm with <u>chalcopyrite</u> 108.70 - 108.73m. Inclination at top 45°. Evidence of alteration below 108.80m. Then stringers of <u>chalcopyrite</u> ($\leqslant$1%) with quartz and feldspar blebs between 108.95 and 109.05m. <u>Pyrrhotite</u> and <u>pyrite</u> seem slightly concentrated between 109.75 and 109.88m. Bronzy mica common between 109.55 and 110.11. Garnets appear below 109.95m and like bronzy mica tends to occur sporadically, although there are certain concentrated horizons. Absent from most of the altered zones - possibly some ? chlorite pseudomorphs however. Patchy <u>pyrrhotite</u> at 110.58. Alteration dies out below 111.40m. Below this a few quartz patches and concordant veinlets. Inclination 45° at 109.75 and 48° at 111.75m. | | | | 5 | 60 | 113 | 33 |
| QUARTZ-VEIN with minor feldspar and undisturbed bands of included amphibolite. Limited stockwork | | | | | | | |

APPENDIX FIVE

ASSAY RESULTS OF DRILL-CORE SAMPLES

## Methods

Copper determinations were performed on-site using a portable X-ray fluorescence analyser (Ecko Electronics Mineral Analyser). The instrument was calibrated using previously analysed, powdered rock samples from surface outcrops at Vidlin, in order to have a similar chemical matrix to the drill cores. Because the geometry, density, and grain size of the drill cores differ markedly from the powdered rock samples, the copper content determined by the Mineral Analyser is only a nominal value, and was later found to be low by a factor of about 0.7 (visually estimated from a scatter plot of AAS Cu versus Mineral Analyser Cu). The use of the instrument is therefore hampered by the physical effects mentioned above and also by a matrix-compositional effect, especially the iron content which varies from low values in the calc-silicate and quartzites to very high values in the massive pyrrhotite-rock. Generally a high iron content will reduce the nominal copper value and conversely erroneously high copper values will be found in the quartzites. Another disadvantage is the relatively small size of the irradiated sample and, coupled with this, the coarse grained and erratic distribution of the chalcopyrite, which produces an unreliable estimate of the copper content, even when averaged over 20 determinations per metre. The advantage of the Mineral Analyser is that a rapid on-site estimation of nominal copper content can be made and used as a guide to the sampling for further chemical analysis.

The chemical analysis was performed by standard atomic absorption techniques, after dissolution of the sample with concentrated HCl, evaporation to dryness, and then addition of $HNO_3$. The normal method of attack with hot $HNO_3$ did not prove satisfactory because of the precipitation of sulphur which produced lower metal values, especially for Pb. The possibility of interference, due to the high iron content of the samples, was checked by a standard addition technique but was not found to be significant.

The chemical analysis was performed on a sample prepared by splitting the core in half, jaw crushing to 1-2mm grain size, quartering and grinding to less than 200-mesh in an agate tema mill.

## APPENDIX FIVE: TABLE 1

| Sample No. | | Upper Depth(m) | Thickness(m) | Mineral Analyser Cu% | A.A.S. Cu% | Pb% | Zn% | Co ppm | Ni ppm | Ag ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE 1 | | | | | | | | | | |
| CHD | 1/45 | 45.00 | 1.00 | 0.39 | 0.525 | 0.058 | 0.450 | 115 | 45 | 6 |
| | 1/46 | 46.00 | 1.00 | 0.59 | 1.330 | 0.078 | 1.570 | 310 | 85 | 6 |
| | 1/47 | 47.00 | 1.00 | 0.59 | 0.900 | 0.060 | 0.675 | 225 | 60 | 6 |
| | 1/48 | 48.00 | 1.00 | 0.64 | 0.950 | 0.081 | 0.610 | 260 | 65 | 6 |
| | 1/49 | 49.00 | 1.00 | 0.80 | 1.025 | 0.090 | 1.180 | 245 | 65 | 7 |
| | 1/50 | 50.00 | 1.00 | 0.51 | 0.875 | 0.054 | 0.330 | 220 | 60 | 5 |
| | 1/51 | 51.00 | 1.00 | 0.58 | 0.880 | 0.060 | 0.680 | 270 | 70 | 5 |
| | 1/52 | 52.00 | 1.00 | 0.88 | 1.340 | 0.044 | 0.525 | 250 | 65 | 6 |
| | 1/53 | 53.00 | 1.00 | 0.72 | 1.160 | 0.057 | 1.250 | 285 | 80 | 7 |
| | 1/54 | 54.00 | 1.00 | 0.33 | 0.895 | 0.061 | 0.445 | 200 | 55 | 6 |
| | 1/55 | 55.00 | 1.00 | 0.74 | 0.925 | 0.058 | 0.500 | 275 | 70 | 5 |
| | 1/56 | 56.00 | 1.00 | 0.66 | 0.955 | 0.038 | 0.610 | 325 | 85 | 5 |
| | 1/57 | 57.00 | 1.00 | 0.89 | 1.140 | 0.050 | 0.600 | 255 | 70 | 5 |
| | 1/58 | 58.00 | 1.00 | 0.59 | 0.730 | 0.031 | 0.525 | 155 | 40 | 5 |
| | 1/59 | 59.00 | 1.00 | 0.25 | 0.300 | 0.006 | 0.033 | 35 | 15 | 3 |
| BOREHOLE 2 | | | | | | | | | | |
| CHD | 2/302 | 30.20 | 0.80 | 0.52 | 0.840 | 0.037 | 1.035 | 310 | 70 | 6 |
| | 2/31 | 31.00 | 0.90 | 0.61 | 0.970 | 0.062 | 1.460 | 320 | 75 | 5 |
| | 2/319 | 31.90 | 0.65 | 1.13 | 1.950 | 0.076 | 1.330 | 270 | 60 | 5 |
| | 2/449 | 44.91 | 1.13 | -- | 0.110 | 0.002 | 0.011 | 80 | 80 | 2 |
| BOREHOLE 3 | | | | | | | | | | |
| CHD | 3/534 | 53.40 | 0.60 | 0.12 | 0.100 | 0.020 | 0.010 | 45 | 65 | 1 |
| | 3/54 | 54.00 | 0.65 | 0.11 | 0.515 | 0.006 | 0.100 | 140 | 30 | 3 |
| | 3/546 | 54.65 | 0.35 | 0.39 | 0.435 | 0.015 | 0.335 | 225 | 45 | 3 |
| | 3/55 | 55.00 | 1.00 | 0.23 | 0.860 | 0.088 | 0.595 | 215 | 45 | 5 |
| | 3/56 | 56.00 | 0.43 | 0.08 | 0.100 | 0.022 | 0.018 | 30 | 20 | 1 |
| BOREHOLE 4 | | | | | | | | | | |
| CHD | 4/474 | 47.40 | 0.60 | 0.10 | 0.445 | 0.008 | 0.370 | 165 | 40 | 2 |
| | 4/48 | 48.00 | 0.60 | 0.05 | 0.130 | 0.007 | 0.030 | 45 | 65 | 1 |
| | 4/486 | 48.60 | 0.85 | 0.33 | 0.615 | 0.004 | 0.155 | 190 | 40 | 3 |
| | 4/494 | 48.45 | 0.55 | 0.00 | 0.250 | 0.003 | 0.080 | 295 | 60 | 3 |
| | 4/50 | 50.00 | 0.85 | 0.35 | 0.780 | 0.005 | 0.060 | 130 | 35 | 4 |
| | 4/508 | 50.85 | 0.57 | 0.01 | 0.075 | 0.005 | 0.008 | 25 | 40 | 1 |

Table 1 continued

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BOREHOLE 5 | | | | | | | | | |
| CHD | 5/595 | 59.54 | 0.94 | 0.24 | 0.390 | 0.015 | 0.165 | 40 | 35 | 3 |
| | 5/604 | 60.48 | 0.52 | 0.02 | 0.145 | 0.023 | 1.085 | 275 | 85 | 4 |
| | 5/61 | 61.00 | 0.70 | 0.34 | 0.425 | 0.073 | 1.340 | 335 | 105 | 6 |
| | 5/617 | 61.70 | 0.65 | 0.35 | 1.000 | 0.030 | 0.570 | 105 | 50 | 6 |
| | 5/623 | 62.35 | 0.73 | 0.48 | 0.740 | 0.041 | 0.650 | 85 | 35 | 4 |
| | 5/63 | 63.08 | 0.92 | 0.05 | 0.090 | 0.005 | 0.050 | 50 | 50 | 1 |
| | 5/64 | 64.00 | 0.70 | 0.05 | 0.135 | 0.004 | 0.024 | 35 | 55 | 1 |
| | 5/647 | 64.70 | 0.85 | 0.003 | 0.035 | 0.003 | 0.011 | 45 | 70 | 1 |
| | 5/655 | 65.55 | 0.65 | 0.004 | 0.050 | 0.003 | 0.019 | 60 | 60 | 2 |
| | 5/662 | 66.20 | 0.90 | 0.001 | 0.075 | 0.003 | 0.036 | 70 | 55 | 2 |
| | 5/671 | 67.10 | 1.05 | 0.01 | 0.040 | 0.003 | 0.038 | 40 | 65 | 1 |
| | 5/681 | 68.15 | 1.03 | 0.03 | 0.100 | 0.004 | 0.096 | 70 | 45 | 2 |
| | 5/691 | 69.18 | 1.08 | 0.08 | 0.085 | 0.007 | 0.075 | 55 | 55 | 2 |
| | 5/702 | 70.26 | 0.64 | 0.04 | 0.030 | 0.005 | 0.042 | 30 | 35 | 1 |
| | 5/709 | 70.90 | 0.36 | 0.33 | 0.570 | 0.078 | 0.370 | 80 | 35 | 6 |
| | 5/712 | 71.26 | 0.74 | 0.40 | 0.250 | 0.042 | 0.600 | 235 | 80 | 4 |
| | 5/72 | 72.00 | 0.84 | 0.38 | 0.740 | 0.006 | 0.095 | 195 | 70 | 4 |
| | 5/728 | 72.84 | 1.07 | 0.00 | 0.005 | 0.003 | 0.009 | 5 | 10 | 0 |
| | 5/739 | 73.91 | 1.08 | 0.09 | 0.115 | 0.003 | 0.028 | 90 | 65 | 2 |
| | 5/75 | 75.00 | 1.00 | 0.10 | 0.120 | 0.005 | 0.034 | 70 | 50 | 3 |
| | 5/76 | 76.00 | 0.78 | 0.02 | 0.155 | 0.005 | 0.042 | 115 | 85 | 4 |
| | BOREHOLE 6 | | | | | | | | | |
| CHD | 6/1050 | 105.00 | 0.60 | -- | 0.055 | 0.002 | 0.006 | 35 | 65 | 1 |
| | 6/1056 | 105.60 | 0.36 | -- | 0.315 | 0.003 | 0.017 | 80 | 75 | 2 |
| | 6/1059 | 105.96 | 1.00 | -- | 0.425 | 0.005 | 0.042 | 110 | 70 | 3 |
| | 6/1069 | 106.96 | 0.76 | -- | 0.565 | 0.020 | 0.330 | 280 | 65 | 4 |
| | 6/1077 | 107.72 | 0.78 | -- | 0.035 | 0.005 | 0.009 | 40 | 90 | 1 |

-- Not determined

Analyst: Miss B.P. Allen, Analytical and Ceramics Unit.

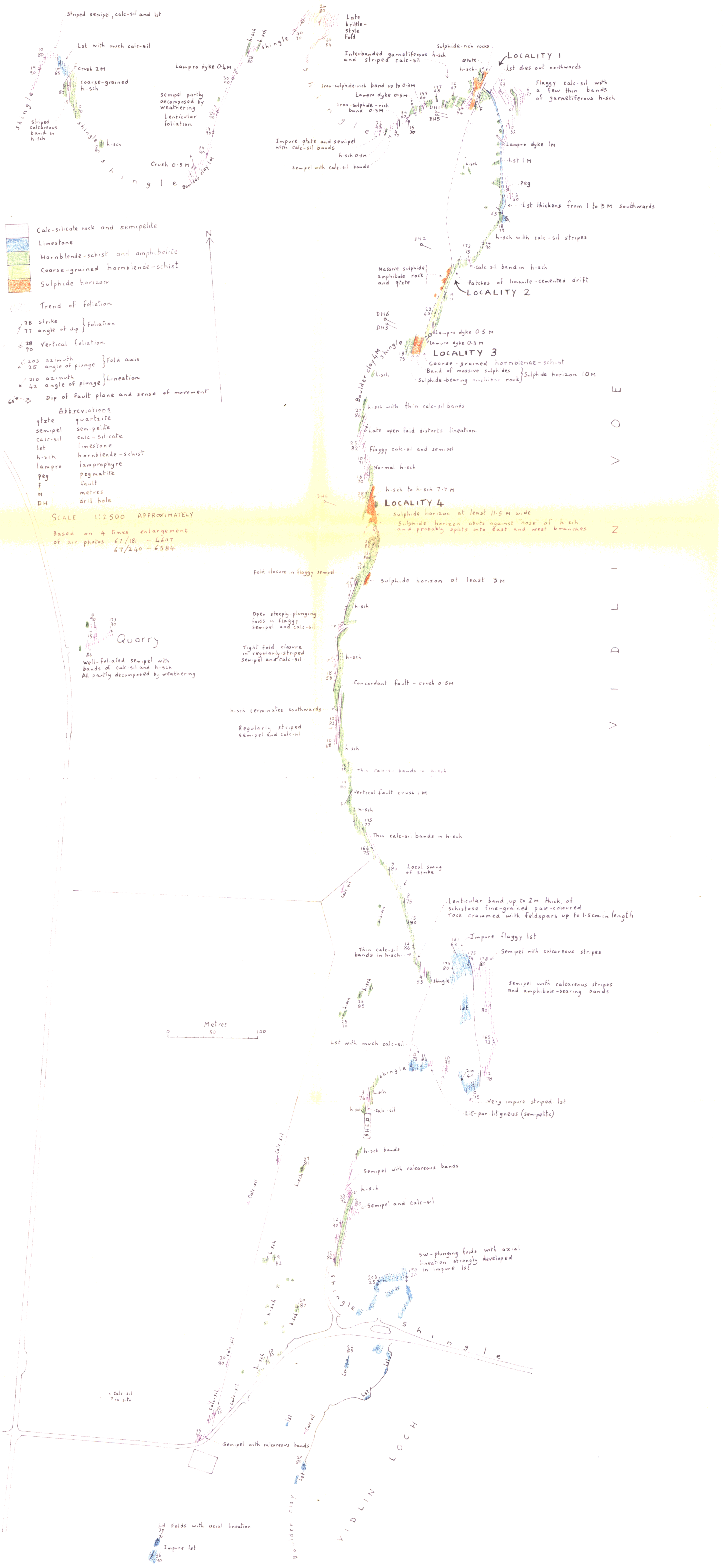


FIG 4 GEOLOGICAL MAP OF VIDLIN NESS

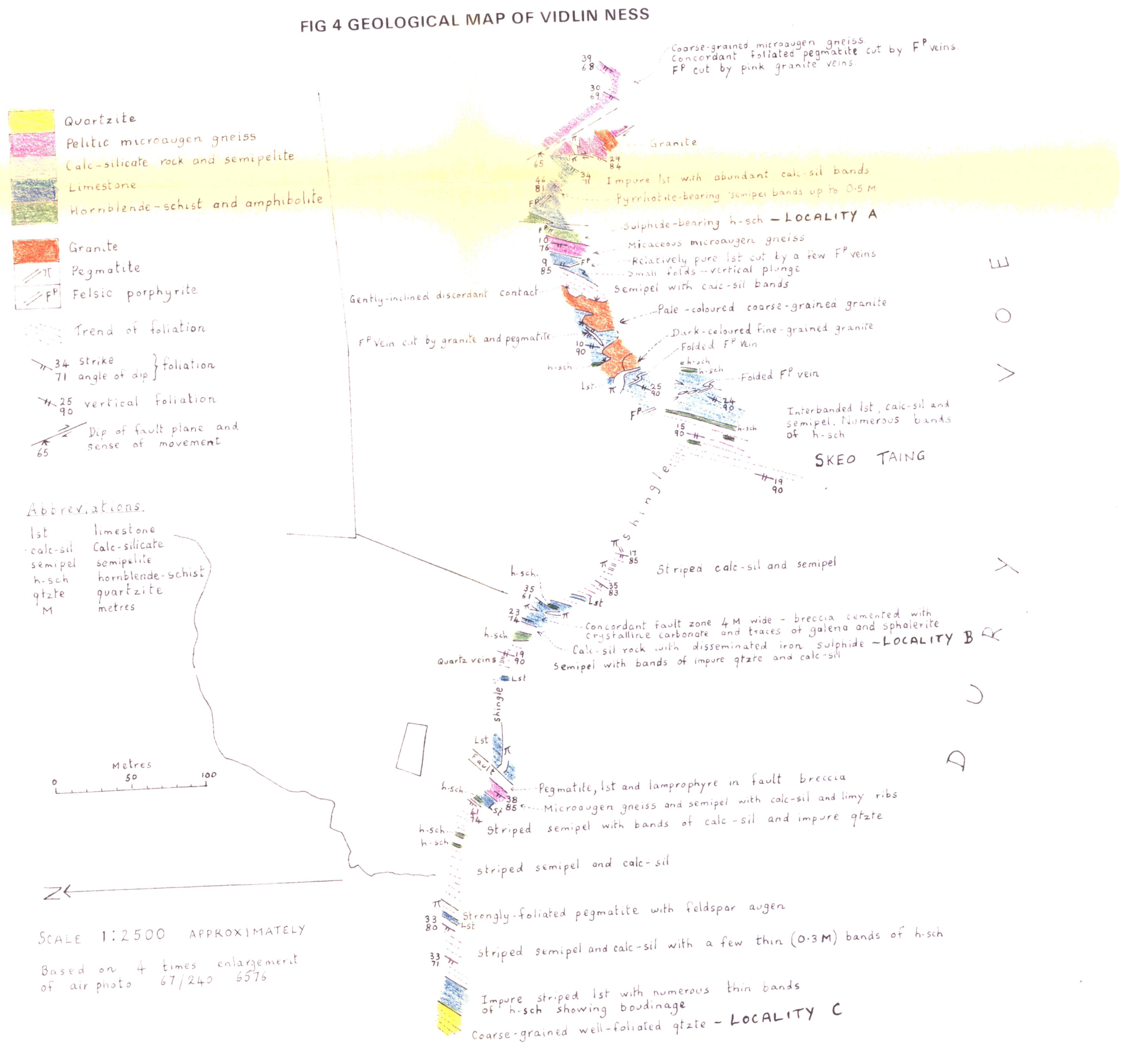


FIG 5 GEOLOGICAL MAP OF PART OF THE COAST OF DURY VOE