GEOLOGICAL NOTES ON O.S. SHEET NJ 91 SW

BELHELVIE DISTRICT

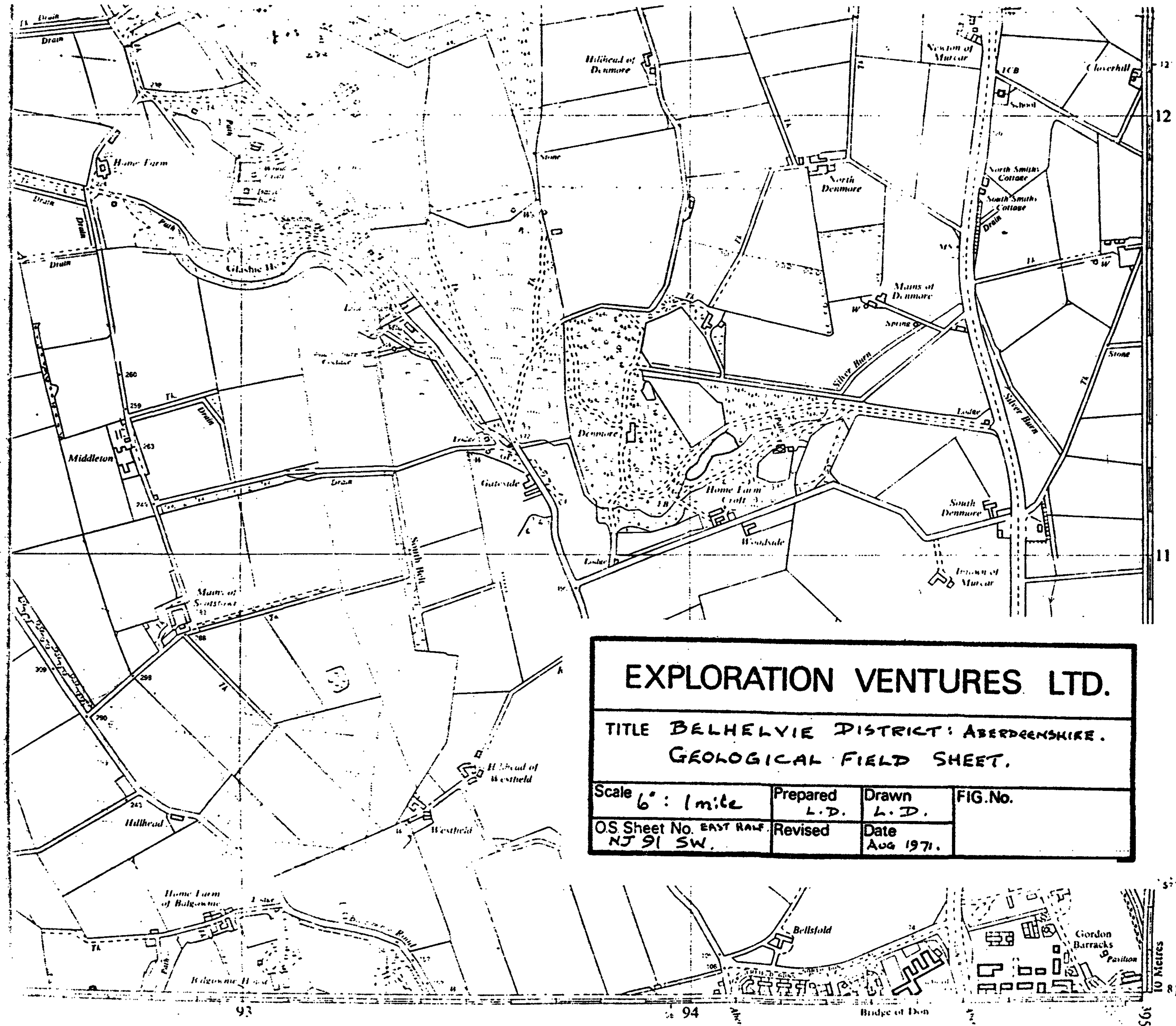
Abundant float throughout the area. Two outcrops - one of gabbro over Mundurno and one of schist or sheared basic beside Newton of Mundurno. Next to nothing in the way of sulphides. Of those found, mainly in basics, though traces found in one of the blocks of felsite.

Large quantities of granite to be found. Assorted colours, from red to grey with most of the blocks medium grained. These blocks were generally rounded, though numerous examples of angular blocks. Closely related to this, traces of porphyry and felsite were found.

Very abundant schists and gneisses. Most of the schists comprised of thin micaceous bands, especially to the NW of Cranfield, but some andalusite schist was also found. Gneisses were mainly rounded, and distributed generously. Numerous blocks of quartzite throughout the area, also in certain places a quartz rich gneiss.

Not a great deal of basics to be found, which mainly consisted of norite and gabbro. Some of the norite was of brown variety. Also traces of rounded dolerite and uralitised basics in the area.

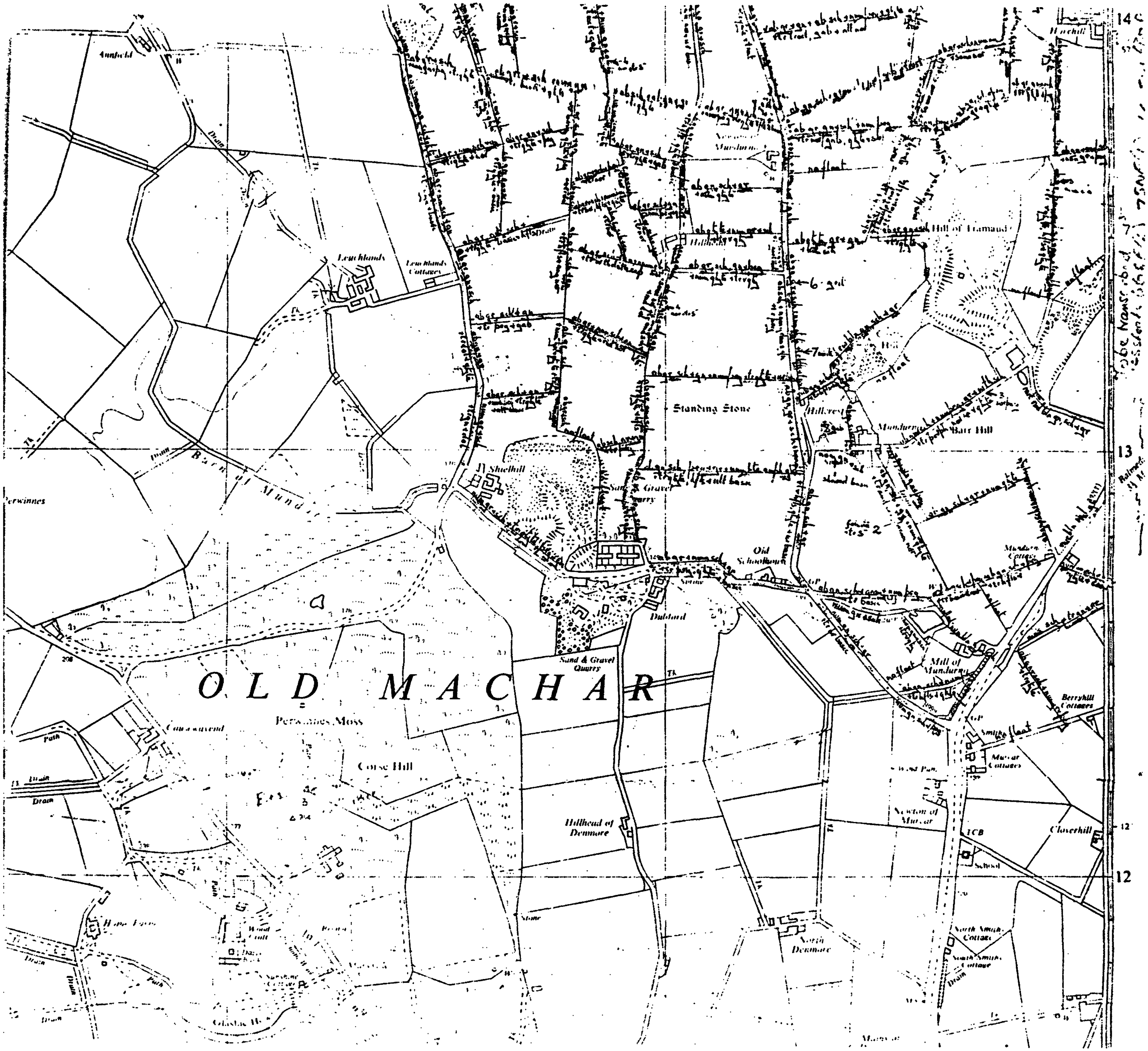
Hardly any ultrabasics located in this area - only a few instances of troctolite and the occasional weathered serpentinite.



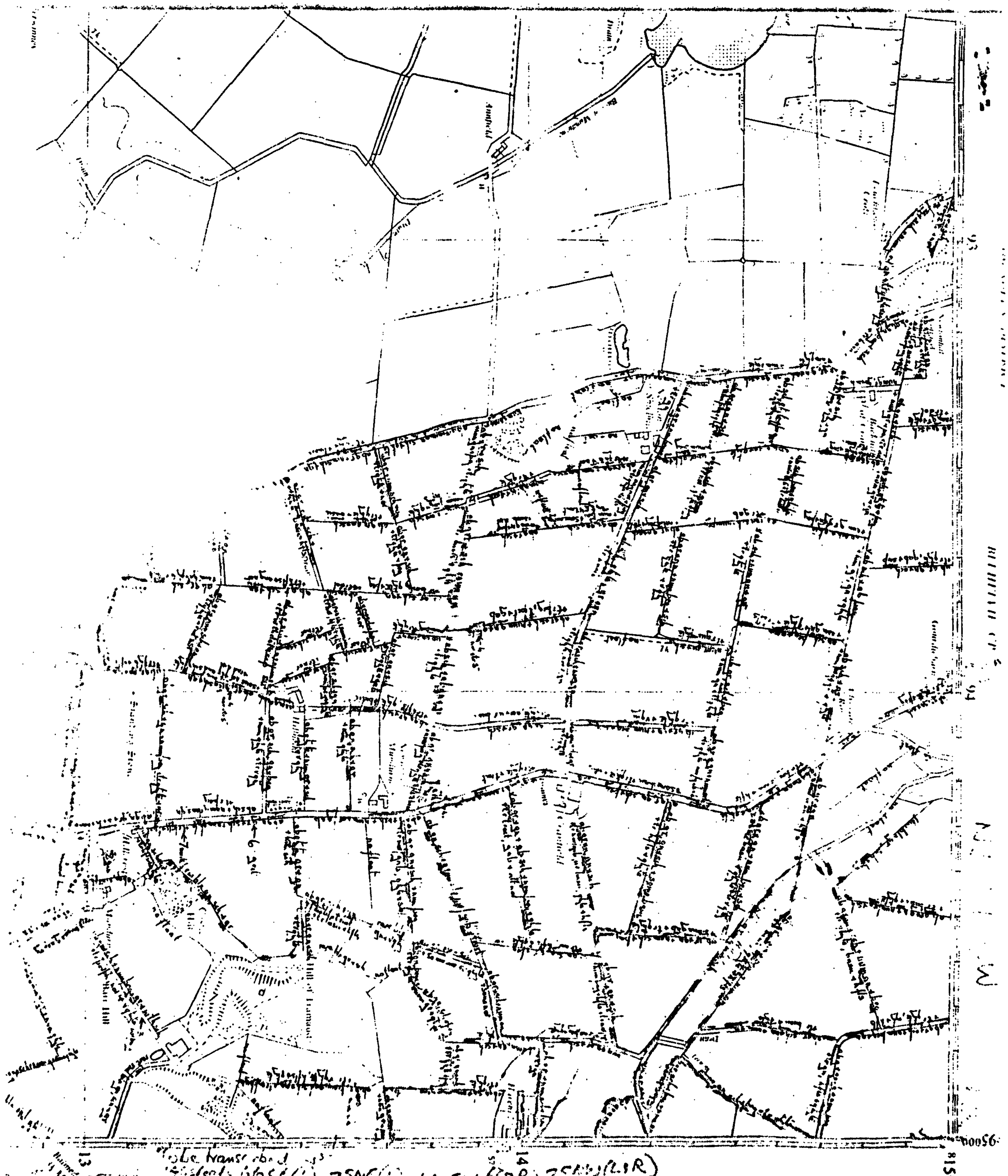
EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT: ABERDEENSHIRE.
GEOLOGICAL FIELD SHEET.

Scale 6" : 1 mile	Prepared L.D.	Drawn L.D.	FIG.No.
O.S. Sheet No. EAST HALF NJ 91 SW.	Revised	Date AUG 1971.	



OLD MACHAR
Standing Stone
Sand & Gravel Quarry
Leuchlands
Leuchlands Cottages
Annfield
Shielhill
Old Schoolhouse
Dubford
Mill of Mundurno
Hillcrest
Barr Hill
Berryhill Cottages
Corse Hill
Perwinnes Moss
Hillhead of Denmore
North Denmore
Newton of Murcar
Murcar Cottages
Cloverhill
School
North Smithy Cottage
South Smithy Cottage
Drain
Path
14
13
12



13
14
95
94

GEOLOGICAL NOTES ON O.S. SHEET NJ 91 NE

BELHELVIE DISTRICT

The area mapped featured part of the south-eastern extremity of the Belhelvie Mass. Generally float to the east of the A92 was extremely scarce owing to the presence of considerable depths of sand or clay, whereas further west float was very abundant, being by no means exclusively confined to recognised field boundaries.

The most common variety of basic was gabbro, often being fairly fine grained, occasionally showing distinct fabric and in places uralitised. Possible outcrops of (olivine) gabbro noted at 955195, and gabbro with traces of sulphide at 953181-2. It was found that the occurrence of basic float was especially concentrated in roughly E-W bands, including these possible outcrops.

Traces of sulphide - usually pyrite - were fairly common throughout the gabbro distribution, but, as the map shows, all the other basic and ultrabasic rocks of the sequence were likewise endowed. To the north-west a very coarse pegmatitic gabbro, but devoid of sulphide mineralisation, had a rather restricted but significant distribution.

Norites, again occasionally altered and uralitised, were common throughout the basic-significant areas.

Apparently separated by a band of granite and schist floats from the basic rocks was an outcrop (and float pattern) of serpentinised picrite/pure serpentinite. This was distinguished both topographically and with respect to vegetation cover from the surrounding, mainly granitic area.

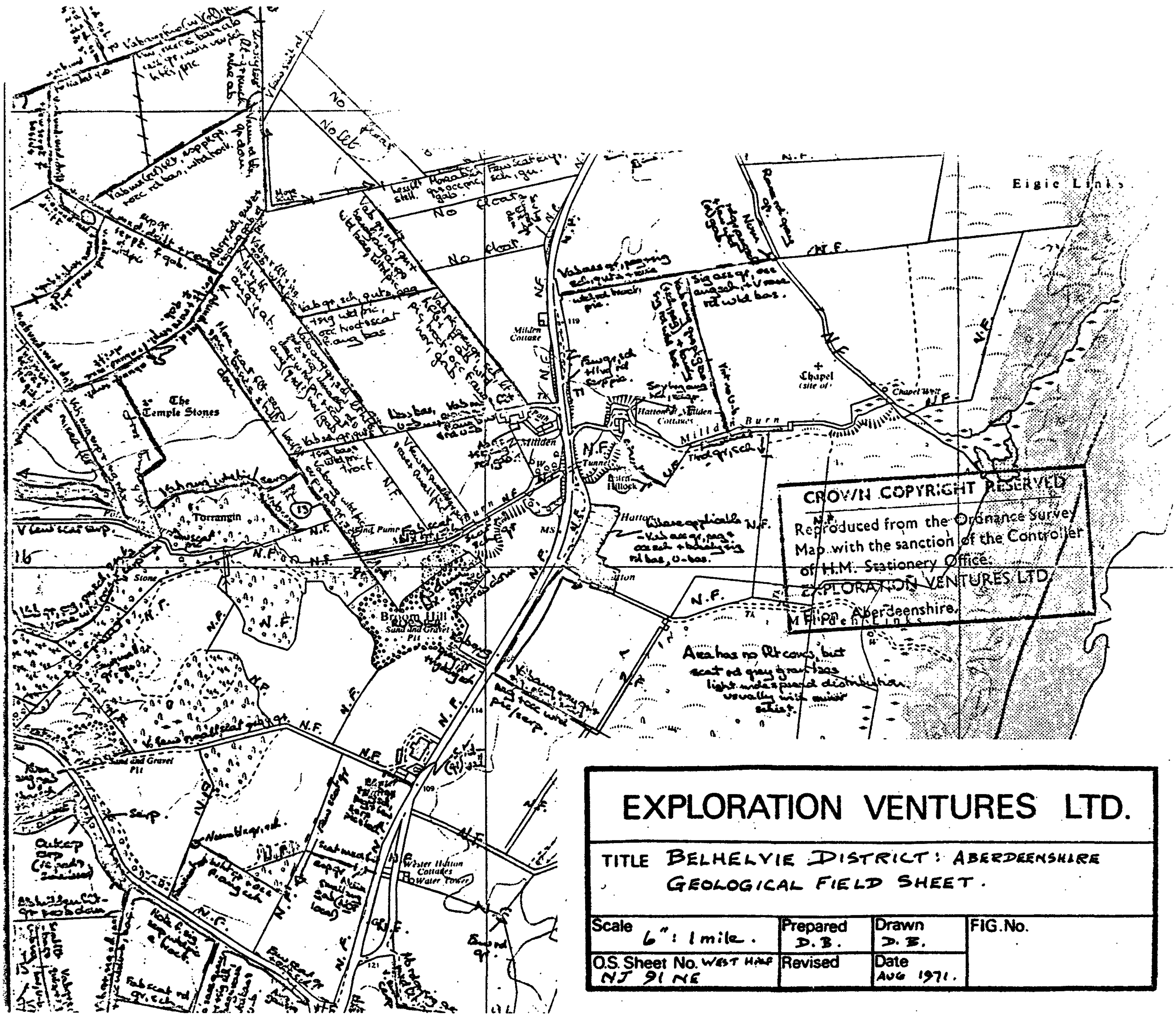
The troctolites in this region also had the olivines radically altered to a distinctive bright red/brown colour, whereas both the picrite and troctolite, fairly significant as generally round blocks in the areas to the north, were there (i.e. in the north) internally quite fresh.

Exceptional (for the area) sulphide occurrence was found in square 9517 with appreciable quantities of mainly pyrite, occasional chalcopyrite and significant pyrrhotite (samples 10, 11, 12). Trace quantities of fine sulphide (pyrite) occurred in some dark hornfelses in the northern half with the only noteworthy feature being significant, probably vein marcasite in hornfels (sample 8 - 3955191).

Schists and fairly siliceous gneisses were widespread throughout the area, generally very round when large, with a possible outcrop of biotite schist/gneiss in a very steep valley at 957189 - apparently 'sandwiched' between the basic outcrops to the north and south. The float pattern further indicates a possible 'finger' of schist within the basic complex.

Granites and associated pegmatites were likewise of similar widespread distribution (but never outcropping), being perhaps more abundant. A pink-red variety was especially common to the north, while in the major granite concentrations of the south the grey variety appeared dominant.

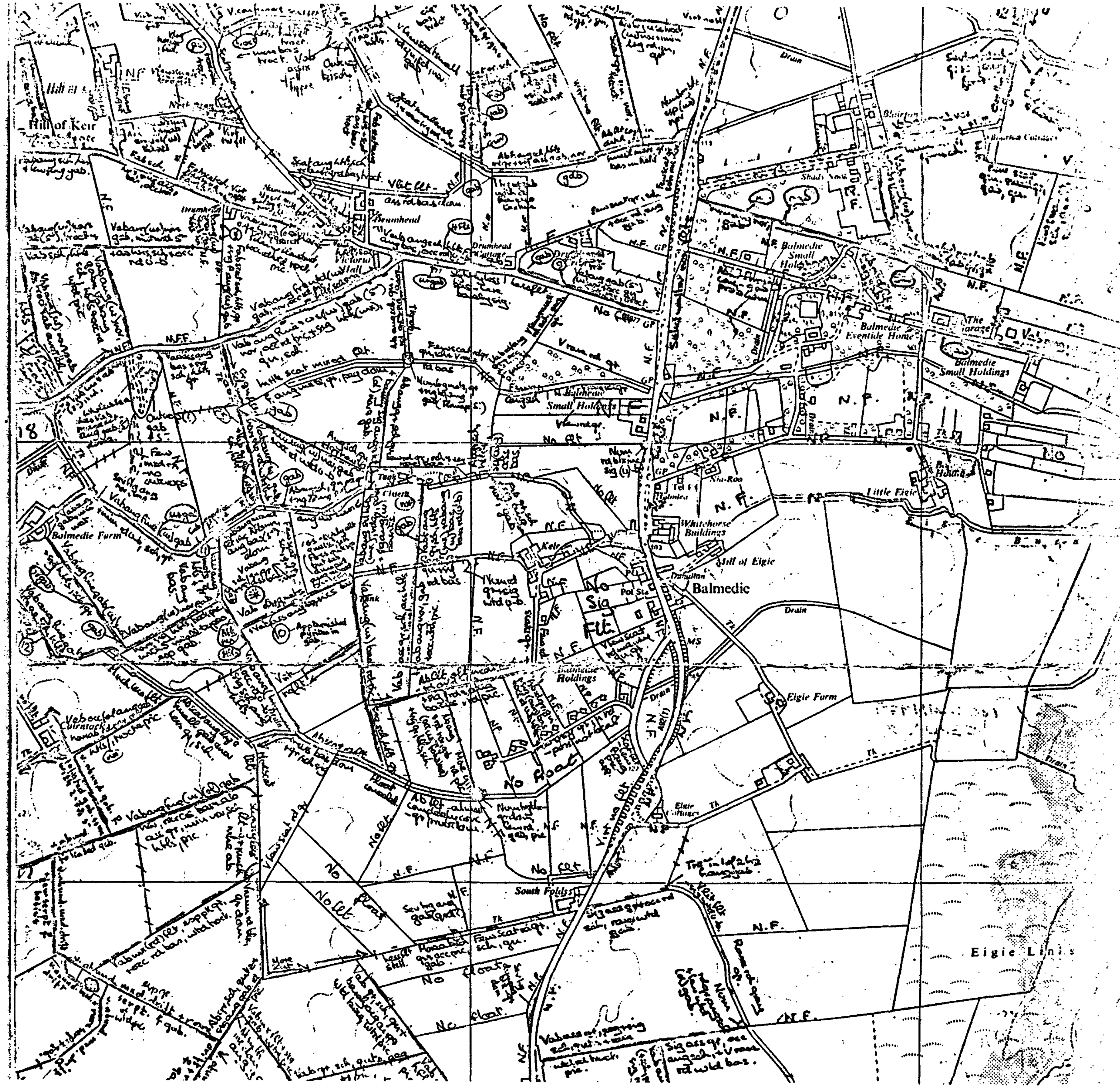
The few vein quartzite blocks found were completely barren. In connection with the sulphide distribution pattern it should be noted that, in these areas, the basics were extremely fresh in exterior morphology, giving no clue as to possible mineral content and therefore sulphides, albeit in trace quantities, are probably more widespread in the appropriate areas. No sulphides were recognised in the ultrabasics to the south.



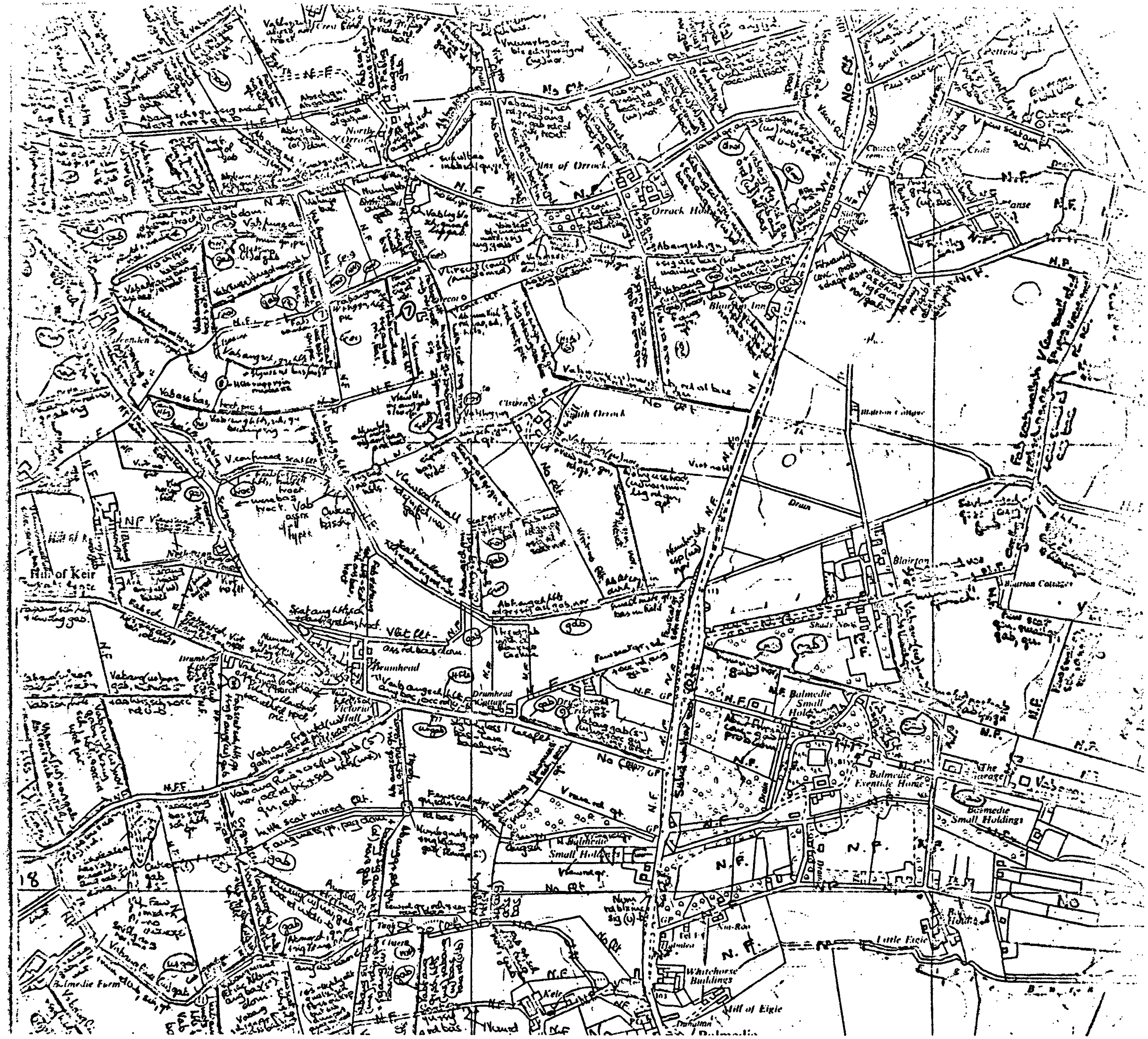
EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT: ABERDEENSHIRE GEOLOGICAL FIELD SHEET.

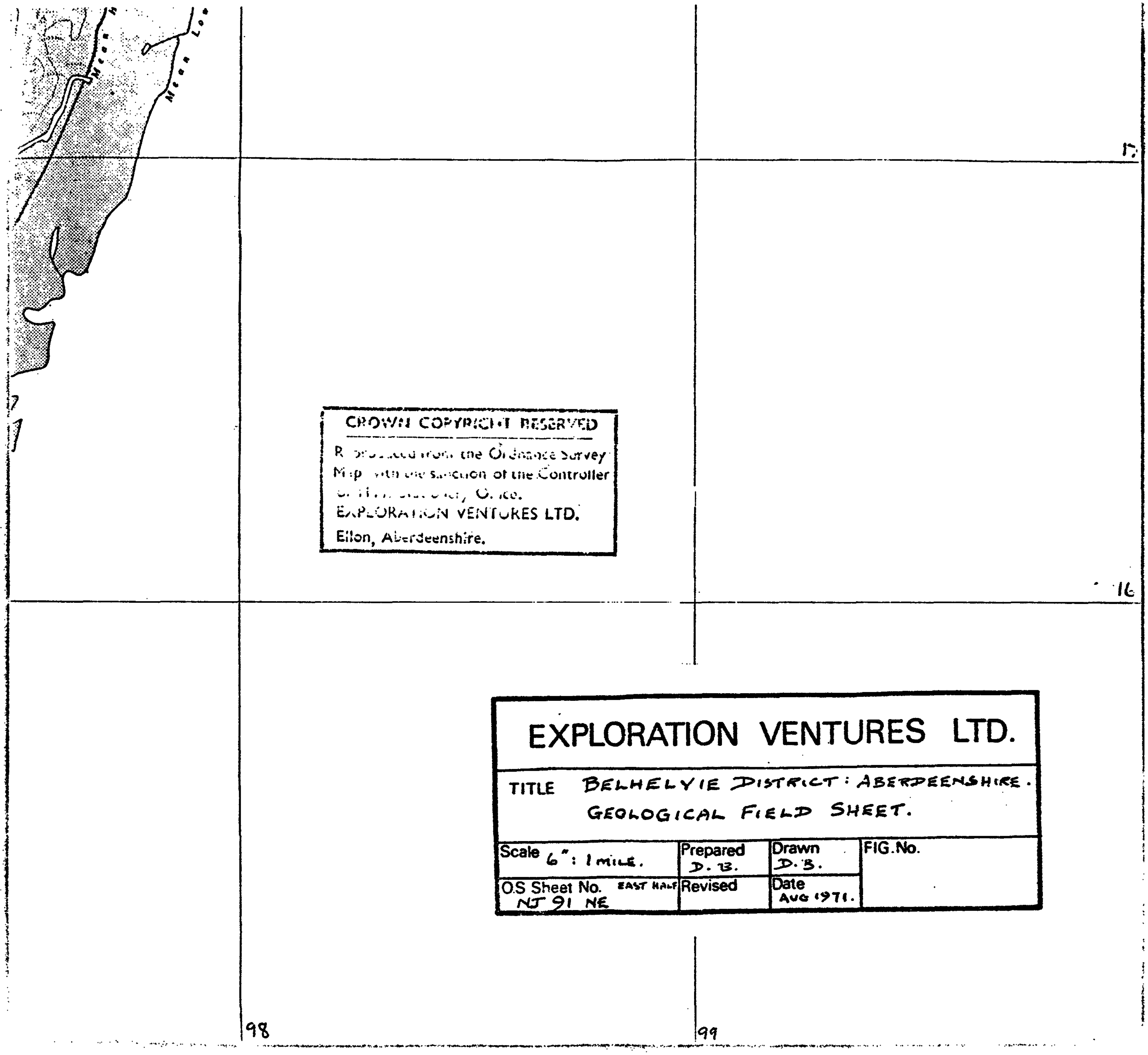
Scale	Prepared	Drawn	FIG.No.
6": 1 mile.	D.B.	D.B.	
O.S. Sheet No. WEST HALF NJ 91 NE	Revised	Date AUG 1971.	

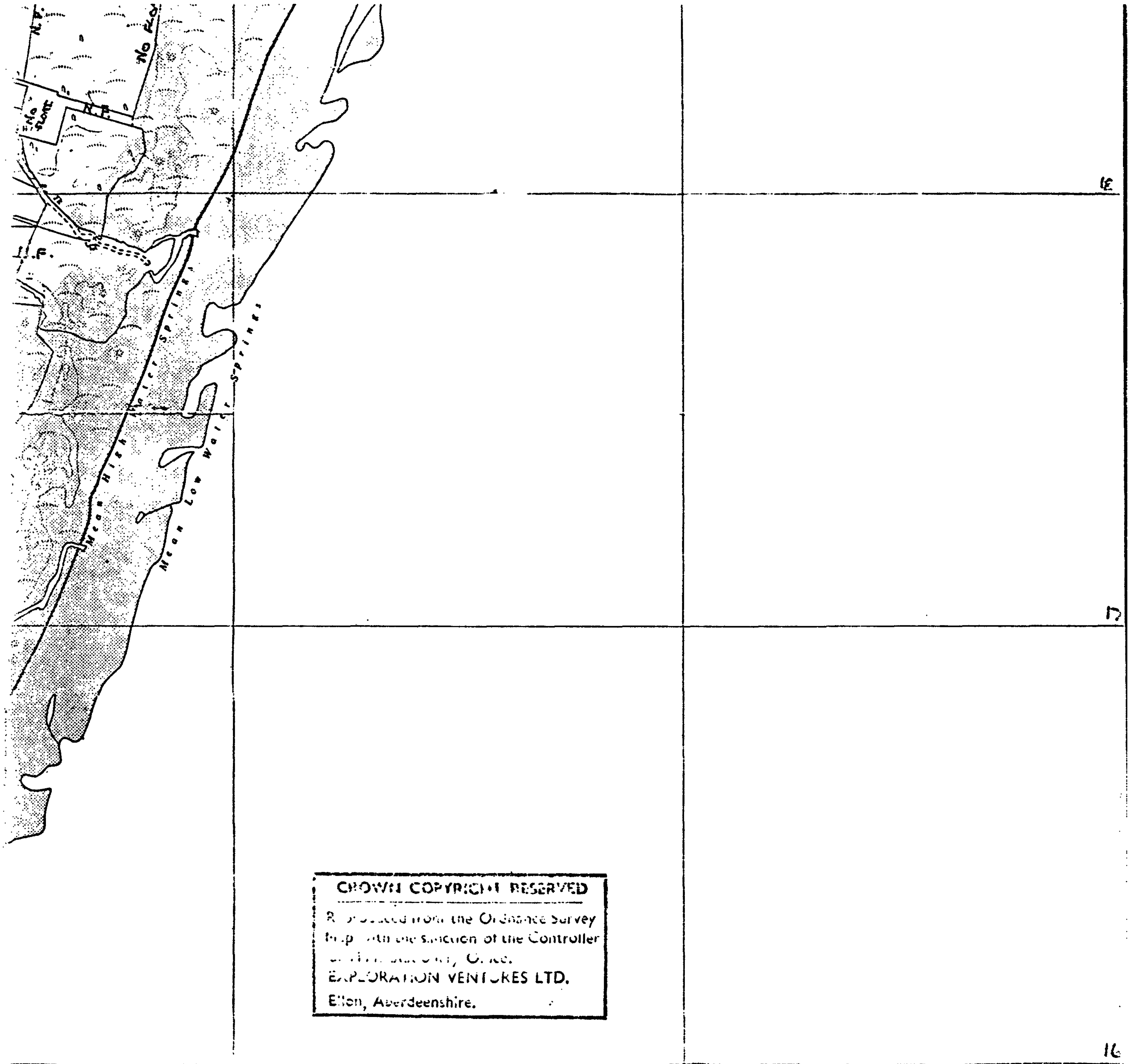


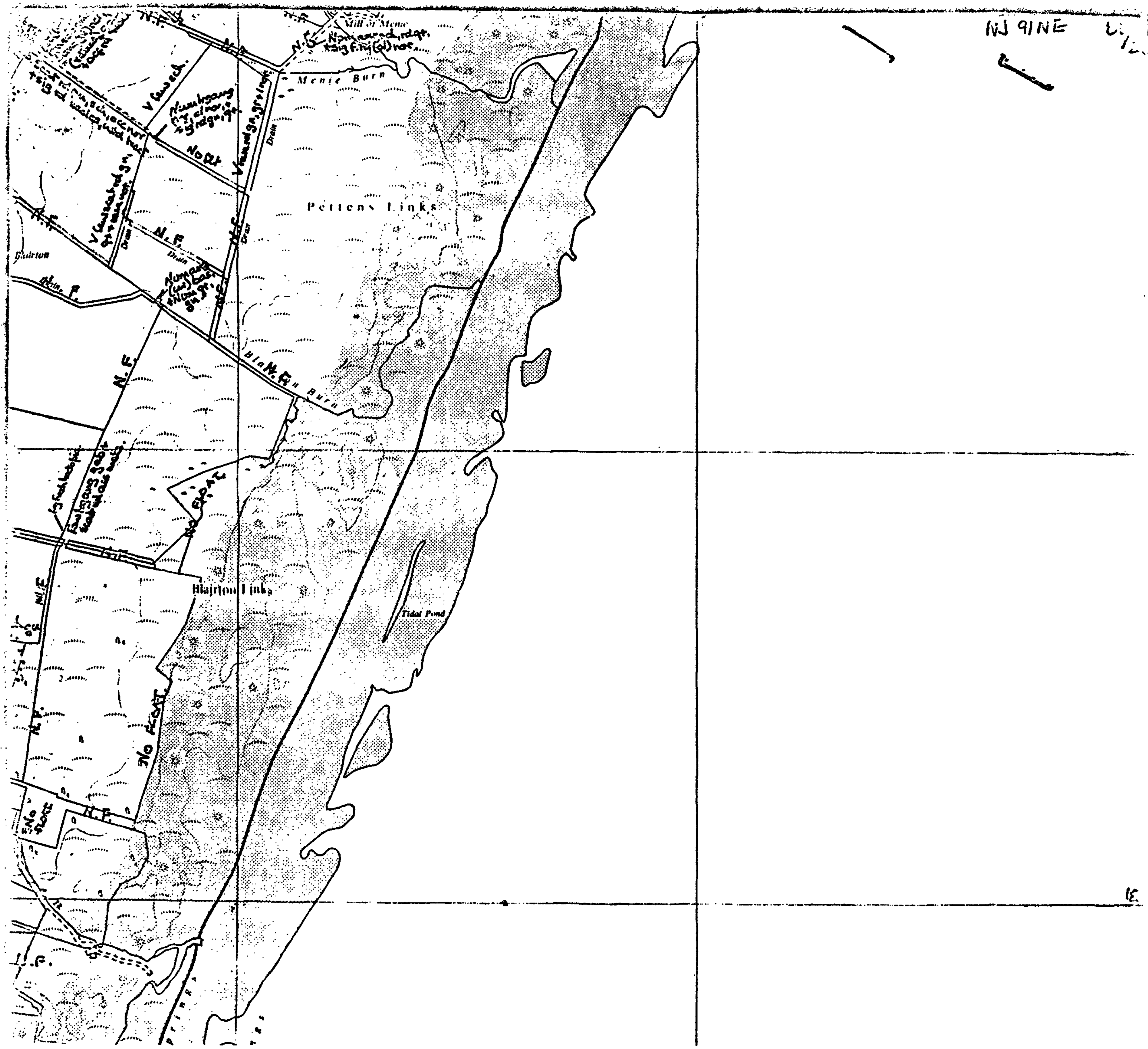
Hill of Keir
Drumhead
Victoria Hall
Blairton
Balmedie Small Holdings
The Garage
Balmedie Eventide Home
Balmedie Small Holdings
Little Eigie
Whitehorse Buildings
Hill of Eigie
Balmedie
Balmedie Farm
Balmedie Holdings
Eigie Farm
Eigie Cottages
South Folds
Eigie Links
Drain

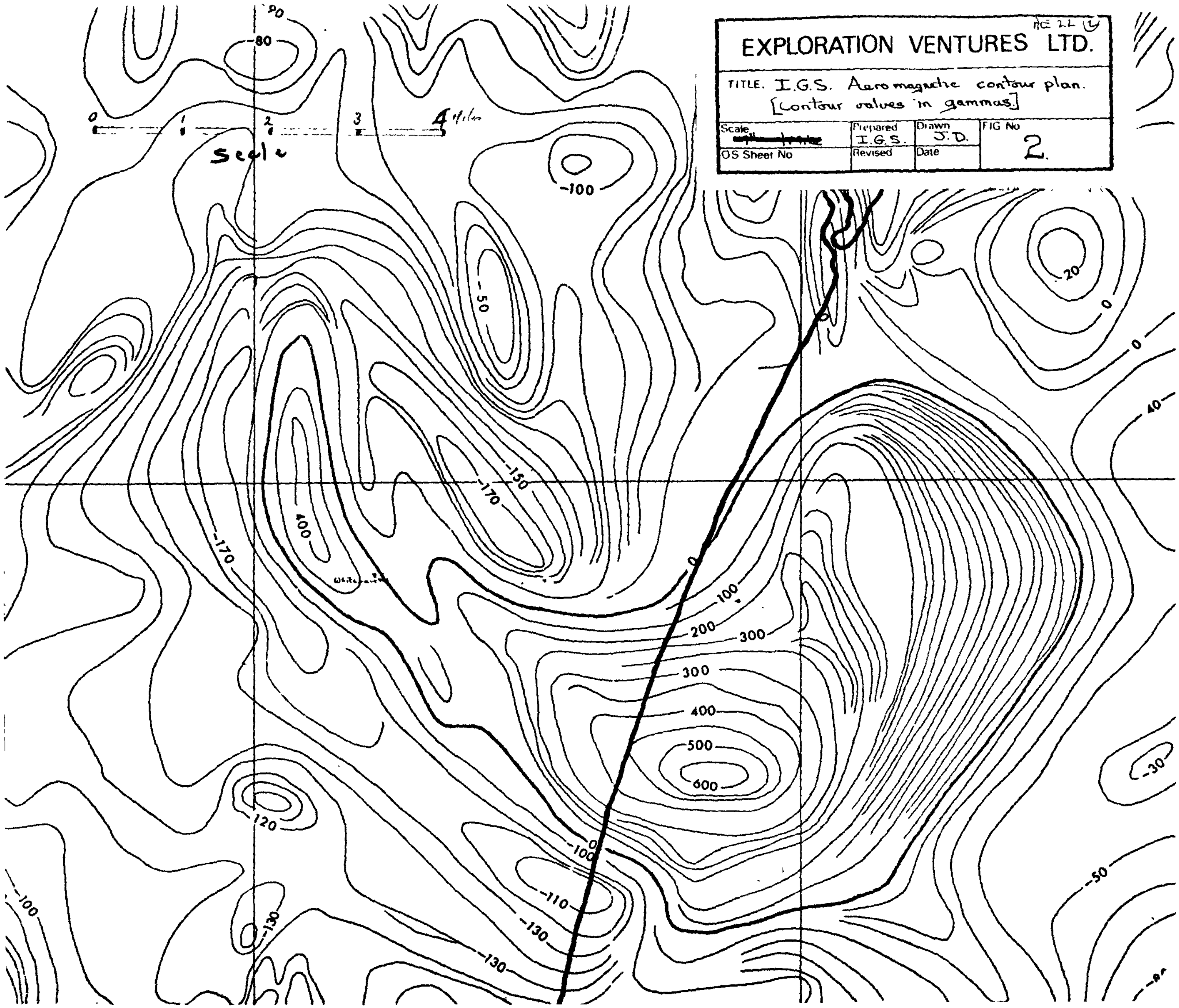


North Orrock
Mains of Orrock
Orrock Holdings
Blairton Inn
South Orrock
Blairton
Blairton Cottage
Hill of Keir
Drumhead
Drumhead Cottage
Victoria Hall
Balmedie Small Holdings
Balmedie Eventide Home
The Garage
Little Eigie
Whitehorse Buildings
Hill of Eigie
Balmedie Farm
Keir
Manse
Church
Drain

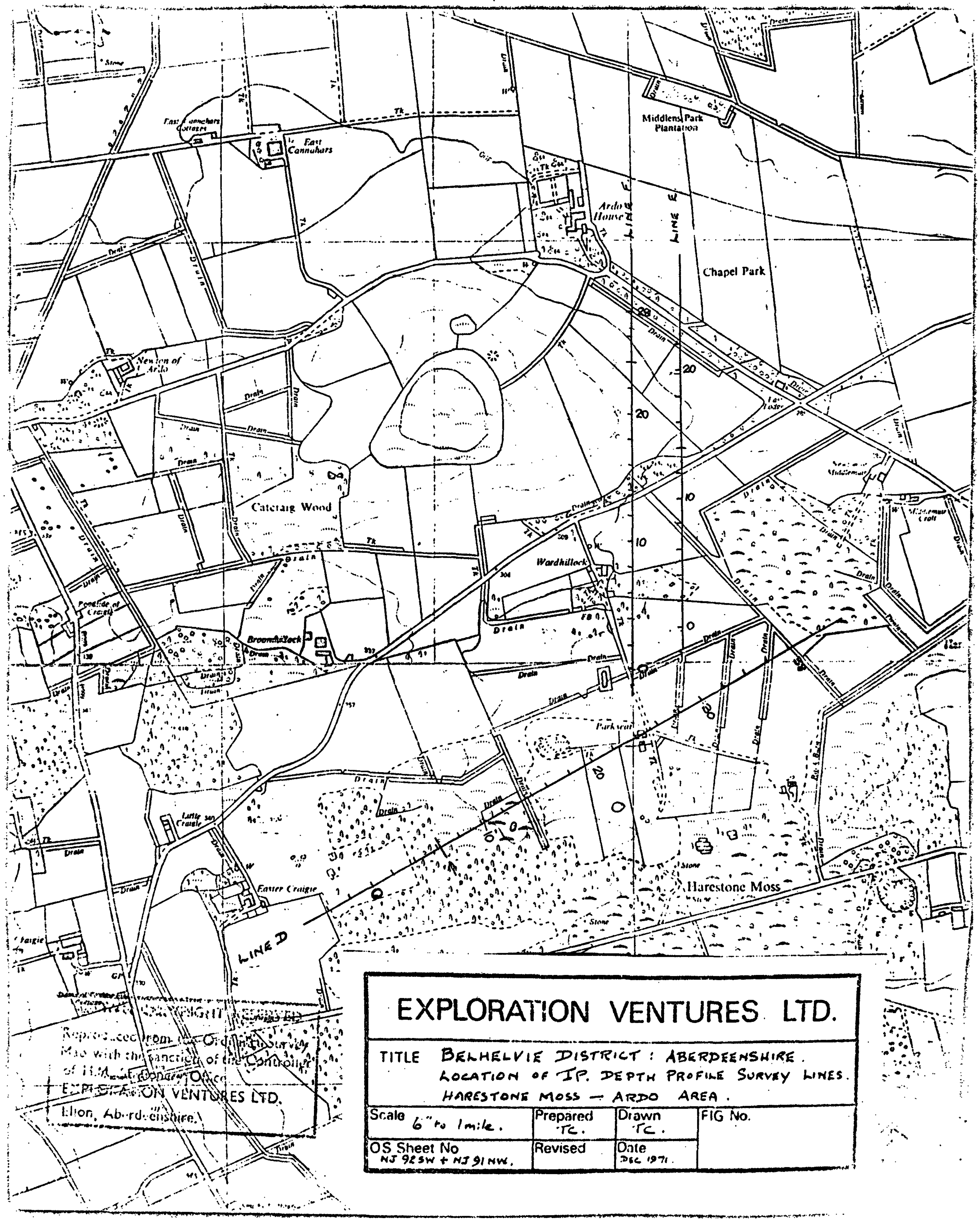

17
16
98
99
CROWN COPYRIGHT RESERVED
EXPLORATION VENTURES LTD.
Ellon, Aberdeenshire.
EXPLORATION VENTURES LTD.
TITLE BELHELVIE DISTRICT : ABERDEENSHIRE.
GEOLOGICAL FIELD SHEET.
Scale 6" : 1 mile.
Prepared D. B.
Drawn D. B.
FIG. No.
O.S Sheet No. EAST HALF NJ 91 NE
Revised
Date AUG 1971.


N.F.
Mean High Water Springs
Mean Low Water Springs
18
17
16


NJ 91NE
Mill of Menie
Menie Burn
Pettens Links
Blairton Links
Tidal Pond
Drain
N.F.
NO FLOAT

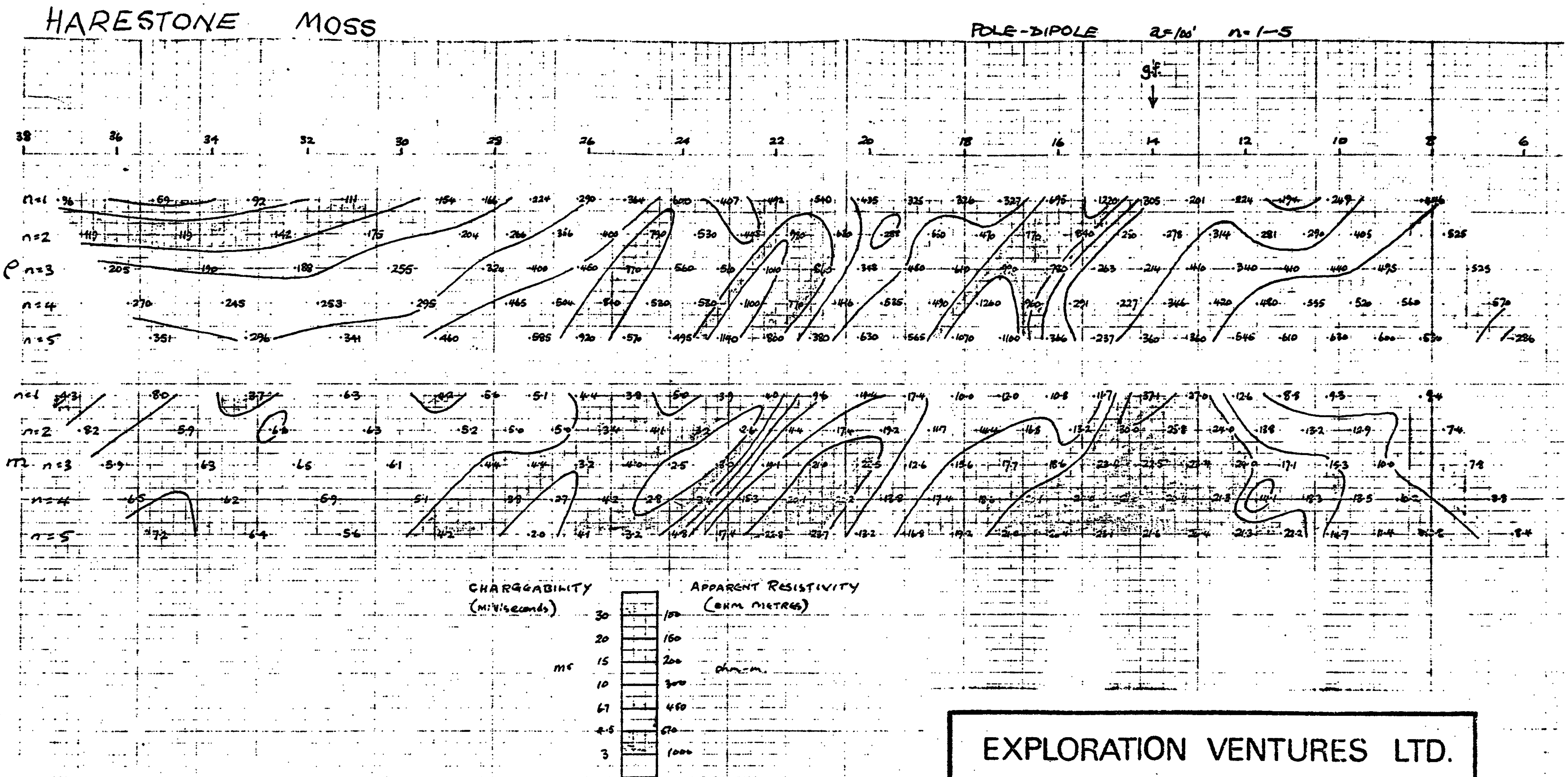


EXPLORATION VENTURES LTD.
TITLE. I.G.S. Aeromagnetic contour plan.
[Contour values in gammas]
Scale
Prepared I.G.S.
Drawn J.D.
FIG No 2.
OS Sheet No
Revised
Date
0 1 2 3 4
Scale
90
-80
-100
50
20
0
0
40
-150
-170
400
-170
0
100
200
300
300
400
500
600
120
0
-100
-110
-130
-130
130
-100
-30
-50



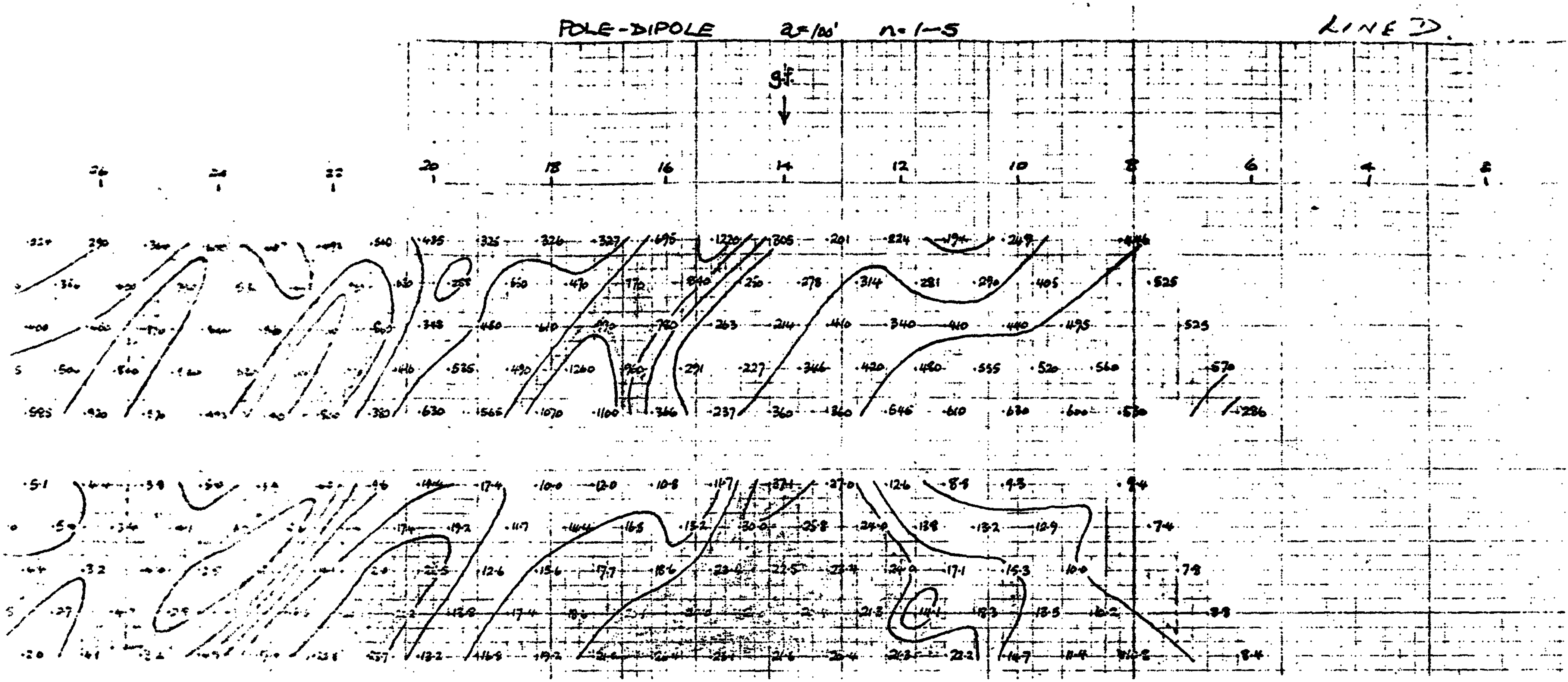
EXPLORATION VENTURES LTD.

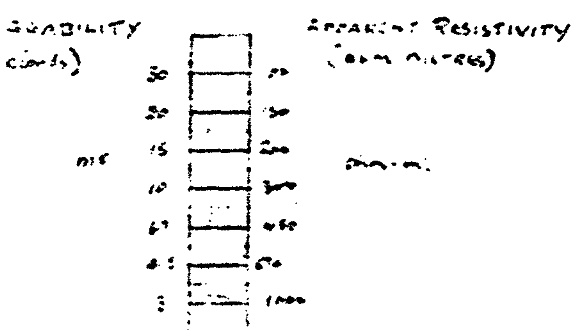
TITLE BELHELVIE DISTRICT : ABERDEENSHIRE. LOCATION OF I.P. DEPTH PROFILE SURVEY LINES. HARESTONE MOSS — ARDO AREA.			
Scale 6" to 1mile.	Prepared TC.	Drawn TC.	FIG No.
OS Sheet No NJ 92 SW + NJ 91 NW.	Revised	Date DEC 1971.	



EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT : ABERDEENSHIRE. INDUCED POLARISATION DEPTH PROFILES. LINE D. HARESTONE MOSS AREA.			
Scale	Prepared T.C.	Drawn T. Cumpster	FIG. No
O.S Sheet No. Located on NJ 91 NW.	Revised	Date Dec 1971	

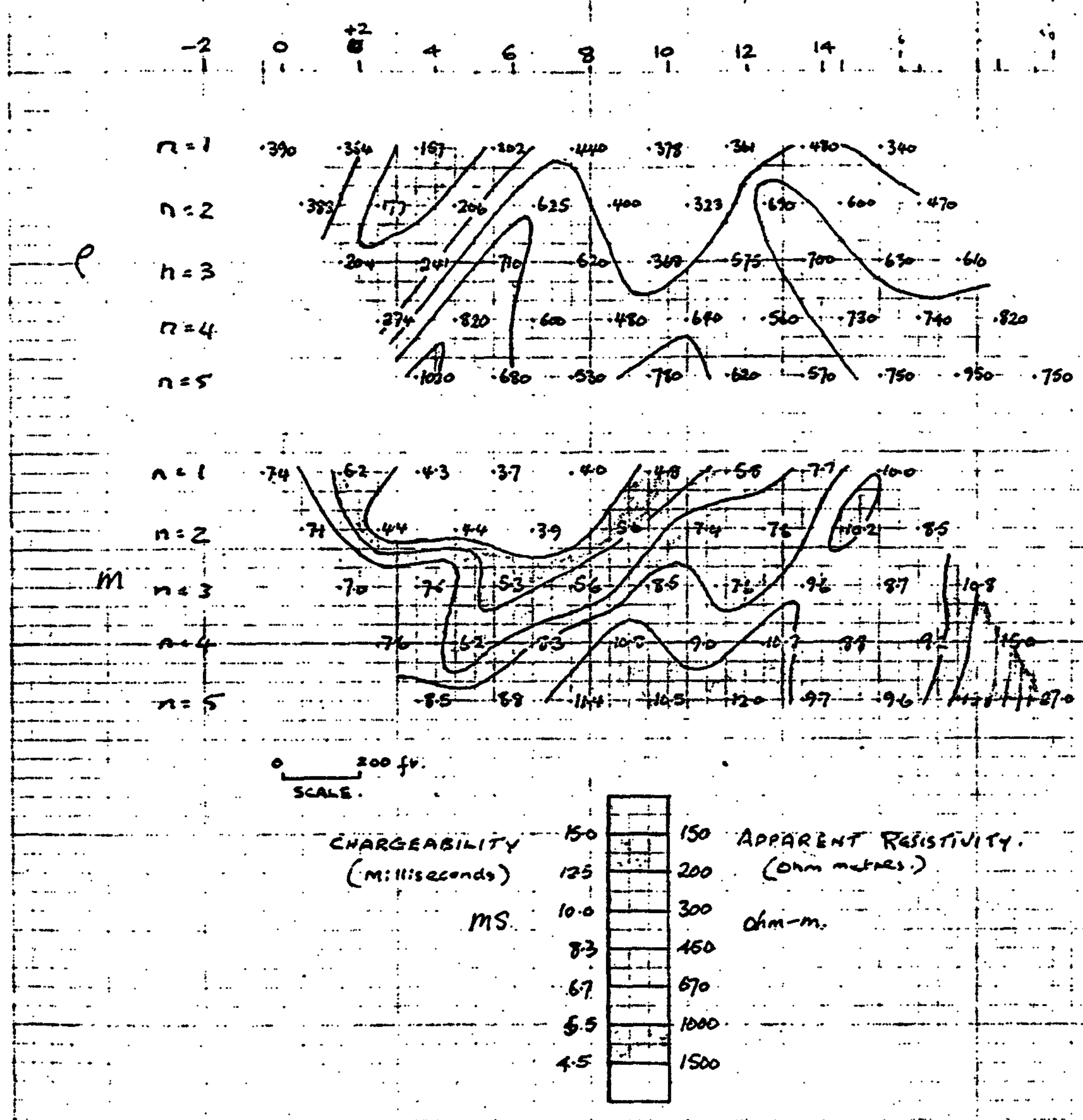


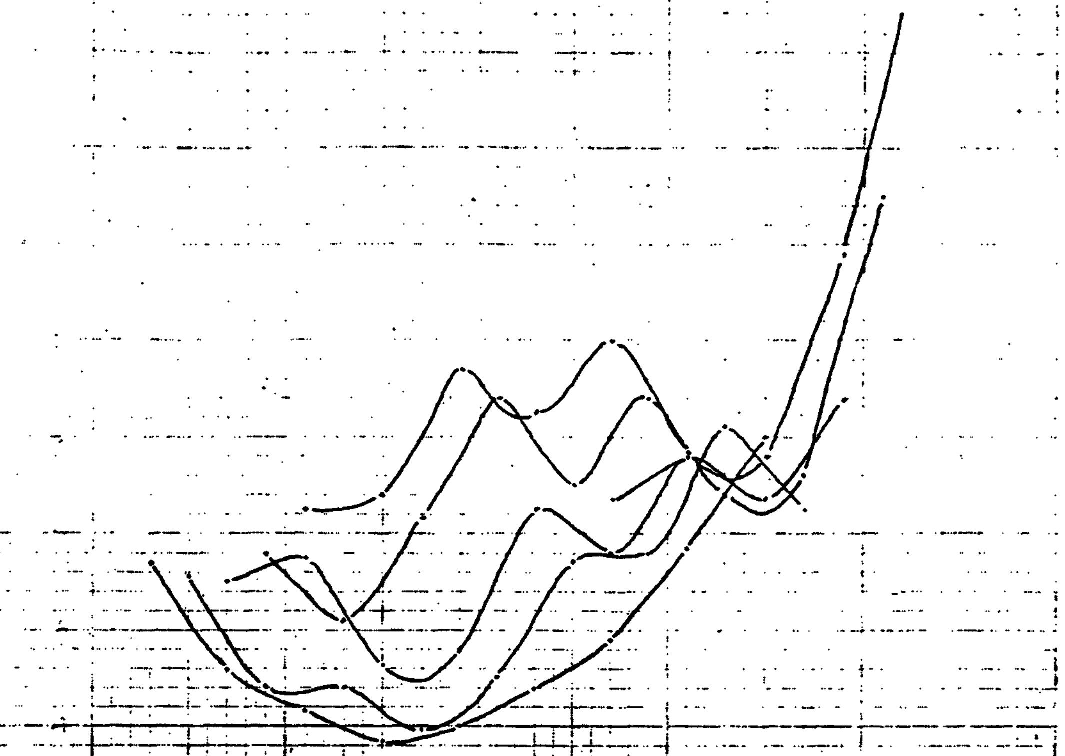


EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT : ABERDEENSHIRE. INDUCED POLARISATION DEPTH PROFILES. LINE D. HARESTONE MOSS AREA.			
Scale	Prepared T.C.	Drawn T. Cumpstey	FIG. No.
OS Sheet No. 91NW.	Revised	Date DEC 1971	

ARDO HOUSE POLE-DIPOLE a = 200' n=1—5 LINE E



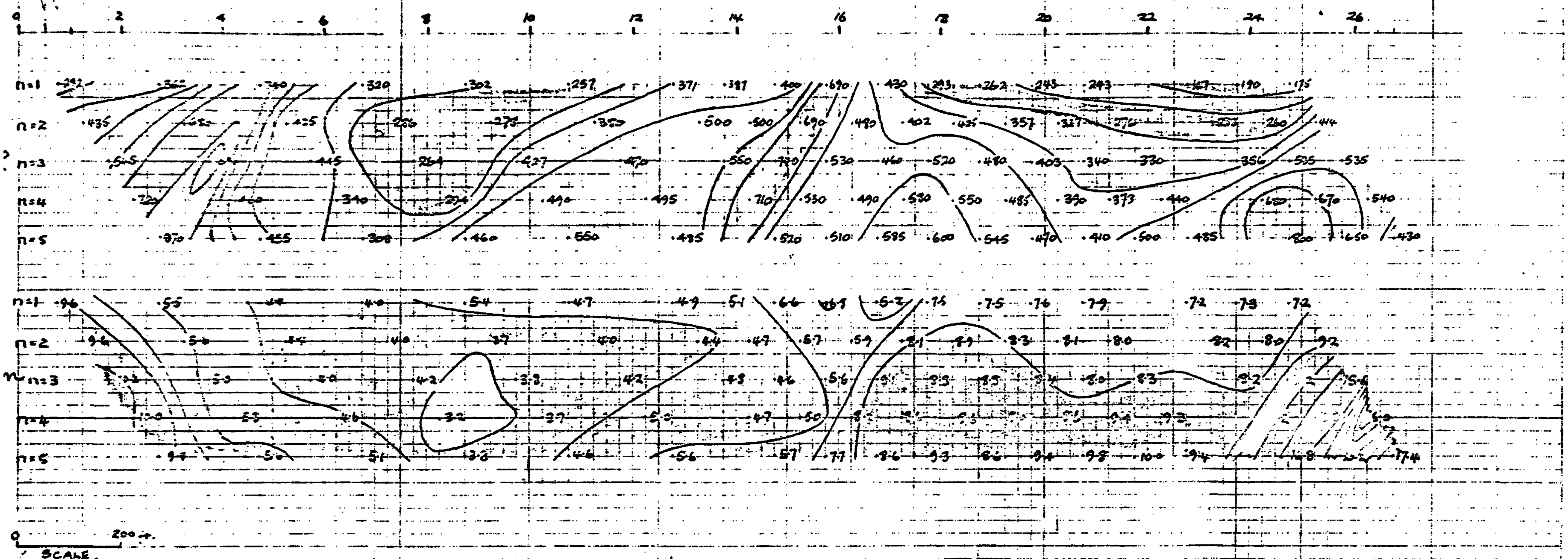


EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT ABERDEENSHIRE.
INDUCED POLARISATION DEPTH PROFILES.
LINE E: ARDO HOUSE AREA.

Scale	Prepared T.C.	Drawn T. COMPSTEY	FIG. No.
O.S. Sheet No. LOCATED ON NJ 92 SW.	Revised	Date DEC 1971	

ARDO HOUSE   POLE-DIPOLE a=10' n=1—5   LINE F



CHARGEABILITY. (MILLISECONDS)   APPARENT RESISTIVITY. (OHM METRES)

MS.	Ωm.
12.5	250
10	300
8.3	370
6.7	460
5.6	550
4.5	670
3.7	820

EXPLORATION VENTURES LTD.

TITLE BELHELVIE DISTRICT: ABERDEENSHIRE.
INDUCED POLARISATION DEPTH PROFILES
LINE F. – ARDO HOUSE AREA.

Scale	Prepared T.C.	Drawn T. Cumpstey	FIG. No.
O.S Sheet No. Located on NJ 92 SW.	Revised	Date Dec. 1971	

EXPLORATION VENTURES LTD

(RIOFINEX)

1972 ACTIVITY REPORT

THE BELHELVIE DISTRICT (DTI Code AE 22)

SUMMARY

Work in this district during 1972 has involved compilation of geological data into reports, geochemical follow-up of stream anomalies south west of Aberdeen, detailed geological investigations and diamond drilling on selected targets.

1. GEOLOGY

A geological report on results of float and outcrop mapping over the Belhelvie complex was compiled along with a report assessing all survey data, and indicating drill targets.

2. GEOCHEMISTRY

Follow-up geochemical stream sampling was undertaken in the Cairn-mon-earn area south-west of Aberdeen to evaluate further streams containing low order molybdenum anomalies. No obvious encouragement was forthcoming and it was concluded that metal was either related to weak sulphide mineralisation or a high trace content in granitic bedrock. (see Figs 11 and 12).

3. GEOPHYSICS

A detailed ground magnetic survey was carried out at Belhelvie Lodge to provide information to assist with siting of exploratory drill holes (see Fig 10). In addition three traverses were surveyed with an expanding electrode array across conductors located by reconnaissance IP.

i. Potterton (Figures 1, 2 and 3). A large anomaly exists on this line centred on Station 9. Both IP and magnetics indicate a broad body and the former tends to suggest depth continuity. The dip, on the basis of magnetics, appears to be to the north (later drilling indicated the presence of dunite and picrite in the area and the response which is indicated to the north of the traverse, Station 23, is related to ultrabasics as well)

ii. Potterton Burn (Figures 4, 5 and 6). This traverse was oriented to intersect the conductor located at the northern end of the traverse discussed in the previous section, at a more optimum angle. A fairly broad conductor was indicated - this was tested by drilling and found to be due to serpentinised dunite.

iii. Muirton (Figures 7, 8 and 9). A broad low order anomaly was located on this traverse. From the IP section and the magnetics it would appear as though 2 bodies are producing the response. Two small shallow bodies are indicated, one at Station 12 and one at Station 16. These results are noticeably lower in amplitude than most anomalies in the area. Initially a drill target was selected in this area, but later this was eliminated on the basis of discouraging geophysical results.

4. DRILLING. During the period 10 exploratory diamond drill holes totalling 5495'6" were drilled in the Belhelvie district to test various targets. Appended is a location plan plus drill sections along with written and graphic logs. No significant sulphide mineralisation was intersected; assay data is included with the logs and sections.

Enclosures

1. A report on results of Belhelvie float/outcrop mapping January 1972 ✓
2. Interim report on the Belhelvie complex March 1972 ✓
3. Detailed magnetic survey results around Belhelvie Lodge (Fig. 10)
4. Detailed 3 electrode expanding array IP surveys (Figs. 1-9) ✓
5. Drill sections, written and graphic logs B 3 to 12 inclusive ✓
6. Results of follow-up geochemical work south-west of Aberdeen. (Figs. 11-12)

Edin Encls 1-6
✓ Geochem .. 1,3,4,5, 6 (Drill Sections sent in separate roll)
Geophysics .. 1, 2, 3, 4
File .. 1 - 6

(NB Fig 3 of encl 2 not sent to Geochemical Div)

Application for contributions under the Mineral Exploration and Investment Grants Act 1972.

Geological Report: Belhelvie AE22

During the period 9th August - 31st December 1971, geological, geochemical and geophysical surveys were undertaken on this project.

(i) <u>Geology</u>

Reconnaissance mapping was carried out over several parts of this district. The location of basic/ultrabasic outcrop and extent of rock float patterns were determined.

(ii) <u>Geochemistry</u>

Soil samples were collected on traverses across the site of an old manganese "mine" at Laverockbraes to determine whether any significant amounts of metal (copper, nickel, lead and zinc), which might relate to base metal mineralisation, were present.

(iii) <u>Geophysics</u>

a) <u>Induced Polarisation</u>

Scintrex time domain IP equipment was employed on a gradient array survey at Potterton House to assess an area of basic igneous rocks. In addition, expanding three electrode array IP surveys were run across conducting zones at Belscampie, Harestone Moss and Ardo to provide data to assist siting of scout drill holes.

b) <u>Magnetics</u>

A detailed magnetometer survey was completed over the southern part of the basic/ultrabasic igneous complex to enhance geological/structural knowledge of this area and aid the mineral potential assessment. A Scintrex MF2 portable magnetometer which measures the vertical force, was used on this work.

<u>Enclosures</u>

1. Geological field sheets. (NJ92SW, NJ91NE, NJ91SW, each with text.)
2. Geochemical copper, nickel, lead and zinc values in soils at Laverockbraes.
3. Induced polarisation results of detailed profiling at Belscampie, Harestone Moss and Ardo.
4. Induced polarisation reconnaissance survey results at Potterton House.
5. Vertical force magnetic field results, south Belhelvie region. (in 9 strips of various lengths)

CONTENTS

LIST OF FIGURES

1. FLOAT DISTRIBUTION

South of Beauty Hill (908205) glacial drift covers most of the ultrabasic western section of the Belhelvie intrusion. The drift consists of a mixture of small to medium sized (a few inches to 3 feet) rounded boulders of gneiss, schist, granite and metasediments together with rare altered ilmenite-rich norite/gabbro boulders of unknown provenance. The eastern boundary of the glacial drift cover runs NNW-SSE as far as Muirton (933 165) where it swings round to an ESE direction.

East of the glacial drift the float pattern is a fairly reliable reflection of the geology of the area as known from outcrops, bore holes and geophysics. On the eastern side of a line running through Auchloon (922 222) - Ardo House (929 211) - Shiels (940 195) - Hill of Keir (950 187) - Cairntack (951 173) - Potterton House (949 160) the interpretation of local float is considerably complicated by the intimate blending of glacial drift and local float. In this eastern area the float consists of schists, gneisses, amphibolites and granite, probably locally derived, mixed with glacial drift of granites and metamorphics together with rounded boulders of basic and ultrabasic rocks originating from the Belhelvie intrusion to the W and SW.

1.1. CENTRAL INTRUSIVE ZONE

The float in this area is largely autochthonous. On sheet NJ 92 SW there is a distinct zonal succession from west to east:- a contact zone of norite/olivine-norite, strongly sheared in most places, is followed by a picrite/serpentinised-picrite horizon; the picrite grades into troctolite; a norite/olivine-norite belt terminates the intrusion to the east. The norite zone contains smaller lenses of picrite 200 m. east of Roadside of Craigie (919 201). A narrow contaminated norite/mixed rock and gabbro zone is in contact with the eastern hornfelsed siliceous schists. The mineralised rocks of Catcraig were derived from this contaminated contact zone.

On sheet NJ 91 NW two NNW-SSE belts of basic/ultrabasic float are separated by a septum of hornfelses, quartzites, siliceous schists and calcareous quartz-schists stretching south as far as Muirton House Farm (937 171). The western serpentinised dunite-troctolite-norite-gabbro belt is a continuation of the same zone on sheet NJ 92 SW. The eastern igneous belt consists of lenses of picrite, troctolite, norite and gabbro. This zone is terminated in the south along the Potterton burn. The southern E-W trending part of the intrusion finds only limited expression in the float due to extensive glacial drift and beach sand cover. There is a large area around Belhelvie village and Rocks of Balmedie Quarry covered by foliated gabbro and rare blocks of mylonitized gabbro (e.g. at 946 1735, rock sample B29).

South of Belhelvie Lodge, along Potterton Burn, an extensive area is covered by mostly sulphide-bearing contaminated basic rocks and partially mobilised siliceous schists. Some light is shed on the strange magnetic signature (cluster of small narrow NW-SE trending highs) of the block between Craigie Wood-Garleybrae Wood (931 179) and Muirton Home Farm (936 171). The area is covered by mixed float consisting of basic, ultrabasic rocks and quartzite with siliceous schists, indicating that the area is underlain by lenses of picrite, troctolite and norite set in a frame of quartzites and siliceous hornfelses.

North of Roadside of Craigie (915 200), and confined to sheet NI 92 SW, several smallish float lenses of granite indicate small granite bodies and/or granite veins intruded into the basic and ultrabasic rocks, probably along tectonically active lines. Uralitization of the troctolites, extensive in places, may be a side effect of the granitic intrusions.

Shearing is indicated by considerable talc formation in the troctolites and shearing of the serpentinite between West Lodge (914 205) and Beauty Hill.

1.2. GEOLOGICAL FRAMEWORK OF THE BELHELVIE INTRUSION

The float pattern indicates that the country rocks east of the intrusion consist of schists and gneisses with numerous amphibolites and amphibole/augite-schist/gneiss lenses. The amphibolites fall into two groups:- magnetic amphibolites with a pronounced schistosity, and non-magnetic amphibolites of dioritic composition and relict igneous textures. The amphibolites are confined to sheets NI 92 SW and 92 SE. Blocks of basic and, to a lesser extent, ultrabasic rocks are scattered throughout this area. The ultrabasics could only have been derived from the main intrusion. (There is no magnetic indication of ultrabasic rocks east of the main intrusion). The wide scatter of basic rocks, often with significant pyrr and cpy. content, may be explained in two ways:- They were derived from gabbroic intrusions that occur east of the main intrusion far more extensively and in far greater numbers than hitherto accepted. Alternatively, they represent transported material carried from the main intrusion. The latter explanation appears more plausible if one takes into account the rounded nature of the basic blocks, bore hole evidence, and geophysical data. The fact that the basic rocks are mixed with conspicuously glacial drift indicates that glacial transport did take place and it is only natural to assume that the ENE glacial movement did carry material with it from the Belhelvie intrusion.

A relatively large granite intrusion exists at Tillery, north-east of the northern termination of the basic intrusion. It is the source for the large abundance of granitic float east of Tillery.

Isolated occurrences of dolerite float with an east-west scatter and confined north of grid line 215, are probably the float features of dolerite dykes with strong magnetic expression.

2. DISTRIBUTION OF SULPHIDE-BEARING FLOAT

Significant sulphide mineralisation in autochthonous float occurs in four areas:-

1) Catcraig (920 205)
2) Ardo (932 205)
3) Howlands (942 190)
4) Potterton (941 169)

2.1. CATCRAIG

Patchy, irregularly disseminated fine grained pyrrhotite occurs in contaminated norites. The sulphide content is variable, it may average 10% with a range of traces to 20%. Pyrrhotite also occurs concentrated along fracture planes. The contaminant is a siliceous hornfels. The mineralised zone is located close to the contact with pyrrhotite and pyrite-bearing siliceous hornfelses and schists. The Ni grade appears to be surprisingly low for the amount of sulphides present, indicating that pentlandite is a rare phase and the pyrrhotite a low nickel variety.

Assay results:-

	% Cu	% Ni
Partially contaminated gabbro with sulphides	0.079	0.014
" " " " "	0.022	0.082
" " " " "	0.026	0.012

Low nickel content of the sulphides appears to be characteristic of certain contaminated norites near the contacts of intrusions (e.g. Harzburg Gabbro). This is also born out by a petrographic investigation of seven sulphide-bearing gabbro specimens from Catcraig (L.P. Holmes, Memorandum, 9.8.1971). Pentlandite was found to be a rare phase in all the samples. The large to medium sized angular blocks occur along the southern edge of Catcraig Wood, a peat bog.

2.2. ARDO

Up to 15% coarse blebby sulphides occur in a contaminated anorthositic gabbro. The Ni content is again relatively low for the amount of sulphides present.

Assay results:-

	% Cu	% Ni
Mineralised gabbro.	0.136	0.158
" contaminated norite	0.110	0.105

Petrographic investigation of an anorthosite revealed approximately 0.3% pentlandite with 5% pyrrhotite and 4% chalcopyrite, (L.P. Holmes, Petrographic Memorandum, 9.8. 1971). The large angular mineralised blocks occur along the northern edge of Harestone Moss, a large peat bog.

2.3. HOWLANDS

5-25% sulphides occur in angular rusty blocks of biotite-schist, hornfels and rarely in contaminated gabbro. In the schists pyrite is the major sulphide phase. It is concentrated along planes of schistosity and occasionally along fractures cutting across the schistosity. The mineralised float occurs in an area immediately NE of the swampy ground along Kepplestone Burn. 300 m. WNW of the Howlands mineralised float area occurs a strong soil Cu anomaly with less intense Ni values in what appears to be water logged clay. The significance of this anomaly should be determined.

2.4. POTTERTON

Sulphides occur in two distinctly different forms. At 9405 1695, along Potterton Burn, streaks of massive sulphides occur in a contaminated norite. Chalcopyrite predominates over pyrrhotite. The latter also occurs as fracture coating. The mineralisation appears to be structurally controlled. Finely disseminated pyrrhotite occurs in siliceous hornfelses and partially remobilised hornfelses within a 400 m. wide zone along Potterton Burn, south of Belhelvie Lodge. The hornfelsed siliceous schists are banded. The sulphides tend to follow this banding: pyrrhotite rich bands alternate with nearly barren zones. It is likely that the pyrrhotite in the contaminated norite and the hornfelses has a low Ni content and pentlandite is probably a rare phase. (There is no petrographic or assay data available for the Potterton area). Similar to Catcraig and Ardo, the mineralised float occurs in a swampy area.

2.5. OTHER OCCURRENCES

There are two other less spectacular occurrences of sulphide mineralisation that may be of some significance. About 100-200 m. E and SE of Braeside of Balnakettle (903 212) 2-5% finely disseminated pyrrhotite and chalcopyrite occur in sheared olivine-norite along the W. contact of the intrusion. If the olivine-norite represents the original magma, then this must have been carrying immiscible sulphide globules which should have settled out of the differentiating silicate liquid and settled at the base of the intrusion. This points to the possible presence of a "stratiform" Cu/Ni sulphide body.

Finally, the pyrite mineralisation in the foliated gabbros of Balmedie Quarry and its neighbourhood may be considered as more than just a curiosity in view of anomalous geophysical (magnetic) and geochemical behaviour in the area. The high magnetic zones at the quarry and at Balmedie Farm do not appear to be due to underlying ultrabasic rocks. Float geology does not indicate the presence of highly magnetic rocks. A pattern of sulphide mineralisation in basic float blocks 300 m. east of Balmedie Farm could be an important indicator. This area deserves further detailed investigation.

2.6. COMMENTS

The four most significant occurrences of sulphide mineralisation are located in or close to swampy, waterlogged ground. Though this may be only a coincidence, one thing is certain: the reliability of soil goechemistry and I.P. in these areas is probably reduced by masking effects. Deep augering or trenching, where possible, might provide important geochemical information.

FINANCIAL ASSISTANCE FOR MINERAL EXPLORATION (M.E.I.G.A.)

COMPANY: EXPLORATION VENTURES LTD

PROJECT: BELHELVIE

REF: AE 22
MRD 84/5/16
MRD 144/5/16

The following Open File material is held by B.G.S. in London, Keyworth and Edinburgh. Available for public inspection from 16.10.80.

- * Extract of draft application 6.8.71 "Geological consideration ..... work programme", with accompanying plan, 1" : 4 miles

- Geological report 9th August to 31st December 1971 with 5 enclosures

  1. Geological field sheets, 6" : 1 mile, NJ91NE, NJ91SW, NJ92SW, each with text

  2. Geochemical Cu, Ni, Pb and Zn values in soil at Laverock Braes. January 1972, 6" : 1 mile. NJ91SW

  3. IP results of detailed profiling at Belscampie, Harestone Moss and Ardo. December 1971

  4. IP reconnaissance survey at Potterton, 6" : 1 mile, October 1971

  5. *Vertical force magnetic field results August/September/ October 1971. 1 : 5,000, NJ91NW + SW, NE + SE (+ negatives) (in 9 strips of various lengths)

- 1972 Activity Report with 6 appendices:

Appendix 1 "A report on results of Belhelvie float/outcrop mapping January 1972", with 3 figures:

Fig 1 - Distribution of float, 6" : 1 mile, 23.3.72

Fig 2 - Location of sulphide bearing float and outcrops 6" : 1 mile, 24.3.72

‡ (Fig 3 - "Outcrop map of Belhelvie")

Appendix 2 "Interim report on the Belhelvie complex" April 1972 with 11 figures

Fig 1 - Interpretive geological map based on float/ outcrop mapping, shallow borehole information and geophysical data. 6" : 1 mile. April 1972 (2 copies)

Fig 1a - Outcrop location map, 6" : 1 mile

Fig 1b - Distribution of float, 6" : 1 mile, 23.3.72

. . . . (continued)

. . . . (continued)

Appendix 6 "Results of follow-up geochemical work ...." consisting of Figs 11 and 12

Fig 11 - Copper, lead and zinc anomalies. Cairn-Mon-Earn. 1" : 1 mile

Fig 12 - Stream molybdenum values, 1" : 1 mile

- * EVL soils research project, summary of results

- Rio Finex letter dated 4th Novembr 1974, enclosing 5 interim reports on the soils research project:

* Report 1 - (presumed to be the unlabelled collection of figures 1 to 17)

Fig 1 - Location of project study areas

Fig 2 - Auchincrieve - line location

Fig 3 a,b,c - Auchincrieve - distribution of basic and ultra basic float

Fig 4 a,b,c - Auchincrieve - Ni geochem.

Fig 5 a,b,c - Auchincrieve - Cu geochem.

Fig 6 a,b,c - Auchincrieve - Soils

Fig 7 - Brodiesord - distribution of pierite and gabbro float

Fig 8 - Brodiesord - Ni geochem.

Fig 9 - Brodiesord - Cu geochem.

Fig 10 - Brodiesord - Soils

Fig 11 - Dunbennan - distribution of basic and ultrabasic float

Fig 12 - Dunbennan - Ni geochem.

Fig 13 - Dunbennan - Cu geochem.

Fig 14 - Dunbennan - Soils

Fig 15 - Brown Hill - Distribution of basic and ultrabasic float

Fig 16 - Brown Hill - Ni geochem.

Fig 17 - Brown Hill - Cu geochem

‡ Fig 18 - Brown Hill - Soils.

. . . . (continued)

* Report 2 - 13.3.70 "Orientation Studies on soils and float from Belhelvie and Arthrath"

* Report 3 - 20.9.70 "Detection of Sulphide Weathering products in soils over ultra basic rocks"

* Report 4 - "Notes on float samples from Aberdeenshire"

* Report 5 - 19.6.71.
1. A computer Geochemical data assessment programme
2. Computer comparison of A vs B horizon sampling
3. Computer assessment of B horizon geochemistry

- * Amax letter dated 25.1.84 detailing drill hole co-ordinates for 77DDB1 to B5 and enclosing 3 maps (1 : 5,000) detailing collar positions
- ‡ Diamond drill core records for BH 77DDB1 to B5
- §‡ Diamond drill core records for DDH B6 to B12
- *‡ Summary core logs 77DDB1 to B5 and 77DDA1
- Fig 7 section through DDH B3
  Fig 8 " " " B4
  Fig 9 " " " B5 & 6
  Fig 10 " " " B7
  Fig 11 " " " B8
  Fig 12 " " " B9
  Fig 13 " " " B10 & 11
  Fig 14 " " " B12

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‡ Not in London * Not in Keyworth § Not in Edinburgh

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A general account of reconnaissance exploration in the Belhelvie district was given in a report dated October 1969. Since that date a large amount of detailed exploration involving geological and geophysical surveys has been undertaken in order to define drilling targets. Various features of the geology are discussed in this report and some drilling targets are outlined.

2. GEOLOGY

(An attempt has been made to compile a geological map of the Belhelvie area, incorporating up-to-date information, (see Figures 1, 1a, 1b). Due to extensive drift cover, positions and nature of rock boundaries are largely interpreted.)

The basic and ultrabasic igneous rocks in the Belhelvie region possibly belong to the southern part of a fairly large, fault-disrupted intrusive complex which may have a lopolithic form. A large part of the body occurs beneath the North Sea, extending up to 6 miles offshore, and the landward section probably represents the 'western limb' of the intrusive. The northern section of the body is not seen and is assumed to have either been folded or faulted out. Nothing is known about the seaward extension. Its presence was first indicated by the IGS aeromagnetic map, (see Figure 2) and the fact that the ground magnetic anomaly is not closed off at the coast supports this (see Figure 3).

The landward section of the intrusive is extensively covered by fluvio/glacial deposits. The best exposed area is at the north end, whilst only scattered, isolated outcrops exist in parts of the central and southern areas. The interpretive geological map is based on float/ outcrop mapping, combined with shallow drill hole information and geophysical data.

Basically two main units, the lower and upper, are present. These have a north to north-north-west strike on the northern section occurring north of a 'structural break' (?hinge zone) which passes through Potterton, whereas to the south and east of the latter, rocks assume an east-west strike direction. It is apparent that the geology of the complex is complicated by post-consolidation deformation, i.e. folding and faulting.

A. Northern Section

The intrusive rocks are flanked to the east, north and west by undifferentiated Dalradian metamorphics which from the few outcrops and float evident appear to consist of a variety of schist, hornfels (locally sulphide-bearing), calc-silicate rocks and gneisses. In outcrops of intrusive rocks, dips of banding, where discernible, are near vertical or steeply inclined to the east. Late stage granite veins of variable width cut all rock types. (The latter have not been included in the geological map).

i) Lower Unit

a) Chilled Horizon. The inferred basal part of the intrusive consists of what is considered to be a chilled border facies up to 800 feet wide, comprising fine to medium grained noritic types with minor lenses of ultrabasic material. This zone is indicated by a belt of weak magnetic anomalies with values ranging mostly from 800 to 1,000 gammas as compared to background values over adjoining metamorphics of 600 to 800 gammas. There is no clear-cut boundary indicated by magnetics between the norite and country rock. Probable outcrops of the norite and moderately abundant float exist at the north end and norite plus pyroxenite has been established in several drill holes put down by Aberdeen University in an attempt to establish the position of the contact. The latter in places is apparently represented by a shear zone. The chilled horizon does not appear to be continuous along the western margin and may be excluded by faulting in the Potterton/Gordieburn area, (vide Figure 1).

b) Ultrabasic Horizon. Immediately east of the aforementioned zone and probably transitional with it is a predominantly ultrabasic horizon up to 2,000 feet wide and 4½ miles long. This consists of a transitional sequence of cumulates comprising dunites, picrites, peridotites and troctolites which are serpentinised and locally hematised. Minor sections of noritic and gabbroic types appear to be locally present. The sequence gives rise to a pronounced belt of magnetic highs ranging from 1,000 to 5,000 gammas (vide Figure 3). At the southern end in the vicinity of Gordieburn, the belt is 1,000 feet across and the narrowing may be accounted for by a major fault which excludes the contact horizon plus 1,000 feet of ultrabasics and brings the latter unit into juxtaposition with metamorphics.

c) Troctolite Horizon. This occurs east of, but is transitional with, the upper part of the previous horizon. It probably attains a maximum width of 1,000 feet in the north, but may grade southwards into noritic and gabbroic types. The position of the upper boundary is indistinct. Magnetic values over the troctolite range from background (< 800 gammas) up to 2,000 gammas, the higher readings coinciding with olivine rich sections. A narrow (up to 200 feet wide) linear ultrabasic horizon is developed within the troctolite sequence which parallels the main ultrabasic unit. Gabbros and norites are locally developed within the troctolite horizon which is probably transitional with the adjacent, essentially basic sequence.

d) Norite and Gabbro Horizon. Norites and gabbros along with minor developments of ultrabasics plus troctolite exist in a zone ranging from 1,000 feet wide in the north to 2,000-3,000 feet wide in the southern part of the northern section. Locally contaminated (hybridised) basic rocks are present, e.g. the Catcraig area. The magnetic picture is complicated. In places background values coincide with outcrops of basic rocks, and the magnetic signature over these is identical to that over the adjoining country rock septum. Highest values, i.e up to 2,000 gammas, occur where serpentinised olivine-rich rocks are present. Generally the latter form smallish, lenticular bands which give rise to a 'streaky bacon' type of magnetic anomaly pattern, (vide Figure 3).

The upper boundary of this horizon is formed against metamorphics in the north and ultrabasics in the south, (vide Figure 1). The precise nature of this is uncertain, but could well be a fault which could account for the straight contact and steep magnetic gradient across it.

ii) Upper Unit

a) Ultrabasic Horizon. This is virtually composed of the same rocks as the lower ultrabasic horizon but has a more irregular form, possibly complicated by faulting and is thinner, being up to 1,800 feet across in the south and ranging from 200 to 800 feet across in the north. It roughly parallels the lower unit, but does not extend as far north, possibly due to fault termination. Magnetic values range from 1,000 up to 3,000 gammas.

b) Basic Horizon. The ultrabasic sequence appears locally to grade upwards into troctolite but there does not seem to be a well-defined horizon as per the lower unit. Gabbros and norites plus troctolites are present within this unit which gives rise to a variable magnetic picture. Values range from background (600 to 800 gammas) up to local highs of 2,000 gammas. The fact that the gabbros have a similar magnetic signature to the adjoining country rocks makes plotting of the contact somewhat difficult. The sequence varies in width from 800 feet to 2,000 feet in the north and is up to 3,000 feet across in the south.

Mineralised, contaminated basic float, probably related to local sources, has been discovered in the Ardo and Potterton areas. In the vicinity of Belhelvie village the gabbros are deformed and show a foliation and local boudinage. Inclusions of country rock in the gabbro are revealed in the roadstone quarry.

B. Southern Section

Only a few outcrops of serpentinised dunite exist in this section of the intrusion which occurs south and east of the Potterton 'hinge zone.' The geology of this area is based almost entirely on an interpretation of the magnetics. There is a marked change of strike direction of rock units in this section compared to the northern one, and it would appear as though faulted, re-orientated counterparts of both units described in the northern section are present, though there are differences. The lower basic contact part of the intrusive has an apparent wider sub-outcrop area either due to thickening of the horizon or the latter assuming a shallower dip. Within this sequence there appear to be a number of ultrabasic 'lenses' and the overall magnetic picture is similar to the 'streaky bacon' pattern developed on the lower gabbro sequence north of Potterton.

What is possibly the equivalent of the lower ultrabasic unit of the northern section is represented by a considerably greater apparent sub-outcrop extent of ultrabasic material which again either indicates a thicker sequence or a decrease in the angle of dip. The horizon as it passes eastwards appears to split into two separate zones which may be separated by basic rocks. The lower section is up to 800 feet across and the upper part increases in width eastwards to more than 4,000 feet across. Unfortunately the magnetic pattern could not be mapped out completely due to the Ministry of Defence firing range on the coast. This ultrabasic horizon is probably bounded to the north by basic rocks (norites, gabbros and troctolites) which in part account for the lower magnetic values. The zone of basics is assumed to separate the two lower ultrabasic horizons from two upper horizons. The lowermost of the latter has no apparent counterpart in the northern sections and is possibly totally surrounded by basic material. The northernmost ultrabasic horizon attains a fairly uniform width (circa 1,000 feet). Basic rocks probably exist above this horizon but it is virtually impossible to determine the position and nature of the metamorphic/intrusive contact. It is possible that an 'embayment' of schists is present, thereby separating gabbros on the northern section from the southern, but since basics in this region have a similar magnetic signature to metamorphics this interpretation may be incorrect and basics from both sections may juxtapose to a greater extent than indicated by Figure 1.

Virtually coincident with the Ellon/Aberdeen main road there appears to be an abrupt termination of several magnetic highs which have values up to +2,000 gammas. To the east of the road the magnetic anomaly continues towards the coast with a fairly uniform gradient and values in the 1,200 to 1,500 gamma range - there are no obvious linear magnetic highs comparable to these west of the road. The University of Aberdeen has some evidence to suggest that younger sediments (ORS based on shallow drill hole and seismic velocity tests) may overlie this coastal section of the intrusion which along with thickish drift may partially suppress the magnetic anomaly.

3. STRUCTURE

As previously discussed the basic/ultrabasic rocks are believed to belong to a folded, fault-disrupted lopolith. The highly inclined nature of the cumulates testify to probable folding, and major faulting is interpreted from the magnetics. Evidence for faulting is seen in certain exposures and is indicated in shallow boreholes.

The landward section of the intrusive's lower unit terminates abruptly at the northern end against a major east-west magnetic lineament. The eastern or upper unit likewise is possibly terminated by a fault and a NNE striking lineament has been interpreted from the magnetics. A fairly large NNE bearing dextral tear fault passes through the Kingseat area which displaces rocks of the lower unit by +1,000 feet. Similarly oriented faults are believed to affect other parts of the complex, causing discontinuities on various lithological units (vide Fig. 1). Minor zones of movement with variable orientatation may affect other units in the complex, so explaining certain magnetic irregularities.

A major zone of disturbance passing through the Potterton/Belhelvie region is inferred. This separates the north and south sections of the complex which have a totally different strike. It is difficult to be certain as to the nature or position of the structure(s?), but one major fault with subsidiary trailing faults has been interpreted (vide Figure 1)

A north-south zone of disturbance can be noted in the Belhelvie quarry region, producing boudinage in the gabbros which are recrystallined and show foliation. It is conceivable that north-south strike faults may affect other parts of the complex which in places may be indicated by abnormally straight contacts and steep magnetic gradients.

A major fault has been inserted along the lower contact at Gordieburn which accounts for the apparent thinning of the lower ultrabasic unit and loss of the contact horizon. It is shown as extending to the SE to form the lower contact of the southern section of the complex. This may be entirely incorrect in that it could equally run due south so making the previously mentioned contact normal, or swing south-east and develop into a strike fault affecting units in the southern section of the complex.

4. MINERALISATION

Weak sulphide mineralisation has been encountered in float, outcrop and cores of ultrabasic rocks, consisting of finely disseminated pyrrhotite, chalcopyrite and pentlandite along with mackinawite and valeriite. Occasionally sulphides occur as a filling to hairline microfractures.

In the Catcraig, Ardo and Potterton areas, mineralised contaminated basic float has been discovered. In the first two areas disseminated (sometimes blebby) pyrrhotite and minor chalcopyrite are present, whilst at Potterton apart from disseminated sulphides, fracture infill pyrrhotite and chalcopyrite occur. In the gabbros of Belhelvie quarry coatings of pyrrhotite and pyrite occur on joints and in microfractures and more rarely patches and disseminations of pyrrhotite and chalcopyrite have been discovered in some blocks. The distribution of mineralised float is shown on Figure 1c.

5. GEOCHEMISTRY

The main anomalous centre (Cu and Ni) is confined to the northern part of the complex where the lower ultrabasic unit is exposed or has a thin drift covering. Anomalies are also developed at other localities on ultrabasics where similar outcrop/thin drift conditions prevail. All the main anomalous centres are virtually surrounded by low order anomalous metal values in soils which blanket a belt of country encompassing a large part of the northern section of the intrusive. Within this area it is difficult to determine the full significance of individual patterns but quite obviously a lot of the metal relates to the high trace content in ultrabasics. Where extensive and complete cover of drift is present over the complex no anomaly is present.

6. INDUCED POLARISATION

Chargeability highs coincide with most of the ultrabasic zones, (vide Figure 4), and are considered to be related to one or a combination of the following:- finely disseminated magnetite, sulphides, serpentinite, or other alteration products (?sericite). Other than anomalies that appear to be due to the ultrabasics or to man-made conductors, no obviously significant response that might be attributable solely to sulphides have been recognised. Unfortunately the geochemical picture does little to assist target selection.

In the southern section of the intrusive, where IP responses were not obtained from some of the ultrabasic units (compare Figures 1 and 8) especially near the coast, readings were probably related to drift and not bedrock.

7. TARGETS

i) Ultrabasics

The ultrabasic horizons have been identified as possible low grade sulphide nickel sources which may have potential. This follows the discovery of weak sulphide dissemination in holes B1 and B2 drilled respectively on parts of the western and eastern ultrabasic horizons of the northern section of the intrusive. In Canada, Dumont is testing a dunite unit within which apparent zonal concentration of nickel (values ranging from 0.1% to 1%) has been recognised both in sulphide form and as a nickel/iron alloy - awaruite. It is considered possible that somewhere within the number of ultrabasic units present in the Belhelvie complex some similar zonal enrichment of nickel in sulphide form might exist which would provide a low grade, large tonnage target. In addition to sulphides the possible presence of platinum group metals cannot be ignored and certainly the complex contains rock types which are very similar to platiniferous sequences in other parts of the world, e.g. Bushveld and Stillwater.

ii) Geological and Contact Zones

Parts of the basal contact may be favourable for sulphide concentration, but very little is known about this part of the intrusion. No obvious geophysical target (IP or EM) has been located in this setting, but it is conceivable that mineralisation could exist in this geologically favourable environment without surface expression.

Quite apart from the lower contact, the possibility exists that contacts elsewhere in the intrusive may have potential and the mineralised float at Catcraig and Ardo may testify to this.

iii) Structural Settings

Some of the most interesting mineralised float has been discovered in the Potterton area within what appears to be an area with structural complexity. It is possible that the sulphides may show some concentration within rocks of this area due to remobilisation as evidenced by samples showing fracture infill sulphides.

8. CONCLUSIONS

There are indications that economic mineralisation might exist in the Belhelvie area. Suggested targets for exploratory drilling are:-

i) The ultrabasic horizons.

ii) Structural environments in the Potterton area.

iii) The basal contact zone.

Sites have already been selected to test some of these settings, (vide Figures 5a, b and c). Additional sites are due to be selected on ultrabasic units in the southern section of the intrusive.

REPORT NO. 2
13.3.70

Soils research project

Orientation studies on soils and float from Belhelvie and Arthrath.

Summary.

This report outlines the results of orientation lab. studies on soil and float samples, with the object of establishing how best to follow-up the fieldwork in these areas.

In the few profiles examined in detail, the light minerals (presumably serpentine minerals) account almost exclusively for anomalous soil Ni contents, the heavy minerals contributing very little either from the grains themselves or from secondary products. This even applies to the poorly drained soil examined.

As well as occurring in light minerals, metals are also present in soils attached to organic matter and probably clay minerals as well.

Organic matter retention may produce greater contrasts in surface than in subsurface samples.

The best way of following up the fieldwork seems to be to concentrate on chemical analyses of heavy mineral separates, with additional particle size, light mineral and float analyses where necessary.

c.c.

M. Smith,
B. Skelton (2)
R.Rice

PCDC
13.iii.70.

Soils research project.

Orientation studies on soils and float from Belhelvie and Arthrath.

Introduction and objectives.

The previous report (9.ii.70) concluded that geochemical anomalies in the two areas were superjacent or due to glacial and/or hydromorphic dispersion.

The purpose of the orientation lab. studies was to establish how best to confirm these conclusions, bearing in mind that over 800 B horizon samples were collected duing the field investigations.

They were also intended to show how sampling etc. during future fieldwork might be improved.

The detailed objectives were to investigate the relationship between soil geochemical values and the following:

i) particle size distribution

ii) heavy minerals

iii) float metal contents

iv) organic matter content and sampling depth

v) presence of indurated (permafrost) horizons.

Methods.

Channel samples were collected every 6" (approx.) down soil pit or exposure faces, where possible from mineralized and unmineralized representatives of each type. The general features of the soils are as follows:

Belhelvie

Type	Mineralized	Unmineralized
Brown Earth	D4/E4 (907219)	L4 (907196)
Peaty gley	G6½ (912212)	O5½ (910187)
Mottled gley	-	N5½ (910191)
Brown Earth on red clay	1000 ft. S. of T26 (948167)	Quarry (944162)
	1150 ft. S. of T26 (948164)	

Arthrath

Brown earth	P4/P5 (968373)	
Podsol	-	S2 (975377)
Gley	U4 (982374)	

A brief outline of laboratory methods is given in the appendix.

Results.

i). Particle size analysis.

The results are shown in Tab. 1.

Only the clay fractions in anomalous gley soils correlate with soil metal content, suggesting that metal retention in these soils is related to the availability of adsorption sites.

Comparison of -80 with -270 mesh metal contents shows a close relationship (Fig. 1). Small differences are almost entirely within the range of analytical variation.

ii). Heavy mineral analysis.

In some anomalous soils there is a positive correlation between %HM and -80 geochem. (Arthrath P4/P5, Belhelvie T26 + 1150 - see Tab. 2).

In others, the correlation is a negative one (Arth. U4, BH D4/E4, G6½)

In BH T26 + 1000 and in all background profiles, there is no apparent correlation.

These varying relationships are probably due to different amounts of heavy minerals contributed to each sample by the parent material and formed during mineral weathering.

In most anomalous soils, however, there is a positive correlation between Ni content and opaque:clear heavy mineral ratios, the only exception being the red clay soil, BH T26 + 1150.

The correlation is less consistent in poorly drained soils, and cannot be detected in background profiles.

No absolute correlations are possible between %HM or opaque:clear ratio values and soil geochem. - each profile is a special case.

Chenical analysis of the heavy minerals clearly eztablishes that the minerals themselves are only contributing a minute proportion of the total metal in the fine sand fraction (Tab. 3.). Most of the opaques are magnetic, mainly magnetite probably with some iron-rich ilmenite. The nickel in the heavy minerals follows the mag:nonmag ratio (Tab. 3) and this is confirmed by chemical analysis of magnetic and non-magnetic fractions.

The conclusion to be drawn is that only about 1% of the fine sand Ni derives from opaque minerals.

Either the fine sand Ni is held in the light minerals (as unweathered serpentine mineral grains) or is present as coatings on grains. It is clearly associated with the fine sand fraction (Tab. 3).

Chemical analysis of the fine sand fraction shows that even after cleaning the grains with HCl to remove iron coatings, large amounts of Ni are still present (Tab. 4). The amount lost duing cleaning ranges from 30-50% in the light minerals, with rather smaller losses from the heavies.

HCl attacks serpentine minerals (Milner, 1962 p.46 (Vol II)) so the losses on solution may reasonably attributed to this.

In an attempt to get conclusive evidence for or against this idea, the distribution of Ni in the untreated heavy mineral fraction was investigated,(Tab. 5), on the grounds that the heavy mineral grains should be more resistant to dilute acid attack than the serpentine in the light fraction.

Unfortunately the light minerals relased from the untreated heavies after removal of iron contain considerable amounts of Ni. The loss of Ni from the untreated heavy minerals during treatemnt may be due to entrained light minerals. This suggestion is supported by the absence of correlation between Ni loss during treatment and Ni content of the clean heavy mineral grains.

The evidence is therefore inconclusive, but on balance it does not seem likely that in the samples investiggted much Ni is present in iron coatings. The majority is almost certainly present in the light mineral grains.

So in looking for evidence of sulphide mineralization it might be wise to concentrate on heavy mineral Ni content, and indications of Ni in oxide coatings.

iii) Float metal contents.

The Ni and Cu contents of a few float blocks of each rock type were determined to get some idea of the range of variation. The information is summarised in the table below.

Rock	Cu		Ni	
	Mean	Range	Mean	Range
Dunite (10)	297	80-650	1435	480-2300
Troctolite(2)	110	40-220	365	200-530
Augitic norite(=gabbro)	68	10-240	74	20-1070
Norite (3)	20	10-30	20	10-30
Schist,gneiss(14)	52	10-120	65	20-330

Generally Ni is higher than Cu, but in some schist,gneiss and augitic norite samples from Arthrath the Cu content is significantly higher than Ni.

Float with anomalous metal contents seems to be associated with most soil geochem. anomalies, and further float analyses seem justified.

iv). Organic matter content and sampling depth.

In most anaomalous profiles at Belhelvie, surface horizons with high organic matter content contain more metal than the underlying B horizons. It is not clear why the Arthrath soils differ in this respect. In background soils the values in the 0-6" sample are generally lower than those of the horizons below. (Tab. 1).

A horizons (0-6" samples) may therefore give contrasts 2-5 times greater than lower-A (6-12") or B horizon samples.

Only B horizon samples were collected during routine pitting last autumn, but future fieldwork will include surface sampling also.

Soil metal contents are considerably reduced by even a thin covering of barren material over anomalous rock. This is well shown in the Belhelvie profile D4/E4, where 18" of gneissic till almost completely masks the high metal values in the dunite below.

v). Presence of indurated (permafrost)horizons

Ni, but not apparently Cu, increases slightly in indurated horizons (x2 - see Tabl 1).

These horizons are confined almost entirely to soils formed in drift dominated by schists and gneisses with background geochem. values.

Their influence on geochemical interpretation is therefore negligible.

Conclusions.

i). In the anomalous soils studied in detail, almost all the Ni seems attributable to serpentine minerals. There is no evidence of any significant accumulations in secondary oxides.

ii) The correlation between geochem., heavy mineral content and heavy mineral opaque:clear ratios seems to be via magnetite accompanying serpentinization.

iii) There is evidence of metal retention by organic matter and, particularly in gley soils, by clay minerals.

iv) The organic matter retention affect may be great enough to give greater contrasts from surface than from subsurface samples.

v) Laboratory analysis of the grid soil samples from Belhelvie and Arthrath should concentrate on the metal contents of the heavy mineral fraction from the fine sand, with supporting particle size, float and light mineral analyses as required.

PCDC .
13.iii.70.

Tab. 1. Particle size data.

Horizon	Depth	-80 Ni (ppm)	-80 Cu (ppm)	% organic-free material: Coarse sand (2000-200 μ)	Fine sand (200-50 μ)	Coarse silt (50-20 μ)	Fine silt (20-2 μ)	Clay (-2 μ)	organic matter (% total soil)
Arthrath: Brown earth at P4/P5 (968373)									
Ap	0-6"	90	320	25	31.5	11.5	24.5	10.5	46
"	6-12	320	580	25	27	14	21	8.5	36
B	12-18	470	1020	27	38.5	15	17	5.5	-
"	18-24	740	1120	25.5	44	12	13.5	4.5	1.5
"	24-30	550	900	28	50	13	8	4	-
Arthrath: Gley at U4 (982374)									
Ap	0-6"	140	78	33	6	15.5	16.5	29	3
"	6-12	150	50	23.5	29	20	17.5	9.5	4.5
Bg	12-18	220	54	26.5	29.5	17.5	15.5	10.5	2
"	18-24	280	62	31	27	16	5	20.5	4
G	24-30	210	74	28	28	20.5	17	5.5	1
"	30-36	450	154	36.5	23	16.5	11.5	11.5	2
Arthrath: Podsol at S2 (975377)									
AO/A1	0-6"	15	12	33	12	5.5	11	38.5	27
A2	6-12"	-10	6	31.5	20	10.5	19.5	18	1.5
Bfe	12-18	10	18	37.5	26	14	16	9	-
"	18-24	20	16	53	18	9	11	8.5	-
Belhelvie: Brown earth at D4/E4 (907219)									
Ap	0-6"	280	82	41	18.5	6.5	33	1	12.5
"	6-12	210	104	45	26.5	8	20	0.5	7
B	12-18	310	80	56	24	6.5	11.5	2	5
"	18-24	1200	420	76.5	8.5	4.5	5	5	7.5
BC	24-30	1800	680	48.5	24.5	7.5	13	6.5	6
"	30-36	2100	680	72	7.5	5	8.5	6	5
Belhelvie: Brown earth at L4 (907196)									
Ao/A1	0-6"	10	13	18.5	20.5	5	23.5	32	60.5
B	6-12	35	14	41	20	7	16	16	9
+	12-18	40	20	42	26	8	14	9.5	2
permafrost	18-24	15	12	42	23.5	8	14	14.5	-
BC	24-30	45	30	41.5	28.5	6	11	13.5	-
"	30-36	60	36	43.5	25	9	13.5	16	-
Belhelvie: Peaty gley at G6½ (912212)									
Ao/A1	0-6"	290	190	12.5	9	8.5	43.5	26	69.5
"	6-12	270	194	8	7	17	42	27	72.5
"	12-18	180	68	12.5	19.5	12	40.5	14	18
G	18-24	150	42	21.5	22.5	14	30.5	11	3
"	24-30	220	47	18	28.5	12	25	16	1
"	30-36	190	44	28.5	31.5	15.5	17	11.5	-

Tab. 1 (cont)

Belhelvie: Peaty gley at O5½ (910187)

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Ao	0-6"	10	13	---	Peat	---			
G	6-12	60	20	30	22	9.5	19	19	12
"	12-18	40	20	46	24.5	7	13	9.5	8.5
"	18-24	50	40	40	24.5	7	12.5	16.5	5.5

Belhelvie: Gley at N5½ (910191)

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Ap	0-6"	30	17	31.5	23.5	12.5	17	15	7
"	6-12"	40	21	35	22	15	17.5	10.5	9.5
Bg	12-18	50	23	15	39	9	17.5	9	7
+	18-24	50	29	27.5	23	13	19	16.5	2.5
p'frost	24-30	50	34	35	22	13	16.5	13.5	4.5
"	30-36	35	28	47.5	20.5	8.5	10.5	11	-
less	36-42	40	30	40	21.5	5.5	14.5	18.5	4.2
compact	42-48	30	36	45.5	19	7.5	22	6	5.3
"	48-54	10	26	48	17.5	14	10.5	11.5	-
"	54-60	30	34	42	21.5	6	14	16	4

Belhelvie: Brown earth on red clay 1150 ft. s. of T26 (948164)

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Al	0-6"	210	46	37.5	32.5	4.5	13	12	5.5
"	6-12	260	62	28.5	28.5	7.5	20	15.5	4.5
B	12-18	290	54	6.5	22.5	17.5	31	23.5	1
"	18-24	720	192	40.5	20.5	9.5	18.5	11	-
"	24-30	420	96	54.5	24	6	8.5	6.5	2
"	30-36	1700	270	90.5	1.5	4	5	0.1	-

Belhelvie: Brown earth on red clay. Top of Quarry at 944162

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Al	0-6"	15	17	20	4	17	29.5	29.5	26
B	6-12	50	26	1	15	2.5	30.5	55	-
"	12-18	40	16	1.5	42.5	16	19.5	21	2
"	18-24	60	20	-	3	5.5	27	64.5	4
BC	24-30	25	7	11.5	72	4	4.5	8	1.5
"	30-36	20	5	32.5	57	1	2	6.5	2.5

Belhelvie: Trench section at 1000 ft. S. of T26 (948167)

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Head	0-30"	220	42	83.5	10	1	5	1	3.6
Head	30-42"	140	52	52.5	19.5	8	10.5	9	-
Sand	42-60"	110	38	36.5	42.5	8.5	6	7	3.6
Sand	60-72"	220	44	92	2.5	4.5	0.2	0.5	1

Belhelvie: Exposure in red clay overlying gravels, side of quarry at 944162

Horizon	Depth	-80Ni	-80 Cu	Coarse sand	Fine sand	Coarse silt	Fine silt	Clay	Organic matter
Clay	0-36"	70	18	2	20.5	33	28.5	18.5	-
Sand	36-48"	80	21	94	0.5	2.5	3	11.5	-
Clay	48-54"	70	22	25	34.5	9.5	17.5	13.5	3
Gravel	54-78"	180	80	85	5	3.5	2.5	4	2.5

Tab. 2. Heavy mineral data.

Depth	-80 Ni (ppm)	-80 Cu (ppm)	Heavy minerals (% -80 fraction)	Heavy minerals opaque:clear ratio
Arthrath: Brown earth at P4/P5				
0-6"	90	320	.59	.47
6-12	320	580	.43	.58
12-18	470	1020	1.47	.88
18-24	740	1120	2.6	2.13
24-30	550	900	2.0	.92
Arthrath: Gley at U4				
0-6"	140	78	2.7	.11
6-12	150	50	1.2	.12
12-18	220	54	.7	.19
18-24	280	62	.7	.18
24-30	210	74	.3	.48
30-36	450	154	.4	.42
Arthrath: Podsol at S2				
0-6"	15	12	.10	.57
6-12"	-10	6	.19	.58
12-18	10	18	.10	.70
18-24	20	16	.08	1.35
Belhelvie: Brown earth at D4/E4				
0-6"	280	82	1.1	.16
6-12	210	104	1.5	.14
12-18	310	80	1.0	.16
18-24	1200	420	.6	.30
24-30	1700	680	.8	1.0
30-36	2100	680	.3	1.0
Belhelvie: Brown earth at L4				
0-6"	10	13	.28	1.24
6-12	35	14	.48	.47
12-18	40	20	.60	.80
18-24	15	12	.60	.33
24-30	45	30	.75	.20
30-36	60	36	.25	1.30
Belhelvie: Peaty glay at G6½				
0-6"	290	190	.50	.16
6-12	270	194	.39	.18
12-18	180	68	1.3	.08
18-24	150	42	1.6	.10
24-30	220	47	.60	.17
30-36	190	44	.70	.33

Tab. 2 (cont.)

Depth	-80 Ni	-80 Cu	Heavy minerals (% -80 fraction)	Heavy minerals opaque:clear ratio
Belhelvie: Peaty gley at O5½				
0-6"	10	13	ND	ND
6-12	60	20	.34	.82
12-18	40	20	1.95	.32
18-24	50	40	1.14	.43
Belhelvie: Gley at N5½				
0-6"	30	17	.02	1.20
6-12	40	21	.05	.39
12-18	50	23	.002	.17
18-24	50	29	.42	.38
24-30	50	34	.40	.56
30-36	35	28	1.4	.45
36-42	40	30	.52	.93
42-48	30	36	.35	.23
48-54	10	26	.10	.17
54-60	30	34	.08	.27
Belhelvie: Brown earth on red clay 1150 ft. S. of T26				
0- 6"	210	46	.37	1.0
6-12	260	62	.30	1.5
12-18	290	54	.08	1.2
18-24	720	192	.89	1.4
24-30	420	96	2.3	1.2
30-36	1700	270	.80	.96
Belhelvie: Brown earth on red clay. Top of quarry at 944162				
0-6"	15	17	.08	.44
6-12	50	26	.17	.37
12-18	40	16	.016	.44
18-24	60	20	.004	.24
24-30	25	7	.10	.95
30-36	20	5	.19	1.32
Belhelvie: Trench section 1000 ft. S. of T26 (948167)				
Head, 30"	220	42	4.4	.87
Head, 12"	140	52	4.5	.30
Sand, 18"	110	38	2.3	.27
Sand 12" lens	220	44	1.7	.82
Belhelvie: Exposure in red clay overlying gravels, side of quarry at 944162				
Clay, 36"	70	18	.05	.98
Sand, 12"	80	21	.65	.56
Clay, 6"	70	22	1.52	.50
Gravel, 24"	180	80	1.20	.10

Tab. 3. Distribution of Ni within the -80+270 mesh fraction.

All results as ppm -80 mesh fraction

Depth	Ni -80* (ppm)	Ni -270* (ppm)	Ni -80+270* (ppm)	Ni -80+270** light mins.	Ni-80+270** heavy mins.	mag:nonmag mins
Arthrath: Brown earth at P4/P5						
6-12"	320	193	127	125	1	ND
12-18	470	181	289	276	4.5	1.1
18-24	740	254	486	327	7.5	3.0
24-30	550	208	342	285	6	1.3
Arthrath: Gley at U4						
6-12"	150	73	77	54	2	ND
12-18	220	137	83	77	1.5	ND
18-24	280	152	128	119	2.5	ND
24-30	210	123	87	129	3	ND
30-36	450	257	193	194	6	ND
Belhelvie: Brown earth at D4/E4						
6-12"	210	160	50	77	5	.22
12-18	310	138	172	197	6.5	.28
18-24	1200	629	570	467	14	.40
24-30	1800	997	802	825	12	.67
30-36	2100	1401	699	562	9	.41

*Based on Riofinex analyses

**Own analyses of untreated separates

Tab. 4. Comparison of Ni contents of light and heavy mineral separates before and after HCl treatment.

Depth	Light minerals (ppm)		Heavy minerals (ppm)	
	Untreated	Treated	Untreated	Treated
Arthrath: Brown earth at P4/P5				
0-6"	220	112	75	51
6-12	350	212	170	135
12-18	560	400	320	250
18-24	570	400	285	270
24-30	440	207	300	205
Belhelvie: Brown earth at D4/E4				
6-12"	160	70	80	45
12-18	360	198	140	105
18-24	1260	700	375	270
24-30	1740	1200	625	340
30-36	ND	2000	730	373

Tab. 5. Effect of HCl treatment of heavy mineral separates.

Depth	Ni in untreated fraction (ppm)	Ni in treated HM fraction (ppm)	Ni in light mins. released on treatment (ppm)	Ni loss during treatment (ppm)
Belhelvie: Brown earth at D4/E4				
6-12"	80	34	3.5	42.5
12-18	140	79	28	37
18-24	375	235	80	60
24-30	625	276	26	323
30-36	730	227	164	339
Arthrath: Brown earth at P4/P5				
6-12"	170	93	35	42
12-18"	320	168	89	63
18-24	285	198	42	45
24-30	300	187	55	112

Appendix.

Analytical procedures.

1. Particle size analysis.

Particle size determinations were made on the -2mm fractions of the soils using a combination of sieve and sedimentation methods. Organic matter was removed by H_2O_2 treatment. The samples were dispersed by ultasonics in the presence of Calgon.

2. Heavy mineral analysis.

Heavy minerals were separated from the -80 +270 mesh fraction (180-50 μ) in bromoform after removal of oxide coatings with 0.2N HCl.

3. Soil geochemical analysis.

Ni and Cu content of -80 and -270 mesh fractions was determined by AA by Riofinex after digestion in 5N HNO_3.

Ni and Cu contents of the -80 +270 mesh fractions was determined from the Riofinex data using the fraction ratios obtained by particle size analysis.

4. Float geochemical analysis.

Ni and Cu contents of float specimens ground to -80 mesh were determined by AA at Bedford College. Digestion in 5N HNO_3.

Soils research project

Detection of sulphide weathering products in soils over ultrabasic rocks.

Summary.

This report describes an attempt to detect sulphide weathering products in soils against a background of weathering silicates.

Samples were investigated from Auchincrieve, Arthrath and Belhelvie. The object was to correlate Ni and Cu held in hydrous oxide coatings (the most likely sulphide weathering product) of the fine sand fraction with available information on bedrock and/or float mineralization.

Drill information from Auchincrieve and Arthrath correlates reasonably well with Ni and Cu in hydrous oxide coatings. At Arthrath, slightly anomalous sulphides in the dolerite dyke are also picked out.

At Belhelvie, there is a good correlation between high coating-Ni,Cu values and anomalous sulphides in float, particularly when incomplete removal of silicate clays from the coatings is taken into account.

In all areas, low metal values in the coatings of gley and mottled gley soils may reflect conditions in the soils more than mineralization in bedrock and float. Negative data from the coatings of such soils therefore does not necessarily exclude the possible presence of sulphides.

Another general problem is the analytical reproducability, which at present limits fairly reliable coating-metal estimation to fine sand containing +100 ppm Ni and +50 ppm Cu.

The general conclusion from these studies is that the approach has considerable potential, particularly in areas with much ultrabasic outcrop or float, in that it indicates where significant mineralization is likely to occur if present at all. This is the case at Belhelvie.

In Arthrath-like situations it may also be useful, but only if the detection limits can be reduced.

A more specific conclusion is that promising mineralization may be present slightly north of the Belhelvie Quarry.

Further work will concentrate on confirming these findings in other areas, and on tackling the analytical problems of low precision and incomplete removal of silicate clays during preparation of the samples for coating analysis.

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Soils research project.

Detection of sulphide weathering products in soils over ultrabasic rocks

Introduction

Use of soil geochemistry in base metal search over ultrabasic rocks is restricted by the variable background values. These may range from -50 ppm Ni over schists and gneisses to +2000 ppm Ni over dunite. At present, soil geochemistry is only used as a reconnaissance technique, drilling targets being based almost exclusively on geophysical information.

Geophysics has its problems, chiefly magnetite. Like pyrrhotite, it is a good conductor as well as being magnetic.

If it is possible to detect sulphide weathering products in soils this will overcome the problem of variable background values, and may assist in the interpretation of geophysical data.

This report assesses the feasability of detecting sulphide weathering products against a background of weathering silicates.

Theory

Making the distinction between sulphide and silicate weathering products depends on satisfaction of the following conditions:-

i) Ni and Cu from sulphides remain associated with Fe on weathering

ii) Ni and Cu from silicates remain associated with Mg on weathering

iii) there is little transfer of Ni or Cu from sulphide to silicate weathering product, or vice versa

iv) there is no scavenging of metals by either weathering product, scavenging being defined here as the considerable accumulation of metals from background levels.

Amorphous hydrous oxides are the chief form in which iron is present as a weathering product in soils. Mg is present as free ions in exchange positions on soil colloids and also in the lattices of some clay minerals such as montmorillonite and some chlorites.

The problem therefore resolves into the technical one of being able to separate hydrous oxides from clay minerals; and then comparing the metal contents of the hydrous oxides with control data (outcrop, DDH or float).

Method.

The procedures used are summarised in the accompanying flow diagram (Fig. 1). Experimental details are given in the appendix.

The fine sand fraction (-80+270 mesh) was used for this study, mainly because it combines a relatively large surface area with ease of handling. A large surface area is desirable because the hydrous oxides mainly occur as coatings round the sand grains.

Use of fine sand has its drawbacks - clay minerals may also occur as grain coatings. This drawback is minimised by treating the fraction ultrasonically in the presence of a phosphate surfactant (Calgon) which should remove much of the clay mineral but little of the hydrous oxide.

Amorphous iron coatings are removed by treatment with sodium dithionite. This reagent is an extremely efficient oxide coating remover, but is known not to attack mineral grains. Unfortunately the high concentrations of the salt required preclude direct analysis of the extract. Instead, analyses were carried out before and after dithionite treatment and the metal content of the coatings determined by difference.

Rather low precision results. Reproducability is within about 10% for Ni, Cu values above 100 and 50 ppm respectively. The results for samples below these levels are unreliable.

Study areas.

Samples were investigated from Auchincrieve, Arthrath and Belhelvie (areas 1-3 in Fig. 2).

The Auchincrieve and Arthrath areas were used as controls, DDH information showing the presence in both of sulphides approaching economic levels. Based on the experience in these areas, the potential of the virgin Belhelvie locality was assessed.

Results.

1. Auchincrieve.

Only small amounts of -80 mesh material collected by CGF were available for this area, with no information of soil types. The results are therefore only useful as a general indication of coating reliability.

Both Cu and Ni reach high values in coatings at a few points on lines +1 and +2 (Figs. 3,4). Mixed with and lying on each side of these points are several samples with high Ni and Cu contents in the grains, but little in the coatings. According to theory, sulphides should be present near lines +1 and +2 with unmineralized ultrabasic rocks to the north and south.

Mineralized graphitic gabbro is present in the riverbank outcrop from the southern end of the exposure up to line +3 (no exposure north of this). DDH HK 1, a vertical hole at the western end of line +1, was in 'good' sulphides*throughout its 201 ft. Inclined hole HK 2, NW of HK 1 (Figs 3,4) went through unmineralized gabbro, serpentinized in parts, with 'bad' mineralization over the lower ⅓ of its 185 ft. drilled length. Unfortunately there is no DDH information south of HK 1.

The drill information therefore seems to fit the interpretation put on the soils data, which suggests that coating:grain values of 1:4 or less for Ni and 1:2.5 or less for Cu may indicate the presence of sulphides in the bedrock nearby.

2. Arthrath.

Samples were collected by us on a 1000 x 500 ft. grid from the B or equivalent soil horizon, or from the top of the permafrost layer where present within the upper two ft. of the soil.

The amount of hydrous oxides in coatings is likely to be related to the soil type, since in poorly drained soils low Eh conditions will permit greater mobility of iron, and hence less is likely to be present in coatings. The relationships for all samples are shown in Tab. 1. The main conclusions are:

i). Metal content of grains

Ni, Fe - decreases with worsening drainage
Cu - no correlation

ii). Metal content of coatings

Fe - decreases with worsening drainage
Ni, Cu - analytical variations at these low levels are too great to show any significant trend. But the percentage of samples with values -1 ppm strongly suggests decreasing contents associated with worsening drainage.

iii). Podsols - the samples are concentrated in the eastern part of the area and are few; hence probably unrepresentative

Therefore samples from poorly drained soils (gleys, mottled gleys) with low coating metal values may not indicate the absence of sulphides.

Samples with more than 100 ppm Ni and 50 ppm Cu are shown in Figs. 5 and 6. Some neighbouring lower values are also included. There are a few sites where the Ni, Cu coating:grain metal contents are closer than 1:4 and 1:2.5 respectively. As at Auchencrieve, these sites are associated with others which have low coating metal contents.

Most of the samples with low metal values in the coatings are in well-drained soils, but a few (e.g. P4, U4, W6) are in poorly drained soils. In the latter, low values in the coatings may be due to the absence of hydrous oxides.

Samples containing more than 2% total Fe in the fine sand are shown in Fig. 7. High metal values (Ni, Cu) in the coatings are usually associated with much coating-Fe. There is therefore the possibility of scavenging, as defined on p. 1. There are also several sites where the coating-Fe is almost as high as in the anomalous samples, but which contain only traces of Ni and Cu.(e.g. P14, V4).

Some kind of scavenging process may therefore be operating, but if so the metals are being released from an abnormally high source.

<u>Interpretation.</u>

12 out of the 18 drill holes shown in Fig. 8 are in areas with gley soils, including 5 out of the 6 with moderate or good sulphides, but some interesting correlations are apparent:

i) At P5 a Cu/Ni coating anomaly is close to moderate bedrock mineralization in AD 1.

ii) There are suggestions of an Ni (but not Cu) coating anomaly at V6, close to moderate or good mineralization in AD 11, 17 and 18.

iii) There is no Ni in the coatings of samples E,F 12, F13 close to very bad holes AD 12,13. Cu values appear to be marginal, but are unreliable.

iv) AD 2 , close to sample points V3,4, is the only hole with appreciable sulphides with no geochemical feature in the soils.

v) There is a Cu (but no Ni) coating anomaly at N1, where a dolerite dyke just impinges on the study area. Float samples from the dyke average 225 ppm Cu and 40 ppm Ni. The theoretical chalcopyrite equivalent is .067% which agrees well with polished section values of .06% (Lynda Holmes). The average Cu content of mafic rocks is said to be ca. 140 ppm.

The results from Arthrath therefore seem to be in line with those from Auchincrieve, although gley soils pose interpretive problems. In well-drained soils, four out of the five situations show some correlation between bedrock sulphide content and coating metal content of the soils close by.

This being so, it is possible that the high coating values at T4 (Brown Earth) and T5 (Mottled Gley) may be associated with promising mineralization SW of AD 5.

3. Belhelvie.

This area was sampled by us on a 1000 x 500 ft. grid, as at Arthrath.

Samples with more than 100 ppm Ni and 5o ppm Cu are shown in Figs. 9 and 10. About half of the 75 samples have coating:grain ratios closer than 1:4 (Ni) and 1:2.5 (Cu).

These samples often contain considerable amounts of coating-Fe, but as at Arthrath similar values are also found in samples with Ni, Cu background coatings. An Mn/Fe concretionary horizon from H 18 gave the following coating values:

Fe 3%, Mn 2%, Ni 5 ppm, Cu 15 ppm.

In the samples with anomalous coatings, the maximum Fe and Mn values are 2% and 800 ppm respectively. There is therefore no evidence of scavenging.

Interpretation

In the absence of DDH information, the only way to check the significance of the data is by correlation with sulphides in float (Tab. 2). This shows that 80% of the samples with anomalous sulphides in float* are included in the group of samples with anomalous Ni, Cu in coatings. Three out of the four samples with anomalous float but background coatings are from gley soils with low coating-Fe values.

Coating analysis therefore segregates soils associated with sulphides from those that are not. But over half the soils in the group with anomalous coatings are associated with float with background sulphides. It is possible that these soils are accumulating in their coatings metal dispersed hydromorphically from weathering sulphides. It is equally possible that clay removal from the coatings is incomplete, and that the high values are due to the presence of silicate weathering products.

All samples with anomalous coatings were therefore analysed for coating-Mg, which is likely to be retained in clays but not in hydrous oxides. The results (Tab. 3) show that 19 samples contain very small

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Rough visual estimates on float slices. Comparison with accurate polished section determinations suggests that the cutoff is about 0.4% (by weight) total sulphides.

amounts of coating-Mg. The high coating-Ni,Cu values in these samples are more likely to derive from weathering sulphides than silicates, and it is encouraging to find that 11 of them are associated with anomalous sulphides in float.

So starting with a group of 75 samples with high Ni and Cu values which could be due to silicates or sulphides, the end product is a group of 19 which probably reflect anomalous sulphide mineralization.

Location of bedrock sources

The distribution of the 19 samples is shown in Fig. 11. They form two distinct groups.

Group 1. These sites lie slightly to the east of an inferred gabbro/ultrabasic contact. Anomalous ?gabbro float occurs at M13 and N12, but similar rocks in float to the east are unmineralized.

This suggests that the contact may be mineralized.

Alternatively, the association of mineralized float with the magnetic feature could mean that the mineralization is possibly associated with this.

Mineralized ?foliated gabbro at Q16 could be associated with a schist/gabbro contact.

Group 2. The sites lie on a complex ultrabasic feature and on foliated gabbros to the east. Anomalous sulphides are present in troctolite, gabbro and foliated gabbro float, very seldom in dunite.

The best mineralization is in foliated gabbro float, very similar to that exposed in the Belhelvie Quarry i.e. probably very local. It is close to a moderate magnetic feature which runs through the quarry near the gabbro/ultrabasic contact. In the north face of the quarry, where the magnetic values are highest, there is very little magnetite in the rock.

There is therefore a reasonable chance that the magnetic feature is due to the presence of considerable amounts of sulphides.

Conclusions.

1. In all three areas there is a correlation between high Ni,Cu values in coatings and the presence of sulphides in bedrock and/or float close by.

2. There are three snags to using this approach:

i) Poorly drained soils - these have only small amounts of hydrous oxides in the coatings, hence base metal retention is low.

ii) Analytical precision - limits application at present to samples with Ni., Cu. values in the fine sand greater than 100 and 50 ppm. respectively.

iii) Incomplete clay removal - may give pseudo-anomalous coating results (but can be partly allowed for by analysis of coating Mg content).

3. There is no evidence of scavenging by hydrous oxides.

4. The approach has potential as a screening technique. It is likely to be particularly useful in extensive areas of ultrabasic rocks or where there is much Ultrabasic float, as at Belhelvie. But it seems quite useful in Arthrath-like situations also, and will become more so if it proves possible to lower the detection limits.

5. At Belhelvie, where the study covered 10 squ. m., it seems that significant mineralization, if present at all, is confined to two areas covering less than 1 squ. m.

6. Using correlated float and where available, outcrop data, coating information may indicate promising geophysical features and therefore DDH targets in areas where geophysical anomalies may be due to minerals other than sulphides, i.e. magnetite.

In this connection, the combined geochemical/geophysical feature close to the Belhelvie Quarry seems to have considerable potential.

Future work.

1. Fieldwork. The general application of the approach will be tested in three other areas (Fig 2, areas 4-6). Float and soil sampling will be carried out as previously. This is now in progress, and will last till the end of November.

2. Lab work. This will follow the same general pattern as reported here. In addition, attention will be paid to:

   i) obtaining greater analytical precision with a view to lowering the detection limit

   ii) the problem on incomplete clay removal.

Costs.

It is estimated that the cost of the first year of the project totalled about £2500, against the budget estimate of £3500. This figure includes ca. £530 for analyses of which about £400 will not be charged to EV until well into the second year (lab. accounts year finishes end-June).

Operational costs for the second year are estimated at £2500-3000.

Appendix.

Experimental details.

1. Dispersion.

25 g. -2mm. fraction was dispersed in 5% Calgon accompanied by ultrasonication for 10 min. This stage needs further attention.

2. Dithionite treatment.

2.5 or 5 g (depending on hydrous iron content) -80+270 fraction was treated with a 4% w/v solution of sodium dithionite ($Na_2S_2O_4$). The mixture was heated in a water bath at 60° for 30 min. Afterwards, the liquid was decanted and the sample dried at 105° in the flask or beaker. The procedure was repeated as necessary until all the grains were bleached and there was no brown colouration on drying.

3. Digestion.

Samples were digested (0.1 g) in 3 ml. 50:50 conc. HNO_3: water for 1 hr. in a waterbath at 95°. 7 ml. water was added after digestion and thoroughly mixed.

4. Analysis.

All analyses were by atomic absorption. In the case of Mg, instead of adding 7 ml. water after digestion, 7 ml of 1% Sr solution was used. This suppresses serious interference by Al, Si, Ti and P but has no affect on the estimation of Ni, Cu, Fe and Mn.

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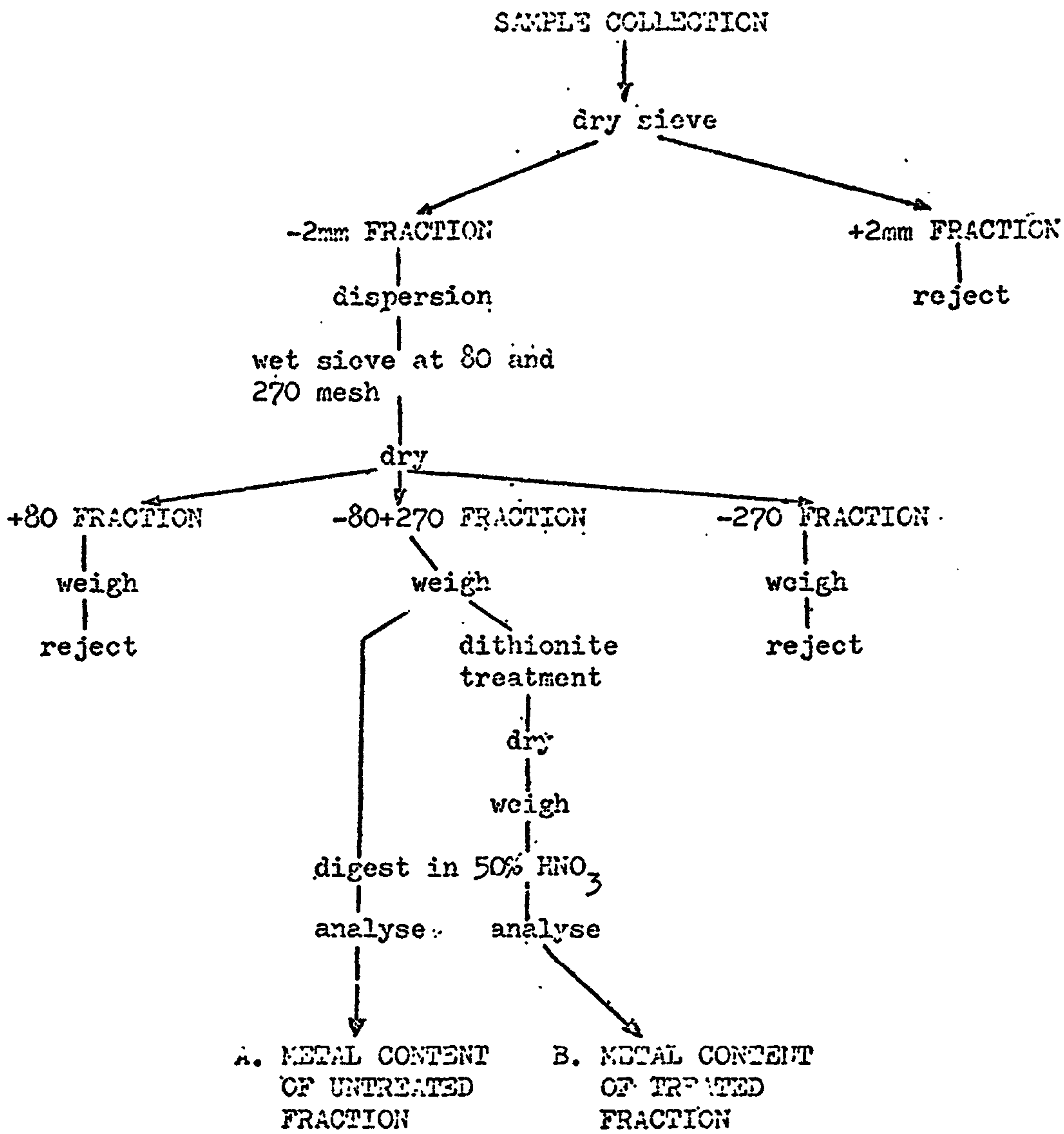
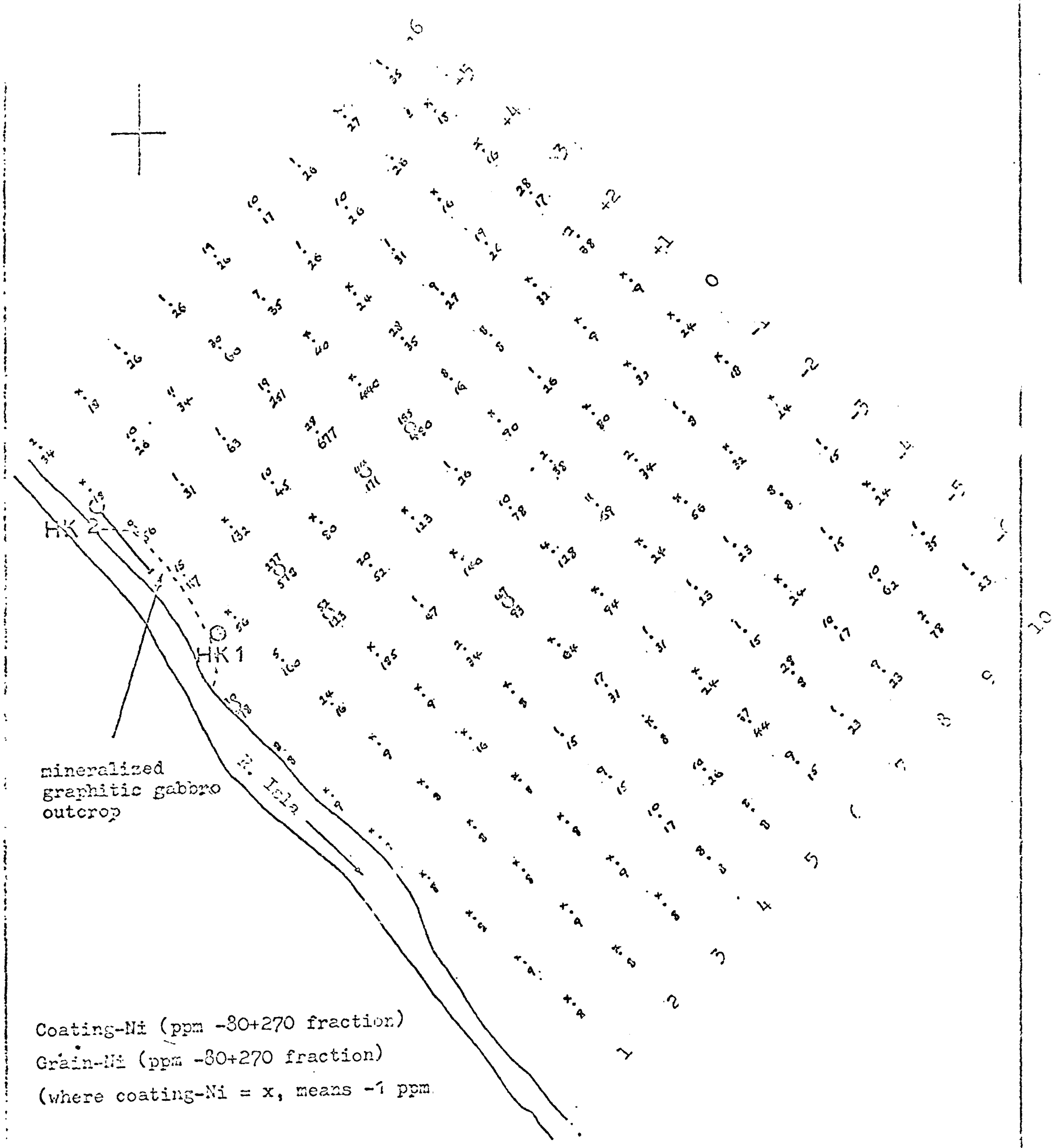
KS.



A - B (corrected for weight loss during dithionite treatment) = metal content of coatings.

Fig. 1. Flow diagram showing treatment stages in the separation and analysis of untreated (A) and treated (B) fine sand fractions, and the determination of the Ni, Cu content of hydrous oxide coatings.

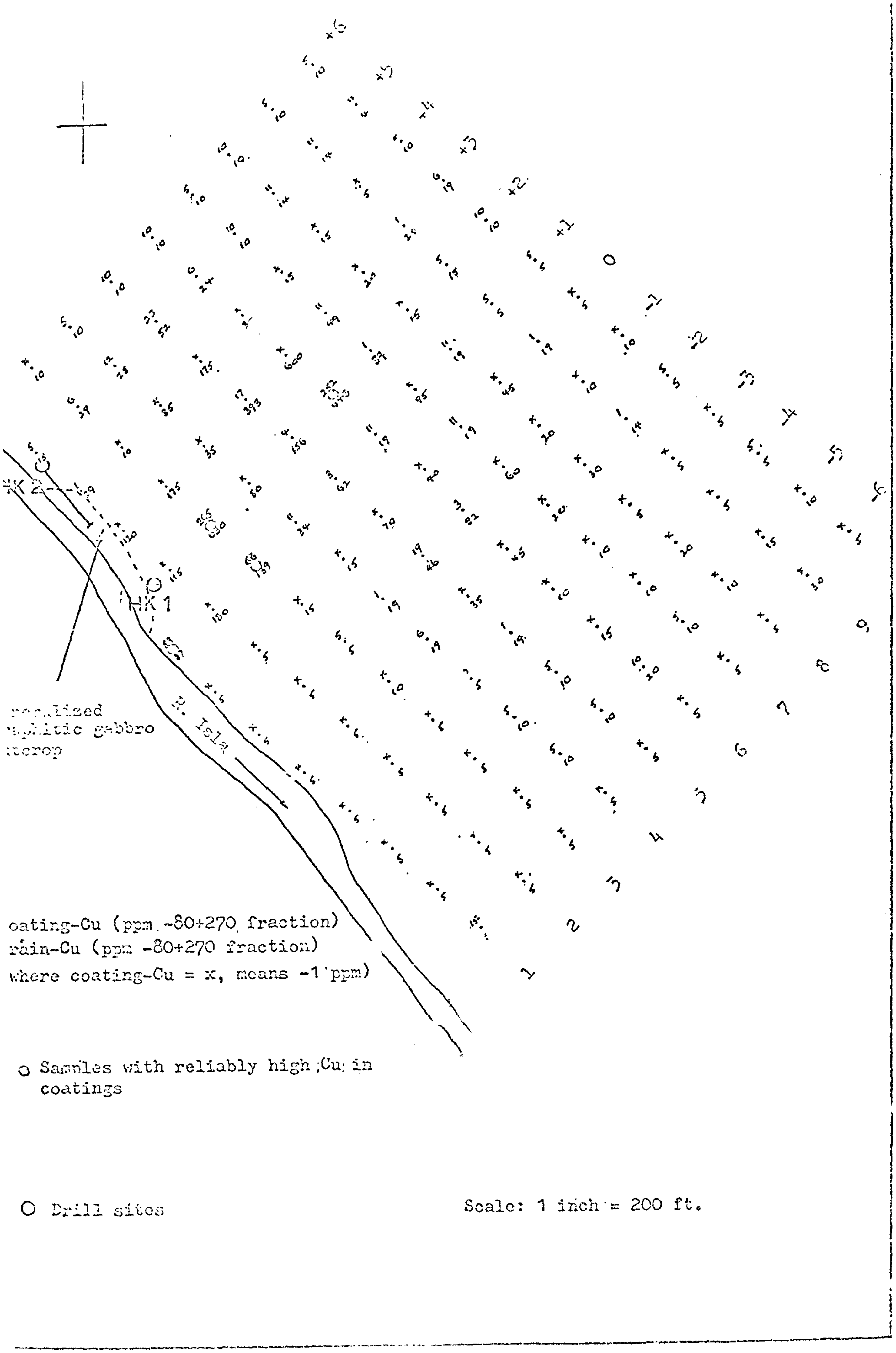


Coating-Ni (ppm -80+270 fraction)
Grain-Ni (ppm -80+270 fraction)
(where coating-Ni = x, means -1 ppm

o Samples with reliably high Ni in coatings

O Drill sites

Scale: 1 inch = 200 ft.



4. Auchincrieve - Cu in coati and grains of -80+270 fraction: drill sites.

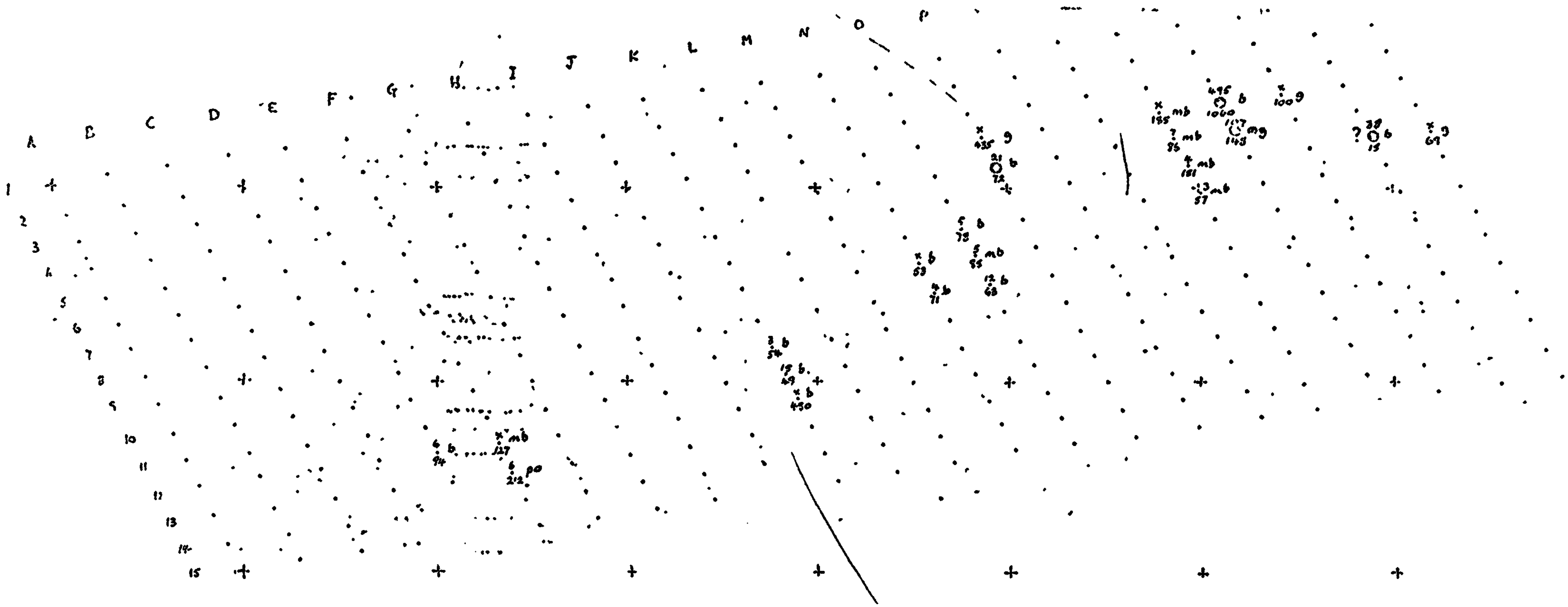
		Soil types				
		Gley (95)[1]	Mottled Gley (42)	Mottled Brown Earth (26)	Brown Earth[2] (125)	Podsol (22)
Cu	Mean grain content (ppm)	11.7	12.3	11.7	14.7	20.9
	Mean coating content (ppm)[3]	4.8	4.7	6.3	6.8	6.1
	Percent. of samples with -1 ppm. in coatings	61	52	33	27	25
Ni	Mean grain content (ppm)	10.4	15.0	18.5	19.3	10.7
	Mean coating content (ppm)	6.6	5.5	5.5	7.7	8.8
	Percent of samples with -1 ppm. in coatings	63	56	21	26.5	33
Fe	Mean grain content (%)	0.75	0.80	1.06	1.25	0.79
	Mean coating content (%)	0.26	0.47	0.66	0.82	0.79
	Percent. of samples with -1 ppm. in coatings	25	16	4	2.5	5

[1]Bracketed figures: no. of profiles in each soil group

[2]Including Brown Earths with permafrost layers

[3]Mean of measurable values only

Tab. 1. Arthrath: Relationship between soil type and Cu, Ni and Fe content of fine sand grains and coatings. Highly anomalous samples excluded.



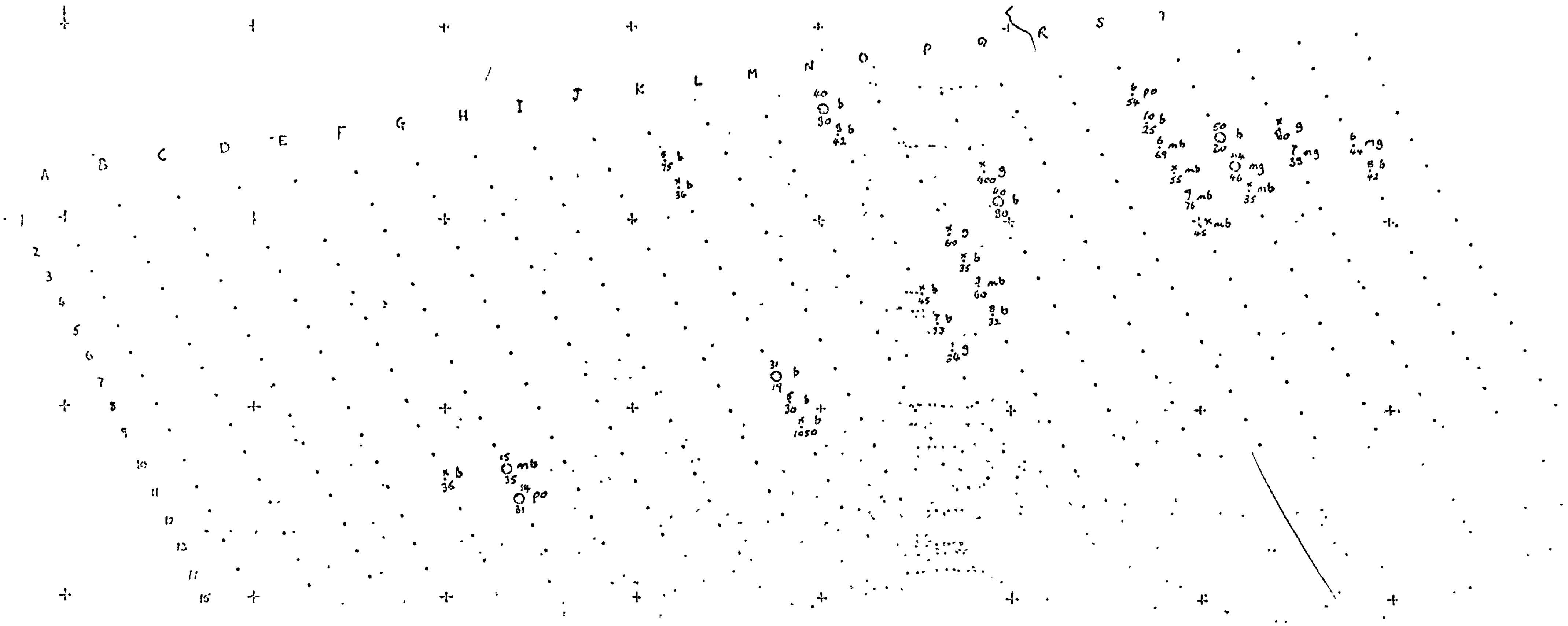
Coating-Ni (ppm -80+270 fraction)
. b etc --- --- --- --- - --- soil types: b = brown earth
Grain-Ni (ppm -80+270 fraction)
mb = mottled brown earth
mg = mottled gley
g = gley
po = podsol

(where coating-Ni = x, means -1 ppm)

O Samples with reliably high Ni in coatings

0 ¼ ½ 1 mile

Fig. 5. Artbrath - sites where Ni in coatings + grains exceeds 100 ppm, plus some associated sites with lower values.

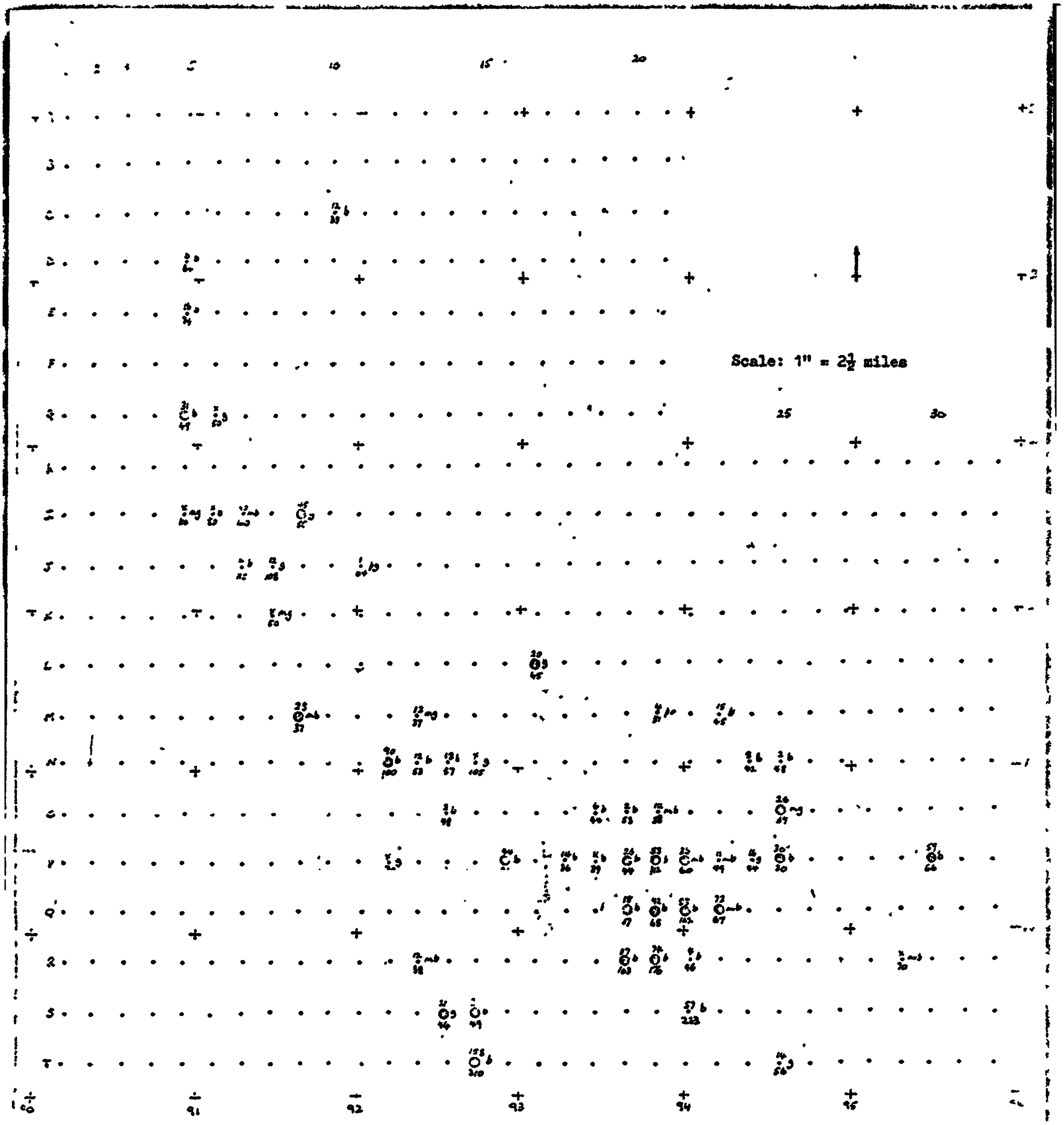


Coating-Cu (ppm -80+270 fraction)
• b etc --- --- --- --- --- soil types: b = brown earth
Grain-Cu (ppm -80+270 fraction)
mb = mottled brown earth
mg = mottled gley
g = gley
po = podsol
(where coating-Cu = x, means -1 ppm)

O Samples with reliably high Cu in coatings

0 ¼ ½ 1 MILE

Fig. 6. Arthrath - sites where Cu in coatings + grains exceeds 50 ppm, plus some associated sites with lower values.

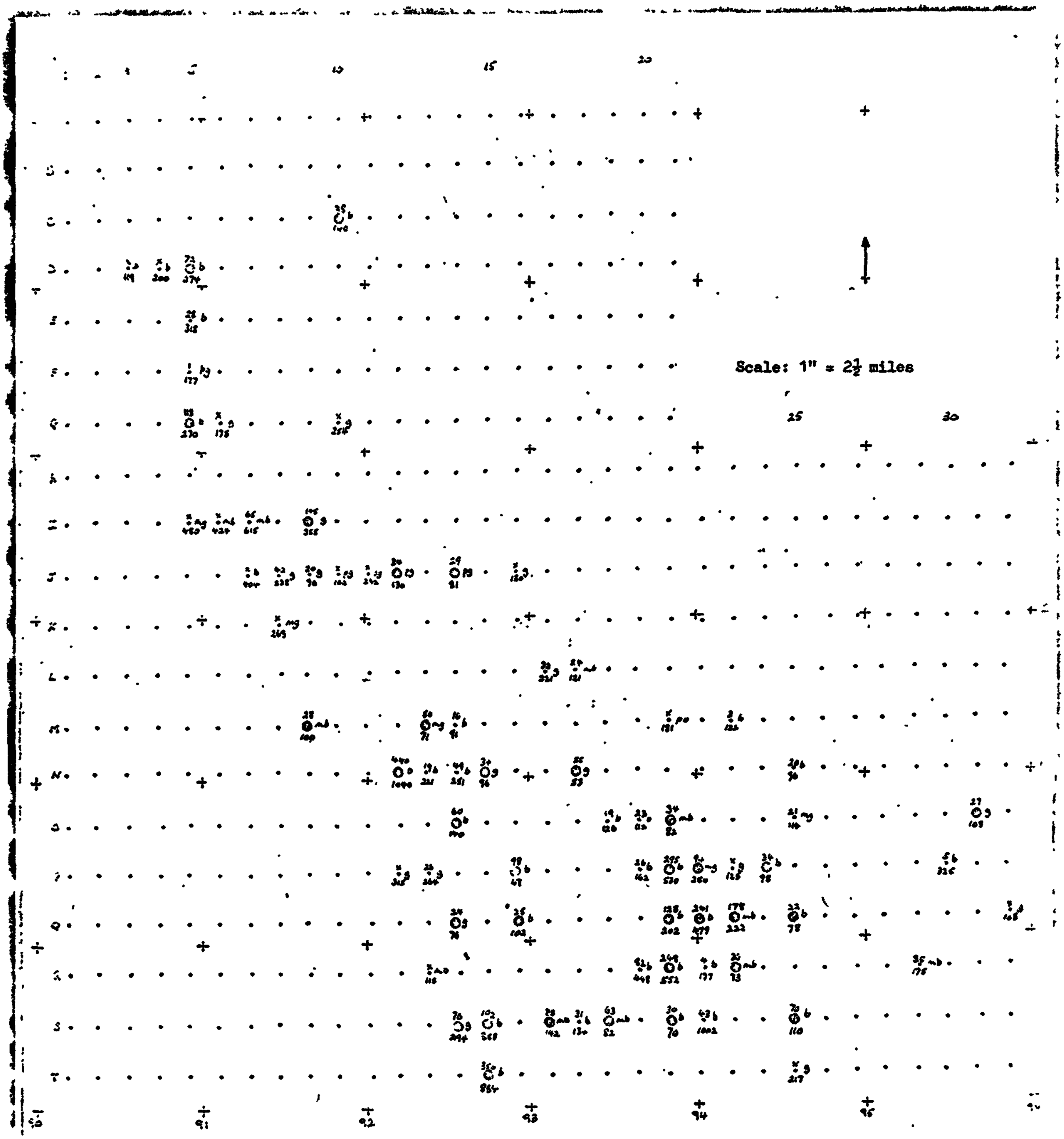


Coating-Cu (ppm -80+270 fraction)
. b etc --- --- --- --- --- soil type: b = brown earth
mb = mottled brown earth
mg = mottled gley
g = gley
pg = peaty gley
pc = podsol

Cr[illegible] (where coating-Cu = [illegible], [illegible] -1 ppm)

⊙ Samples with high coat[illegible]

[illegible]. [illegible]helvie - sites where Cu in coatings + grains exceeds 50 ppm.



Coating-Ni (ppm -80+270 fraction)
. b etc --- --- --- --- --- soil types: b = brown earth
mb = mottled brown earth
mg = mottled gley
g = gley
pg = peaty gley
p = podsol

Grain-Ni (ppm -80+270 fraction)
([illegible] = x, [illegible] -1 ppm)

O [illegible] high coating-Ni

Fig. 9. Belhelvie - sites where Ni in coatings + grains exceeds 100.ppm.

	Samples with anomalous	Samples with background sulphides in float
Samples with anomalous coating-Ni, Cu	17	20
Samples with background coating-Ni, Cu	4	27

Tab. 2. Belhelvie- correlation of coating data with anomalous sulphides in float.

	Samples with -1000 ppm coating-Mg	Samples with +1000 ppm coating-Mg
Samples with anomalous coating-Ni, Cu but background sulphides in float	8	13
Samples with anomalous coating-Ni, Cu and anomalous sulphides in float	11	6

Tab. 3. Belhelvie - correlation of sulphide levels in float with presence or absence of large amounts of coating-Mg.

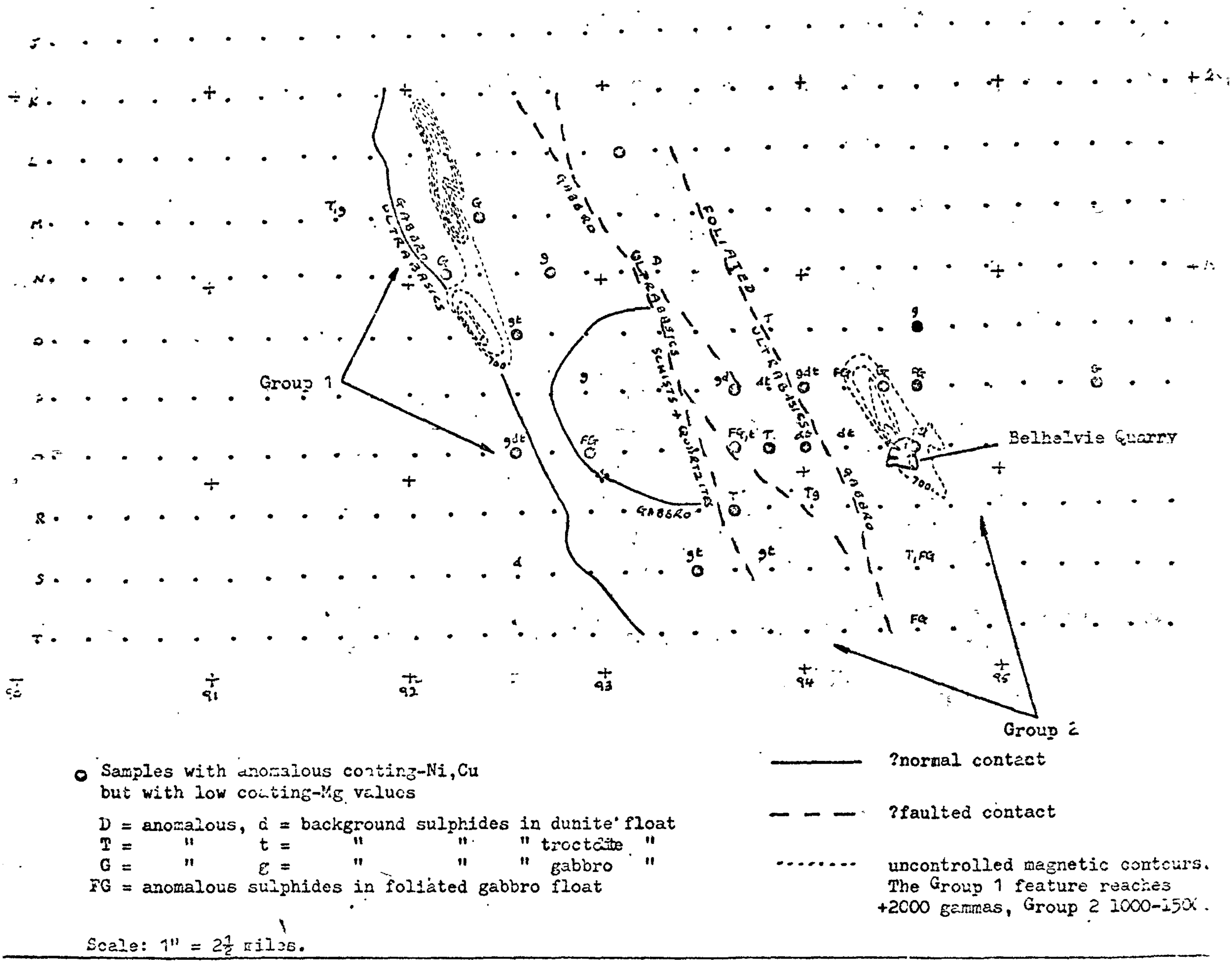


Fig. 11. Location of samples with anomalous coating-Ni and/or -Cu but with low coating-Mg values at Belhelvie in relation to geological and selected geophysical data, and to float sulphide content. NB The geological information is from MacEwen's reconnaissance study; the position of some of the contacts may have been modified by later work at Aberdeen.

REPORT NO. 4.

[redacted]

Soils research project

Results of fieldwork in the Huntly area

Summary

This report evaluates further studies of Soil type/float type/soil geochemistry relationships.

The four areas investigated were Auchincrieve, Brodiesord, [illegible] and Brown Hill.

All four show broadly similar patterns, namely a close correlation between dominant float type and soil geochemistry, and a less obvious (but [illegible] probably indirect) relationship between soil type and soil geochemistry. Most of the base metal anomalies are though to originate from silicate minerals in solid or mechanically dispersed rock.

It may be worth having a look at the sites listed on p.7, where geochemical anomalies are not associated with ultrabasic float. Some of these anomalies could conceivably originate from oxidising sulphides, although there [illegible] possible explanations.

There is a possibility that assessment of soil type/float type/soil geochemistry relationships may be fouled up by the generalisations of data needed in order to prepare understandable maps. Some kind of computerised assessment seems preferable, and we shall try this out.

Future work (in the laboratory) will concentrate on developing and [illegible] the hydrous oxide coating procedure, on assessing present soil sampling procedures (by comparing our own A and B horizon geochemical data with standard "B" horizon data); and writing and testing a simple computer data evaluation programme.

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Soils research project.

Results of fieldwork in the Huntly area.

Introduction.

A previous study[1] showed that soil type and float information may indicate base metal dispersion mechanisms and possible sources of base metal geochemical anomalies in soils.

Later chemical work[2] showed that metal values in hydrous oxides are strongly influenced by soil type. Since these studies also indicated a close relationship between base metals associated with hydrous oxides and the presence of sulphide mineralization, it is clear that knowledge of the soil types present in an area of interest is necessary for the effective interpretation of geochemical data.

This report outlines the results of further studies of soil type/float type/ soil geochem. relationships in four areas of interest to CGF. From these additional studies, it was hoped to confirm the previous conclusions; and thereby to indicate the advantages of using soil and float data generally in exploration.

Study areas.

Four areas were investigated:

1). Auchincrieve	a) 35	pits	on	a	1000x500	ft.	grid
	b) 30	"	"	"	500x250	ft.	"
	c) 64	"	"	"	100x100	ft.	"
2). Brodiesord	488	"	"	"	1000x500	ft.	"
3). Dunbennan	50	"	"	"	1000x500	ft.	"
4). Brown Hill	240	"	"	"	1000x500	ft.	"
Total:	907 pits						

The areas are shown in Fig. 1. Fieldwork commenced on Sept. 14th and was completed on Dec. 14th, giving an average of about 70 pits/week.

Methods.

At each site the following information was noted:

i). General site data - relief position, presence of glacial features, river terraces etc; signs of disturbance or possible contamination

ii). Soil type

iii). The nature of the soil parent material e.g. alluvium, scree, hillwash, terrace sand, boulder clay etc.

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[1] Soils research project: 'Fieldwork results from Belhelvie and Arthrath' (Feb.'70

[2] Soils research project: 'Detection of sulphide weathering products in soils over ultrabasic rocks' (Sept. '70)

Soil samples were taken from A and B horizons (G horizons in gley and peaty gley soils).

20 float stones were collected from the B horizons and identified. Rounded stones (usually quartzites) were noted but not included in the 20.

Maps showing the distribution of dominant soil and float types were then prepared for each area and the information compared with available -80 soil geochemical information (Ni, Cu).

Summary of information from the four areas.

1. Auchincrieve. The three areas are shown in Fig. 2.

Geology.

Picrite, olivine gabbro, graphitic gabbro, granite and black schist are all thought to be present in the areas. Mineralization seems to be largely confined to the graphitic gabbros.

Relief.

The areas lie on a spur sloping steeply to the south, with the R. Isla to the west, south and east.

Float. Outcrop is limited, but where present there is a good correlation between float and solid geology, i.e. most of the float seems to be quite local. Dominant float types are shown in Fig. 3.

Float and soil geochem.

There are some fairly good correlations between float rock types and soil geochemistry (Figs. 4,5). Granite, schist, and olivine gabbro are generally associated with near-background Ni, Cu values (less than 200, 60 ppm respectively). Cu values in picrite may reach 250 ppm, and Ni over 1000 ppm., contrasting with the soils associated with graphitic gabbro and olivine gabbro (in part) which have Cu and Ni values locally exceeding 1000 ppm; and generally almost as much Cu as Ni.

Soils and soil geochem.

The distribution of the soil types is shown in Fig. 6.

In area (a) the soil geochemical values are too low for much correlation with soil type to be possible. There is no correlation apparent in area (b). In area (c) however, there is a very clear correlation between the highest Ni and Cu values and Brown earths, the geochemical trough between the two anomalies coinciding with Mottled gley soils.

Whether or not a soiltype/soil geochem correlation is detectable therefore seems to depend on the scale of the study in this case.

2. Brodiesord.

Geology.

The rocks strike NNE/SSW. Most of the area is underlain by serpentinised picrite, gabbro (including olivine gabbro) or gneiss, but calcsilicate, epidiorite, troctolite and many altered basic and ultrabasic rocks are alos present in minor amounts.

Relief.

The relief is closely related to the geology. Quartzites outcrop on the western margin of the area along the crests of Durn and Fordyce Hills, which are aligned with the strike. Serpentinised picrite outcrops on the eastern slopes of these hills, giving way to gabbro and olivine gabbro flooring the central valley, which is covered with thin (less than 25 ft.) moraine or glacial outwash. The small hills on the eastern margin of the study area are mainly gneiss.

Float.

Drift seldom exceeds 25 ft., even in the central valley, and is considerably thinner on the slopes of Durn and Fordyce Hills. Although there has been some downslope displacement (which mainly has taken the form of some masking of the picrites by quartzitic Head) the float generally seems to reflect underlying geology with little displacement. The distribution of dominant basic and ultrabasic float types is shown in Fig. 7.

Float and soil geochem.

+200 ppm Ni/ -50 ppm Cu/ +50% serpentinised picrite float correlate fairly well in the western part of the map. Ni values are generally lower, but Cu values higher to the east, coinciding more or less with dominant gabbro float. On most other rock types both Cu and Ni values in soils are low. (Figs 8,9).

Sporadic high Ni values (+300 ppm) associated with low Cu (-50 ppm) and minor amounts of ultrabasic float at e.g. D,E 13 may be due to either serpentinised picrite buried below shallow drift or to finely divided serpentinised picrite or its weathering products in sand,silt or clay fractions.

Similar Ni values associated with higher Cu (+50 ppm), again with only minor amounts of ultrabsic float, may be due to unserpentinised picrite near surface, or possibly to sulphides, or their respective weathering products. Sites which belong in this category are I21-H22; F,G,H 13; N,O 14.

Soils and soil geochem

High Ni values can be seen to coincide with virtually any soil type (Fig. 10) and are therefore probably due to silicate-Ni derived from serpentinised picrite.

High Cu values occur mainly in mottled gleys, gleys and peaty gleys. A silicate origin for them seems likely also (from gabbros underlying the valley floor). Correlation of high Cu with soil type seems to be fortuitous, therefore, although the possibility of some hydromorphic dispersion cannot be entirely ruled out.

3. Dunbennan.

The southern part of this area has been considerably disturbed (reservoir, pylons etc.).

Geology.

The strike is roughly N/S. The dominant rocks are picrite, troctolite, olivine gabbro and altered ?hypersthene gabbro.

Relief.

Picrite outcrops on the top and upper slopes of Dunbennan Hill, which is aligned with the strike. Olivine gabbro and troctolite underlie most of the lower slopes. They are covered by alluvium close to the R. Deveron.

Float.

Drift is thin on the top of Dunbennan with many picrite outcrops and much picrite float. The picrite has travelled downslope to some extent, covering part of the troctolite and olivine gabbro outcrop. Although there seems to have been some mixing of float on the lower slopes, the dominant float rock type reflects the underlying geology quite well. The distribution of dominant float types is shown in Fig. 11.

Float and soil geochem.

Ni geochem is shown in Fig. 12 and Cu in Fig. 13.

+1000 ppm Ni occurs where picrite float overlies solid picrite; +200 ppm correlates fairly well with +50% picrite float. Ni values over part of the 'trocto-gabbro' and troctolite adjacent to the picrite exceed 200 ppm but more usually are between 100 and 200 ppm. Over the gabbro, Ni is seldom more than 100 ppm and may be much less where alluvium is present.

Cu values from 50 to 100 ppm correlate with 50% picrite float, but values of 50-100 ppm Cu are also found over the adjacent troctolite, 'Trocto-gabbro' and gabbro. The only Cu above 200 ppm occurs at where gabbro, picrite and andalusite schist meet and virtually outcrop.

Soils and soil geochem.

Ni values above 200 ppm are mainly associated with brown earths and mottled brown earths, though sometimes with mottled gleys and gleys also. The same goes for +50ppm Cu values. Poorly drained soils with high metal contents are usually downslope of higher values, and may be due to hydromorphic dispersion.

4. Brown Hill.

Geology.

The strike is generally ENE/WSW. The main rock types are gabbro serpentinised picrite, quartzite and (mainly hornfels) schists, with some serpentinization of basic and country rocks.

Relief.

The relief is dominated by a ridge aligned with the strike, consisting of Evron and Brown Hills, the latter rising to over 1500 ft. This ridge separates valleys to the N and S, the southern valley being underlain by serpentinised picrites. The hillsides are generally very steep with numerous rock outcrops and minor screes.

Float.

Except near rock outcrops the float is fairly well mixed, probably because of downslope movement. A small patch of boulder clay at C7-F5 is associated with poorly drained soils and contains rounded quartzite pebbles. The drift in the northern valley is generally thicker than in the southern. The dominant float types are shown in Fig. 15.

Float and soil geochem.

Ni values above 200 ppm are associated with serpentinised picrite (solid or float), or serpentinised adjacent rocks. Cu values are generally less than 50 ppm. Ni values are lower but Cu higher in gabbros and schist (-100, +50ppm respectively). Both Ni and Cu form linear anomalies parallel to the strike (Figs 16,17).

Soils and soil geochem.

The distribution of soil types is shown in Fig. 18. Ni values ranging from 200 to +1000 ppm are associated with peaty gleys, gleys and mottled gleys of the southern valley underlain by serpentinised picrite. They are therefore probably due to silicate-Ni. +50 ppm Cu is mainly found in brown earth, mottled brown earth and mottled gley profiles.

Conclusions.

1. In all areas with the exception of Brown Hill there seems to be a reasonable correlation between dominant float type and adjacent solid geology. There seems to have been little displacement due to glacial activity. At Brown Hill, the steep slopes have mixed the float rather more than in the other areas.

2. In all areas there is a quite close correlation between dominant float type and soil geochemistry, often close enough to suggest characteristic ranges of Ni and Cu values for each type:-

Dominant float	Location	Ni range	Cu range.
Quarzite, Gneiss	Brodiesord	-100	-50
Hornfels schist, gabbro	Brown Hill	-100	30-100
Gabbro	Auchincrieve	80-200	40-200
Olivine gabbro	Brodiesord	100-200	40-100 (-200)
'Trocto-gabbro'	Dunbennan	100-200(-400)	-50(-100)
Serpentinised picrite	Brown Hill	400-1500	-50
" "	Brodiesord	200-700	-50
Picrite	Dunbennan	200-1000+	50-200
Graphitic gabbro	Auchincrieve	400-1100	500-1400

Note: the great difference in the Cu/Ni ratios between picrite and serpentinised picrite - and the possible uncertainty this suggests in the use of Cu/Ni ratios in data assessment.

3. There is a good correlation between soil type and soil geochemistry at Dunbennan and Brown Hill. At Auchincrieve there is a very good correlation in area (c) between mottled gley soils and offpeak Ni/Cu values. This correlation is not apparent in the coincident part of area (b), in which a larger grid was used. At Brodiesord thereis only a weak correlation between soil type and geochemistry.

4. In most areas float and/or bedrock type appears to be the factor chiefly influencing geochemical values, with anomalies tending to follow the strike. The correlation between soil type and geochemistry seems to be indirect i.e.

   a) bedrock controls slope intensity and float type
   b) slope intensity controls soil type
   c) float type controls soil geochemistry

   therefore d) the apparent correlation between soil type and geochem found in some areas (e.g. Brown Hill).

5. Another possible explanation for the rather weak correlation between soil type and geochemistry is suggested by the Auchincrieve data (see 3 above). It is possible that the generalisations which have to be made in preparing intelligible soil and soil geochemical maps may obscure important relationships. Other ways of evaluating this kind of data are therefore required.

6. Mineralization. One of the outstanding features of this study is the much closer correlation between float and soil geochem. than between soil type and soil geochem. This suggests that most of the base metal geochemical anomalies are due to silicate-bound metal (especially where the anomalies occur in poorly drained soils)

Although finely divided ultrabasic material may be responsible for some of the anomalies not associated with ultrabasic float, some of these could possibly be due to oxidising sulphides.

Parts of Brodiesord and Brown Hill areas where this situation occurs are:

Brodiesord: I21-H22; F,G,H 18; N,O 14
Brown Hill: G4-I4

The other outstanding feature is the close correlation between soil type and geochemistry at Auchincrieve (c), which is the best mineralized area of the four investigated. This supports the idea put forward previously[1] that sulphide-derived basemetals are apparently extremely mobile in poorly drained soils. Since this explanation may account for the distinct 'trough' in the Ni and Cu values at Auchincrieve (c) it could also explain the absence of any pronounced anomaly associated with bedrock sulphides at Muirtack (Arthrath).

7. This study seems to confirm the importance of taking soil types into consideration when looking for sulphide mineralization.

Further work.

Laboratory studies including:

i) Comparison of A and B horizon data

ii) Improvement of precision and lowering of the detection limit of the hydrous-oxide coating procedure.

and also

iii) developing a simple multivariate data handling computer technique to improve and simplify data assessment.

PHH
PGDC
2.2.71

1 Soils research project: 'Detection of sulphide weathering products in soils over ultrabasic rocks' Conclusion 2.i (Sept. '70)

Summary.

A computer programme has been written to obtain a more detailed assessment of the geochemi data obtained from the project. The programme assesses the significance of each metal value relative to variations in soil type and float composition.

The programme has been used to evaluate A vs. B horizon sampling. The conclusion reached is that A horizons are unsuitable alternatives to B horizon samples. If A and B horizon samples are inadvertently collected together from an area, interpretation of the geochemical data is likely to be seriously impaired.

The programme ahs also been used to evaluate the B horizon results from 5 areas. There is a consistent relationship between dominant float type and B horizon metal values in each area. There are large variations in metal values from one soil type to another, but there is no great consistentcy in the metal values when similar soil types from different areas are compared. It is concluded from this that B horizon geochemistry mainly reflects float composition at the sample point.

Of the three areas which have not yet been drilled (Belhelvie, Brodiesord and Brown Hill), only Brodiesord stands out as having distinct mineralization potential on this assessment. Brown Hill has possibilities for Cu mineralization, but Belhelvie looks dead as mutton.

Soil research project.

Report on: 1. A computer geochemical data assessment programme
2. Computer comparison of A vs. B horizon sampling
3. Computer assessment of B horizon geochemistry.

Introduction

The interpretation of data presented in map form seems uncomfortably imprecise. A computer programme has therefore been written in an attempt to get a clearer interpretation of the data obtained in the soils research project.

1. A computer geochemical data assessment programme

The following data is input:

a) A coded description of each soil profile*
b) Dominant float type at each sample point
c) Number (out of 20) of basic and ultrabasic float blocks at each sample point
d) Metal values
e) Sample lab. numbers.

The programme carries out three operations:

a) Identifies the soil profiles, finds the mean and standard deviations for each metal for each soil type, prints out the lab. no. of each sample which has any metal value more than 1 or 2 standard deviations greater than the mean, together with soil type and relevant metal values.

b) Repeats the process, grouping the samples according to dominant float type.

c) Repeats the process, grouping the samples according to the numbers of basic or ultrabasic float blocks at each site.

The theoretical advantage of this procedure lies in its assessment of the significance of the metal values at each sample point relative to similar points (i.e. metal values of a Brown Earth sample are compared with the metal values of all other Brown Earths in a sample area; and of a sample with dominant u-basic float with all other samples with dominant u-basic float etc.). The computer handles the data for 500 samples in about 10 secs, at a cost of about £20. It would take about 20 working days to do this manually, given persistent sanity, at a cost of c. £120.

2. Computer comparison of A vs. B horizon sampling.

During the 1970 field session, A and B horizon samples were collected from about 900 sites at Auchincrieve (130), Brown Hill(300) and Brodiesord (500). The -80 fractions were digested in 50:50 HNO_3 and analysed in the usual way. The analytical results were then assessed using the programme outlined above.

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*see appendix

Comments on the results (Tab. 1) are:

a) For both soil- and float-type correlations, the absolute metal values of A horizons are 25-50% <u>less</u> than B horizons; the range of metal values in the A horizon is also 25-50% less i.e. metals from relatively concentrated sources in B horizons are dispersed over a much greater area in A horizons.

b) There is no consistent relationship between A and B horizon metal values.

c) There is no general relationship between A or B horizon metal values and soil type.

d) B horizon metal values correlate very well with dominant float type. Information from Brown Hill is included as an example (Tab. 2). A horizons are unreliable - this is also brought out by the Brown Hill data. The serpentinized picrite rock contains about 2000 ppm Ni and 30 ppm Cu; the basic rocks contain about 200 ppm Ni and 70ppm Cu. According to the B horizon/float correlation, the picrite contains most Ni and least Cu, which is fine; but according to the A horizon/float correlation, the picrite contains most Ni <u>and</u> Cu. This is misleading - the Cu is coming not from the picrite but via seepage and/or downslope movement of float from the topographicall higher basic rocks.

e) A horizons therefore may seriously interfere with the geochem. interpretation.

3. Computer assessment of B horizon geochemistry.

B horizon results from Arthrath, Auchincrieve, Belhelvie, Brodiesord and Brown Hill have been assessed from a prospecting viewpoint using this programme. Only experience will reveal what criteria, if any, are significant in terms of mineralization using this kind of assessment.

Provisionally, any of the following criteria may possibly be significant:

1. High Ni and Cu values (especially when combined with (2) below) associated with a particular float type
2. Ni:Cu ratios less than 1.5 in a particular float type
3. Sites which are anomalous (i.e. with metal values higher tha the mean + 1 S.D.)for at least three of the following: Ni in soils; Cu in soils; Ni in float; Cu in float; and where the float anomalies are not just due to large numbers of float blocks of a particular rock type. Sites in this category are referred to below as 'significant' sites.

The location of the study areas is shown in Fig. 1.

A. Arthrath.

The float data suggests that the norites are a possible target (Tab.3). 'High' Cu values associated with granite and gneiss float may be due to faulty identification - in weathered float blocks separation of the three lithologies can be difficult.

'Significant' anomalies form a 4-site cluster on lines S and T, with a trail of 'non-significant' anomalous sites heading off in the Muirtack direction, suggesting fairly extensive mineralization. This cluster is close to the main proved mineralization occurrence. Another area of proved mineralization south of P4 is marked by a single 'significant' site at that point (Fig. 2).

B. Auchincrieve.

The graphitic gabbro stands out as the most likely source of the high Ni and Cu values in the soils (Tab. 3).

On the small grid (Fig 4c) there is only a line of 3 'significant' points, with 4 additional isolated occurrences, and on the large grids (Fig.4a,b) there is only one 'significant' point (I11). The reason for this apparently weak correlation between soil geochem., soil type and float type in an area where mineralization virtually outcrops is to be found in the programme. The programme is designed to pick out sites which are anomalous for a particular soil or float type i.e. the assumption is that for a given float type only some of the sites associated with that particular type will contain abnormal amounts of metal. If <u>most</u> of the sites associated with a particular soil or float type are unusally mineralized (as in this case), few of them will appear to be anomalous. But where this situation occurs, there should be indications of the potential of an area from the metal/float correlation. This is so with the graphitic gabbros at Auchincrieve (Tab. 3)

The 'significant' site I 11, which is associated with an occurrence of mineralized float, strengthens the possibility of interesting mineralization on the eastern margin of the ground held by EVL and in the adjacent alien territory.

C. Belhelvie.

Tab. 3 shows that there is no obvious target rock type at Belhelvie.

There are two large 'significant' clusters, on lines G-J (7 sites) and P-S (9 samples), with scattered smaller clusters and individual sites elsewhere (Fig. 5). Most of these clusters are associated with Brown Earths and dominant dunite float, which casts doubt on their significance from a mineralization point of view.

Most of the area is covered by till and outwash, notable exceptions being the N. part of the western ridge (Beauty Hill) and Over Hill, where dunite virtually outcrops, and where the two large 'significant' clusters occur. The float over these two clusters consists almost entirely of dunite, but elsewhere, due to glacial mixing, the float may still be dominated by dunite although in very small quantities (as little as 25% of the count).

The consequence of this is a low threshold for the metal/dominant dunite correlation; the highest values which occur where there is most dunite float, record as anomalous in the assessment.

In a similar way, the very much higher values in Brown Earths over the dunite outcrops stand out relative to the other parts of the area where Brown Earths are associated with a smaller proportion of dunite in the float assemblage.

Grouping the sites according to the numbers of ultrabasic rocks at each site shows that about half of the two large 'significant' clusters can be accounted for in this way. The remaining sites, which mostly occur over the ultrabasic/basic contact, could at a pinch be due to mineralization, but they can also be explained by local variations in the degree of serpentinisation.

The conclusions about Belhelvie therefore seem to be:

i) that there is no evidence from this assessment to suggest the occurrence of any significant mineralization

ii) that ultrabasic areas with variable glacial deposition pose special interpretative problems - 'significant' anomalies may not necessarily be due to mineralization.

D. Brodiesord.

As at Belhelvie, there is no obvious target rock type at Broddiesord.

Two clusters of 'significant' sites are present, both associated with dominant gabbro float. There are also several isolated examples and pairs of 'significant' sites. (Fig. 6). Comparison of Fig. 6 in this report with Fig. 7 in the previous one (Results of fieldwork in the Huntly area) shows that only part of the areas with dominant gabbro float is picked out by this assessment, suggesting that the gabbros are locally mineralized. Almost all the 'significant' sites remain anomalous when the numbers of basic or ultrabasic rocks at each point are taken into account.

There is therefore a good chance that they are associated with sulphide mineralization.

E. Brown Hill.

No rock type looks particularly interesting, although some have close Ni:Cu ratios and/or relatively high Cu values (hornfels schist, gabbro, black schist, serpentinised basics - Tab. 3).

There are no 'significant' clusters at Brown Hill, just a few scattered individual sites, suggesting that the area has not much mineralization potential.

In the southern half of the area, anomalous sites contain abnormal amounts of Ni only and almost certainly reflect serpentinisation rather than mineralization. (Fig. 7).

In the northern half of the area, sites are anomalous almost exclusively for Cu only. Although the chances are that such sites merely represent minor amounts of chalcopyrite in the country rocks, it is just possible that some of the Cu mobilised during the extreme serpentinisation of the ultrabasics has come to rest here as sulphide. The line of Cu-anomalous sites extending from E5-J6, mainly associated with black schist float, might be worth further evaluation with this possibility in mind.

Conclusions and recommendations.

1. Assessment of individual metal values relative to soil and float variations looks a very promising alternative to contouring as a means of geochemical interpretation.

2. Clusters of 'significant' sites probably reflect interesting sulphide mineralization, as at Arthrath and Auchincrieve, where they are associated with known sulphide occurrences, provided that variations in the amount of basic and ultrabasic float can be discounted.

3. Of the areas where little or no drilling has as yet been undertaken, Brodiesord alone stands out as having considerable potential.

   Large 'significant' clusters and scattered 'significant' points are present at Belhelvie, but these are associated with an unfavourable rock type (dunite) and are at least partly due to variations in the amount of dunite float.

   There are no 'significant' clusters at Brown Hill, but there may be some Cu potential there.

4. The assessment may also pick out possibly mineralized rock types, as at Arthrath and Auchincrieve.

5. Metal values in both A and B horizon samples vary with soil type, although there is no consistent relationship either between the A and B horizon values themselves, or between the different soil types. It seems particularly important to ensure that only B horizon samples are collected.

6. B horizon values correlate consistently with dominant float type, but A horizon/float correlations are liable to be misleading.

Further work.

'Coating' studies of the soils from Auchincrieve and Dunbennan have been completed. The results from Brodiesord and Brown Hill should be forthcoming by the end of July.

Computer assessment (using the programme described here) of the 'coating' results for Auchincrieve clearly establish - for this area, at least - that the 'coating' approach differentiates well between metals originating from sulphide vs. silicate sources.

PCDC
RHH
17.6.71.

Appendix - Collection of soil profile data in the field
(extract from Riofinex report dated 17.2.71).

4. Recognition of the soil types

Given that soil type information may be useful in exploration, how to fit its collection into exploration programmes must be considered.

It is argued that considerable training and a fair amount of experience is needed for even a geologist to be able to identify different kinds of soils with confidence. It is probably quite unrealistic to expect that a labourer could be trained to do this reliably. Reliable and consistent soil identification is essential.

One way of sidestepping this difficulty is based on the fact that each soil type diagnosis is based on a small number (about 10) of simple observations. Whereas deciding if a soil is or is not a brown earth may at times be difficult, the attributes of brown earthiness can be evaluated by noting the answers to simple questions like -

> Is a horizon detectable between A and C horizons?
> If so, how much grey is there in this horizon?
> Is the A horizon highly organic?
> etc.

Using a procedure of this kind can make soil identification a) simple b) reliable c) minimally subjective. In fact, identification of the soil types in the field is not required. All that is necessary is for the field staff to record the answers to the questions on computer coding forms, which can then be carded and processed along with the analytical results. The soil at each sample point can be identified by computer, which can also work out the threshold values for each soil type.

A suitable questionnaire and soil data recording sheet is shown on the attached modified FORTRAN coding form. The questionnaire was fieldtested during the visit and proved generally satisfactory. Some modifications and additional entries have been made and are now included in the questionnaire.

5. Sampling procedures.

Recording soil profile data is bound to increase sampling costs and it is important to look for ways of minimising this. Two possibilities are:

i) by increasing the reliability of sampling, sample density could be reduced

ii) to carry out posthole auger sampling /data recording only at intervals along the lines, infilling with screw auger samples without data recording.

It is suggested that the second procedure should be used for the time being, alternating screw and posthole auger sampling on a 1000x200ft. spacing. Modifications can be made to this procedure later if necessary.

University of London Computer Centre
20 GUILFORD STREET · WC1 · 01-405 8400

FORTRAN

PROJECT NO.=

Author .... Date ....

Job number .... Page .... of ....

Telephone number .... Bin number ....

	FIELD SOIL DATA				SAMPLE NUMBER	METAL 1	METAL 2	METAL 3	METAL 4	METAL 5	METAL 6	METAL 7		
	A	B	C	D										
1 2 3 4 5 6	7 8 9 10	11 12	13 14 15 16	17 18 19	20 21 22 23 24 25 26	27 28 29 30 31 32	33 34 35 36 37 38	39 40 41 42 43 44	45 46 47 48 49 50	51 52 53 54 55 56	57 58 59 60 61 62	63 64 65 66 67 68	69 70 71 72	73 74 75 76 77 78 79 80

LAB USE ONLY	
METAL 1=	METAL 5=
METAL 2=	METAL 6=
METAL 3=	METAL 7=
METAL 4=	

PUT -1 IN LAST TWO COLS. OF EACH UNUSED 'METAL' SPACE

NOTES

A7 Is a horizon detectable between A and C horizons? If positive put 1 in col. A7; if negative put Ø

A8 Any contamination suspected?

B12 How much grey is there in the first subsurface horizon? Use the following classes –

C14 Is the organic matter content of the surface horizon more than c. 7%? If positive put 1 in col. C14; if negative put Ø

D18 Are basic rocks (e.g. limestones, basic and ultrabasic igneous rocks etc.) present in the soil? If positive put 1 in col. D18; if negative put Ø

Questions replaced by those on attached sheet

A9 Was peat sampled? If positive put 1 in col. A9; if negative put Ø

A10 Is the site on the floodplain of a large (usually) river? If positive put 1 in col. A10; if negative put Ø

If subsurface horizon absent put Ø

if negative put Ø

ENTER ONE CHARACTER ONLY IN EACH COLUMN
ENTER ONLY PROJECT NO. AND PAGE NO. AT TOP OF SHEET

E20-26 Put the sample number in these columns, as far to the RIGHT as possible

Revised soils questionnaire.

A5,6 Dominant float type. Number from 1 for each area. Do not use continuous numbering for all the rock types in e.g. N. Wales prospects.

A7 Is a distinct horizon present beneath the organic horizon(s)?(i.e. is there is a soil layer between the organic layer(s) and the parent material). If positive or uncertain (grey layer: could be G horizon or PM) put 1 in col. A7; otherwise 0.

A8 Any contamination suspected?
If from old workings put 1)
If from agricultural, forestry etc.operations put 2) in col. A8.
If none suspected put 0)

A9 Was peat sampled? If positive put 1 in col.A9; otherwise 0.

A10 Is the site on the floodplain of a large (usually) river?
If positive put 1 in col. A10; otherwise 0.

B12 How much of the horizon below the organic horizon(s) is orange- or yellowish-brown?

if more than 75% put 1)
75-50% put 2)
50-25% put 3) in col. B12*
if less than 25% put 4)

If A7 is 0, B12 is 0.

C14 Is the organic matter content of the organic horizon(s) more than 50%? (if more than one organic horizon is present both must contain more than 50% O.M. for a positive answer). If positive put 1 in col.C14; otherwise 0.

C15 Is the total thickness of the organic horizon(s) more than 6 ins? If positive put 1 in col. C15; otherwise 0.

C16 Is an iron or humus pan present below a mainly grey horizon*? (such a pan must be present immediately below a grey horizon for a positive answer) If positive put 1 in col. C16; otherwise put 0.

D18 If the site is on a slope, what is the downslope direction?

If N put 1	If NE put 2)
If E put 3	If SE put 4)
If S put 5	If SW put 6) in col. D18
If W put 7	If NW put 8)
If site is level put 0	)

D19 Does at least the top 2ft of the profile consist of an intimate mixture of organic and inorganic matter, with no distinct colour changes (all shades of chocolate-brown), and with less than [illegible] organic matter? If positive put 1 in col D18; otherwise 0.

*discount where possible colours due to rock fragments or partly [illegible] plant roots.

NOTES ON FLOAT SAMPLES FROM ABERDEENSHIRE

Introduction

30 float samples were supplied by Dr. P. Cazalet for identification and brief mineralogical description. The 30 samples had been divided into two groups. The first group (A) from the Arthrath area consists of norites and some metamorphosed rocks; the second group (B) from the Belhelvie area consists of troctolites, modified norites and metamorphosed rocks.

A1 - Hybridised Gabbro Norite

This is fine to medium grained and contains the following minerals in varying proportions throughout -:

plagioclase, quartz, biotite, green spinel, sericite, clinozoisite, opaques, ?cordierite, ?alkali felspar, and ?garnet.

The assemblages are similar to specimens previously examined of gabbro norite modified by partially melted small country rock xenoliths. A1 contains many of these xenoliths.

A2 - Andalusite-Cordierite Schist

This is a classical specimen of porphryoblastic andalusite and cordierite with minor biotite, plagioclase, quartz and/or felspar and opaques. It is a thermally metamorphosed pelite (hornblende or pyroxene hornfels facies.)

A3 - Altered Augitic Norite

This consists of coarse grained plagioclase, bronzite, augite and opaques with variable alteration of plagioclase to sericite, and mafics to chlorite and ?"limonite".

A4 - Retrograde Metamorphosed (formerly Garnet) Schist

This consists of pseudomorphs of rounded garnet crystals, now composed of very fine aggregates of chlorite, quartz, opaques, minor biotite, and muscovite. Other minerals which have remained more stable, are muscovite which forms parallel aggregates "flowing" round the garnet, quartz, chlorite and opaques.

It is a regionally metamorphosed pelite of former higher green schist grade which has suffered retrograde metamorphism.

This is composed predominantly of a granular aggregate of the above minerals. Occasionally the cordierite is slightly porphryoblastic. It is a SiO_2 rich, K_2O poor pelite in the hornblende or pyroxene hornfels grade of thermal metamorphism.

A6 - Granite

This is a typical granite, with coarse grained quartz, alkali felspar, plagioclase, some myrmekite, biotite and muscovite.

A7 - Hybridised Anorthosite

This consists of clusters of plagioclase and clusters of cordierite with quartz, spinel, alkali felspar, biotite and opaques. Some clusters probably represent almost completely melted and incorporated xenoliths.

A8 - Altered Norite

This is composed of coarse grained original plagioclase and orthopyroxene with biotite, hornblende and opaques. All mafics show more than one stage of alteration, e.g. pyroxene - hornblende - chlorite. The plagioclase shows less alteration to sericite. Some epidote is present.

The alteration could be caused by weathering, or hydrothermal activity and/or medium greenschist grade of thermal metamorphism.

A9 - Hybridised Basic Rock

The original plagioclase and orthopyroxene have been resorped and later minerals have formed, including biotite and hornblende. This could be a mild hybridised rock or else a norite disturbed during crystallisation.

A10 - Hybridised Xenolithic Rich Basic Rock

This specimen contains garnet which encloses large grains of opaques, biotite, and quartz, all in a cordierite-alkali felspar matrix, together with aggregates of plagioclase, biotite and minor spinel. In some parts of the specimen very dense sericite aggregates are pseudomorphing some mineral and the matrix here is biotite, opaques, plagioclase and spinel.

The variability of this specimen can be explained by the presence of partially melted xenoliths with garnet, as outlined by Gribble (1968). This is the first time that garnet has been observed in any specimen of hybridised rock submitted from Aberdeenshire.

A11 - Norite

This is a typical coarse grained norite with very little alteration.

A12 - Altered Cordierite-Andalusite-Biotite-Muscovite Schist

This is composed of sericite aggregates, biotite, muscovite, opaques, hornblende, epidote and andalusite. The sericite appears to pseudomorph cordierite.

The specimen is most probably a andalusite-cordierite bearing thermally metamorphosed pelite (hornblende or pyroxene hornfels grade) which has suffered subsequent alteration.

B1 - Troctolite

This is coarse grained, plagioclase rich, and consists of partially altered rounded olivine within the plagioclase ground mass.

B2 - Troctolite

This is coarse grained typical troctolite containing more olivine and being more altered than B1.

B3 - Saxonite

This is a rounded olivine cumulate with interstitial altered pyroxene and minor plagioclase, all minerals having been altered.

B4 - Altered Troctolite

The olivine has altered to serpentinite and opaques. From the interstitial minerals there has been much formation of pale amphibole, clinozoisite, chlorite and the occasional relic hornblende. Compared to B5, and similar specimens, it could well show a similar history, i.e. late magmatic disturbance or late magmatic hydrothermal activity; most probably the former.

B5 - Amphibolitised Norite Gabbro

This is composed of large plagioclase laths with aggregates of fairly fine grained orthopyroxene and clinopyroxene, amphibole and muscovite. There has been extensive subsequent replacement of the pyroxene by amphibole, possibly at a late magmatic stage. Plagioclase shows deformation. This is similar to several of the following specimens, and as mentioned above, they are interpreted as having been subjected to late magmatic disturbance, possibly complicated by the incorporation of country rock. Late magmatic hydrothermal activity is not considered as likely.

B6 - Augitic Norite

This is fairly similar to the last specimen, but there are many more and larger grains of both clinopyroxene and orthopyroxene. Amphibole has replaced both fairly extensively. Several chlorite aggregates are present.

There is not very much plagioclase and quartz occurs in small grains. Cordierite is suspected but not confirmed.

<u>B7 - Altered Augitic Norite</u>

This shows the same characteristics as B5 but all minerals have suffered extensive alteration including plagioclase. In this there are also some reaction rims between plagioclase and pyroxene, as opposed to amphibole rims around the pyroxene formed by deposition and/or resorption. Opaques are present but very altered.

<u>B8 - Amphibolitised Augitic Norite</u>

This is very similar to B5, with not quite so much pyroxene in B8.

<u>B9 - Amphibolitised Augitic Norite</u>

This is fairly similar to B5 and B8 but there is less clinopyroxene and there are occasional pseudomorphs of resorbed olivine. There are also extensive reaction rims as in B7 (myrmekitic in part).

<u>B10 - Augitic Norite</u>

This is much more like normal norite with only very small amphibole rims around orthopyroxene although these show myrmekitic texture occasionally. A few amphibole aggregates of B5 type occur.

<u>B11 - ?Schistose Xenoliths in Contaminated Igneous Rocks</u>

Two main assemblages are present. The first consists of plagioclase, opaques, clinopyroxene and orthopyroxene, with minor hornblende and biotite. The second consists of biotite, clinozoisite, muscovite and quartz and shows schistose texture.

It is tentatively identified as a schist xenolith in contaminated igneous rock.

<u>B12 - Augitic Norite</u>

This is similar in type to B5. In B12 there has been more development of sericite alteration products.

<u>B13 - Biotite-Quartz-Sillimanite Schist</u>

This contains the above minerals, together with very occasional garnet, alkali felspar and albite grains. It is a regionally metamorphosed pelite in the almandine-amphibolite facies.

B14 - Amphibolitised Augitic Norite

This is again similar in type to B5 and B12, etc.

B15 - Norite

This is a typical Arthrath type norite with coarse grained orthopyroxene, plagioclase, occasional olivine, very little alteration, very little hornblende, and very few opaques.

B16 - Highly Complex

There are two distinct assemblages in this, possibly one has been injected into the other, but both are extremely complex. There is much clinozoisite, ?dioside, hornblende and fine grained aggregates of unidentified minerals.

B17 - Norite

This is a typical norite. There has been occasional formation of amphibole of B5 type.

B18 - Amphibolitised Norite

This is similar in type to B5, etc.

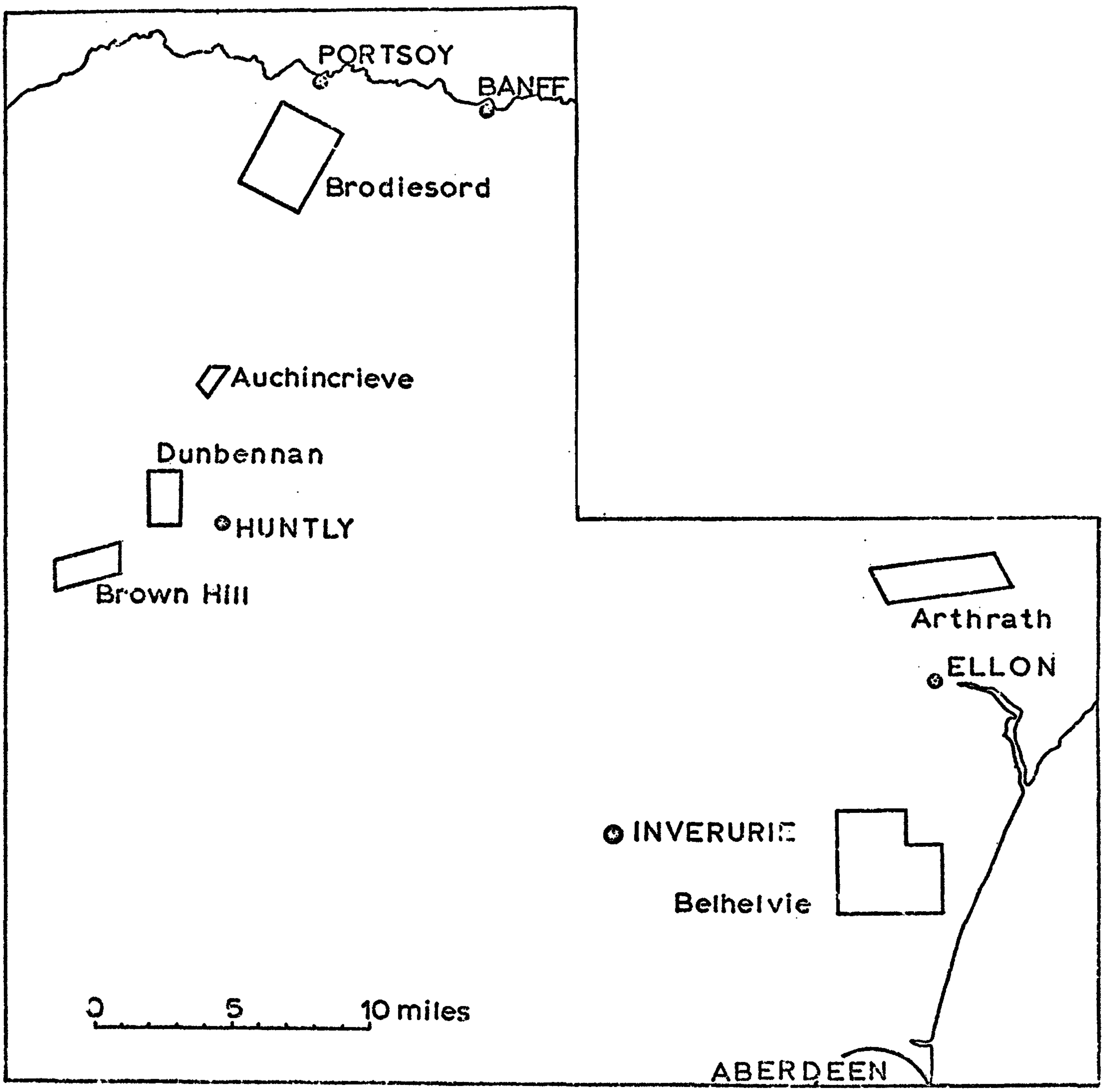


Fig. 1. Location of project study areas

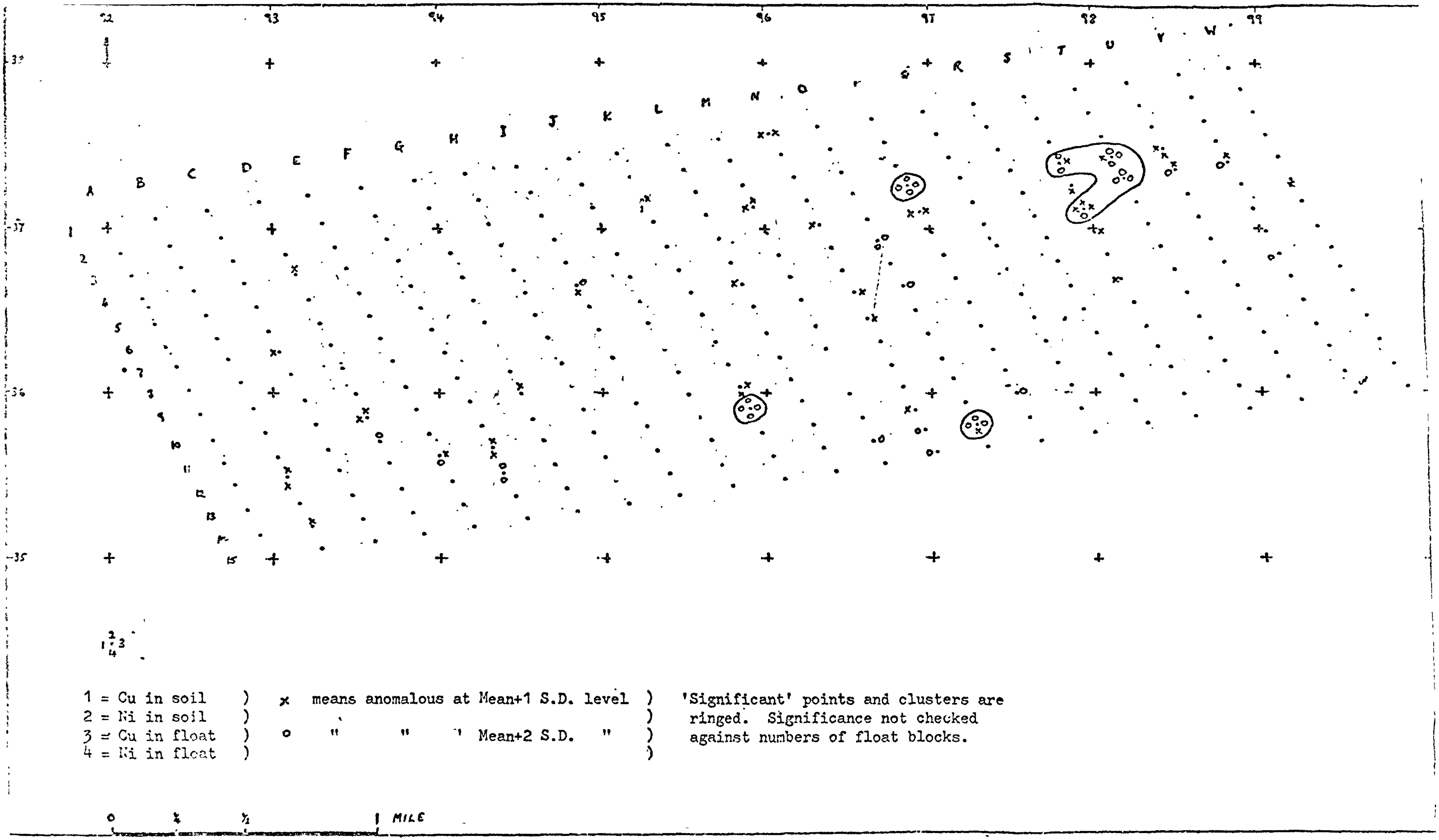


Fig. 2. Arthrath – distribution of sites with anomalous Ni or Cu values relative to the amounts present in soil type or dominant float type groups.

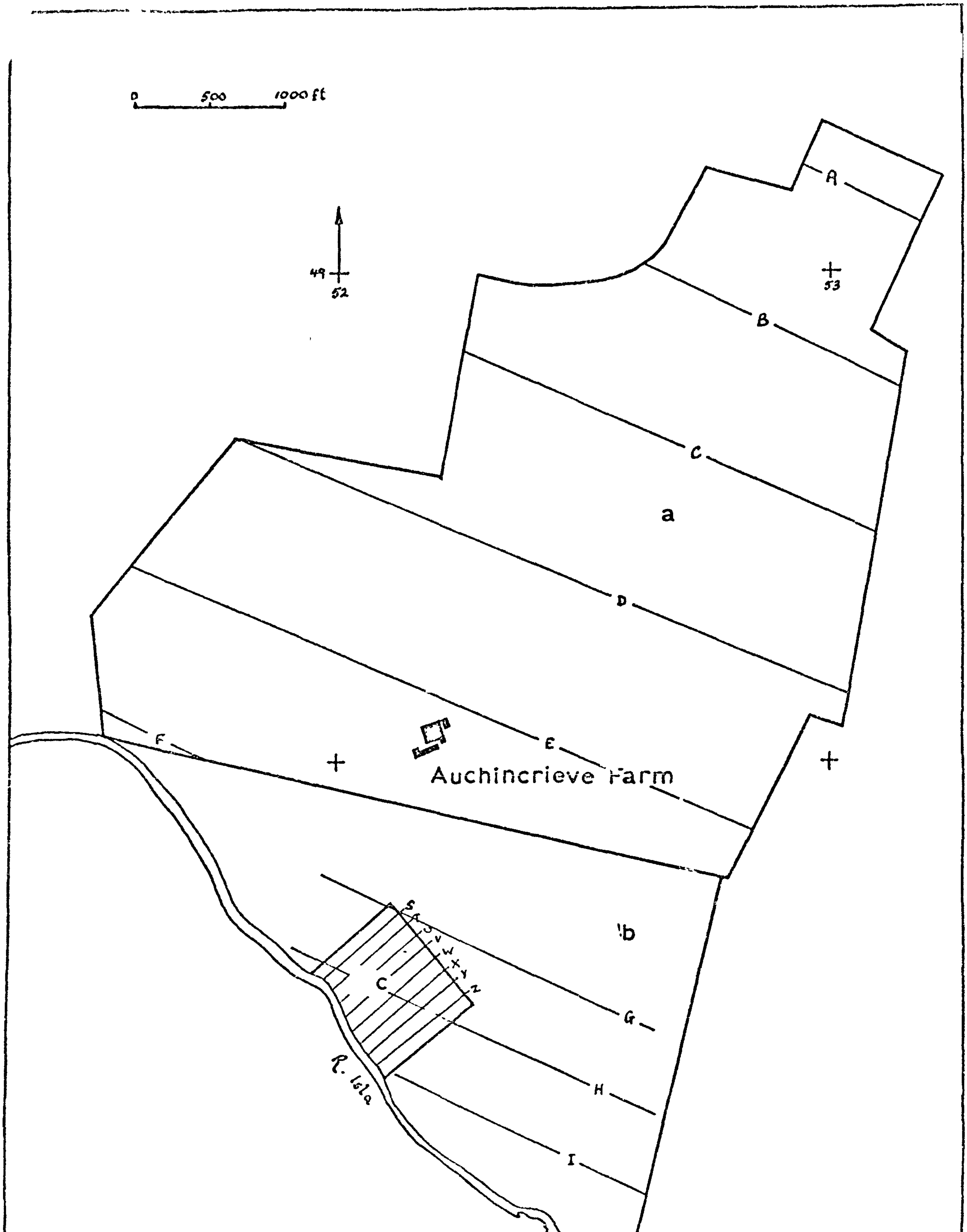
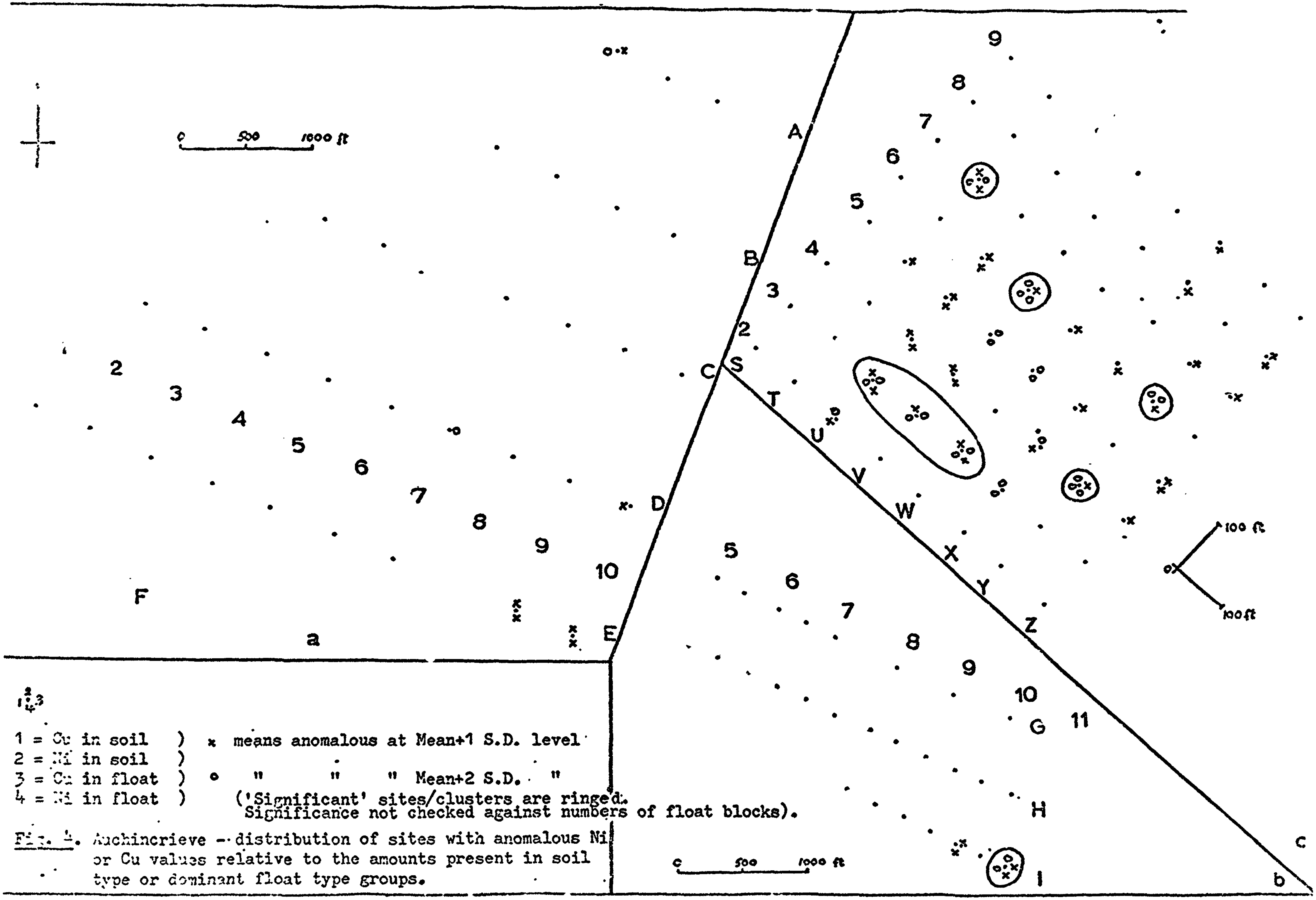
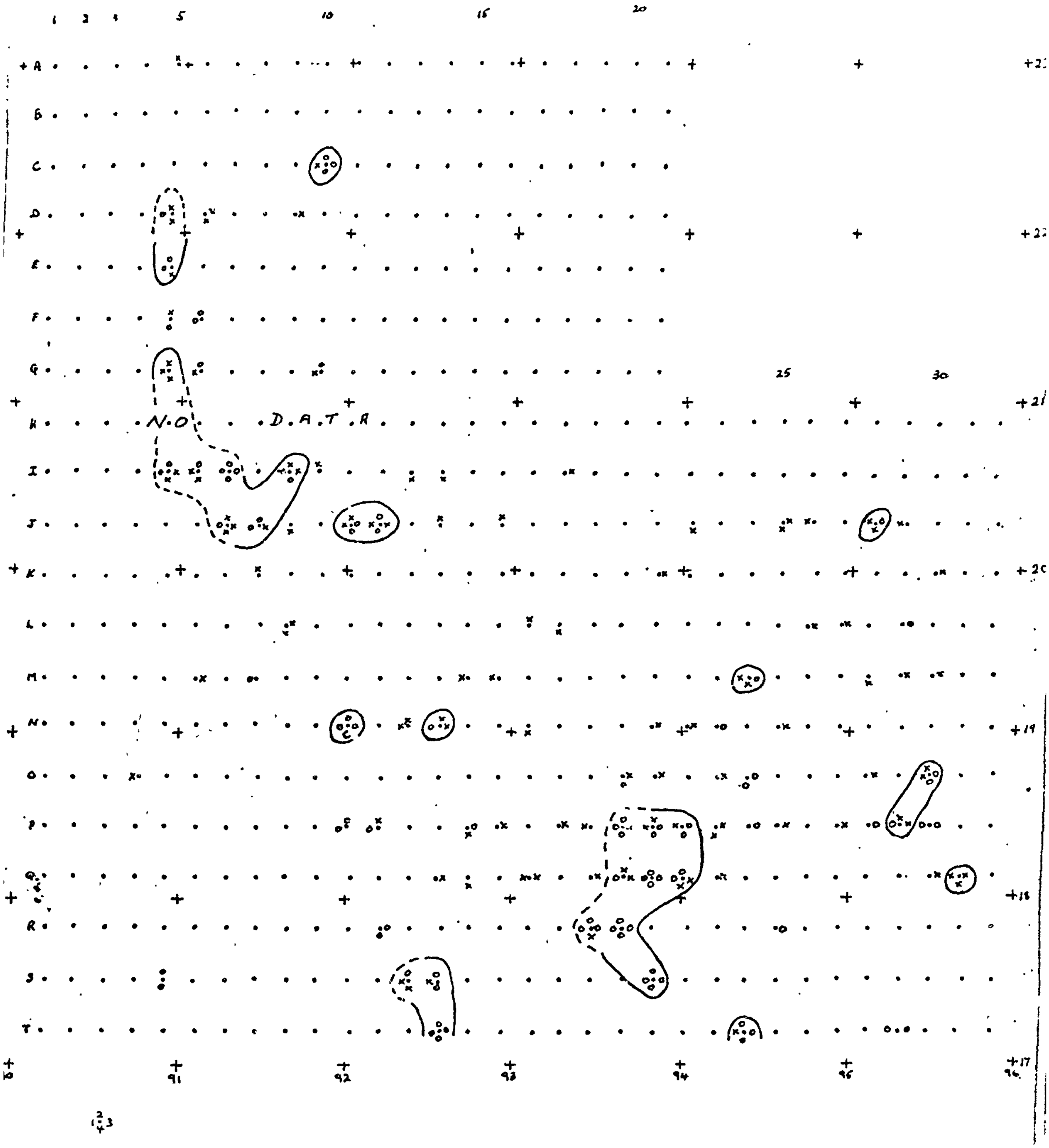


Fig. 2. Auchincrieve - line location.



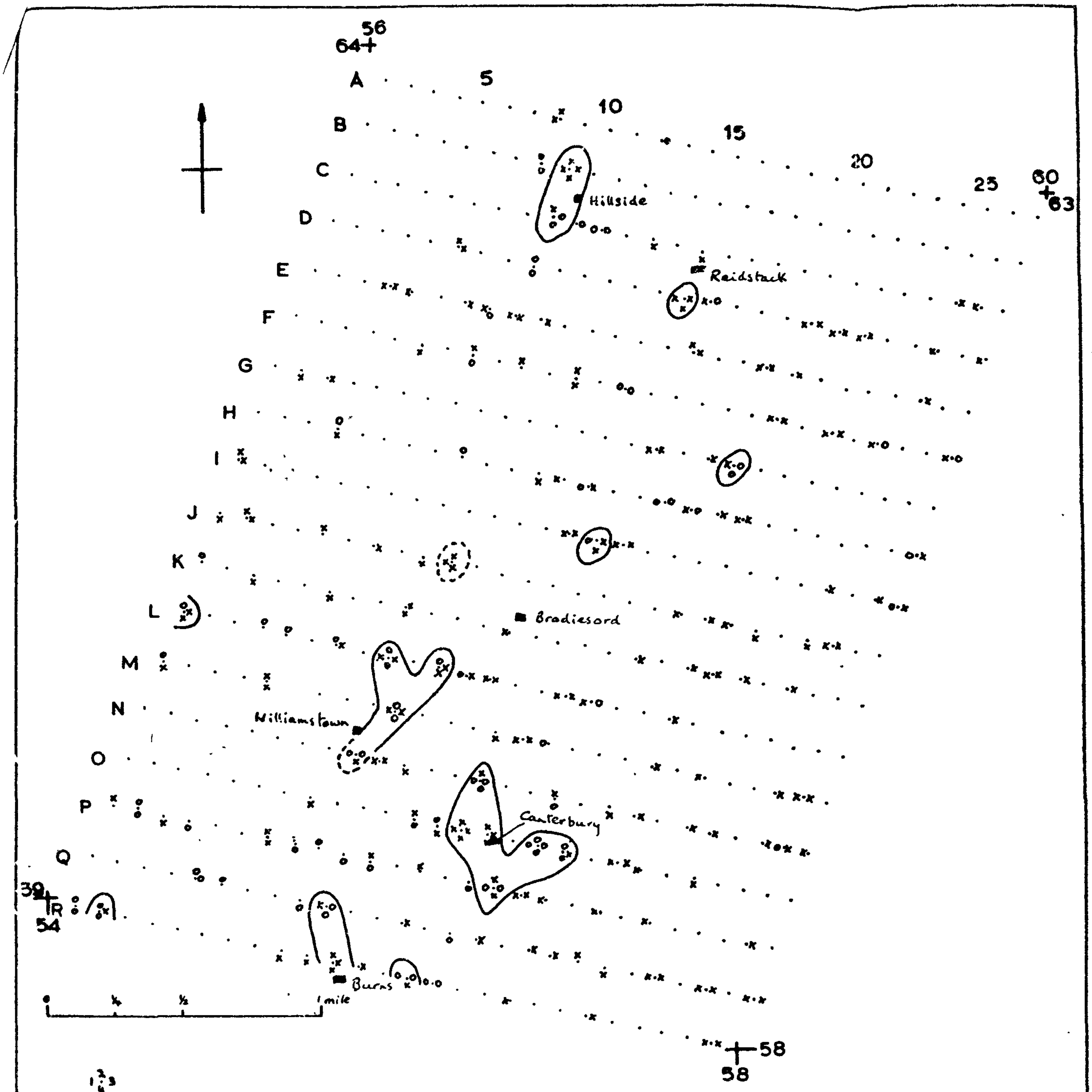
1 = Cu in soil) x means anomalous at Mean+1 S.D. level
2 = Ni in soil)
3 = Cu in float) o " " " Mean+2 S.D. "
4 = Ni in float) ('Significant' sites/clusters are ringed. Significance not checked against numbers of float blocks).

Fig. 4. Auchincrieve - distribution of sites with anomalous Ni or Cu values relative to the amounts present in soil type or dominant float type groups.



1 = Cu in soil) x means anomalous at Mean+1 S.D. level) 'Significant' sites or clusters bounded by
2 = Ni in soil)) solid line are anomalous regardless of the
3 = Cu in float) o " " " Mean+2 S.D. level) numbers of basic or ultrabasic float blocks
4 = Ni in float)) present; not so where bounded by broken line.

Fig. 5. Belhelvie - distribution of sites with anomalous Ni or Cu values relative to the amounts present in soil type or dominant float type groups.



1 = Cu in soil)
2 = Ni in soil)
3 = Cu in float)
4 = Ni in float)

x means anomalous at Mean+1 S.D. level.)
o " " " Mean+2 S.D. level.)

'Significant' sites or clusters bounded by solid line are anomalous regardless of the numbers of basic or ultrabasic float blocks present; not so where bounded by broken line

Fig. 6. Brodiesord - distribution of sites with anomalous Ni or Cu values relative to the amounts present in soil type or dominant float type groups.

1 = Cu in soil)
2 = Ni in soil)
3 = Cu in float)
4 = Ni in float)

x means anomalous at Mean+1 S.D. level

o " " " Mean+2 S.D. level

'Significant' sites are ringed. All are anomalous regardless of the numbers of basic or ultrabasic float blocks present.

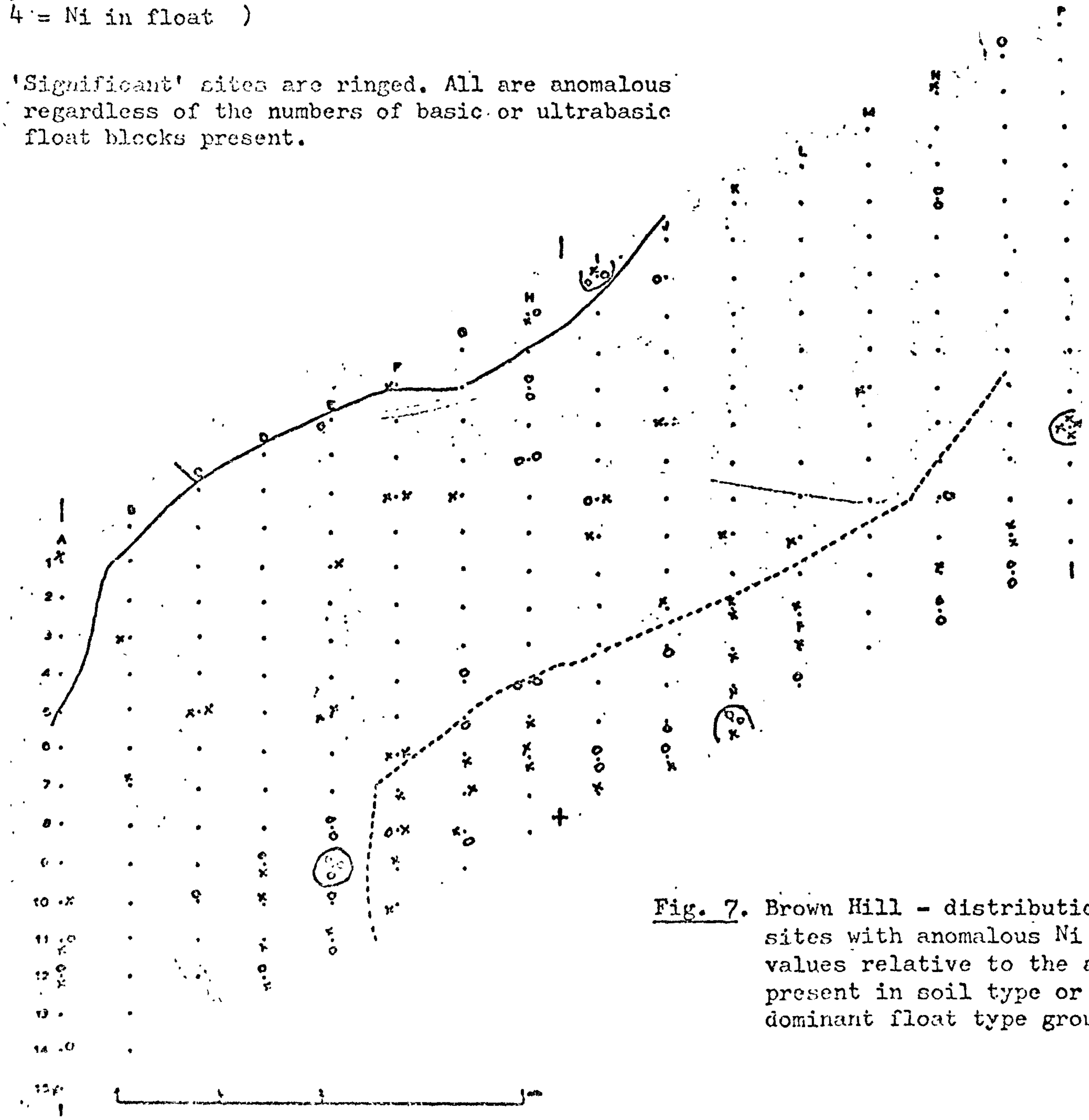
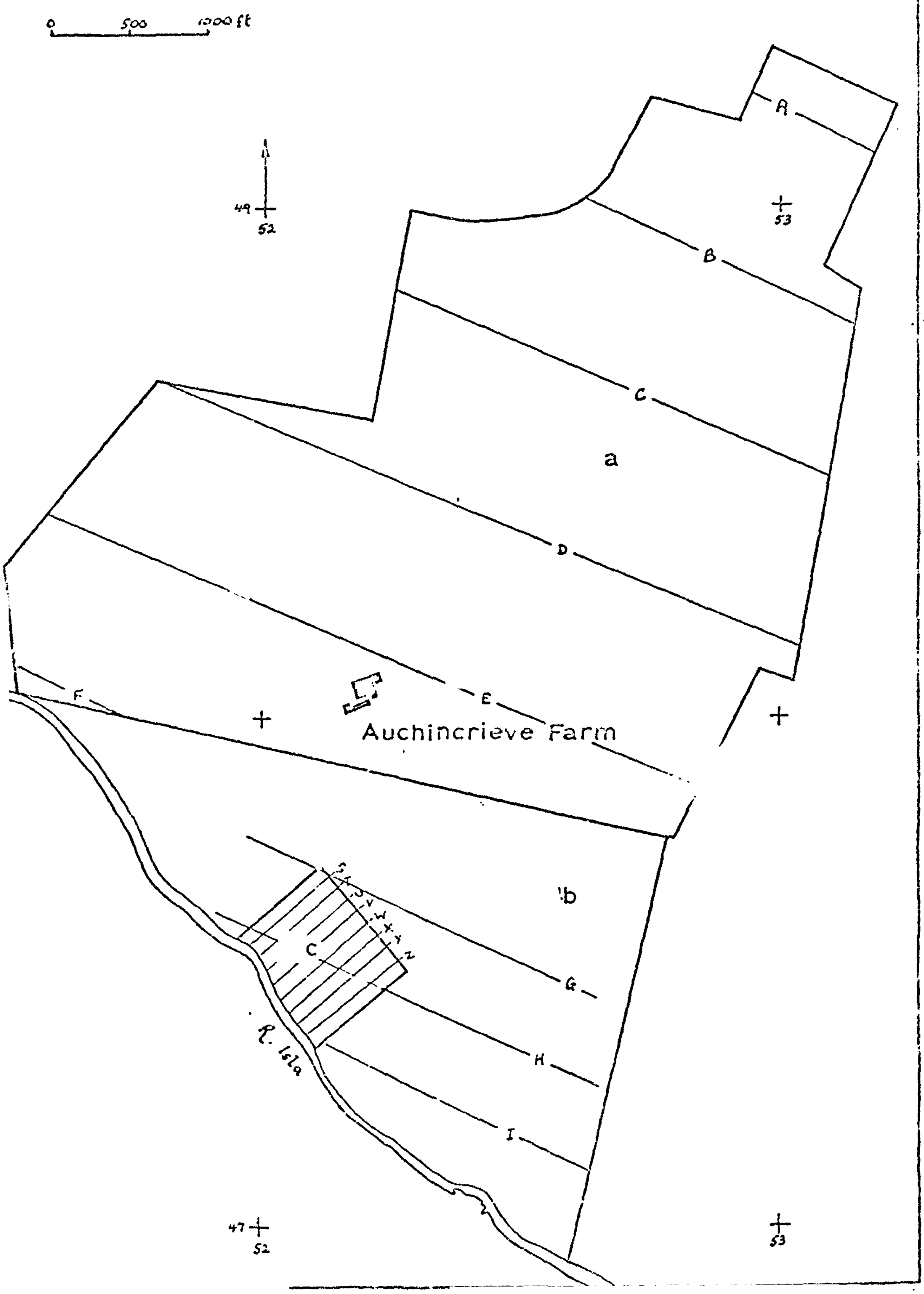


Fig. 7. Brown Hill - distribution of sites with anomalous Ni or Cu values relative to the amounts present in soil type or dominant float type groups


0 500 1000 ft
49
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Auchincrieve Farm
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R. Isla

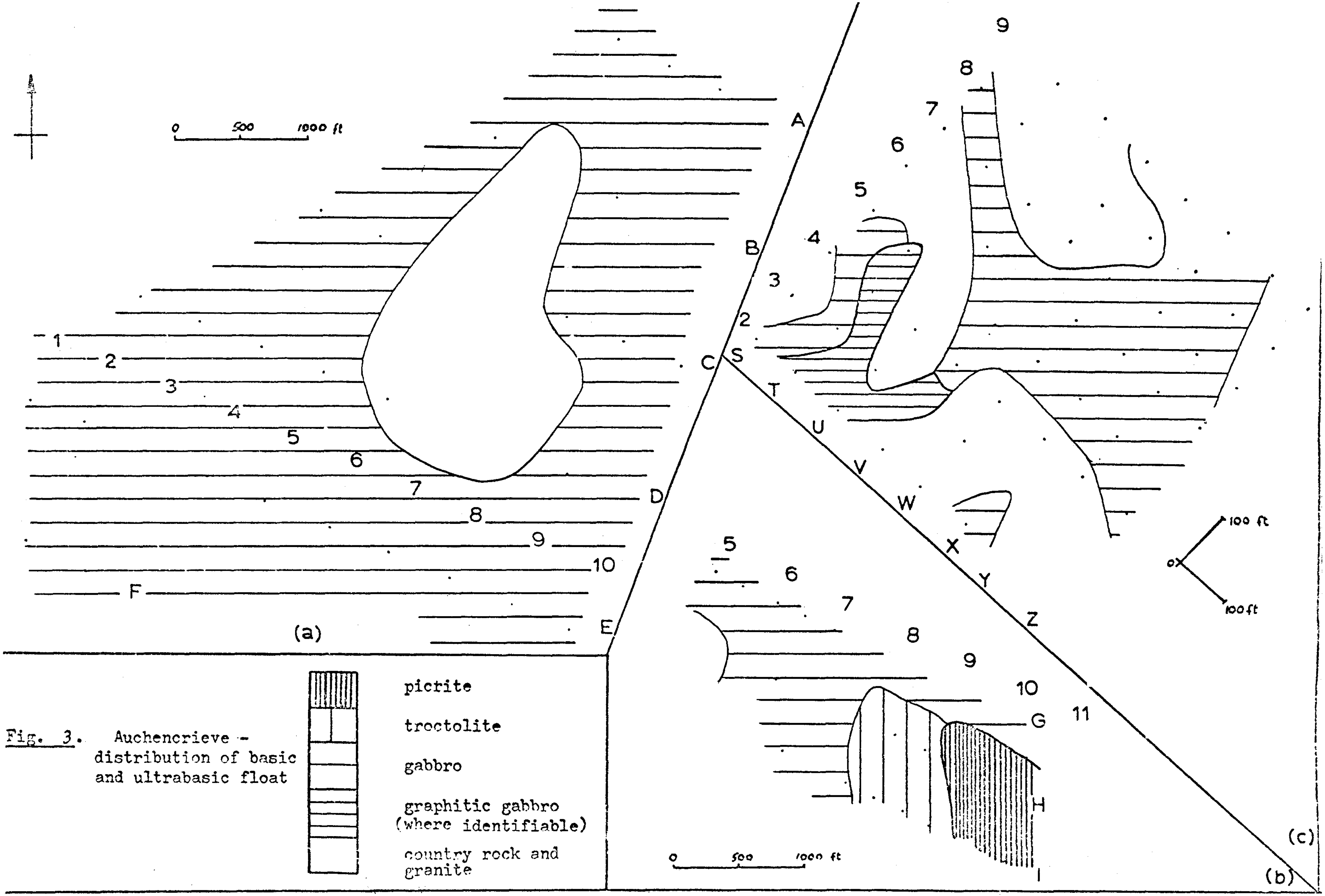

Fig. 3. Auchencrieve - distribution of basic and ultrabasic float

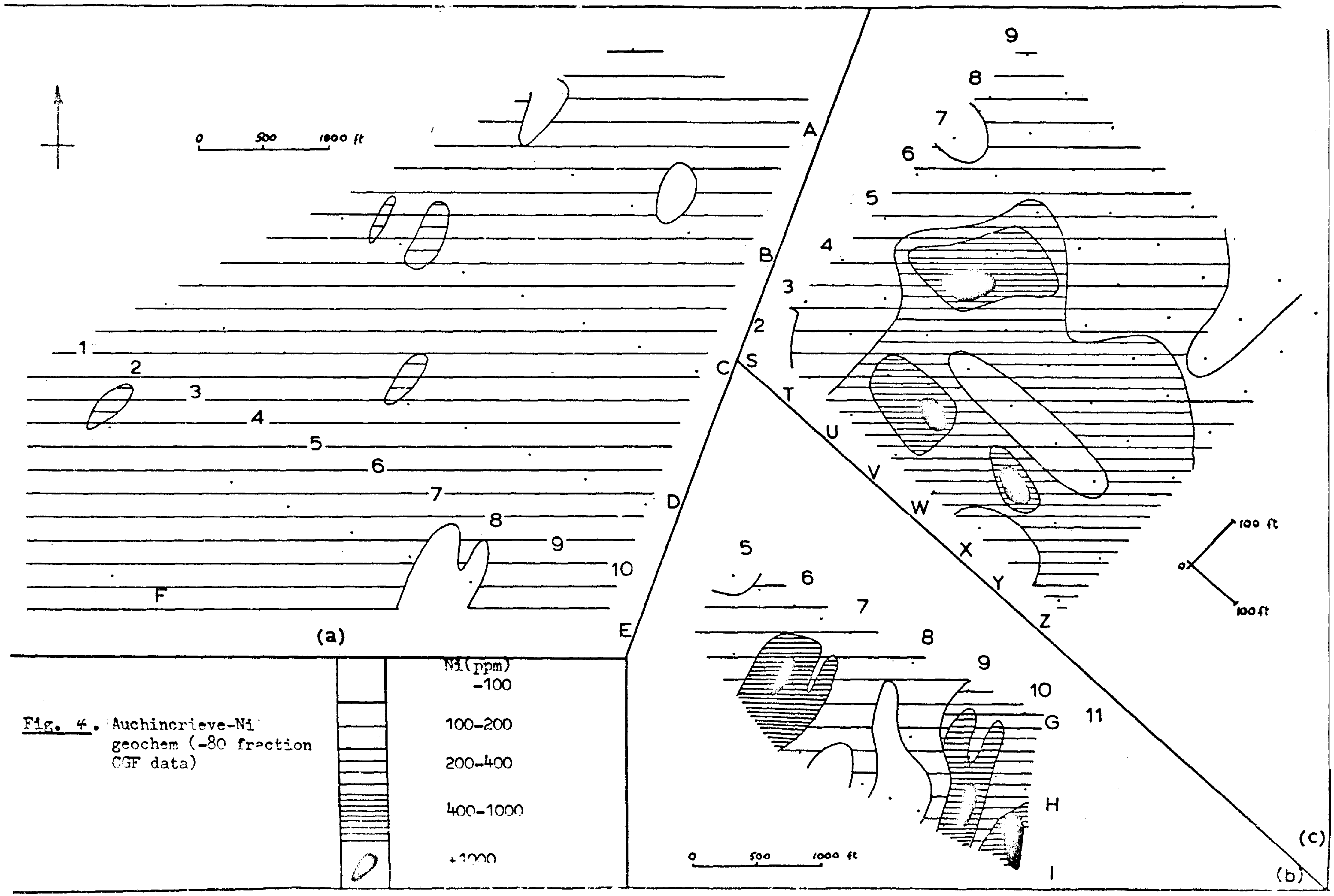

Fig. 4. Auchincrieve-Ni geochem (-80 fraction CGF data)

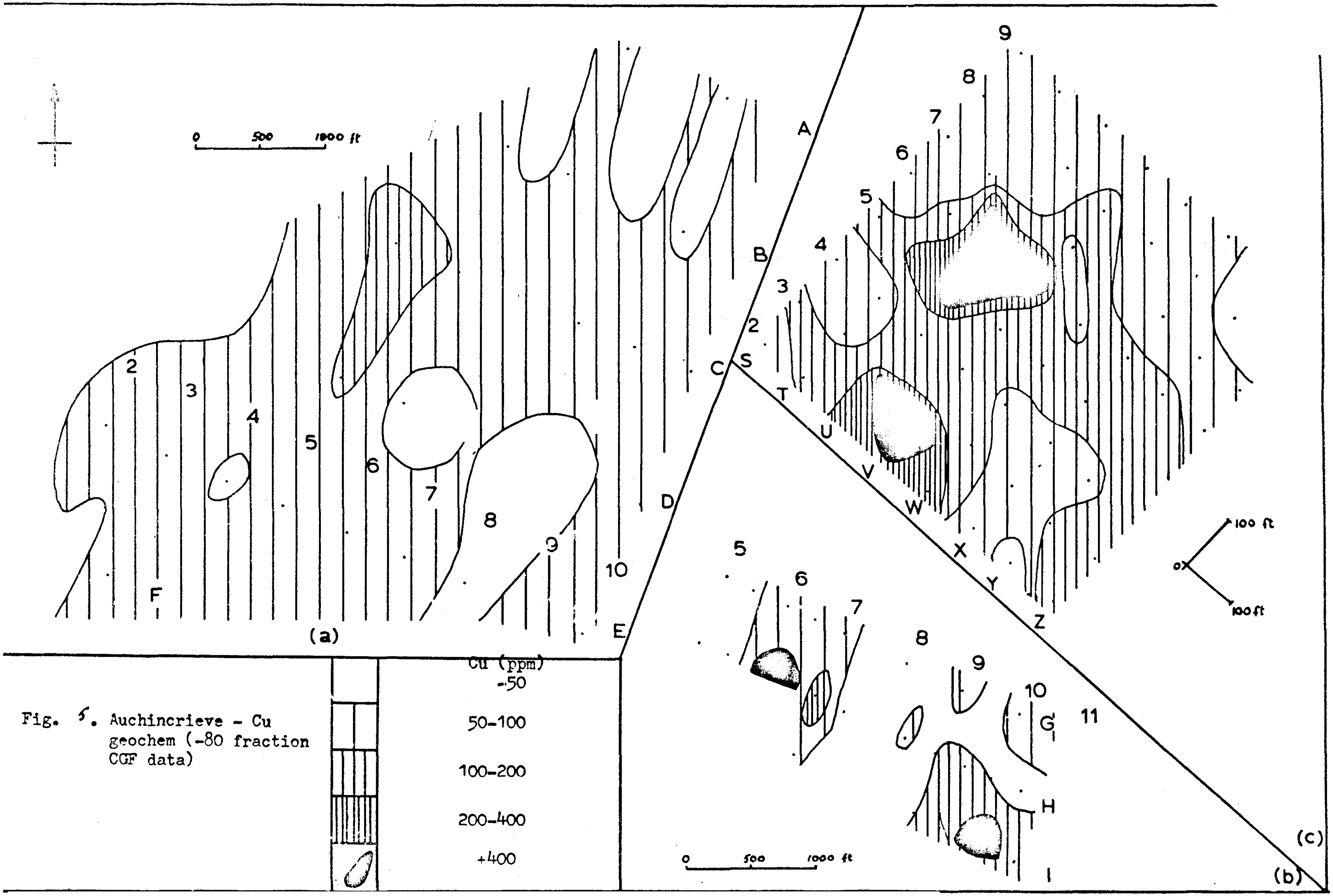

Fig. 5. Auchincrieve - Cu geochem (-80 fraction CGF data)

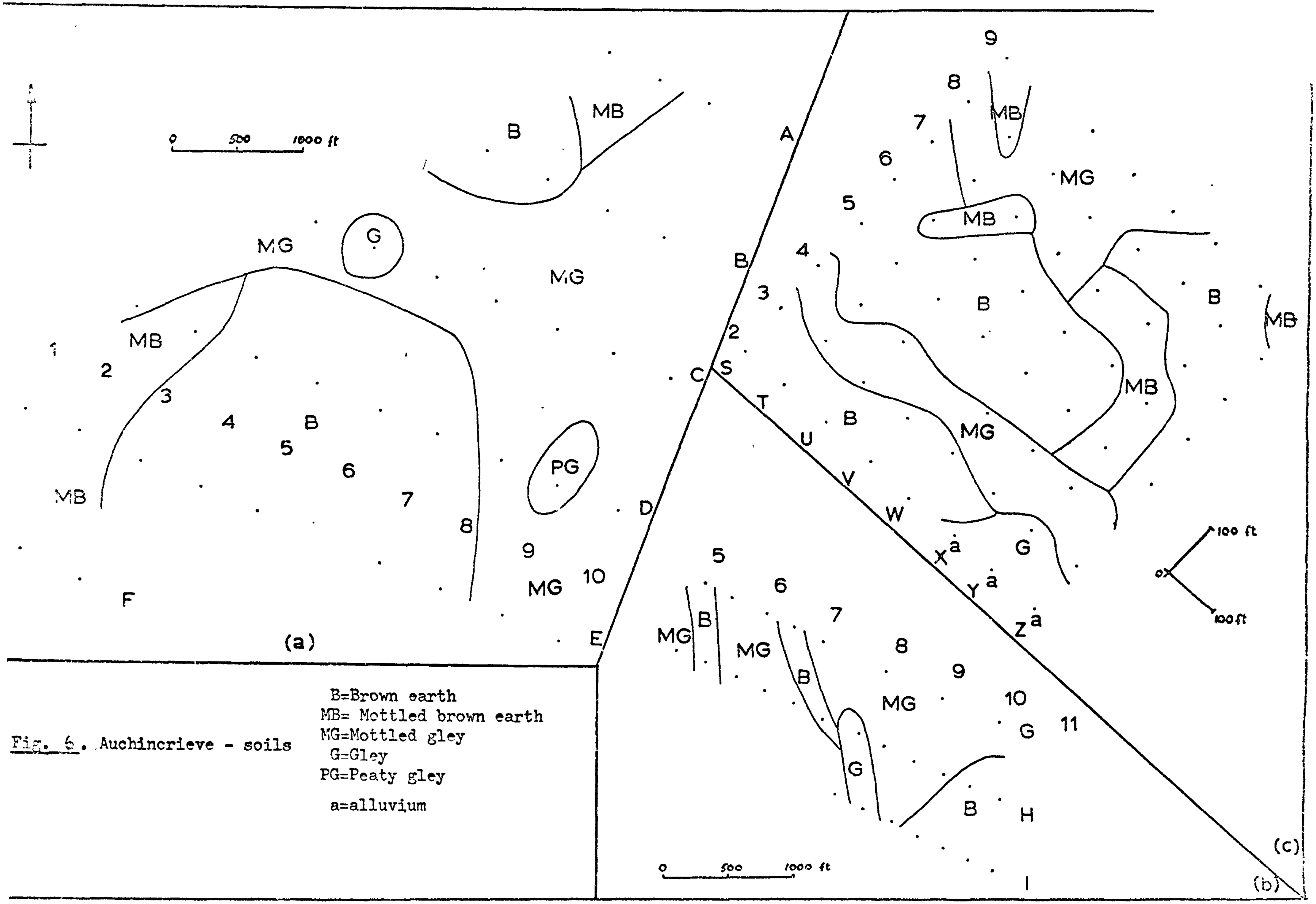

Fig. 6. Auchincrieve - soils

B=Brown earth
MB= Mottled brown earth
MG=Mottled gley
G=Gley
PG=Peaty gley

a=alluvium

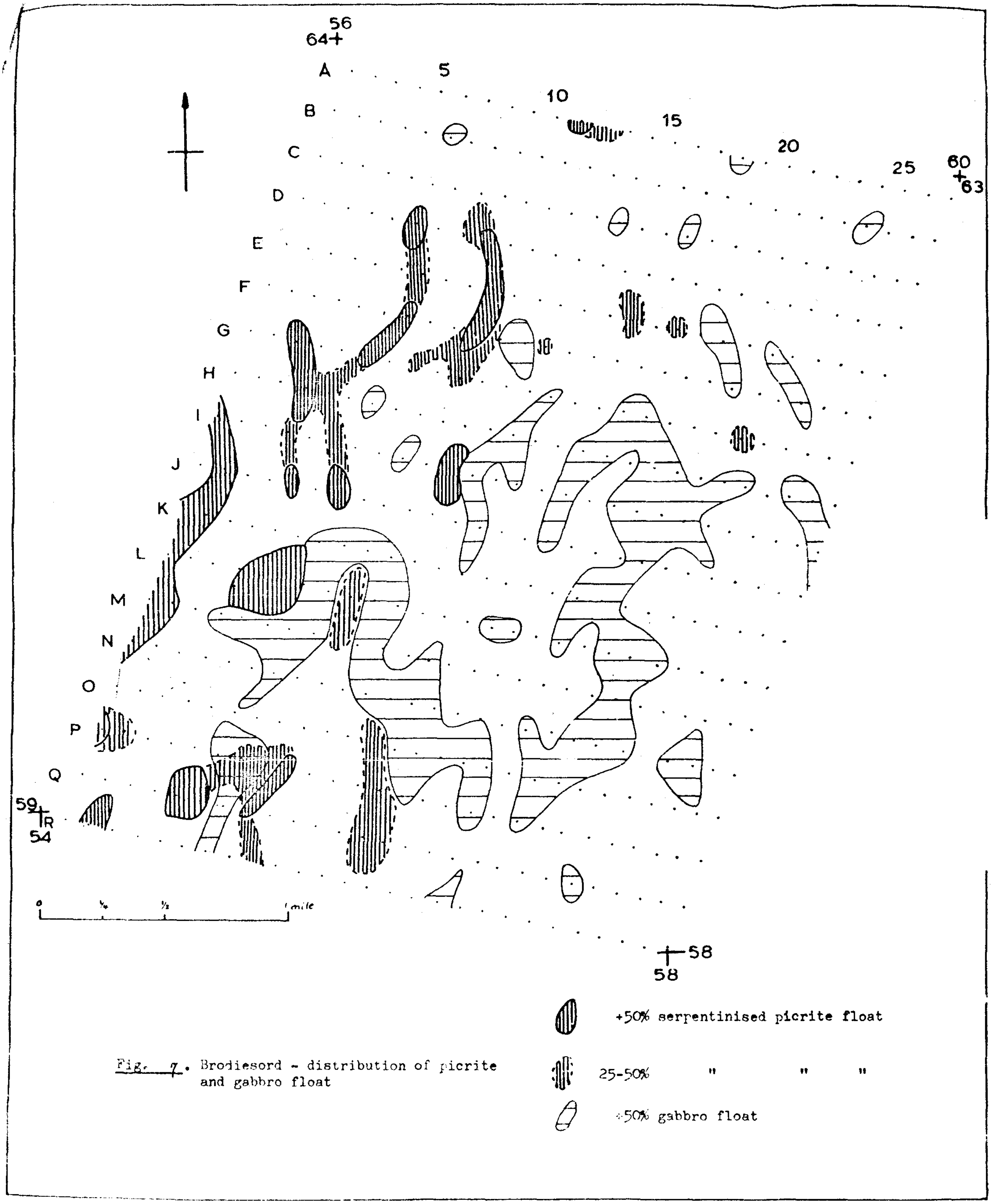

Fig. 7. Brodiesord - distribution of picrite and gabbro float

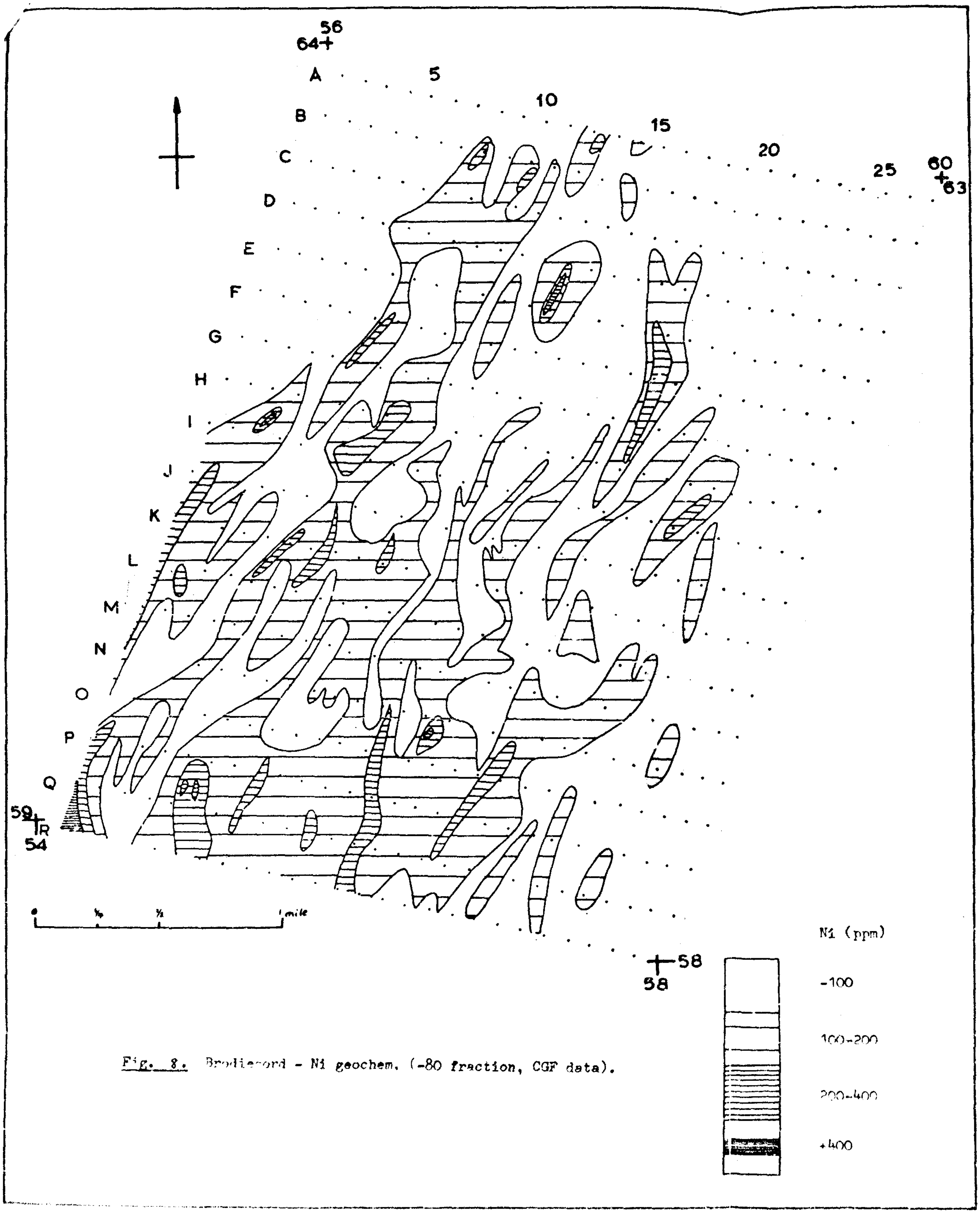

Fig. 8. Brodiecord - Ni geochem. (-80 fraction, CGF data).

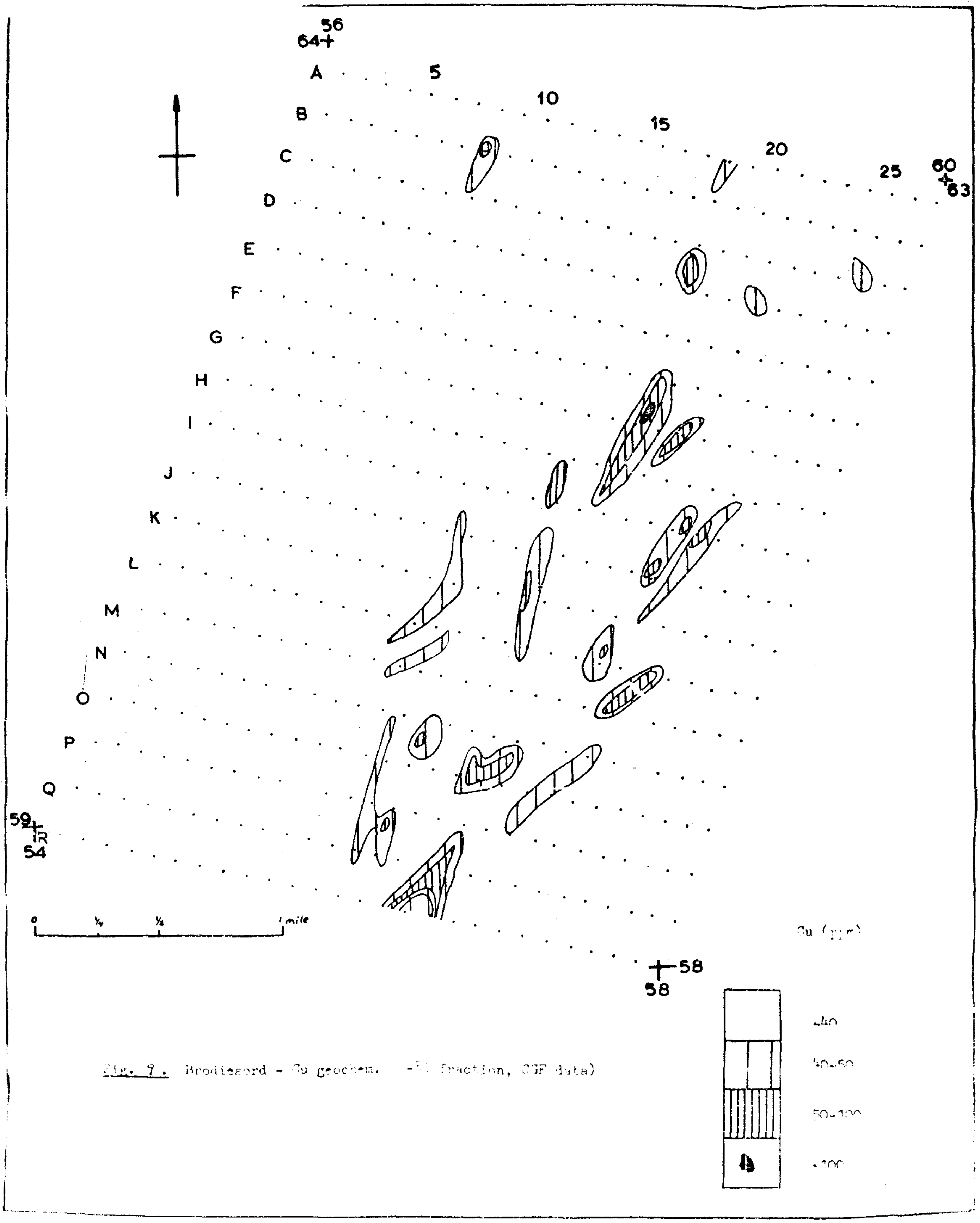

Fig. 9. Brodiesord - Cu geochem. -[illegible] fraction, CGF data)

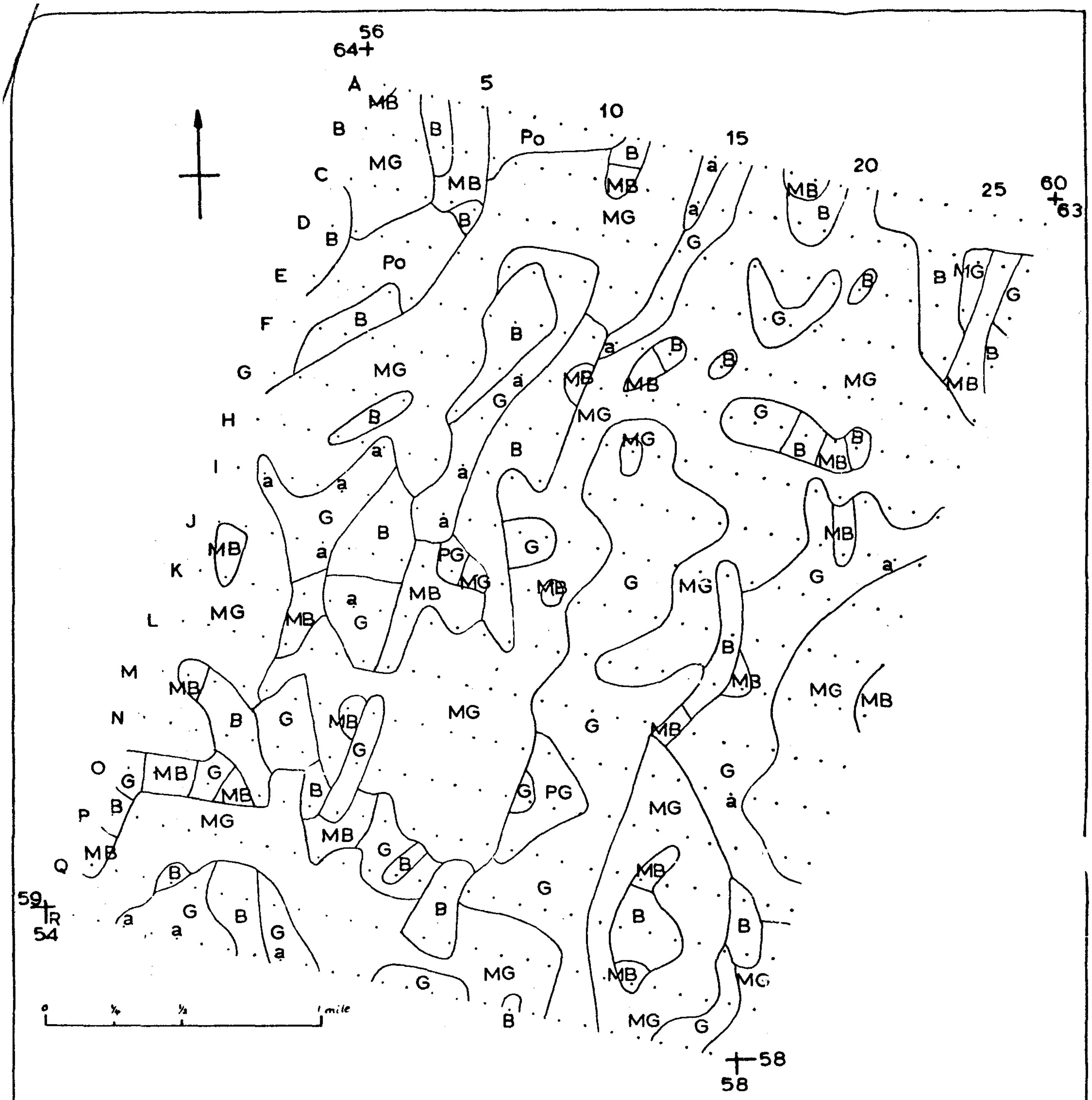

Fig. [illegible]. [illegible] - soils.

B = Brown earth
MB = Mottled brown earth
MG = Mottled gley
G = Gley
PG = Peaty gley
Po = Podsol
a = alluvium

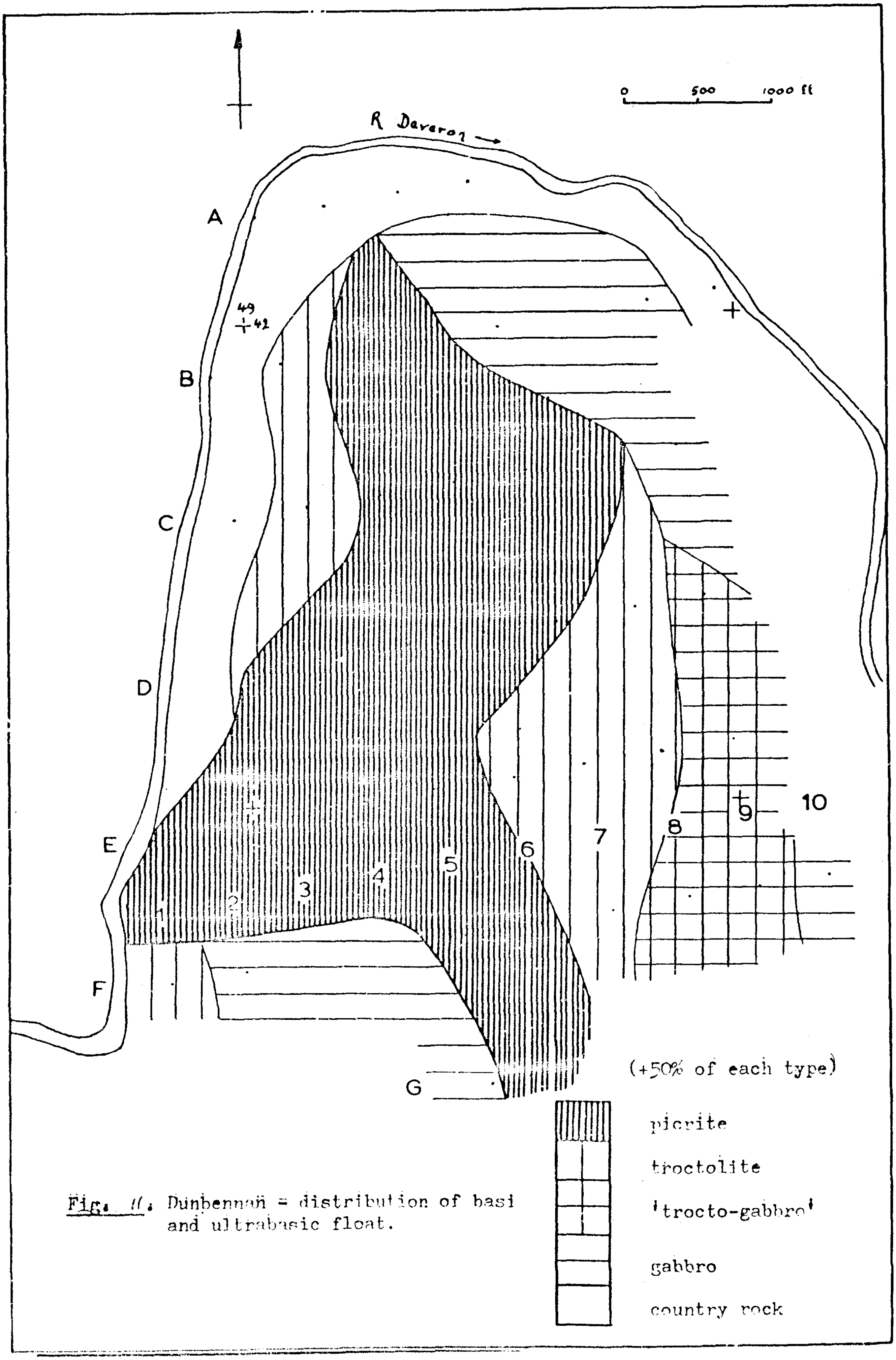

Fig. 11. Dunbennan - distribution of basic and ultrabasic float.

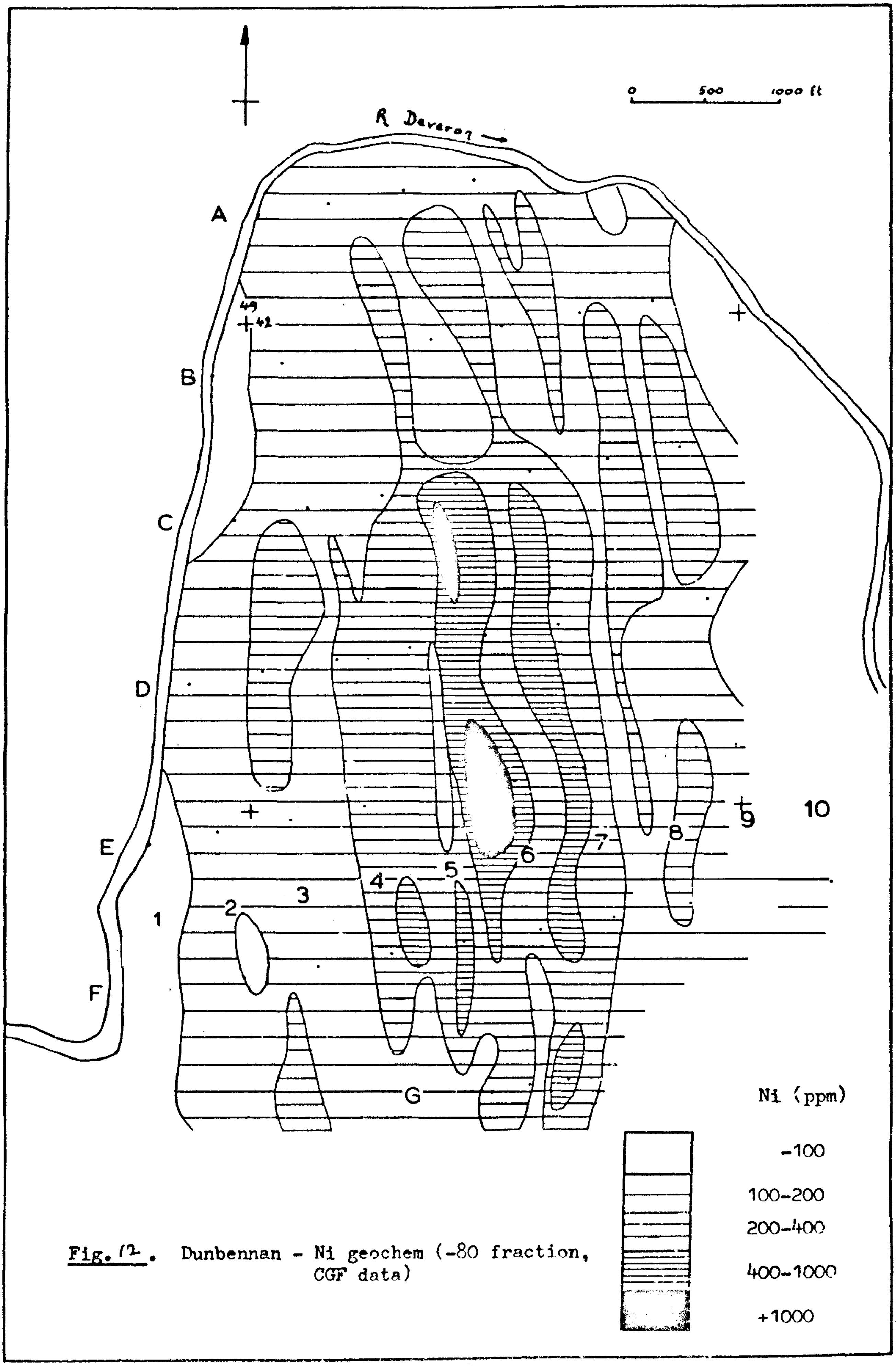

Fig. 12. Dunbennan - Ni geochem (-80 fraction, CGF data)

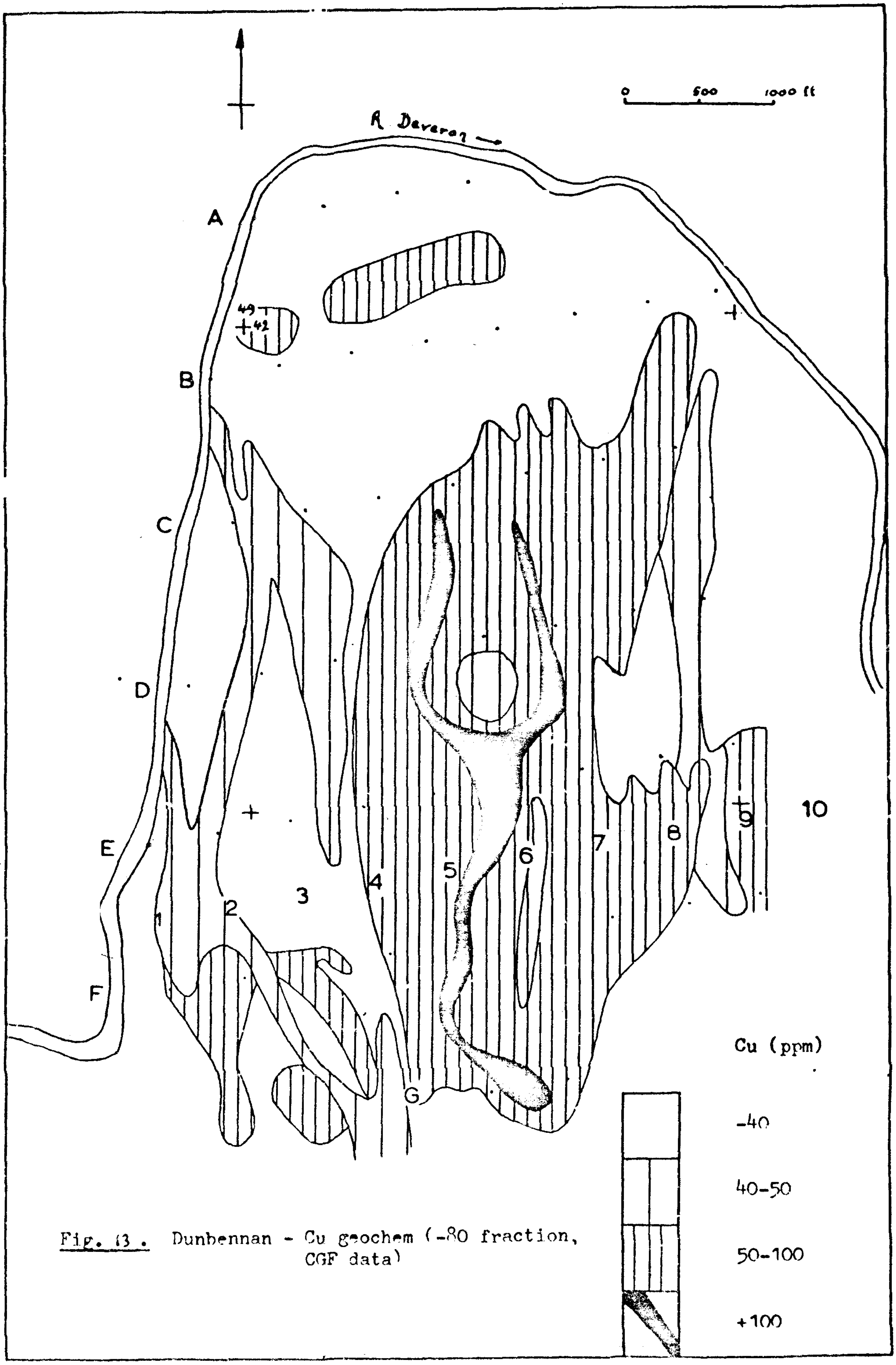

Fig. 13. Dunbennan - Cu geochem (-80 fraction, CGF data)

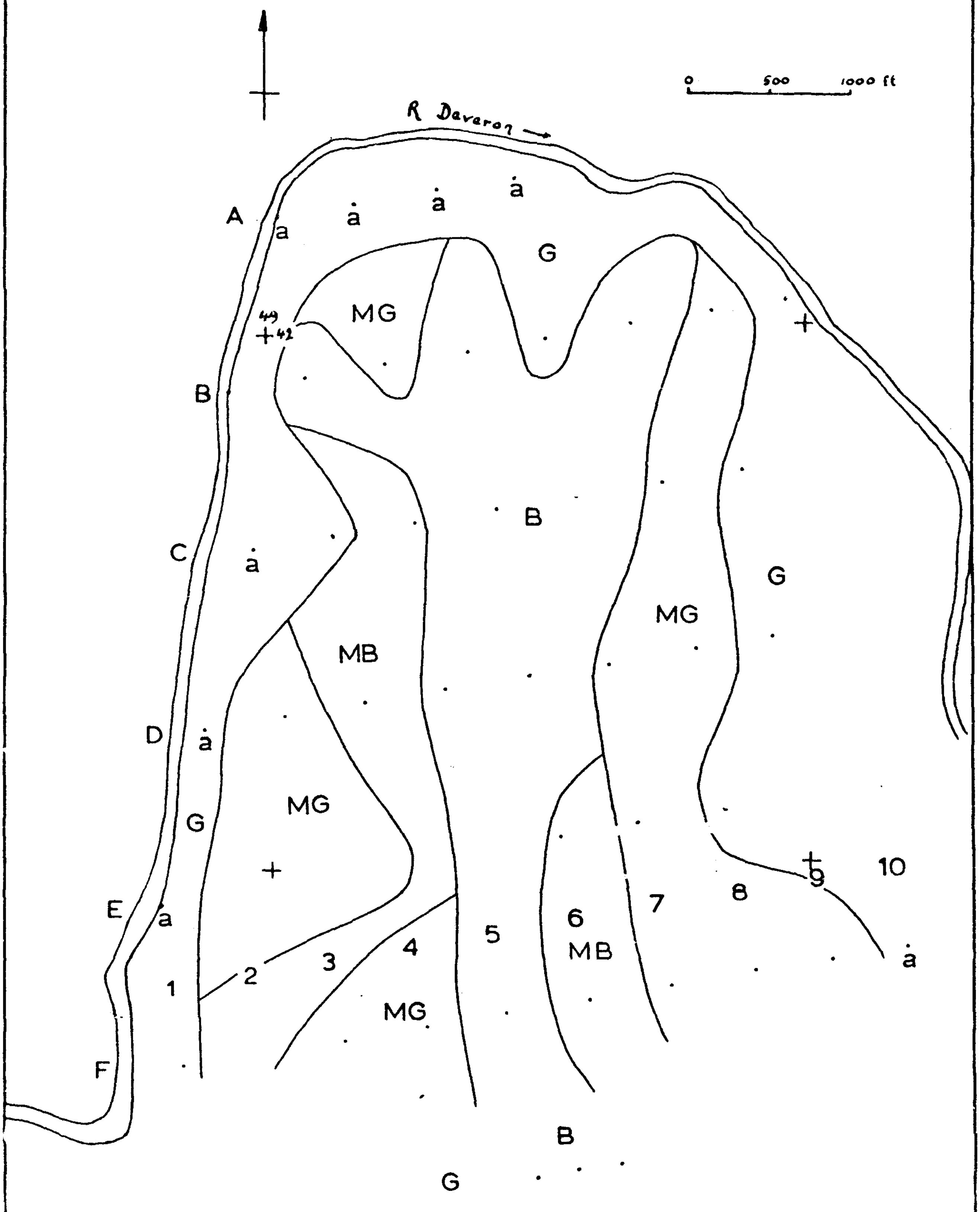

Fig. 14. Dunbennan - soils.

B = Brown earth
MB = Mottled brown earth
MG = Mottled gley
G = Gley

a = alluvium

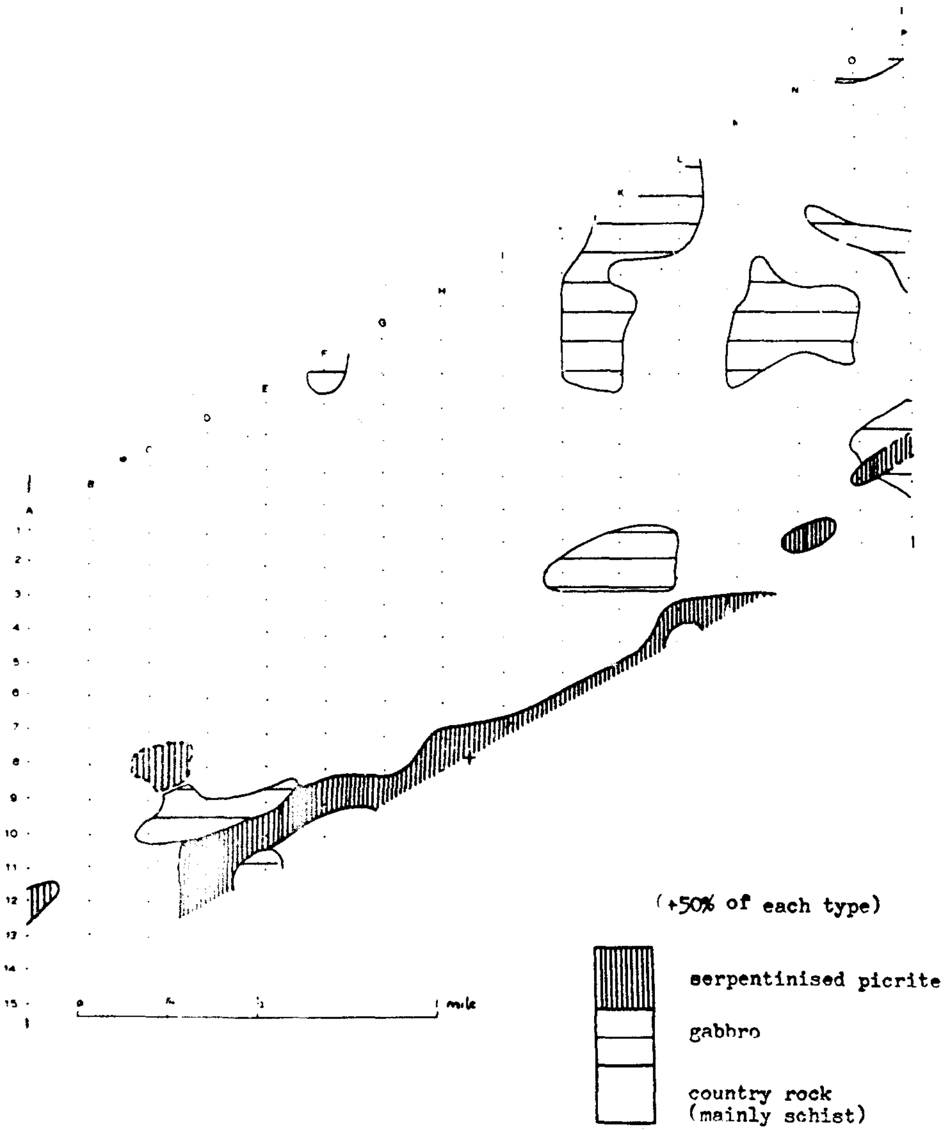

Fig. 5. Brown Hill - distribution of basic and ultrabasic float

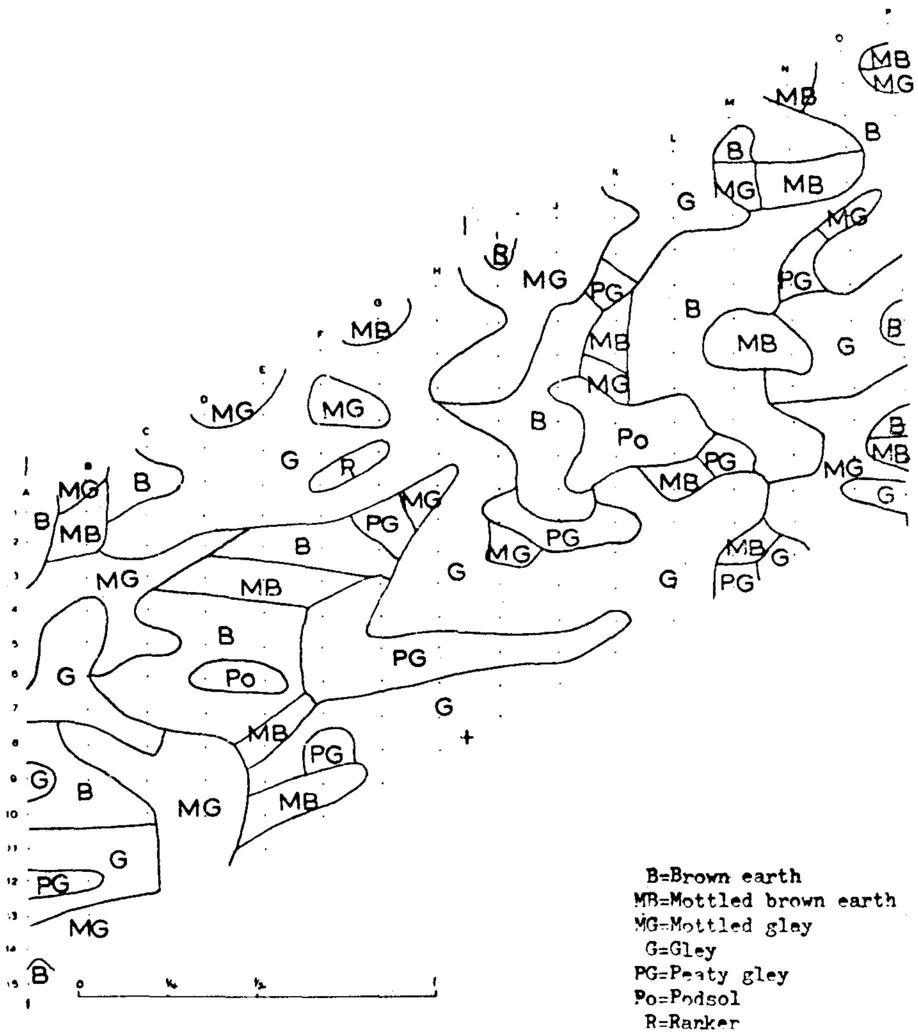

Fig. 18. Brown Hill - soils

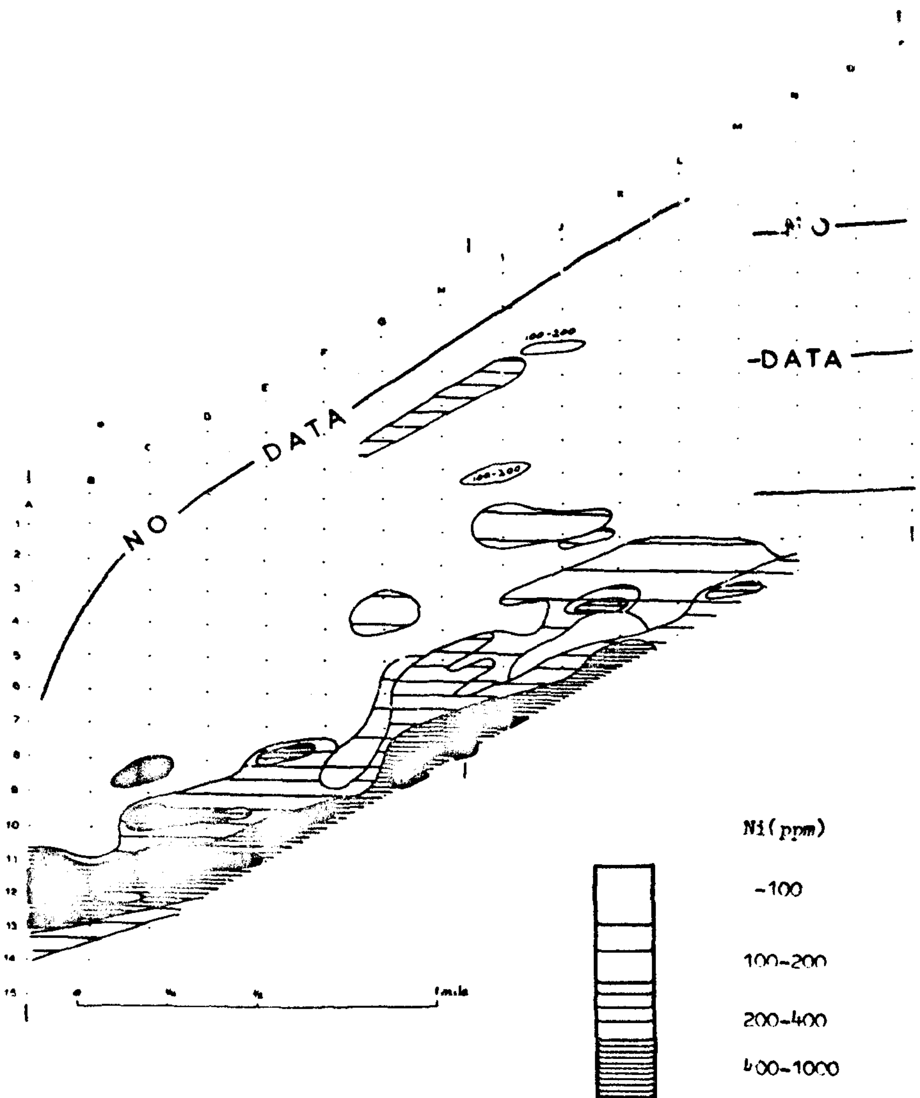

Fig. 16. Brown Hill - Ni geochem (-80 fraction, CGF data).

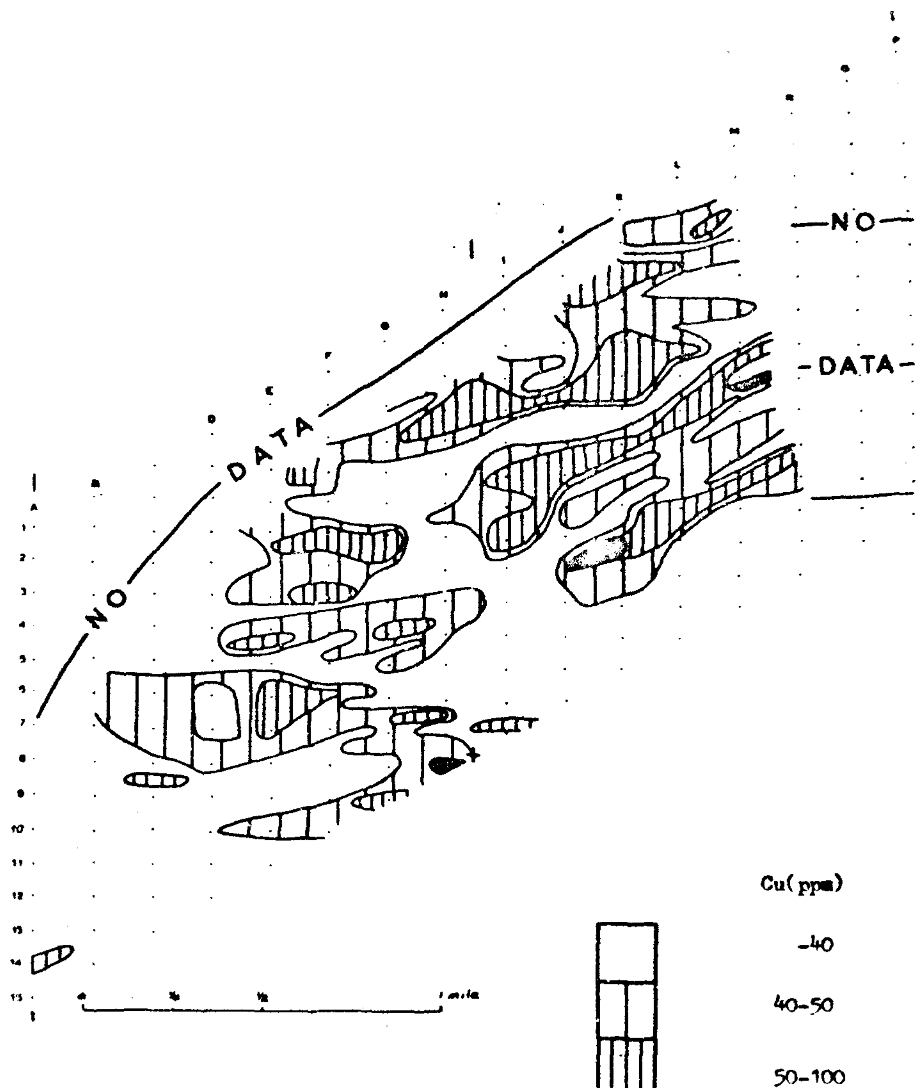

Fig. 17. Brown Hill - Cu geochem (-80 fraction, CGF data)

EVL SUMMARY OF METALLURGICAL TESTWORK

April 1971 to Feb. 1973

CONTENTS

1. MINERAL PROCESSING TESTWORK

1.1 Flotation

A considerable number of flotation tests have been conducted since April 1971, even though it was known, at that time, that the ore was not responding well to flotation due to oxidation during storage. The results of testwork were assessed with this in mind, and the tests designed to allow comparison of techniques and reagents by testing them within the same short period.

1.1.1 Removal of copper and nickel from a graphite concentrate

72 flotation tests were conducted to determine the reason for the copper and nickel flotation into the graphite pre-float obtained from CGF ores and hence obtain a copper-nickel free graphite concentrate. The testwork was conducted on CGF2 and CGF5. Tests were conducted on:-

i. frothers, to try to minimise frother collecting power.
ii. slime dispersants, to avoid smearing of graphite or sulphides.
iii. washing, to remove any possible oil contamination
iv. decontamination of equipment by reagents, prior to flotation.
v. size of grind
vi. flotation time
vii. copper depressants
viii. cleaner flotation
ix. a comparison with graphite-free ores.

It was concluded that (i) copper-nickel flotation into the graphite concentrate was achieved by the collecting power of the frother, (ii) a coarser grind would reduce this metal loss, but also reduce graphite recovery, (iii) copper-nickel depression during graphite cleanerflotation would recover the metals from the graphite pre-float, (iv) use could be made of the differing flotation times between graphite and the metals to reduce copper and nickel losses to the graphite concentrate.

1.1.2 Graphite depression in copper-nickel flotation

19 flotation tests were conducted on CGF1 and CGF2 in an attempt to obtain a copper-nickel concentrate with graphite depression.

A series of possible graphite depressants were tested. It was concluded that Aero depressant 633 was the best graphite depressant tested. ICI reagent's DS 4990 and DS4991 may be as effective as Aero 633, but the others were not as good. None of the reagents was totally satisfactory.

1.1.3 Silicate depression in copper-nickel flotation

5 flotation tests were conducted on RTZ 2.2 to compare the use of tylose as silicate depressant, with the ICI reagent series Cellophas, an alternative carboxymethylcellulose. It appeared that Cellophas may be more effective than tylose and have a lower process cost per ton ore.

1.1.4 Sulphide Collector

Sodium mercaptobenzthiazole was tested on RTZ 2.2 as an alternative to potassium amyl xanthate and found to have a possible application.

1.2 Gravity Separation

1.2.1 Shaking Table

Tests were conducted on CGF2 in an attempt to separate graphite from the ore by gravity. A successful separation would then indicate a possible means of separating copper and nickel from the graphite pre-float concentrate. The testwork was, however, totally unsuccessful possibly due to the shape of the graphite.

1.2.2 Heavy liquid tests

Heavy liquid tests were conducted on RTZ 1.2 and CGF5 at each of 4 different grinds. The ground material was deslimed and separations made at sg. 3.3 and 3.8 at Warren Spring Laboratories. The tests were not altogether satisfactory; a large proportion of the metals remaining in the lightest fraction even at very fine grinds.

1.3 Bacterial leaching of Pyrrhotite

A sample of pyrrhotite flotation concentrate, upgraded by magnetic separation, was sent to CRA in Australia for leaching tests. The results indicated that the nickel was fairly readily extracted, but that further work was required.

2. MINERALOGY

2.1 Microscopic examination of head material with reference to liberation

Examination of the results of microscopic examination suggested that improved beneficiation could be achieved on RTZ 1.3, RTZ 2.2, CGF2, and CGF5, by finer grainding. This was proved to some extent in practice.

2.2 Microscopic examination of tailings from CGF3 for metal occurrence

The tailings from flotation tests on CGF3 contained considerable proportions of the metals, particularly nickel, and were therefore examined microscopically to determine the metal occurrence. The results of this examination suggested that the copper may occur as cuprite included in limonite and the nickel as silicates; very small amounts of sulphide minerals were present.

2.3 Electronprobe micro-analysis of head material

The head samples were examined by electron probe. The results indicated that the cobalt content of the pentlandite was variable and the nickel content of the pyrrhotite was very variable.

3. ANALYSES

3.1 Iron

Iron analyses were conducted on the products of a test on CGF5, by the standard $HNO_3/HClO_4/HCl$ digestive and also by HF digestion, and AAS. A good metallurgical balance was achieved by both techniques.

3.2 Sulphur

Sulphur analyses were conducted on the products of tests on CGF3 and CGF5 by a gravimetric technique. Metallurgical balances were good and flotation recoveries high.

3.3 Molybdenum

Molybdenum analyses were conducted by AAS on the products of a test on CGF1 and showed very low molybdenum contents, $<$ 0.01% MO.

3.4 Precious Metals

The test products from several tests on RTZ 2.1 and CGF5 were sent to Johnson-Matthey Ltd. for precious metal analysis. The flotation tailings were upgraded by a gravity technique prior to dispatch. The results indicated that:-

(i) the gold content was negligible.

(ii) the silver, platinum and palladium were recovered in the flotation concentrates.

(iii) the silver recovery to the copper-nickel concentrate was high.

3.5 Complete analyses

Samples of flotation concentrates from RTZ 1.2 and CGF5 were sent to Warren Spring Laboratories for complete analysis by X-ray fluorescence and emission spectrography. The results were in agreement with analyses previously conducted at Chessington and by Johnson-Matthey.

3.6 Check analyses for copper and nickel

5 different samples, and one duplicate, of head material were prepared, and each split into four for check analysis for copper and nickel by four different laboratories. The laboratories concerned were:- Riofinex, Chessington; I.G.S.; Analytical Services Laboratory, Imperial College, Gold Fields Laboratories (pty) Ltd, South Africa.

Analyses were conducted by atomic absorption, titration, gravimetry, and polarography. The analytic results were in excellent agreement, showing the reliability of the analytical and sampling techniques at Chessington.

Ex Belhelvie

EVL SOILS RESEARCH PROJECT

SUMMARY OF RESULTS

The EVL soils research project was initiated in October 1969 under a three-year grant to cover the costs of a bursary to Bedford College, London University, plus field and analytical costs incurred by the student involved.

The purpose of the project was to investigate ways of improving geochemical interpretation in glaciated areas underlain by basic and ultrabasic rocks, the problem being that Ni and Cu in both silicate and sulphide forms might give similar geochemical responses.

Selection of areas

Initial work in the winter of 1969/70 was mainly on the East side areas, Belhelvie and Arthrath. These areas were chosen to compare the effects of good and bad exposure respectively. In the case of Arthrath, although exposure is poor, there was a fair amount of drill hole data available. Some laboratory work was also carried out on soil samples collected by CGF from Auchencrieve.

The 1970/71 winter fieldwork season was concentrated on the West Side, where the Brown Hill, Brodiesord and Dunbennan areas were investigated, and further work carried out at Auchencrieve.

Finally, in the autumn of 1971 geochemically background areas Old Rayne (West Side) and New Deer (East Side) were studied.

Field methods

The procedure used in the field was similar for all areas. Pits were dug to the B horizon on grids with line and station spacings of 1,000 ft. and 500 ft. respectively. At Auchencrieve, the part with known mineralization was sampled on a 100 x 100 ft. grid, in addition to wide-spaced sampling over a larger area.

A and B horizon soil samples were collected from each pit, accompanied by description of the soil profile, and collection of 20 float blocks from the B horizon.

Results

The initial phase of the project consisted of orientation studies at Belhelvie and Arthrath. The results showed reasonable correlations between soil types, float types and Riofinex soil geochemistry at Belhelvie. Highest Ni values coincided with well drained soils in thin drift over solid dunite, or in areas with dunite-dominated float. Lower values were found in poorly drained soils, usually downslope from dunite bodies but sometimes associated with dunite float.

The float patterns demonstrated that a considerable proportion of the western dunite ridge was covered by drift derived mainly from country rocks, and strongly suggested that dominant ice movement was from the west.

At Arthrath the Ni anomalies were in poorly drained soils downslope of an E-W seepage line. The anomalies were associated with norite float, but elsewhere in the area norite float correlated with low geochemical values. It seemed from this that the geochemical anomalies were either due to dunite, or to locally mineralised norite.

Due to poor exposure it was difficult to be sure of ice movement directions or transport distances. The impression given was that no great movement had occurred, and the N/S orientation of the float types suggested ice movement, if any, from the north.

The main conclusions were that soil and float studies provided useful information in interpreting geochemical data. However, the fact that expression of the Arthrath mineralization appeared to depend mainly on ground waters coming to surface suggested some possibility of mineralisation in similar topographic settings elsewhere escaping geochemical detection.

The initial fieldwork was followed by laboratory studies to obtain information on the forms in which the base metals were held in soils

Channel samples were collected down soil profiles representing the major types at Belhelvie and Arthrath. Some types were collected from mineralised and unmineralised areas. Ni and Cu were determined on -80 and -270 mesh fractions. These results were compared with those of particle size, heavy and light mineral and organic matter analysis.

It was found that in poorly drained soils there was a good correlation between clay and base metal contents. There were also indications that A horizons might give better contrasts than B.

Study of light and heavy mineral fraction revealed that most of the base metals seemed to originate from low S.G. minerals, presumably silicates, but the methods used were too drastic to determine what proportion, if any, of the metals was held in iron oxide coatings. There was some correlation between opaque:clear and between magnetic:nonmagnetic mineral ratios and geochemistry of the fine sand fractions in anomalous profiles. It was concluded from this that in well drained soils most of the metals were present in silicate form in the profiles studied. In poorly drained soils, retention of base metals by clay minerals could be an important factor.

Recommendations made for further laboraroty studies included additional investigations of heavy mineral base metal contents, and development of methods to study base metal contents of iron oxide coatings of mineral grains. Consideration of the practical difficulties involved in routine use of heavy mineral geochemistry, following discussions with Chessington laboratory staff, led to a decision not to proceed with this line of study. Follow-up laboratory work therefore concentrated on oxide coating studies.

A further recommendation was made to look at the relative merits of A vs. B horizon sampling.

The third phase of the project was a laboratory study of metals in oxide coatings. The object was to evaluate the possibility of detecting sulphide weathering products (oxides) against a background of weathering silicates. Oxide coatings were removed from mineral grains by sodium dithionite, a reagent known to reduce and dissolve iron oxides without attacking silicates. For practical reasons fine sand material (-80 +270 mesh) had to be used, and metals present in the oxide coatings estimated by difference rather than directly.

A first step was an empirical correlation between metals in oxide coatings and available information on mineralisation. This showed encouraging results at Arthrath and Auchincrieve, where oxide fractions containing more than 20% and 40% of the total Ni and Cu respectively correlated with mineralisation.

Snags revealed during the study were:-

(a) there were indications that metal values in coatings were lower in poorly drained than in well drained soils.

(b) the coating results were unreliable below 100ppm and 50ppm total Ni and Cu respectively.

A similar study at Belhelvie showed a large number of samples with 'anomalous' coating Ni and Cu. In the absence of drill hole data, the significance of these samples was assessed by correlation of sulphide contents of float samples. About half the samples with anomalous base metals in coatings were associated with anomalous sulphides in float. This suggested that silicate clays were present along with oxides as coatings to the mineral grains. Analysis of the Mg content of coatings showed that many contained abnormal amounts of Mg, suggesting a significant silicate clay presence.

Taking all this into acoount, starting with 75 samples with anomalous total Ni and Cu, coating analysis eliminated all but a group of 19 samples with anomalous metal contents in coatings which could not be explained by presence of clays. Eleven of these samples correlated with abnormal sulphide contents in float.

Most of the samples with background metal values in coatings but anomalous sulphides in float came from poorly drained soils.

This study covered 10 sq. miles and defined two areas of interest less than 1 sq. mile.

The conclusions from this study were that the oxide coating approach seemed interesting, because it could be used to screen geochemical anoma lies associated with geophysical conductors. which might equally be due to magnetite or pyrrhotite. However the problems of low analytical sensitivity required further investigation. So did the problems of clay removal from coatings, and relating coating metals contents to soil types. These aspects were scheduled for study in later phases of the project.

At the end of the first year, the project had established the following points:-

1. A good correlation between soil geochemistry, float and soil types in two East Side areas.

2. The possibility that A horizon might give better contrasts than B horizon geochemical data.

3. A reasonable correlation between metals held in oxide coatings in soils and sulphide mineralisation.

Work during the second year was designed to confirm and extend these findings by investigating field areas on the West Side, and trying to improve the procedure for estimating metal contents of oxide coatings.

All work during the second year of the project was in the Auchencrieve, Brodiesord, Dunbennan and Brown Hill areas on the West Side.

In all four areas there was a good correlation between soil geochemistry and dominant float types. In areas of strong relief (Dunbennan and Brown Hill) soil geochemistry also correlated well with soil type. This was also the case in parts of the Auchencrieve area, but not at Brodiesord where over much of the area relief contrasts are weak.

In all areas there appeared to have been little displacement of float by glacial activity, but at Brown Hill the steep slopes had apparently caused rather more mixing of float than elsewhere.

The conclusions from this study were that it confirmed results from the East Side showing general correlations between soil geochemistry and float and soil types. Further, it suggested a closer relationship between geochemistry and float rather than geochemistry and soils.

In parts of the Brodiesord and Brown Hill areas some geochemical values seemed abnormally high for the gabbros and contact epidiorites with which they were respectively associated, suggesting possible mineralisation.

One of the problems brought to light by this study was the difficulty of checking apparent correlations between float and soil types, and soil geochemistry. It was also possible that the generalisations made in preparing maps and overlays could be obscuring important relationships. A computerised data handling programme was therefore written in an attempt to solve both problems.

The object of the programme was to divide samples into soil profile or float type groups. Means and standard deviations were calculated for the metal values of the samples in each group. The output from the programme was a list of samples, with values of those metals which exceeded the threshold for particular float or soil types.

Two variations of the programme were run. The first correlated geochemistry with dominant float type. The second related geochemistry to numbers of basic or ultrabasic float blocks out of the total of 20 collected at each site.

The programme was used to compare the results of -80 mesh A and B horizon samples collected from Auchencrieve, Brown Hill and Brodiesord. It was found that A horizons contained less metal and had a more restricted range of metal values than B horizons, suggesting dispersion of metals from B horizons over a much greater volume of A horizon material. No consistent relationship could be detected between A horizon data and soil or float types. This work therefore failed to substantiate previous indications that A horizon might have some advantages over B horizon geochemistry.

Computerising the assessment of B horizon geochemical results confirmed that they reflected float composition more closely than soil type. This conclusion applied to all the areas studied on East and West Sides.

The results from Auchencrieve picked out the graphite gabbros as the rock type most likely to be mineralised. Cu:Ni ratios in samples with dominant graphitic gabbros float were close to unity. A group of samples with anomalous metal values with respect to float and soils occurred in the area.

In the remaining areas, no single rock type had particularly striking metal values but at Arthrath the norites had slightly higher values than other rock types, with Cu:Ni ratios close to unity also. In this area, and also at Brodiesord, the evaluation picked out clusters of samples which contained more metals than normal for the associated float type.

At Belhelvie similar clusters were detected when geochemistry was correlated with dominant float type. However, the correlation with numbers of basic or ultrabasic float blocks at each sample point strongly suggested that they were due to concentrations of unmineralised ultrabasic float rather than to mineralisation.

At Brown Hill only a few scattered anomalous sample points occurred, suggesting low potential for significant mineralisation.

The conclusions from this study was therefore that using separate thresholds for different float and to a lesser extent soil types led to a distinctly clearer picutre of mineralisation potential in the areas studied.

While this work was in progress, further laboratory studies were being made of improving metal extraction from oxide coatings. Unfortunately, these studies failed to find any method which led to improved detection limits for Ni and Cu in oxide coatings. This failure meant that areas such as Brodiesord, where total Ni and Cu values were generally below 100 ppm and 50 ppm respectively, could not be effectively assessed. Consequently no further work was carried out in this potentially interesting field of study.

The final field work phase was over Old Rayne (West Side) and New Deer (East Side). Both were background areas. Soil Ni and Cu levels were very low - at Old Rayne they were too low for reliable correlation - but at New Deer slightly higher Ni and Cu values could be correlated with gabbro float.

Conclusions

Essentially the study was a two pronged attach on the problem of distinguishing soil geochem anomalies due to base metal silicates from those due to base metal sulphides.

One prong was based on the clearly demonstrable fact that different rock types, and the float derived from them, cause widely differing base metal thresholds in soils. The routine geochemical work carried out by EVL considered all data as belonging to a single population. The research project clearly showed that recongition of different populations within an area clarified the geochemical picture, and developed assessment methods which made possible a more objective definition of anomalies. An important additional step developed during the project was the ability to correlate anomalies with particular rock types, solid or in float. As a result it was possible to pull out areas where a particular rock (or float) type contained abnormal amounts of base metals which could be due to sulphide mineralisation.

The other prong was to try to devise methods which would directly differentiate between sulphide and silicate weathering products. These methods showed promise in early work, but it was impossible to refine them sufficiently for routine application. Both heavy mineral and oxide coating methods could be useful, but with the latter the detection limits were unacceptably high, and with both the methods were too lengthy for routine use.

Technically, therefore, the float/soil/geochemistry correlation approach seems the only one which might be worth developing further.

Soil type		Arthrath				Auchincrieve				Belhelvie				Brodiesord				Brown Hill			
		Ni		Cu		Ni		Cu		Ni		Cu		Ni		Cu		Ni		Cu	
		M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD	M	M+2SD
Brown Earth	A horizon	-	-	-	-	185	451	129	487	-	-	-	-	65	153	14	28	56	470	30	62
	B horizon	38	170	30	194	301	1041	204	862	89	415	32	110	112	440	17	37	55	235	59	233
Mottled Brown Earth	A horizon	-	-	-	-	137	247	73	143	-	-	-	-	73	141	14	30	32	46	35	51
	B horizon	51	191	26	88	160	292	94	174	60	172	26	56	108	218	26	60	52	100	54	94
Mottled Gley	A horizon	-	-	-	-	162	393	84	208	-	-	-	-	68	140	16	42	73	267	28	44
	B horizon	17	33	14	34	184	478	131	361	102	316	34	92	123	383	26	52	78	198	47	79
Gley	A horizon	-	-	-	-	145	373	54	104	-	-	-	-	65	133	18	44	56	164	27	51
	B horizon	36	358	21	103	145	341	72	162	68	190	24	64	99	235	24	48	82	236	39	73
Peaty Gley	A horizon	-	-	-	-	-	-	-	-	-	-	-	-	30	88	6	10	172	666	41	107
	B horizon	17	33	18	34	-	-	-	-	48	114	19	33	60	188	10	20	233	841	60	160
Peat	A horizon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	60	34	52
	B horizon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	80	37	57
Podsol	A horizon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	30	38	110
	B horizon	20	32	30	40	-	-	-	-	149	501	43	111	-	-	-	-	40	68	55	77
Ranker	A horizon	-	-	-	-	310	1038	101	275	-	-	-	-	-	-	-	-	-	-	-	-
	B horizon	-	-	-	-	472	1796	138	470	-	-	-	-	-	-	-	-	-	-	-	-
Differentiated Alluvium	A horizon	-	-	-	-	221	605	181	605	-	-	-	-	83	157	19	41	36	44	40	60
	B horizon	17	31	11	23	384	1224	302	1044	60	158	23	57	114	234	24	48	50	66	30	38
Undifferentiated Alluvium	A horizon	-	-	-	-	150	332	85	209	-	-	-	-	122	432	16	38	40	98	34	64
	B horizon	-	-	-	-	145	353	82	214	78	310	33	127	152	566	19	47	30	58	35	67
Range of values (all soil types)	A horizon	-	-	-	-	165	791	127	501	-	-	-	-	92	344	13	34	156	636	14	66
	B horizon	21	327	19	171	327	1504	230	882	101	387	24	94	92	378	16	40	203	783	30	195

Tab. 1. Relationship between metal contents of A and B soil horizons vs. soil type.

Dominant float-type	Arthrath			Auchincrieve			Belhelvie			Brodiesord			Brown Hill		
	Ni	Cu	Ni:Cu	Ni	Cu	Ni:Cu	Ni	Cu	Ni:Cu	Ni	Cu	Ni:Cu	Ni	Cu	Ni:Cu
Gneiss	20	49	0.4	-	-	-	46	21	2.2	61	28	2.2	-	-	-
Quartzite	28	25	1.1	162	85	1.9	55	25	2.2	83	19	4.4	99	38	2.6
Mica schist	15	14	1.1	-	-	-	52	26	2.0	-	-	-	96	42	2.3
Black schist (quartzitic at Arthrath and Brown Hill)	26	32	0.8	215	171	1.3	-	-	-	92	29	3.1	104	64	1.6
Granite	27	47	0.6	50	30	1.7	48	16	3.0	-	-	-	-	-	-
Metadiorite	-	-	-	-	-	-	-	-	-	-	-	-	70	45	1.5
Hornfels schist	-	-	-	-	-	-	-	-	-	-	-	-	59	52	1.1
Contaminated basics	25	30	0.8	199	134	1.5	-	-	-	-	-	-	-	-	-
Graphitic gabbro	-	-	-	899	713	1.3	-	-	-	-	-	-	-	-	-
Norite	47	49	1.0	-	-	-	65	24	2.6	-	-	-	-	-	-
Gabbro	-	-	-	-	-	-				110	25	4.4	63	59	1.1
Serpentinised basics	-	-	-	-	-	-	-	-	-	-	-	-	191	75	2.5
Troctolite	-	-	-	335	90	3.7	-	-	-	-	-	-	-	-	-
Dunite, unserpentinised picrite	-	-	-	783	246	3.2	137	42	3.3	-	-	-	-	-	-
Serpentinised picrite	-	-	-	-	-	-	-	-	-	330	18	18.5	542	38	14.5

Tab. 3. Relationship between metal values in soil B horizons and dominant float type.

Dominant float type	Mean Ni values in:		Mean Cu values in:	
	A horizons	B horizons	A horizons	B horizons
Quartzite	114	99	27	38
Slate, Mica schist	59	96	32	42
Black quartz schist	62	104	36	64
Hornfels schist	41	59	31	52
Metadiorite	54	70	30	45
Gabbro	31	63	30	59
Serpentinised basics	205	191	54	75
Serpentinised picrite	415	542	42	38

Tab. 2. Brown Hill - relationship between metal contents of A and B soil horizons and float type.

B.1.

NOT OPEN FILE

RIOFINEX

Diamond Drill Core Record

Drilled by	Boyles Bros.
Date started	13.1.69
Date completed	4.2.69

Grid Ref: NGR 9295E, 1702N — 1400 L — 8,333 N

Depth 456' 10" — Core Recovery 82.2 % — Logged by L.C. MacEwen

D.D.H. No.	B1
Area	Belhelvie
Location	250N 42E
Collar R.L.	
Orientation	
Inclination	45° S.W.

Footage From	Footage To	Footage Rep.	Angles	Geological Log – Description	Sample No.	Assay From	Assay To	Cu %	Ni %	Zn %	Rep.
0'	39' 2"	39' 2"		Sandy Drift with boulders	So 445	39' 2"	53'10"				13' 8"
39' 2"	90'	50'10"		Greenish-grey weathered serpentinite. Original	446	53'10"	62'11"				9' 1"
				olivine now entirely altered although locally the	447	62'11"	67'11"				5'
				original crystal outlines are discernable.	448	67'11"	72'11"				5'
				Minor magnetite and picotite. Occasional thin	449	72'11"	83' 0"				9'11"
				Magnetite bands at c.40°	450	83'	93'				10'
				Very minor traces of Sulphides.	451	93'	103'				10'
[illegible]	159'	69'		Black, unaltered Serpentinite (serpentinised	452	103'	113'				10'
				Dunite).	453	113'	123'				10'
				92% Serpentine 0.7% Interstitial Plagioclase.	454	123'	133'				10'
				3.6% Opaques (Sulphides and Magnetite) 3.2% Picotite	455	133'	143'				10'
				and Chromite. Percentages vary little from this	456	143'	153'				10'
				analysed specimen. Locally an increase in	457	153'	163'				10'
				Plagioclase	[illegible]	163'	[illegible]				[illegible]
				Numerous minor fractures	459	176'	186'				10'
[illegible]	176' 9"	17' 9"		[illegible]. Composed essentially of	460	[illegible]	[illegible]				10'
				[illegible] and orthoclase. Talc grey-green [illegible]	[illegible]	[illegible]	206'				10'
				Highly fractured at variable angles.	[illegible]	206'	[illegible]				10'
[illegible] 9"	449'	272' 3"		Black unaltered serpentinite (Serpentinised	[illegible]	[illegible]	[illegible]				10'
				Dunites)	464	225'	236'				10'
				Dominantly composed of serpentine with very	465	236'	246'				10'

DRILLED BY			# RIOFINEX	D.D.H. No.	B1
DATE STARTED			**Diamond Drill Core Record**	AREA	
DATE COMPLETED				LOCATION	
NX. FROM	TO			COLLAR R.L.	
BX. FROM	TO			ORIENTATION	
AX. FROM	TO		*Depth* ______ *Core Recovery* ______ % *Logged by* ______	INCLINATION	

FOOTAGE			ANGLES	GEOLOGICAL LOG	ASSAY RECORD						
FROM	TO	REP.		DESCRIPTION	SAMPLE NO.	FROM	TO	CU %	Ni %	ZN %	Rep.
				minor interstitial plagioclase. Minor magnetite,	Sc 466	246'	256'				10'
				Picotite and Chromite.	467	256'	266'				10'
				Traces of Sulphides	468	266'	276'				10'
				Locally where serpentinisation has been	469	276'	286'				10'
				less intense the outlines of the original olivine	470	286'	296'				10'
				crystals can be seen	471	296'	306'				10'
				c. 350' minor interstitial brown hornblende	472	306'	316'				10'
				present.	473	316'	326'				10'
				From 360' downwards there are local	474	326'	336'				10'
				increases in the plagioclase content to c. 5%.	475	336'	346'				10'
				The areas of plagioclase increase are diffuse.	476	346'	356'				10'
				Fractures generally minor and variable.	477	356'	366'				10'
				Locally minor coating of sulphides on shear	478	366'	376'				10'
				surfaces. Calcite and ?chalcedony also present.	479	376'	386'				10'
449'	456'10"	7' 10"		Diorite. Composed essentially of orthoclase	480	336'	396'				10'
				and quartz. Pale grey-green in colour.	481	396'	406'				10'
				Numerous variable fractures.	482	406'	416'				10'
				No sulphides.	483	416'	426'				10'
					484	426'	436'				10'
				END OF HOLE 456' 10"	485	436'	449'				13'
					486	449'	456'10"				7'10"

RIOFINEX

Diamond Drill Core Record

DRILLED BY
DATE STARTED
DATE COMPLETED
NX. FROM TO
BX. FROM TO
AX. FROM TO

Depth ________ Core Recovery ________ % Logged by ________

D.D.H. No. B2
AREA
LOCATION
COLLAR R.L.
ORIENTATION
INCLINATION

FOOTAGE FROM	FOOTAGE TO	REP.	ANGLES	GEOLOGICAL LOG DESCRIPTION	ASSAY RECORD Ni SAMPLE NO.	FROM	TO	CU %	~~[illegible]~~ %	~~[illegible]~~ %	Rep	Rec.
				plagioclase. Olivine content increases from	SC583	53'·4"	58'·4"				5·0	5·0
				c. 25% to c. 40% down the hole. Both the olivine	~~584~~	~~160·6~~	~~165·6~~				~~5·0~~	~~5·0~~
				and plagioclase are somewhat altered.								
				Minor fractures.								
				Sulphides; trace to absent.								
				Minor thin bands of anorthosite locally. The								
				cumulate olivine crystals show definite								
				segregation alignment. Plagioclase shows								
				some green serpentinous staining.								
115' 9"	119'	3' 3"		Interlayered Troctolite and Serpentinised Dunite.								
				Layering at c. 40° (35°-45°).								
				From 115' 9"-118' 3" Six thin serpentinised Dunite								
				layers c. 1" in thickness. From 118' 3"-119' there								
				are variable segregations of troctolite and serpentinised								
				dunite.								
				The Troctolite is composed of cumulus olivine and								
				plagioclase. The olivine is serpentinised and partially								
				oxidised with the extensive development of red								
				haematite.								
				The serpentinised Dunite is also oxidised with								
				extensive development of red haematite.								

NOT OPEN FILE

BY	Boyles Bros.
STARTED	6.2.69
COMPLETED	24.2.69
FROM	TO
FROM	TO
FROM	TO

NGR

GRID REF. 9403E 1827N

RIOFINEX

Diamond Drill Core Record

3120E 2853N

Depth 332' *Core Recovery* 66.6% % *Logged by* E.C. MacEwen

D.D.H. No.	B2
AREA	Belhelvie
LOCATION	~~266.5N 93.6E~~
COLLAR R.L.	
ORIENTATION	
INCLINATION	45°

FOOTAGE FROM	TO	REP.	ANGLES	GEOLOGICAL LOG DESCRIPTION	SAMPLE No.	FROM	TO	CU %	PB %	ZN %	
0'	1' 3"			Soil.							
1' 3"	20' 4"	19' 1"		Troctolite with indefinite Anorthosite banding							
				or layering.							
				Troctolite: composed mainly of plagioclase							
				and minor c. 25% Olivine. The cumulate olivine							
				is somewhat serpentinised. The plagioclase is partly							
				sericitised.							
				The olivine shows some alignment c. 30°.							
				Minor anorthosite lenses c. 2' 6" also at 30°.							
				c. 9' 1"-10' 9" (1' 8") Indistinct anorthosite band							
				with minor olivine. Other thin bands and minor							
				segregations of anorthosite present throughout.							
				Traces of Sulphides.							
				Fracturing minor and variable.							
20' 4"	25' 9"	5' 5"		Anorthosite layer with minor olivine locally							
				composed entirely of somewhat altered plagioclase.							
				Alteration to sericite. Some green serpentinous							
				staining from the altered olivine.							
				Very minor traces of Sulphides.							
				Minor fractures.							
25' 9"	115' 9"	90'		Troctolite: composed of Olivine and							

RIOFINEX

Diamond Drill Core Record

DRILLED BY			D.D.H. No.	B2
DATE STARTED			AREA	
DATE COMPLETED			LOCATION	
X. FROM	TO		COLLAR R.L.	
BX. FROM	TO		ORIENTATION	
AX. FROM	TO		INCLINATION	

Depth ________ *Core Recovery* ________% *Logged by* ________

FOOTAGE FROM	FOOTAGE TO	FOOTAGE REP.	ANGLES	GEOLOGICAL LOG DESCRIPTION	SAMPLE No.	FROM	TO	CU %	PB %	ZN %	
				Numerous fractures. No Sulphides.							
119'	147' 3"	28' 3"		Serpentinised and extensively oxidised Dunite layer with							
				an extensive development of brick red haematite. Little							
				or no interstitial material. Less altered-oxidised from							
				136'-144' 6". Minor plagioclase and trace of sulphides.							
				Crystal outlines in the serpentinised dunite visible.							
				Very minor interstitial plagioclase also altered.							
				Numerous minor fractures, with micaceous infilling.							
				Also Calcite.							
				Lower contact c. 60°							
147' 3"	147'11"	8"		Variable Troctolite band. Serpentinised and							
				oxidised cumulate olivine in plagioclase.							
				Lower contact at c. 40°.							
[illegible]47'11"	149' 8"	1' 9"		Olivine rich Troctolite highly serpentinised and							
				oxidised. Plagioclase also altered.							
				Lower contact at c. 35°-40°.							
[illegible]9' 3"	151' 9"	2' 1"		Troctolite with dominant plagioclase. Olivine							
				serpentinised and oxidised. Plagioclase altered.							
				Minor fractures c. 30°. Lower contact transitional.							
[illegible]	154' 3"			Serpentinised Dunite with a considerable							
				plagioclase content. Grades into an Olivine-rich							

DRILLED BY	
DATE STARTED	
DATE COMPLETED	
X. FROM	TO
BX. FROM	TO
AX. FROM	TO

RIOFINEX

Diamond Drill Core Record

Depth ________ Core Recovery ________ % Logged by ________

D.D.H. No.	B2
AREA	
LOCATION	
COLLAR R.L.	
ORIENTATION	
INCLINATION	

FOOTAGE FROM	FOOTAGE TO	REP.	ANGLES	GEOLOGICAL LOG DESCRIPTION	SAMPLE No.	FROM	TO	CU %	[illegible] %	[illegible] %	[illegible]	Rec
				troctolite locally. The olivine is oxidised and serpentinised. Layering c. 40°-45°. Lower contact transitional. Variable fractures. No sulphides.								
154' 5"	167' 4"	13' 1"		Troctolite Plagioclase > olivine. Olivine serpentinised and locally oxidised. Plagioclase somewhat sericitised. Lower contact transitional. Minor fractures with calcite. Traces of sulphides.	SC584	160'-6"	165'-6"				5.0	5.0
16 ' 4"	169'	1' 8"		Dunite layer. Olivine serpentinised and oxidised. Very minor plagioclase. Lower contact c.40°. Minor fractures.								
169'	172' 6"	3' 6"		Troctolite cumulus olivine dominant. Olivine serpentinised and oxidised. Plagioclase somewhat altered. Minor fractures. No Sulphides. Lower contact c.40°								
172' 6"	180' 9"			Dunite layer; serpentinised and oxidised. Very minor plagioclase, muscovite and sericite. Locally very minor poikilitic pyroxene. No sulphides. Minor fractures. Lower contact lost.								
180' 9"	183' 2"			Troctolite layer. Cumulus serpentinised and oxidised olivine in altered plagioclase. Olivine content variable. Lower contact ?c.45°. Minor fractures. Little or no sulphides.								

RIOFINEX

Diamond Drill Core Record

LOGGED BY	
DATE STARTED	
DATE COMPLETED	
FROM	TO
FROM	TO
FROM	TO

Depth ________ Core Recovery ________ % Logged by ________

D.D.H. No.	B2
AREA	
LOCATION	
COLLAR R.L.	
ORIENTATION	
INCLINATION	

FOOTAGE			ANGLES	GEOLOGICAL LOG	ASSAY RECORD							
FROM	TO	REP.		DESCRIPTION	SAMPLE No.	FROM	TO	CU %	[illegible] %	[illegible] %	[illegible]	Rec
83' 2"	240'	56' 10"		Oxidised Serpentinised Dunite. Dominantly								
				serpentinised olivine. Magnetite, a minor constituent,								
				but extensively oxidised to red haematite. Minor								
				chromite and picotite and interstitial plagioclase.								
				Oxidation decreases downwards.								
				Very minor traces of sulphides.								
				Numerous variable fractures.		' "	' "					
240'	332'	92'		Unoxidised Black Serpentinised Dunite.	SC 585	270.0	275.0				5.0	5.0
				Essentially composed of serpentinised olivine	586	323.0	328.0				5.0	3.10
				with minor <5% interstitial plagioclase. Minor								
				Magnetite, Chromite and Picotite also present.								
				Very minor traces of sulphides.								
				Numerous variable fractures.								

END OF HOLE 332'

OPEN FILE **B.3.**

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA	BELHELVIE - KINGSEAT
O.S. Map No.	NJ 91 NW
Grid Ref.	39124 E / 81884 N
Page no	1
D.D.H. No.	B3
COLLAR CO ORDINATES	
COLLAR ELEVATION	126 metres
ORIENTATION	238° GRID
INCLINATION OF HOLE	−45°
TOTAL DEPTH	110.34 Metres
OVERALL RECOVERY	77.5 %
Drilled by	D.P.I.
Logged by	C.A.F.B.
Date started	17th MARCH 1972
Date completed	25th MARCH 1972

CORE SIZES	FROM	TO
HW	7.61	17.88
HQ	17.88	57.13
BQ	57.13	110.34

REMARKS: Badly broken ground causing poor core recovery.

GEOLOGICAL LOG

[...]ERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0.00	7.61	7.61	0	DRIFT		Unconsolidated sand and boulder drift		
7.61	12.19	1.58		TROCTOLITE		Serpentinised troctolites with olivine replaced by haematite and serpentinite.	35°	
12.19	23.81	16.62		PICRITE		Highly fractured serpentinised picrite with some haematitisation. Occasional thin irregular stringers of pyrite and chalcopyrite associated with small amounts of disseminated sulphides.	45°	
28.81	[illegible]	[illegible].03		GRANITE		thin granite vein almost completely altered to talc and steatite.		
33.89	35.00	3.11		PICRITE / DUNITE		Serpentinised picrite and dunite. Small scattered stringers and irregular thin lenses of pyrite occur near base of granite vein.	45°	
35.00	57.00	22.00		TROCTOLITE		Serpentinised troctolite with bands of picrite and dunite. Small amounts of disseminated and fracture infill pyrrhotite, pyrite and chalcopyrite		
57.00	59.00	2.00		GRANITE		thin granite vein altered to talc and steatite	45°	
59.00	65.22	6.22		GRANITE		leucocratic biotite / muscovite granite with the biotite showing a faint lineation.		
	110.34	15.12		GRANITE		medium grained equigranular quartz rich biotite muscovite granite. Small garnets occur in several places.		

ASSAY RECORD

Sample no.	From	To	Rep	Sample core rec.	Cu	Ni
1415	21.00	23.00	2.00			
1416	26.00	28.00	2.00			
1417	32.00	34.00	2.00			
1418	45.50	47.50	2.00			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA: B[illegible]HELVIE	O.S. Map No. NJ 91 NW	Grid Ref. 9140 E 1823 N	Page no 1	D.D.H. No. B4.
COLLAR CO ORDINATES: 9140 E 1823 N	COLLAR ELEVATION: 122 0 m.	ORIENTATION: 238°	INCLINATION OF HOLE: −45°	TOTAL DEPTH: 250.94 Metres
OVERALL RECOVERY: 94.78 %				
Drilled by: D.P.I.	Logged by: C.A.F.B.	Date started: 28/3/72	Date completed: 1/1/72	

CORE SIZES	FROM	TO
H	0	8.37
NX	8.37	53.30
BQ	53.30	250.94

REMARKS

OPEN FILE.

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0	7.61	7.61		DRIFT		Unconsolidated sand and gravel drift		
7.61	13.47	5.86		GRANITE.		Medium to coarse grained pegmatitic granite partly altered to talc and chlorite cut by pegmatitic veins.	45°	
13.47	15.46	1.99		SERPENTINITE		massive grey, green and black serpentinite with disseminated pyrrhotite and chalcopyrite		
15.46	19.52	4.06		PICRITE.		Fractured and broken serpentinised picrite partly haematitised small amounts of disseminated pyrrhotite.	45°	
19.52	24.39	4.87		DUNITE		Serpentinised dunite consisting of olivine and serpentine with occasional laths of bronzite. Pyrrhotite generally finely disseminated throughout with occasional coarser blebs		
24.39	43.58	19.19		PERIDOTITE		Serpentinised olivine bronzite peridotite with variable amount of interstitial felspar. Bronzite and olivine are the dominant minerals. This grades into a picrite where the bronzite decreases and the [illegible] content increases. Finely disseminated pyrrhotite occurs throughout with scattered coarser blebs.		
43.58	64.70	21.12		Dunite / Picrite		Apparent alternating bands of serpentinised dunites and picrites with occasional pyrrhotite bands. Small amounts of disseminated pyrite and pyrrhotite present		

ASSAY RECORD %

Sample no.	From (m)	To	Rep	Sample core rec	Cu	Ni
1419	14	16	2			
1420	16	18	2			
1421	18	20	2			
1422	20	22	2			
1423	22	24	2			
1424	24	26	2			
1425	26	28	2			
1426	28	30	2			
1427	30	32	2			
1428	32	34	2			
1429	34	36	2			
1430	36	38	2			
1431	38	40	2			
1432	40	42	2			
1433	42	44	2			
1434	44	46	2			
1435	46	48	2	(A)		% 0.18
1436	48	50	2			
1437	50	52	2			
1438	52	54	2			
1439	54	56	2			
1440	56	58	2			
1441	58	60	2			
1442	60	62	2			
1443	62	64	2			
1444	64	66	2			
1445	66	68	2			
1446	68	70	2			
1447	70	72	2			
1448	72	74	2			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE

Page no. 2

DH: 54

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD (m) Sample no	From	To	Rep	Sample core rec	Ni	%
6[illegible]·80	66·45	1·65		PICRITE		Serpentinised picrite with thin steatite		<<	1449	74	76	2			
						veins containing small amounts of pyrite.			1450	76	78	2			
									1451	78	80	2			
66·45	66·60	0·15		GRANITE		Steatitised granite vein.	45°		1452	80	82	2			
									1453	82	84	2			
66·60	69·00	3·30		PICRITE.		Serpentinised picrite with thin bands of			1454	84	86	2			
						massive grey serpentinite containing			1455	86	88	2	(A)	(5) 0.35	0.19
						finely disseminated pyrite.			1456	88	90	2			
									1457	90	92	2			
69·00	82·21	13·21		DUNITE		Serpentinised dunite with thin bands of			1458	92	94	2			
						picrite and lherzolite peridotite.			1459	94	96	2			
						Fracture and fault zones occur at 74·40-60m and			1460	96	98	2			
						75·20m. Brecciated dunite with calcite matrix			1461	98	100	2			
						occurs at 79·50 - 79·75 m.			1462	100	102	2			
						Disseminated pyrite occurs throughout as well			1463	102	104	2			
						as on some joint and fracture planes.			1464	104	106	2			
									1465	106	108	2			
82·21	136·38	54·17		PICRITE / DUNITE		Mainly serpentinised picrite with bands			1466	108	110	2			
						of serpentinised dunites. Pyrite occurs in fine			1467	110	112	2			
						disseminated form with occasional coarser			1468	112	114	2			
						blebs and in thin stringers associated	35°		1469	114	116	2			
						with calcite and serpentinite veins.			1470	116	118	2			
						The picrite becomes highly serpentinised near			1471	118	120	2			
						end of run grading into pure serpentinite,			1472	120	122	2			
						and steatite from 135·56 - 136·38.			1473	122	124	2			
									1474	124	126	2			
136·38	143·60	7·22		DUNITE / PICRITE		Highly serpentinised dunites and picrites with			1475	126	128	2	(A)	(5) 0.35	0.19
						veins of serpentine. Pyrite occurs disseminated			1476	128	130	2			
						and in fracture infill and associated with sulphide			1477	130	132	2			
						veins. Chalcopyrite and pyrrhotite occur to a			1478	132	134	2			
						lesser extent in disseminated form.			1479	134	136	2			
									1480	136	138	2			
143·60	145·5[illegible]	1·9[illegible]		DUNITE.		Serpentinised and haematitised dunite.			1481	138	140	2			
									1482	140	142	2			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 3   D.D.H. No. B4

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD							
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni	
145.50	157.74	12.24		DUNITE / PICRITE.		Serpentinised dunites and picrites with		fe	1483	142	144	2				
						Scattered 10 cm veins of grey serpentine.			1484	144	146	2				
						In places - 145.73 - 146.30 the percentage			1485	146	148	2				
						of felspar increases to a near troctolite			1486	148	150	2				
						pyrite and some pyrrhotite occurs and relates			1487	150	152	2				
						to fine grained disseminations [illegible] and with			1488	152	154	2				
						and replacing felspar cavities. Fracture infill			1489	154	156	2				
						pyrite and pyrrhotite.			1490	156	158	2				
									1491	158	160	2				
157.74	160.98	3.24		DUNITE		highly serpentinised dunites and peridotites			1492	160	162	2				
						often composed of up to 90% serpentine			1493	162	164	2				
						and steatite.			1494	164	166	2				
						Variable amounts of sulphides increases			1495	166	168	2	(A)			BPcu 0.06
						towards end run where core is badly			1496	168	170	2				
						fractured.			1497	170	172	2				
									1498	172	174	2				
160.98	162.00	1.02		STEATITE.		White or grey massive fractured and			1499	174	176	2				
						broken steatite and serpentine. Probably			1500	176	178	2				
						represents fault zone.	35°		1501	178	180	2				
									1502	180	182	2				
162.00	168.00	6.00		OLIVINE NORITE		Grey green spotted highly altered and			1503	182	184	2				
						serpentinised rock composed of olivine			1504	184	186	2				
						crystals in a matrix of pyroxenes.			1505	186	188	2				
						Probably represents an olivine norite grading			1506	188	190	2				
						to pyroxenite.	50°		1507	190	192	2				
									1508	192	194	2				
[illegible]8.00	211.72	43.72		DUNITE		Serpentinised and brecciated dunites with			1509	194	196	2				
						bands of picrite. Fracture and vein infill			1510	196	198	2				
						pyrite and some pyrrhotite occurs mainly			1511	198	200	2				
						associated with serpentine veins.			1512	200	202	2				
									1513	202	204	2				
[illegible]	21[illegible]	1.13		GRANITE.		pale leucocratic [illegible] quartz granite			1514	204	206	2				
						vein. Highly steatitised at contacts			1515	206	208	2	(A)			BPcu 0.19
									1516	208	210	2				

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE

Page no. 4

D.D.H. No. B 4

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
215.85	231.04			DUNITE / PERIDOTITE		Serpentinised peridotites, dunites and peridotites. Pyrite and pyrrhotite generally finely disseminated increasing towards end of run	35°	Se
231.04	234.09			NORITE		clay gouge representing fault zone passing into highly altered and steatilised leucocratic rock probably representing a norite. Irregular xenoliths of finer basic material occurs containing moderate amounts of disseminated medium to fine grained pyrrhotite and chalcopyrite. Xenoliths of dunite also occur containing abundant pyrrhotite.		
234.09	239.1			BRONZITITE		Coarse grained band of bronzite rich rock containing fragments of dunite and medium grained disseminated pyrrhotite. Steatite veins are common.	35°	
239.1	250.94			CONTAMINATED NORITE		Fine to medium grained felspar / pyroxene rich rock extensively contaminated and fractured with veins of steatite. Probably represents a contaminated norite. Traces of disseminated pyrrhotite present.		
						COMPLETED TO DEPTH OF 250.94 m.		

m ASSAY RECORD %

Sample no.	From	To	Rep	Sample core rec	Cu	Ni
1517	210	212	2			
1518	216	218	2			
1519	218	220	2			
1520	220	222	2			
1521	222	224	2			
1522	224	226	2			
1523	226	228	2			
1524	228	230	2			
1525	230	232	2			
1526	232	234	2			
1527	234	236	2			

EXPLORATION VENTURES LTD DIAMOND DRILL CORE RECORD	AREA BE[illegible]LVIE	O.S. Map No. NJ 91 [illegible]	Grid Ref.	Page no 1	B.5.	D.D.H. No. B5.
	COLLAR CO ORDINATES	COLLAR ELEVATION	ORIENTATION 238°	INCLINATION OF HOLE	TOTAL DEPTH 242 93 Metres	OVERALL RECO[VERY] 96.86
	Drilled by D.P.I Logged by C.M.F.B.	Date started 12/4/72 Date completed 21/4/72	CORE SIZES TNX NQ BQ	FROM 7.61 10.36 [illegible]	TO 10.36 51.82 242.43	REMARKS

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					m. ASSAY RECORD %								
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec.	Cu	Ni		
0	7.61	7.61	0	DRIFT.		Unconsolidated glacial sand and gravel.		Rc	1528	10	12	2	(A)			[illegible]	0.2
									1529	12	14	2					
7.61	38.91	31.30		DUNITE.		Medium to coarse grained serpentinised			1530	14	16	2					
						dunite. Badly fractured and broken due			1531	16	18	2					
						to weathering and oxidation down to 13.50m.			1532	18	20	2					
						Small amounts of disseminated pyrrhotite from			1533	20	22	2					
						13.50 – 25.60. with moderate amounts of			1534	22	24	2					
						finely disseminated sulphides from 25.50 –			1535	24	26	2					
						29.40.			1536	26	28	2					
						From 29.40 – 38.91. Small amounts of disseminated			1537	28	30	2					
						pyrrhotite with occasional larger blebs within			1538	30	32	2					
						alternating medium and coarse grained –			1539	32	34	2					
						serpentinised dunites.			1540	34	36	2					
									1541	36	38	2					
38.91	40.14			GRANITE		Leucocratic partly altered granite vein.			1542	38	40	2					
						Badly fractured with steatite veins near			1543	40	42	2					
						base.	70°		1544	42	44	2					
									1545	44	46	2					
40.14	87.78			DUNITE		Dark massive serpentinised dunite with			1546	46	48	2					
						occasional softer granular dunitic bands			1547	48	50	2					
						Overall small amounts of disseminated			1548	50	52	2					
						fine grained pyrrhotite present with			1549	52	54	2	(A)			[illegible]	0.2
						scattered richer bands [illegible] 42.00 – 43.0m...			1550	54	56	2					
						and 47.30 – 50.00m			1551	56	58	2					
						Highly serpentinised and steatitised from			1552	58	60	2					
						87.30 – 87.78m.			1553	60	62	2					
									1554	62	64	2					
[illegible]	90.07			GRANITE		Leucocratic altered granite vein. Steatitised			1555	64	66	2					
						at top and partly tourmalinised at base.			1556	66	68	2					
						Upper contact broken while lower contact irregular			1557	68	70	2					

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 2   D.D.H. No. B5

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Core angle	Rock strength	ASSAY RECORD (m) Sample no.	From	To	Rep	Sample core rec	Cu (%)	Ni (%)	
140.07	176.06	35.99		DUNITE		Dark massive serpentinised dunites	10°	2	1558	70	72	2				
						with some bronzite pyroxenite bands			1559	72	74	2				
						occurring from 142 metres - 156.10 m			1560	74	76	2				
						Overall small amounts of disseminated			1561	76	78	2				
						pyrrhotite and ? pyrite present. Chalcopyrite			1562	78	80	2				
						and pyrrhotite visible around 167-170 m.			1563	80	82	2				
						Small steatite veins scattered throughout	55°		1564	82	84	2				
									1565	84	86	2				
176.06	176.79	0.73		GRANITE.		Steatitised leucocratic granite vein.	45°		1566	86	87.50	1.5				
									1567	90	92	2				
176.79	194.66	17.87		DUNITE.		Dark mainly massive serpentinised dunite			1568	92	94	2				
						with several soft fractured, steatitised			1569	94	96	2				
						zones.			1570	96	98	2				
						Finely disseminated pyrrhotite occurs in			1571	98	100	2				
						small amount throughout as well as on			1572	100	102	2				
						some joint and fracture planes as			1573	102	104	2				
						thin smears. Occasional disseminated	45°		1574	104	106	2				
						chalcopyrite visible.			1575	106	108	2				
									1576	108	110	2				
194.66	197.4	2.73		GRANITE.		Medium grained leucocratic biotite	45°		1577	110	112	2				
						granite.	55°		1578	112	114	2				
									1579	114	116	2				
197.41	242.93	45.52		DUNITE		Dark massive serpentinised dunite			1580	116	118	2				
						with occasional serpentine veins.	60°		1581	118	120	2				
						Generally small amounts of disseminated			1582	120	122	2				
						pyrrhotite and some chalcopyrite.			1583	122	124	2				
						Several thin granite veins occur throughout.	50°		1584	124	126	2				
									1585	126	128	2				
						HOLE COMPLETED AT 242.93 metres.			1586	128	130	2				
									1587	130	132	2	0			[illegible]
									1588	132	134	2				
									1589	134	136	2				
									1590	136	138	2				
									1591	138	140	2				

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area OGILVIE Page no. 3 D.D.H. No. B5

SECTION DEPTHS (Metres) | GEOLOGICAL LOG | ASSAY RECORD %

TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	[illegible]	[illegible]
							5C	1592	140	142	2			
								1593	142	144	2			
								1594	144	146	2			
								1595	146	148	2			
								1596	148	150	2			
								1597	150	152	2			
								1598	152	154	2			
								1599	154	156	2			
								1600	156	158	2			
								1601	158	160	2			
								1602	160	162	2			
								1603	162	164	2			
								1604	164	166	2			
								1605	166	168	2			
								1606	168	170	2			
								1607	170	172	2			
								1608	172	174	2			
								1609	174	176	2			
								1610	176	178	2			
								1611	178	180	2			
								1612	180	182	2			
								1613	182	184	2			
								1614	184	186	2			
								1615	186	188	2			
								1616	188	190	2			
								1617	190	192	2			
								1618	192	194.5	2.5			
								1619	197.5	200	2.5			
								1620	200	202	2			
								1621	202	204	2			
								1622	204	206	2			
								1623	206	208	2			
								1624	208	210	2			
								1625	210	212	2			

...ATION VENTURES LTD
DRILL CORE RECORD

Area BELHE[illegible]IG

Page no. 4

D.D.H. No. B[illegible]

DEPTHS (Metres)		GEOLOGICAL LOG					ASSAY RECORD						%		
DEP	REC	ROCK TYPE	Graphic log	Description	Intersec. angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Au		
						SC	1626	212	214	2					
							1627	214	216	2	(1)			0.21	0.[illegible]
							1628	216	218	2					
							1629	218	220	2					
							1630	220	222	2					
							1631	222	224	2					
							1632	224	226	2					
							1633	226	228	2					
							1634	228	230	✓					
							1635	230	232	2					
							1636	232	234	2					
							1637	234	236	2					
							1638	236	238	2					
							1639	238	240	2					
							1640	240	242	✓					
							1641	242	242.93	0.93					

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA Be[redacted]IE.	O.S. Map No. [redacted]	Grid Ref. 9174 E 1043 N	Page no 1.	D.D.H. No. 86/82
COLLAR CO-ORDINATES	COLLAR ELEVATION 113.70 m	ORIENTATION 230° Grid	INCLINATION OF HOLE −45°	TOTAL DEPTH 210.31 Metres
OVERALL RECOVERY 95.9 %				
Drilled by D.P.I.	Logged by C.A.T.B.	Date started 22/4/72.	Date completed 28/4/72	

CORE SIZES	FROM	TO
HX	0	3.[illegible]
NQ	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

REMARKS

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0	7.61	7.61	0	DRIFT.		Unconsolidated sand and gravel.		Sc
7.61	9.14		1.53	DUNITE.		Badly shattered, weathered serpentinised and haematitised dunite.		
9.14	39.10		29.96	DUNITE.		Fractured highly serpentinised and haematised coarse grained dunite. Yellow oxides occur in fractures and disseminations down to 39 m. Magnetite in disseminated form is abundant. Fine grained pyrrhotite moderately abundant from 30 m − 39.10 with some fracture-infill pyrrhotite and pyrite between 3[illegible] − 3[illegible].10 m.		
39.10	45.00		5.90	DUNITE.		Highly serpentinised and haematised (to [illegible]) coarse grained dunite. Disseminated and compacted thin veinlets & stringers of pyrrhotite abundant particularly around 41.00 m. Olivine crystals totally replaced by serpentine.		
45.00	136.00		91.09	DUNITE.		Massive or fairly fractured serpentinised medium to coarse grained dunite with thin bands of serpentinised [illegible]. These are cut by several fracture and crush zones 63.50 − 67.00; 76.00; 82.50; 92.30 − 102.90; 103.70 − 104.20; 105.30 − 106.20; 112.6[illegible] − 113.30; 114.05 − 114.50; 118.70 − 119.50. These [illegible] are often graphitic. Magnetite is abundant throughout. Disseminated and some chalcopyrite [illegible] moderately abundant down to 105.00 m.		

ASSAY RECORD %

Sample no.	From	To	Rep	Sample core no.	Cu	Ni		
1642	10	12	2					
1643	12	14	2					
1644	14	16	2					
1645	16	18	2					
1646	18	20	2					
1647	20	22	2					
1648	22	24	2					
1649	24	26	2					
1650	26	28	2					
1651	28	30	2					
1652	30	32	2					
1653	32	34	2					
1654	34	36	2	@			5%	0.21
1655	36	38	2					
1656	38	40	2					
1657	40	42	2					
1658	42	44	2					
1659	44	46	2					
1660	46	48	2					
1661	48	50	2					
1662	50	52	2					
1663	52	54	2					
1664	54	56	2					
1665	56	58	2					
1666	58	60	2					
1667	60	62	2					
1668	62	64	2					
1669	64	66	2					
1670	66	68	2					
1671	68	70	2					

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE

D.D.H. No. [illegible]

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	GEOLOGICAL LOG ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	ASSAY RECORD Sample no	From	To	Rep	Sample core no	Cu	Ni		
						From 105.00 m - 136.20 m pyrrhotite		S	1672	70	72						
						usually finely disseminated in small			1673	72	74						
						amounts with occasional richer bands			1674	74	76		(1)			[illegible]	[illegible]
						Steatite and Serpentinite veins common			1675	76	78						
						throughout.			1676	78	80						
									1677	80	82						
136.20	137.42	0.22		GRANITE.		Highly steatitised leucocratic biotite			1678	82	84						
						granite vein. Brecciated at contacts.	55°.		1679	84	86						
									1680	86	88						
137.42	171.80	4.38		DUNITE.		Almost completely serpentinised coarse			1681	88	90						
						grained dunites with abundant			1682	90	92						
						disseminated and stringers of magnetite			1683	92	94						
						Zones of brecciated and fractured			1684	94	96						
						dunites common associated with			1685	96	98						
						steatite veins. - 137.42 - 145.00 m.			1686	98	100						
						Disseminated pyrrhotite occurs in moderate			1687	100	102						
						amounts down to 155.00 m. and then			1688	102	104						
						only in small amounts with occasional	40°		1689	104	106						
						richer bands. down to 168.10 m.			1690	106	108						
						thin stringers and veinlets of pyrite occur			1691	108	110						
						from 168.10 - 171.33 m.			1692	110	112						
						171.33 - 178.10 is massive serpentinite.			1693	112	114						
									1694	114	116		(A)			[illegible]	[illegible]
171.80	178.10	6.30		GRANITE.		Leucocratic biotite granite extensively			1695	116	118						
						steatitised at and near contacts.			1696	118	120						
						Upper contact brecciated.			1697	120	122						
									1698	122	124						
178.10	210.31	32.21		DUNITE.		Highly serpentinised mainly massive			1699	124	126						
						dunite with [illegible]			1700	126	128						
						Serpentinisation almost complete down to			1701	128	130						
						180.10 m. with abundant pyrite in			1702	130	132						
						[illegible] veining and thin stringers			1703	132	134						
						From 180.10 - 210.31, generally only small			1704	134	136						
									1705	136	138						

B7.

EXPLORATION VENTURES LTD DIAMOND DRILL CORE RECORD	AREA Belhelvie	O.S. Map No. N.J. 92 SW	Grid Ref. 9311 E 2031 N
	COLLAR CO ORDINATES	COLLAR ELEVATION 84·21 m.	ORIENTATION 006° GRID
	Drilled by ODI Logged by C.A.T.B.	Date started 2/5/72 Date completed 9/5/72	

Page no	D.D.H. No.	INCLINATION OF HOLE	TOTAL DEPTH	OVERALL RECOVERY
1	B 7	−45°	195·99 Metres	97·3 %

CORE SIZES	FROM	TO	REMARKS
[illegible]	13.72	45.72	
BQ	45.72	195.99	

INTERSECTION DEPTHS (Metres) — **GEOLOGICAL LOG** — **ASSAY RECORD**

FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec.
0	13.72	13.72	0	DRIFT		Unconsolidated sand, gravel and boulders.							
13.72	16.00	2.28		CONTAMINATED OLIVINE NORITE		Highly altered, chloritised olivine norite. Bleaching texture.	45°						
16.00	48.84	32.84		OLIVINE NORITE		Medium to fine grained leucocratic 'spotted' olivine norite, consists of numerous, but variable amounts, of small altered magnetitised olivine crystals in a matrix of grey felspar and orthopyroxenes. Many small steatite veins present associated with small faults and fractures. Only traces amounts of pyrite, pyrrhotite and chalcopyrite present throughout.	35°						
48.84	49.46	0.62		CONTAMINATED NORITE.		Highly contaminated chloritic olivine norite containing medium to coarse, < 35 mm, blebs and disseminated pyrrhotite and lesser amounts of chalcopyrite. Texture indicates some autobrecciation.							
49.46	103.60	54.14		OLIVINE NORITE.		Massive medium grained 'spotted' olivine norite. The percentage of olivine is variable. Between 62.30 and 72.00 m the norite is more equigranular with olivines occurring in the matrix. In some small zones the olivines are altered to haematite.							

...N VENTURES LTD
...LL CORE RECORD

Area ...... Belheline ...... Page no. 3 D.D.H. No. B 6

Metres	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
				Numerous small fracture and crush		SC	1706	138	140	2			
				zones throughout :- 192.00, 184.00-184.40m,	25°		1707	140	142	2			
				195.00-196.00m; 203.80-204.10; 205.00,			1708	142	144	2			
				208.80, 209.55			1709	144	146	2			
							1710	146	148	2			
				T.D. 210.51 metres.			1711	148	150	2			
							1712	150	152	2			
							1713	152	154	2			
							1714	154	156	2			
							1715	156	158	2			
							1716	158	160	2			
							1717	160	162	2			
							1718	162	164	2			
							1719	164	166	2			
							1720	166	168	2			
							1721	168	170	2			
							1722	170	172	2			
							1723	178	180	2			
							1724	180	182	2			
							1725	182	184	2			
							1726	184	186	2			
							1727	186	188	2			
							1728	188	190	2			
							1729	190	192	2			
							1730	192	194	2			
							1731	194	196	2			
							1732	196	198	2			
							1733	198	200	2			
							1734	200	202	2			
							1735	202	204	2			
							1736	204	206	2			
							1737	206	208	2			
							1738	208	210	2			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

[illegible] BILHE/VIE [illegible]

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core loss
						Sulphide veins are numerous throughout. Generally only trace amounts of pyrrhotite and chalcopyrite							
103.60	127.00	23.40		OLIVINE NORITE.		Spotted olivine norites as above but containing variable amount of white flecks of felspar. This represents slight contamination. The olivines are haematised from 107.26 - 110.50. Trace amounts of disseminated sulphides. This zone is gradational from the uncontaminated norites above to the highly contaminated norite below.							
127.00	148.62	21.62		CONTAMINATED NORITE.		Olivine norite highly contaminated by siliceous and felsic material. The percentage of olivines present is variable. Olivine rich between 135 - 149 m. Numerous fault and fracture zones. Badly fractured with quartz veins between 144 - 148.62 m. Generally small to trace amounts of finely disseminated pyrite and chalcopyrite with occasional coarser blebs of pyrrhotite, pyrite and chalcopyrite at 137.[illegible] and 137.55 m. 20 cm granite vein at 141.00 m.							
148.62	170.20	21.58		GABBRO		Coarse grained massive to partly fractured biotite gabbro. The biotite crystals have been extensively altered							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE. Page no. 3 D.D.H. No. B·7

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.
						is chlorite. The matrix is mainly felspar with some free quartz. Stilbite and serpentinite veins are common. Also containing haematite. A small 15 cm dyke of olive green chloritic lamprophyre occurs at 162·38 m							
						Further thin 'stringers' of this dyke rocks also occurs at 164·78 and 165·10 m. Course grained pegmatitic gabbro occurs in thin bands between 165·00 - 166·00 m and 167·00 m. They contain small amounts of disseminated medium grained chalcopyrite and pyrite. The rest of the gabbro only contains trace amounts of sulphides. From 167·00 m the gabbro becomes finer grained with an increase in the biotite content. It is also contaminated by siliceous material from 169·75 m.	20°						
170·20	195·99	25·79		HORNFELS.		Medium to fine grained banded siliceous biotite and chlorite rich hornfels with bands of mica schist and biotite gneiss. These are injected by numerous quartz veins and irregular lenses of fine grained chloritised igneous rock. Granite veins occur between 186·96 - 187·49 and 195·20 - 195·99 m. Banding and foliation is well developement but with no fixed dip or direction.							

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

AREA BEL[illegible]LVIE	O.S. Map No. NJ 91 N[illegible]	Grid Ref. 9294 E 1978 N	Page no 1	D.D.H. No. B.8
COLLAR CO ORDINATES	COLLAR ELEVATION 86.50m	ORIENTATION 332° GRID.	INCLINATION OF HOLE −45°	TOTAL DEPTH 105.55 Metres
OVERALL RECOVERY 93.76 %				
Drilled by D.P.I.	Logged by C.M.F.B.	Date started 16/5/72	Date completed 12/5/72	REMARKS

CORE SIZES	FROM	TO
NX	3.05	4.57
NQ	4.57	[illegible]
BQ	[illegible]	105.55

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0	3.05	3.05	0	DRIFT		Unconsolidated sand, gravel and boulders.		
3.05	17.37	14.32		PICRITE		Badly fractured and broken serpentinised picrite. Numerous small soft sand infilled fracture zones causing poor core recovery down to 13.00m. Only trace amounts of visible disseminated sulphides. 13.00 - 17.00m Massive serpentinised picrite with small amounts of disseminated and fracture infill pyrrhotite and pyrite, mainly associated with thin serpentine veins. 17.00 - 17.37m. Soft brecciated serpentinite in fracture/fault zone.		
17.37	34.02	16.65		DUNITE / PICRITE		Massive to partly fractured serpentinised dunites with bands of serpentinised picrite. The latter contains coarse grey segregations of bronzite. Interstitial grey serpentinite and felspar give a pseudo-banding (?) effect down to 21.20m. 21.20 - 23.00m Highly serpentinised dunite heavily fractured and veined with a 75cm granite vein @ [illegible]m. From 23.60m the rock is mainly picrite with large crystals of bronzite.		
34.02	35.11	1.09		GRANITE		Leucocratic partly brecciated coarse grained granite vein with xenoliths (?) of picrite	30°	

ASSAY RECORD

Sample no	From	To	Rep	Sample core rec	Cu %	Ni %			
1739	14	16	2	(i)			(i) [illegible]%	0.21	
1740	64	66	2						
1741	102	104	2						

.PLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE

Page no. 2

D.D.H. No. B 8

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD										
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.						
35.11	48.90	13.79		PICRITE.		Medium grained dark serpentinised picrite composed of olivine and interstitial feldspar and ortho pyroxenes. Only trace amounts of finely disseminated pyrrhotite visible.													
48.90	62.15	14.25		PERIDOTITE.		Massive medium grained serpentinised peridotite with only trace amount of finely disseminated sulphides visible. Composed of altered olivines and interstitial orthopyroxenes. Between 52.15 – 53.15 Peridotite is highly serpentinised with soft clay infilled fractures and a 30 cm serpentinised granite vein	40°												
62.15	63.00	0.8[illegible]		SERPENTINITE		Massive green serpentinite with pseudo banding and rewelded brecciated structures ? Shear zone	35°												
63.00	105.55	42.5[illegible]		DUNITE / PICRITE		Moderate to highly serpentinised sequence of dunites, picrites and peridotites. Individual bands are indistinct and only recognized by the varying % of interstitial feldspar and orthopyroxenes present; the latter often forming large crystals. Sequence mainly unfractured with few steatite veins. 30 cm pegmatite vein with ? biotite hornfels xenoliths strikes @ 95.78 Only trace amounts of fine grained sulphides visible.	50°												

EXPLORATION VENTURES LTD.
DIAMOND DRILL CORE RECORD

AREA	BE[illegible]LVIE
O.S. Map No.	NJ·91 N[illegible]
Grid Ref.	9436 E 1693 N
Page no	1
COLLAR CO ORDINATES	
COLLAR ELEVATION	530 m
ORIENTATION	259° GRID
INCLINATION OF HOLE	−45°
TOTAL DEPTH	133·78 Metres
Drilled by	D·P·I
Logged by	C·A·F·B.
Date started	15/5/72.
Date completed	18/5/72.
REMARKS	

CORE SIZES	FROM	TO
[illegible]	[illegible]	10·67
[illegible]	[illegible]	32·12
[illegible]	[illegible]	133·78

B.9.
93.08%

GEOLOGICAL LOG / ASSAY RECORD

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
0	9·14	9·14	0	DRIFT		Unconsolidated sand gravel and boulders.		Sc							
9·14	21·06	11·92		DUNITE		Very badly shattered and broken highly serpentinised dunites. Only small sections of massive core collected down to 18·60m. The dunite is medium grained composed of Serpentine and Talc minerals giving a mottled dark green / white texture. The numerous fractures are infilled with sandy serpentine minerals. White serpentine veins common often containing small stringers of pyrite and pyrrhotite. Pyrite, pyrrhotite and chalcopyrite also occur in thin hair line fractures through not in any concentration. Magnetite is relatively abundant.									
21·06	26·97	5·91		TROCTOLITE / ANORTHOSITE		Alternating banded sequence of serpentinised troctolites and fine grained Anorthosites. The Troctolites contain ~~[illegible]~~ variable amounts of altered olivine in a fine grained matrix of felspar and serpentine minerals. The olivines often show faint crystal banding. The Anorthosite is a leucocratic rock composed of felspar & serpentine minerals. Trace amounts of visible disseminated pyrrhotite and chalcopyrite.	25°								

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 2 D.D.H. No. B·9

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD					
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample % core	Ni
26.97	30.46	3.49		ANORTHOSITE		Fine medium and coarse grained leucocratic anorthosites. Composed of felspar and serpentine minerals with occassional patches containing olivine crystals. Pseudo-banding due to alignment of the serpentine minerals. 10 cm dyke rock occurs @ 27.90. Small to trace amounts of disseminated pyrite and chalcopyrite visible.	60°	4						
30.46	33.60	3.14		TROCTOLITE.		Serpentinised and magnetitised troctolite similar to previous section. The rock is partly fractured and steatitised with residual brecciated texture from 32.34 - 37.94 m								
33.60	[illegible]	1.21		SERPENTINITE.		Fine grained soft talcose & shattered steatite and serpentinised zone with 10 cm chloritised dyke rock. The zone contains fragments of anorthosite.	30°							
34.81	38.01	3.20		ANORTHOSITE.		? Chloritised, serpentinised and steatitised anorthosite, with occassional stringers of pyrite.								
38.01	61.20	23.19		ANORTHOSITE / TROCTOLITE.		Complex sequence of alternating bands of anorthosite and troctolite. The anorthosites are mainly fine grained with only traces of disseminated chalcopyrite. The bands of troctolite are irregular and only recognised by their olivine content, which is very variable.	45°							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE. Page no. 3 D.D.H. No. B.9

INTERSECTION DEPTHS [Metres] FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD in % Sample no	From	To	Rep	Sample core rec	Ni	Cu
						Throughout the sequence small dark green serpentinite zones occur containing hair line fractures infilled with pyrite and also serpentine veins with small stringers of pyrite. The banding dips @ 35-40° c/a	35.	Tc.							
61.20	62.80	1.60		DUNITE.		Dark green massive highly serpentinised dunite. Partly net veined by white serpentine. Pyrite is moderately abundant in the upper section within the veins occurring as thin stringers and also in thin fractures	35°								
62.80	68.96	6.16		ANORTHOSITE/TROCTOLITE		Fine grained massive sequence of anorthosites and troctolites similar to previous section. Thin dark green serpentinite bands contain thin stringers and infilled fractures of pyrite at 63.90-64.10 and 66.13-66.70. The contact between this sequence and underlying dunite is sharp due to a thin slickensided shear zone making an angle of 90° c/a	20°		1742	66	68	2			
							20°		1743	68	70	2			
68.96	137.86	68.82		DUNITE		Massive to partly fractured material. A highly serpentinised dark green to black dunite. The texture is very uniform throughout. From 68.96-69.62 the dunite contains thin stringers and thin fracture infill pyrite. 69.62 - 94.00 Numerous thin hairline fractures are infilled with pyrrhotite. Coarse blebs of	10°		1744	70	72	2			
									1745	72	74	2			
									1746	74	76	2			
									1747	76	78	2			
									1748	78	80	2			
									1749	80	82	2			
									1750	82	84	2			
									1751	110	112	2			
									1752	130	132	2			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 4 D.D.H. No. 8.9

INTERSECTION DEPTHS [Metres]				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec
						of pyrrhotite also occurs in thin white serpentine veins eg 76.20m. 78.30m and 81.10m From 84.00m the dunites contain only trace amounts of very fine grained pyrrhotite and ? chalcopyrite mainly associated with the altered olivine crystals.							
						T.D. 133.78m.							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

B.10

AREA	BELHELVIE
O.S. Map No.	NJ 91 NW
Grid Ref.	9445E ~~1644N~~ 1671*
Page no	1
D.D.H. No.	[illegible]
COLLAR CO-ORDINATES	-
COLLAR ELEVATION	51.82 m.
ORIENTATION	355° Grid
INCLINATION OF HOLE	-44°
TOTAL DEPTH	76.73 Metres
OVERALL RECOVERY	91.23 %
Drilled by	D.P.I.
Logged by	C.A.F.B.
Date started	19/5/72
Date completed	23/5/72
REMARKS	* See tabulation sheet [initials]

CORE SIZES	FROM	TO
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	GEOLOGICAL LOG ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	ASSAY RECORD Sample no.	From	To	Rep	Sample [illegible]	Cu	Ni %		
0	12.98	12.98	0	DRIFT		Unconsolidated sand gravel and boulders.		Sc	1753	16.00	18.00	2.0				Ⓑ .042	.127
12.98	18.66	5.68		DUNITE / PICRITE		Badly shattered and broken sequence of highly serpentinised dunites and picrites with numerous soft sandy serpentinite infilling fractures. Small amounts of fracture infill and thin stringers of pyrite present.											
18.66	24.52	5.86		PICRITE		Partly fractured dark medium coarse grained serpentinised picrite with bands of fine grained serpentinised and partly haematitised dunite. Trace amounts of disseminated pyrrhotite and chalcopyrite and fracture infill pyrite											
24.52	29.50	4.98		DUNITE		Badly broken and shattered serpentinised dunites with thin bands of picrite. The dunites are partly haematitised. Trace amounts of disseminated & fracture infill pyrite and chalcopyrite present.		Sc	1754	26.00	28.00	2.0					
29.50	32.05	2.55		DUNITE		Massive to partly fractured serpentinised and partly haematitised dunites with bands of picrite. Banding is irregular and indistinct. 5 cm vein of carbonate occurs at 35.15 [illegible] disseminated and blebs of chalcopyrite and pyrrhotite											

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE   Page no. 2   D.D.H. No. B.10

INTERSECTION DEPTHS [Metres] FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD Sample no	From	To	Rep	Sample	Cu %	Ni %
						Towards the end of the run the dunites are gradually replaced by serpentinised and anorthositic material.									
37.05	40.35	3.30		BRONZITE ANORTHOSITE		Alternating bands of medium to coarse grained bronzite anorthosite and medium grained troctolite. The anorthosite contains irregular lenses of dunite/serpentinite material and is cut by numerous steatite veins. Medium to fine grained disseminated chalcopyrite and pyrrhotite occur throughout with occasional coarse blebs and fracture infill. The troctolites contain only trace amounts of sulphides.	30° 20°		Sc 1755	38.00	40.00	2.0			
40.35	49.04	8.69		DUNITE/ PICRITE		The above sequence grades down into serpentinised dunites and picrites. These are partly banded due to difference in interstitial feldspar content. 5cm vein of bronzite anorthosite at 27.70 contains coarse blebs of pyrrhotite and some chalcopyrite. The dunites and picrites contain only trace amounts of sulphides.			Sc 1756	46.00	48.00	2.0			
49.04	51.14	2.10		BRONZITE ANORTHOSITE		Medium to coarse grained highly serpentinised bronzite anorthosite with thin bands of serpentinised and brecciated dunites. The coarser sections produce a distinctive texture composed of coarse [illegible] bronzite crystals.	25°								

INTERSECTION DEPTHS (Metres) FROM	TO	INT	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni
						and irregular felspar lathes in a matrix of semi opaque serpentine. Coarse blebs of pyrrhotite and some chalcopyrite occurs throughout though <2.5% overall.									
51.14	57.49	6.35		DUNITE		Massive to partly fractured serpentinised dunite and picrite. Mainly fine grained. Trace amounts of disseminated and fracture filled pyrite and pyrrhotite.		Sc	1757	56.0	58.0	2.0			
57.49	63.12	5.63		SERPENTINITE / DUNITE.		FAULT ZONE composed of soft sandy serpentinite with bands or blocks of massive to partly fractured serpentinised dunite. Steatite and serpentinite veins are abundant. Some containing thin stringers of pyrite and pyrrhotite.									
63.12	76.78	13.66		DUNITE / PICRITE		Irregularly banded sequence of serpentinised dunites and fine grained picrite extensively invaded by amorphous talc and serpentinite material in the form of lenses and crosscut veins. Only trace amounts of pyrite and pyrrhotite occur infilling thin fractures and in stringers in serpentinite veins.		Sc	1758	68.0	70.0	2.0			
						T.D. 76.78 m.									

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA: BEL[illegible]VIE	O.S. Map No. NJ 91 N[illegible]	Grid Ref. 9445E 1673N	Page no 1
D.D.H. No. B.[illegible] (B.11)			
COLLAR CO ORDINATES:	COLLAR ELEVATION: 51.82m	ORIENTATION: 035° Grid	INCLINATION OF HOLE: -45°
TOTAL DEPTH: 170.02 Metres	OVERALL RECOVERY: 87.67 %		
Drilled by: D.P.I.	Logged by: C.A.F.B.	Date started: 25/5/72	Date completed: 5/6/72

CORE SIZES	FROM	TO
[illegible]	[illegible]	[illegible]
NX	[illegible]	[illegible]
[illegible]	[illegible]	157.[illegible]

REMARKS:

GEOLOGICAL LOG

FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0	7.62	7.62	0	DRIFT		Unconsolidated sand and gravel.		
7.62	29.40	21.78		DUNITE.		Rounded pebbles, fragments and small sections of dunites interbedded with sand and silt. Probably represents either a dunite boulder / gravel bed or highly fragmented bed rock.		
29.40	31.55	2.15		DUNITE		Shattered and intensely serpentinised dunite with numerous small net veins of white serpentine some containing finely granular pyrite.		
31.55	139.65	[illegible]03.10		DUNITE.		Moderately to highly serpentinised dunite massive to partly fractured dark green to black. Extremely uniform dense texture throughout. The sequence down to ± 38.00m is cut by thin veins and lenses of massive granular and micaceous green and grey serpentine. thin highly altered and serpentinised ? brecciated bands occur between 60.76m and 63.58m. Only trace amounts of very fine grained sulphides are visible throughout the sequence. Serpentine veins become more numerous from ± 131.00m to the end of the run sometimes containing thin stringers of pyrite. The contact is sharp though broken and [illegible]	40 / 90°	Sc

ASSAY RECORD %

Sample no	From	To	Rep	Sample core rec.	Cu	Ni
1759	32.00	34.00	2.00			
1760	57.00	59.00	2.00			
1761	82.00	84.00	2.00			
1762	105.00	107.00	2.00			
1763	130.00	132.00	2.00			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE

D.D.H. No. B·1

SECTION DEPTHS [Metres]				GEOLOGICAL LOG				ASSAY RECORD					
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec. angle	Rock strength	Sample no.	From	To	Rep	Sample core rec
[illegible]	146.21	11·56		NORITE.		Medium to fine grained serpentinised and uralitised olivine norite. Consists of totally altered olivine crystals in a matrix of felspar and serpentine. In the finer grained bands the alteration is less pronounced with interstitial ferromagnesian minerals occurring between the felspar. Steatite veins are abundant. Between 143.50 - 143.90 the olivines are totally haematised forming fine bands. The norite is predominantly fine grained from 145.60 to the end of the run. The crystal layering dips at 35° while the contacts between fine & coarse bands dip at 50°. No mineralisation present. (Sequence ≡ to similar sequence at base of D.D.H. B-1?)	50° 60°						
[illegible]	148.35	2·14		SERPENTINE.		FAULT ZONE. Soft clay gouge with fragments and small sections of serpentinite. Small amounts of very fine grained sulphides visible in the sections.							
[illegible]	152.11	4·31		DUNITE / PICRITE		Highly serpentinised partly broken dunite and picrite. Extensively invaded by steatite and serpentine veins. Trace amounts of fine grained sulphides visible with occasional thin stringers of [illegible]. Lower contact sharp	60°						

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELLEVUE Page no. 3 D.D.H. No. B·11.

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intercept angle
152.66	160.31	7.65		ANORTHOSITE		Alternating Succession of fine grained coarse anorthosites with medium grained troctolite. The matrix is similar in both types being fine grained to dense leucocratic felspar and serpentine. The troctolite contains medium to coarse grained olivine crystals - partly altered. Contact between the bands are mainly well defined. ~~No~~ Only scattered traces of disseminated sulphides visible. From 159.02 m the sequence is mainly fine grained finely banded anorthosites. The contact appears gradational in the sequence below.	60° 55°
160.31	165.86	5.55		NORITE		Fine grained grey norite. Partly serpentinised and uralitised consisting of fine grained felspar altered serpentine with interstitial ferromagnesium minerals. The sequence contains occasional irregular lenses and ? bands of siliceous material. Contact is gradational. Occasional fine blebs of pyrrhotite and chalcopyrite, stringers present.	55°
165.86	175.02	9.16		PELITIC GNEISS.		Complex sequence of hornfels and biotite gneiss. The rocks are partly laminated with ... to medium grained biotite muscovite quartz and felspar.	50°

ASSAY RECORD

Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu %	Ni %		
SC	1764	155.02	157.0	2.0					

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA	Belhelvie
O.S. Map No.	NJ 91 NW
Grid Ref.	9373 E 1593 N
Page no	1
D.D.H. No.	B.12
COLLAR CO-ORDINATES	
COLLAR ELEVATION	74.68 m.
ORIENTATION	291° (Grid)
INCLINATION OF HOLE	−45°
TOTAL DEPTH	178.31 Metres
OVERALL RECOVERY	92.1[illegible]
Drilled by	D.P.I.
Logged by	C.A.F.B.
Date started	8/6/72
Date completed	14/6/72

CORE SIZES	FROM	TO
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

REMARKS

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersect angle	Rock strength	ASSAY RECORD Sample no.	From	To	Rep	Sample core rec	% Cu	Ni
0	9.14	9.14	0	DRIFT		Unconsolidated sand and gravel.									
9.14	18.90	9.76		DUNITE		Badly fractured and broken serpentinised and haematised dense reddish coloured dunite. Trace amounts of fine grained disseminated sulphides visible.	40°								
18.90	21.00	2.10		SERPENTINITE.		Badly fractured and broken felspathic, [illegible] serpentinised grey banded rock with scattered large flakes and crystals of biotite and pyroxene. The lower contact is soft and brecciated representing a fault or shear. The rock is probably represent[illegible] a hydrothermally altered and sheared dyke or serpentinite vein.	42°								
21.00	43.00			DUNITE.		Partly to badly fractured dark, dense serpentinised dunite. Numerous soft sandy fracture zones occur. Only scattered traces of visible fine grained disseminated sulphides [illegible]. Thin picrite bands occur [illegible].									
43.00	53.32	10.32		PICRITE		Moderately to highly serpentinised picrite with bands of serpentinised dunite. Generally unfractured. Visibly [illegible] [illegible] [illegible] sulphides.	70°		S 1765	50	52	[illegible]			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE	Page no. 2	D.D.H. No. B-12

INTERSECTION DEPTH (Metres)				GEOLOGICAL LOG					ASSAY RECORD					%	
FROM	TO	[illegible]	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
59.32	[illegible]	[illegible]		SERPENTINITE.		Green and grey massive soft serpentinite			1766	60	62	2.0			
						irregular rewelded brecciated texture.									
						Abundant disseminated magnetite with									
						trace amounts of disseminated sulphides									
						Probably represents a shear zone.	50°								
63.06	[illegible]	[illegible]		DUNITE/PICRITE.		Mainly massive dark moderately to									
						highly serpentinised dunite with									
						picrite bands down to 93.00 m. Thin		Sc	1767	75	77	2.0			
						seams of graphite occur on fracture									
						and joint planes.									
						From 93.00 m the dunite contain									
						gradually more felspar. This is fine									
						grained interstitial down to 103.00 m									
						From 103.00 – 126.24 The succession is	55°	Sc	1768	100	102	2.0			
						mainly medium grained highly serpentinised									
						picrite.		Sc	1769	125	127	2.0			
						From 126.24 – 136.62 – Highly serpentinised									
						dark grey and green dense dunite.	50°								
						Throughout the succession only small									
						to trace amounts of fine grained									
						sulphides are visible.									
136.62	[illegible]	[illegible]		TROCTOLITE/		Complex irregularly massive banded									
				ANORTHOSITE/		sequence of olivine rich troctolites, dunite		Sc	1770	140	142	2.0			
				DUNITE.		anorthosites and picrites. This zone									
						may be the result of continual crystallisation									
						during cooling and separation of the magma.									
						The sequence is moderately to strongly									
						serpentinised and contains small amounts									
						of fine disseminated pyrrhotite and chalcopyrite									
						with some thin and medium sized pods &									
						stringers of pyrrhotite mainly associated with									
						latter serpentinite veins									

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 3 D.D.H. No. [illegible]

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec.	Cu	Ni
						From 143.37 – 144.87 the rock are badly shattered and highly serpentinised and steatitised. This represents a shear zone.									
144.87	152.85	7.98		TROCTOLITE		Massive serpentinised fairly uniform olivine rich medium grained troctolite. This contain large segregation of bronzite. Felspar and bronzite also occur interstitially.			Sc 1771	150	152	2.0			
						Only trace amounts of fine disseminated sulphides visible with occasional thin stringer of pyrrhotite.	50°								
152.85	157.90	5.05		TROCTOLITE / ANORTHOSITE.		Irregularly banded sequence of olivine rich highly serpentinised troctolites and serpentinised bronzite anorthosite. The anorthosite bands contain small to moderate amounts of medium grained disseminated chalcopyrite and pyrrhotite. The troctolite bands only contain trace amounts.									
157.90	163.63	5.73		ANORTHOSITE.		Medium to fine grained highly serpentinised bronzite anorthosite [illegible] by large and small lenses and blebs of green and black serpentinite.									
						The sequence gradually becomes more foliated and sheared towards the end of the run with moderate amount of haematite occurring as thin stringers within the foliation planes and generally interpenetrating the rock. Moderate amounts of chalcopyrite and pyrrhotite occur in parts.			Sc 1772	160	162	2.0			

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELLEVUE

Page no. 4

D.D.H. No. B.12

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core le.	Cu	Zn
						ff to amphibolite									
						The lower contact is marked by									
						a thin 6 cm clay gouge zone.	60°								
[illegible]	178.31	1.68		Siliceous schist		Siliceous leucocratic highly banded									
						metamorphic country rock. It is badly									
						shattered and broken and contains			1773	170	172	2.0			
						abundant thread, orange and yellow oxide									
						bands and in fracture / joint infill.									
						The banding lies between 65-80°									
						to the core axis. This is probably									
						// to a major shearing direction.									

DUPLICATE

Encl 5

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA Belhelvie - Kingseat	O.S. Map No. NJ 91 NW	Grid Ref. 391240E 818836N	Page no 1		D.D.H. No. B 3
COLLAR CO ORDINATES	COLLAR ELEVATION 126 metres	ORIENTATION 239° Grid	INCLINATION OF HOLE −45°	TOTAL DEPTH 110·34 Metres	OVERALL RECOVERY 77·5 %
Drilled by D.P.I	Date started 17th March 1972				
Logged by C.A.F.B.	Date completed 25th March 1972				

CORE SIZES	FROM	TO
TNX	7·61	17·83
NQ	17·83	37·15
BQ	37·15	110·34

REMARKS: Badly broken ground causing poor core recovery.

GEOLOGICAL LOG

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0·00	7·61	7·61	0	DRIFT		Unconsolidated sand and boulder drift.		
7·61	12·19	4·58		TROCTOLITE.		Serpentinised troctolites with olivine replaced by haematite and serpentinite.	35°	
12·19	28·81	16·62		PICRITE.		Highly fractured serpentinised picrite with some haematitisation. Occasional thin irregular stringers of pyrite and chalcopyrite associated with small amounts of disseminated sulphides.	45°	
28·81	31·89	3·08		GRANITE.		thin granite vein almost completely altered to talc and steatite.		
31·89	35·00	3·11		PICRITE/DUNITE.		Serpentinised picrite and dunite. Small scattered stringers and irregular thin lenses of pyrite occur near base of granite vein.	45°	
35·00	57·00	22·00		TROCTOLITE.		Serpentinised troctolite with bands of picrite and dunite. Small amounts of disseminated and fracture infil pyrrhotite, pyrite and chalcopyrite		
57·00	59·00	2·00		GRANITE.		thin granite vein altered to talc and steatite	45°	
59·00	65·22	6·22		GRANITE.		leucocratic biotite/muscovite granite with the biotite showing faint lineation.		
65·22	110·34	45·12		GRANITE		Medium grained equigranular quartz rich biotite muscovite granite. Small garnets occur in several places.		

ASSAY RECORD %

Sample no	From	To	Rep	Sample core rec	Cu	Ni				
SC 1415	21·00	23·00	2·0		·051	·19				
1416	26·00	28·00	2·0		·063	·20				
1417	32·00	34·00	2·0		·047	·23				
1418	45·50	47·50	2·0		·053	·19				

AE 22

EXPLORATION VENTURES LTD DIAMOND DRILL CORE RECORD	AREA BELHELVIE	O.S. Map No. NJ 91 N.W	Grid Ref. 91402E 18228N	Page no 1	D.D.H. No. B 4
	COLLAR CO ORDINATES 9140 E 1823 N	COLLAR ELEVATION 122.0 m.	ORIENTATION 239° GRID	INCLINATION OF HOLE -45°	TOTAL DEPTH 250.94 Metres
					OVERALL RECOVERY 94.78 %
	Drilled by D.P.I. Logged by C.A.F.B.	Date started 28/3/72 Date completed 1/4/72			REMARKS

CORE SIZES	FROM	TO
H	0	8.37
NX	8.37	57.30
BQ	57.30	250.94

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Description (GEOLOGICAL LOG)	Intersec angle	Sample no (ASSAY RECORD %)	From	To	Rep	Sample core rec	Cu	Ni
0	7.61	7.61		DRIFT	Unconsolidated sand and gravel drift.		1419	14	16	2 m		.006	.06
							1420	16	18	2		.023	.32
7.61	13.47	5.86		GRANITE.	Medium to coarse grained pegmatitic granite		1421	18	20	2		.022	.32
					partly altered to talc and steatite cut by	45°	1422	20	22	2		.066	.50
					pegmatitic veins.		1423	22	24	2		.038	.37
							1424	24	26	2		.030	.30
13.47	15.46	1.99		SERPENTINITE	massive grey, green and black serpentinite		1425	26	28	2		.025	.27
					with disseminated pyrhotite and chalcopyrite		1426	28	30	2		.020	.26
							1427	30	32	2		.029	.29
15.46	19.52	4.06		PICRITE.	Fractured and broken serpentinised picrite.		1428	32	34	2		.034	.30
					partly haematitised. Small amounts of disseminated		1429	34	36	2		.038	.29
					pyrhotite.	45°	1430	36	38	2		.038	.29
							1431	38	40	2		.037	.29
19.52	24.39	4.87		DUNITE	Serpentinised dunite consisting of olivine		1432	40	42	2		.023	.25
					and serpentine with occasional lathes of		1433	42	44	2		.016	.22
					bronzite. Pyrhotite generally finely disseminated		1434	44	46	2		.011	.19
					throughout with occasional coarser blebs.		1435	46	48	2		.007	.18
							1436	48	50	2		.009	.19
24.39	43.58	19.19		PERIDOTITE	Serpentinised olivine bronzite peridotite with		1437	50	52	2		.012	.21
					variable amounts of interstitial felspar.		1438	52	54	2		.007	.20
					Bronzite and olivine are the dominant minerals.		1439	54	56	2		.004	.20
					This grades into a picrite where the bronzite		1440	56	58	2		.005	.19
					decreases and the felspar content increases.		1441	58	60	2		.016	.26
					Finely disseminated pyrhotite occurs throughout		1442	60	62	2		.023	.26
					with scattered coarser blebs.		1443	62	64	2		.033	.25
							1444	64	66	2		.029	.23
43.58	64.70	21.12		DUNITE / PICRITE.	Apparent alternating bands of serpentinised		1445	66	68	2		.011	.14
					dunites and picrites with occasional peridotite		1446	68	70	2		.014	.16
					band. Small amounts of disseminated pyrite and		1447	70	72	2		.016	.17
					pyrhotite present.		1448	72	74	2		.017	.16

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 2   D.D.H. No. B4.

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
64.70	66.45	1.65		PICRITE		Serpentinised picrite with thin steatite			SC 1449	74	76	2		.033	.17
						veins containing small amounts of pyrite.			1450	76	78	2		.039	.18
									1451	78	80	2		.040	.17
66.45	66.60	0.15		GRANITE		Steatitised granite vein.	45°		1452	80	82	2		.035	.17
									3	82	84	2		.042	.16
66.60	69.00	3.30		PICRITE.		Serpentinised picrite with thin bands of			4	84	86	2		.035	.15
						massive grey serpentinite containing			5	86	88	2		.053	.19
						finely disseminated pyrite.			6	88	90	2		.050	.21
									7	90	92	2		.026	.17
69.00	82.21	13.21		DUNITE		Serpentinised dunite with thin bands of			8	92	94	2		.040	.16
						picrite and bronzite peridotite.			9	94	96	2		.038	.16
						Fracture and fault zones occur @ 74.40-60m and			1460	96	98	2		.034	.17
						75.20m. Brecciated dunite with calcite matrix			1	98	100	2		.030	.14
						occurs at 79.50 - 79.75 m.			2	100	102	2		.043	.20
						Disseminated pyrite occurs throughout as well			3	102	104	2		.040	.20
						as on some joint and fracture planes.			4	104	106	2		.032	.19
									5	106	108	2		.044	.21
82.21	136.38	54.17		PICRITE/DUNITE		Mainly serpentinised picrite with bands			6	108	110	2		.017	.17
						of serpentinised dunites. pyrite occurs in fine			7	110	112	2		.040	.22
						disseminated form with occasional coarser			8	112	114	2		.040	.18
						blebs and in thin stringers associated	35°		9	114	116	2		.055	.20
						with calcite and serpentinite veins.			1470	116	118	2		.045	.19
						The picrite becomes highly serpentinised near			1	118	120	2		.051	.19
						end of run grading into pure serpentine,			2	120	122	2		.038	.18
						and steatite. from 136.36 - 136.38.			3	122	124	2		.032	.18
									4	124	126	2		.033	.20
136.38	143.60	7.22		DUNITE/PICRITE.		Highly serpentinised dunites and picrites with			5	126	128	2		.026	.19
						veins of serpentine. pyrite occurs disseminated			6	128	130	2		.038	.22
						and in fracture infill and associated with serpentine			7	130	132	2		.034	.24
						veins. Chalcopyrite and pyrrhotite occur to a			8	132	134	2		.029	.23
						lesser extent in disseminated form.			9	134	136	2		.018	.16
									1480	136	138	2		.024	.16
143.60	145.50	1.90		DUNITE.		Serpentinised and haematitised dunite.			1	138	140	2		.027	.21
									2	140	142	2		.031	.22

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE. Page no. 3 D.D.H. No. B4

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni
145.50	157.74	12.24		DUNITE / PICRITE.		Serpentinised dunites and picrites with			SC 1483	142	144	2 m		.026	.22
						Scattered 10 cm veins of grey serpentine.			4	144	146	2		.023	.25
						In places – 145.73 – 146.30 the percentage			5	146	148	2		.022	.26
						of felspar increases to a near troctolite			6	148	150	2		.028	.27
						pyrite and some pyrrhotite occurs and medium			7	150	152	2		.041	.22
						to fine grained disseminations throughout and infilling			8	152	154	2		.040	.16
						and replacing felspar cavities. Fracture infill			9	154	156	2		.067	.23
						pyrite and pyrrhotite.			1490	156	158	2		.064	.21
									1	158	160	2		.040	.19
157.74	160.98	3.24		DUNITE		highly serpentinised dunites and peridotites			2	160	162	2		.016	.04
						often composed of up to 90% serpentine			3	162	164	2		.029	.06
						and steatite.			4	164	166	2		.024	.06
						Variable amounts of sulphides increases			5	166	168	2		.027	.06
						towards end run. where core is badly			6	168	170	2		.040	.11
						fractured.			7	170	172	2		.043	.14
									8	172	174	2		.034	.13
160.98	162.00	1.02		STEATITE.		White or grey massive fractured and			9	174	176	2		.035	.13
						broken steatite and serpentine. Probably			1500	176	178	2		.034	.13
						represents a fault zone.	35°.		1	178	180	2		.053	.18
									2	180	182	2		.045	.14
162.00	168.00	6.00		OLIVINE NORITE		Grey green spotted highly altered and			3	182	184	2		.043	.16
						serpentinised rock composed of olivine			4	184	186	2		.060	.23
						crystals in a matrix of pyroxenes.			5	186	188	2		.043	.18
						Probably represents an olivine norite grading			6	188	190	2		.052	.21
						to pyroxenite.	50°		7	190	192	2		.055	.21
									8	192	194	2		.054	.18
168.00	211.72	43.72		DUNITE		Serpentinised and haematitised dunites with			9	194	196	2		.048	.17
						bands of picrite. fracture and vein infill			1510	196	198	2		.041	.17
						pyrite and some pyrrhotite common mainly			1	198	200	2		.039	.18
						associated with serpentine veins.			2	200	202	2		.042	.24
									3	202	204	2		.026	.19
211.72	215.85	4.13		GRANITE.		pale leucocratic biotite quartz granite			4	204	206	2		.028	.20
						vein. Highly steatitised at contacts			5	206	208	2		.020	.19
									6	208	210	2		.028	.20

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE   Page no. 4   D.D.H. No. B 4

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength
215.85	231.04			DUNITE / PICRITE		Serpentinised picrites, dunites and peridotites. Pyrite and pyrhotite generally finely disseminated increasing towards end of run.	35°	
231.04	234.09			NORITE		Clay gouge representing fault zone passing into highly altered and steatitised leucocratic rock probably representing a norite. Irregular xenoliths of finer basic material occurs containing moderate amounts of disseminated medium to fine grained pyrhotite and chalcopyrite. Xenoliths of dunite also occur containing abundant pyrhotite.		
234.09	234.94			BRONZITITE		Course grained band of bronzite rich rock containing fragments of dunite with medium grained disseminated pyrhotite. Steatite veins are common.	35°	
234.94	250.94			CONTAMINATED NORITE		Fine to medium grained felspar / pyroxene rich rock extensively contaminated and fractured with veins of steatite. Probably represents a contaminated norite. Traces of disseminated pyrhotite present.		
						COMPLETED TO DEPTH OF 250.94 m.		

ASSAY RECORD %

Sample no	From	To	Rep	Sample core rec	Cu	Ni
1517	210	212	2		·040	·21
8	216	218	2		·049	·33
9	218	220	2		·025	·24
1520	220	222	2		·030	·20
1	222	224	2		·041	·28
2	224	226	2		·020	·28
3	226	228	2		·013	·25
4	228	230	2		·014	·18
5	230	232	2		·034	·13
6	232	234	2		·040	·10
1527	234	236	2		·052	·16

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA: BELHELVIE	O.S. Map No. NJ 91 NW	Grid Ref. 91572E 18327N	Page no: 1
D.D.H. No. B.5			
COLLAR CO-ORDINATES:	COLLAR ELEVATION:	ORIENTATION: 239° GRID	INCLINATION OF HOLE: -45°
TOTAL DEPTH: 242.93 Metres	OVERALL RECOVERY: 96.86 %		
Drilled by: D.P.I	Logged by: C.A.F.B.	Date started: 12/4/72	Date completed: 21/4/72

CORE SIZES	FROM	TO	REMARKS
H	0	7.61	open hole
TNX	7.61	10.36	
NQ	10.36	51.82	
BQ	51.82	242.93	

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	GEOLOGICAL LOG: ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	ASSAY RECORD %: Sample no	From	To	Rep	Sample core rec.	Cu	Ni
0	7.61	7.61	0	DRIFT.		Unconsolidated glacial sand and gravel.			1528	10	12	2		.040	.22
									9	12	14	2		.043	.26
7.61	38.91	31.30		DUNITE.		Medium to coarse grained serpentinised			1530	14	16	2		.032	.22
						dunite. Badly fractured and broken due			1	16	18	2		.030	.20
						to weathering and oxidation down to 13.50m.			2	18	20	2		.020	.18
						Small amounts of disseminated pyrrhotite from			3	20	22	2		.039	.19
						13.50 – 25.60. with moderate amounts of			4	22	24	2		.135	.46
						finely disseminated sulphides from 25.60 –			5	24	26	2		.119	.45
						29.40.			6	26	28	2		.039	.32
						from 29.40 – 38.91. Small amounts of disseminated			7	28	30	2		.027	.30
						pyrrhotite with occasional larger blebs within			8	30	32	2		.007	.19
						alternating medium and coarse grained ±			9	32	34	2		.033	.21
						serpentinised dunites.			1540	34	36	2		.062	.26
									1	36	38	2		.014	.25
38.91	40.14			GRANITE		leucocratic partly altered granite vein.			2	38	40	2		.014	.12
						Badly fractured with steatite veins near			3	40	42	2		.012	.21
						base.	70°		4	42	44	2		Not	assayed
									5	44	46	2		.011	.19
40.14	82.78			DUNITE		Dark massive serpentinised dunite with			6	46	48	2		Not	assayed
						occassional softer granular dunitic bands			7	48	50	2		.035	.19
						Overall small amounts of disseminated			8	50	52	2		Not	assayed
						fine grained pyrrhotite present with			9	52	54	2		.040	.21
						scattered richer bands i.e 42.00 – 43.00m			1550	54	56	2		Not	assayed
						and 47.50 – 50.00 m.			1	56	58	2		.047	.21
						Highly serpentinised and steatitised from			2	58	60	2		.065	.23
						87.30 – 82.78 m.			3	60	62	2		.058	.25
									4	62	64	2		.062	.25
82.78	90.07			GRANITE		leucocratic altered granite vein. Steatitised			5	64	66	2		.061	.28
						at top and partly tourmalinised at base.			6	66	68	2		.063	.35
						Upper contact broken while lower contact irregular.			7	68	70	2		.048	.27

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 2 D.D.H. No. B5

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni
90.07	176.06	85.99		DUNITE		Dark massive serpentinised dunites	70°		1558	70	72	2 m		·048	·27
						with some bronzite peridotite bands			1559	72	74	2		·082	·36
						occurring from 142 metres – 156·10 m			1560	74	76	2		·042	·20
						Overall small amounts of disseminated			1561	76	78	2		·023	·15
						pyrrhotite and ? pyrite present. Chalcopyrite			1563	80	82	2		·047	·22
						and pyrrhotite visible around 167 – 170 m.			1565	84	86	2		·047	·21
						Small steatite veins scattered throughout	55°		1567	90	92	2		·041	·18
									1569	94	96	2		·032	·21
176·06	176·79	0·73		GRANITE.		Steatitised leucocratic granite vein.	45°		1571	98	100	2		·042	·21
									1573	102	104	2		·050	·21
176·79	194·66	17·87		DUNITE.		Dark mainly massive serpentinised dunite			1575	106	108	2		·048	·24
						with several soft fractured, steatitised			1577	110	112	2		·021	·24
						zones.			1579	114	116	2		·035	·20
						Finely disseminated pyrrhotite occurs in			1581	118	120	2		·036	·22
						small amount throughout as well as on			1583	122	124	2		·029	22
						some joint and fracture planes as			1585	126	128	2		·022	25
						thin smears. Occasional disseminated	45°		1587	130	132	2		·017	·20
						chalcopyrite visible.			1589	134	136	2		·027	·18
									1591	138	140	2		·030	·19
194·66	197·41	2·75		GRANITE.		Medium grained leucocratic biotite	45°		1593	142	144	2		·055	·22
						granite.	55°		1595	146	148	2		·041	·20
									1597	150	152	2		·076	·24
197·41	242·93	45·52		DUNITE		Dark massive serpentinised dunites			1599	154	156	2		·021	·18
						with occasional serpentine veins.	60°		1601	156	160	2		·036	·21
						Generally small amounts of disseminated			1603	162	164	2		·044	·22
						pyrrhotite and some chalcopyrite.			1605	166	168	2		·025	·22
						Several thin granite veins occur throughout.	50°		1607	170	172	2		·031	·24
									1609	174	176	2		·028	·27
						HOLE COMPLETED AT 242·93 metres.			1611	178	180	2		·027	·24
									1613	182	184	2		·035	·23
									1615	186	188	2		·045	29
									1617	190	192	2		·025	·23
									1619	197·5	200	2·5		·033	·25
									1621	202	204	2		·048	·18

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE　　Page no. 3　　D.D.H. No. B5

INTERSECTION DEPTHS (Metres): FROM | TO | REP | REC

GEOLOGICAL LOG: ROCK TYPE | Graphic log | Description | Intersec angle | Rock strength

ASSAY RECORD %

Sample no	From	To	Rep	Sample core rec.	Cu	Ni
1623	206	208	2		·027	·23
1625	210	212	2		·032	·23
1627	214	216	2		·041	·19
1629	218	220	2		·055	·21
1631	222	224	2		·020	·15
1633	226	228	2		·012	·25
1635	230	232	2		·022	·13
1637	234	236	2		·058	·23
1639	238	240	2		·047	·21
1641	242	242·93	·93		·054	·22

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA: BELHELVIE.	O.S. Map No.	Grid Ref.: 91744E, 18436N.	Page no: 1.	D.D.H. No.: D.D.H. B-6
COLLAR CO ORDINATES	COLLAR ELEVATION: 113.70 m.	ORIENTATION: 239° GRID	INCLINATION OF HOLE: −45°	TOTAL DEPTH: 210.31 Metres
OVERALL RECOVERY: 95.9 %				
Drilled by: D.P.I.	Logged by: C.A.F.B.	Date started: 22/4/72.	Date completed: 28/4/72	REMARKS

CORE SIZES	FROM	TO
NX	0	35'
NQ	35'	160'
BQ	160'	695'

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	ASSAY RECORD % Sample no.	From	To	Rep	Sample cor. rec	Cu	Ni
0	7.61	7.61	0	DRIFT.		Unconsolidated sand and gravel.			1642	10	12	2m		.069	.25
									3	12	14	2		.033	.22
7.61	9.14		1.53	DUNITE.		Badly shattered, weathered serpentinised and			4	14	16	2		.045	.21
						haematitised dunites.			5	16	18	2		.051	.23
									6	18	20	2		.055	.24
9.14	39.10		29.96	DUNITE.		Fractured highly serpentinised and haematised			7	20	22	2		.050	.22
						coarse grained dunites. Yellow oxides occur			8	22	24	2		.063	.24
						in fractures and disseminations down to 30 m.			9	24	26	2		.077	.25
						Magnetite in disseminated form is abundant.			1650	26	28	2		.065	.24
						Fine grained pyrrhotite moderately abundant			1	28	30	2		.051	.22
						from 30 m – 39.10 with some fracture infill			2	30	32	2		.077	.26
						pyrrhotite and pyrite between 38.00 – 39.10 m.			3	32	34	2		.060	.24
									4	34	36	2		.051	.21
39.10	45.00		5.90	DUNITE.		Highly serpentinised and haematised (to 40.50m)			5	36	38	2		.060	.23
						coarse grained dunites. Disseminated and			6	38	40	2		.035	.19
						compacted thin veinlets & stringers of pyrrhotite			7	40	42	2		.044	.19
						abundant particularly around 41.00 m.			8	42	44	2		.062	.25
						Olivine crystals totally replaced by serpentine.			9	44	46	2		.011	.39
									1660	46	48	2		.079	.33
45.00	136.00		91.00	DUNITE.		Massive or partly fractured serpentinised			1	48	50	2		.073	.32
						medium to coarse grained dunites with			2	50	52	2		.086	.32
						thin bands of serpentinised peridotites. These			3	52	54	2		.058	.27
						are cut by several fracture and crush			4	54	56	2		.043	.26
						zones. 63.50 – 65.00; 78.00; 82.50; 92.30			5	56	58	2		.050	.24
						102.40; 103.70 – 104.20; 105.80 – 106.20; 112.60 –			6	58	60	2		.062	.26
						113.50; 114.05 – 114.50; 118.70 – 119.50. These			7	60	62	2		.062	.26
						bands are often graphitic.			8	62	64	2		.066	.26
						Magnetite is abundant throughout.			9	64	66	2		.037	.20
						Disseminated and some chalcopyrite usually			1670	66	68	2		.028	.19
						moderately abundant down to 105.00 m.			1	68	70	2		.029	.19

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE — Page no. 2 — D.D.H. No. B·6

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD % Sample no	From	To	Rep	Sample core rec.	Cu	Ni.
						From 105·00 m – 136·20m pyrrhotite			1672	70	72	2m		·024	·20
						usually finely disseminated in small			3	72	74	2		·057	·23
						amounts with occasional richer bands			4	74	76	2		·054	·26
						steatite and serpentinite veins common			5	76	78	2		·067	·30
						throughout			6	78	80	2		·066	·30
									7	80	82	2		·040	·24
136·20	137·42	0·22		GRANITE.		Highly steatitised leucocratic biotite			8	82	84	2		·009	·08
						granite vein. Brecciated at contacts.	45°		9	84	86	2		·028	·23
									1680	86	88	2		·029	·25
137·42	171·80	4·38		DUNITE.		Almost completely serpentinised coarse			1	88	90	2		·035	·26
						grained dunites with abundant			2	90	92	2		·026	·24
						disseminated and stringers of magnetite			3	92	94	2		·003	·06
						Zones of brecciated and fractured			4	94	96	2		·040	·24
						dunites common, associated with			5	96	98	2		·040	·28
						steatite veins: – 137·42 – 145·00 m.			6	98	100	2		·032	·27
						Disseminated pyrrhotite occurs in moderate			7	100	102	2		·026	·24
						amounts down to 145·00m and then			8	102	104	2		·035	·26
						only in small amounts with occasional	40°		9	104	106	2		·017	·22
						richer bands. down to 168·10 m.			1690	106	108	2		·013	·22
						Thin stringers and veinlets of pyrite occur			1	108	110	2		·003	·19
						from 168·10 – 171·33 m.			2	110	112	2		·005	·14
						171·33 – 178·10 is massive serpentinite.			3	112	114	2		·006	·18
									4	114	116	2		·023	·22
171·80	178·10	6·30		GRANITE.		Leucocratic biotite granite extensively			5	116	118	2		·025	·23
						steatitised at and near contacts.			6	118	120	2		·035	·26
						Upper contact brecciated.			7	120	122	2		·031	·26
									8	122	124	2		·030	·25
178·10	210·31	32·21		DUNITE.		Highly serpentinised mainly massive			9	124	126	2		·026	·24
						dunite with bands of picrite.			1700	126	128	2		·015	·20
						Serpentinisation almost complete down to			1	128	130	2		·031	·24
						180·90m. with abundant ? pyrite in			2	130	132	2		·018	·22
						net veining and thin stringers.			3	132	134	2		·012	·19
						From 180·90 – 210·31 generally only small			4	134	136	2		·030	·20
						amounts of disseminated sulphides.			5	136	138	2		·004	·03

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 3 D.D.H. No. B 6

INTERSECTION DEPTHS [Metres]				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni
						Numerous small fracture and crush			Sc 1706	138	140	2m		·029	·18
						zones throughout:- 182·00, 184·00-184·40m,	25°		7	140	142	2		·018	·21
						195·00 - 196·00m; 203·80 - 204·10; 205·40,			8	142	144	2		·023	·21
						208·80; 209·55.			9	144	146	2		·035	·22
									1710	146	148	2		·045	·25
						T.D. 210·31 metres.			1	148	150	2		·040	·25
									2	150	152	2		·027	·30
									3	152	154	2		·041	·25
									4	154	156	2		·031	·25
									5	156	158	2		·018	·23
									6	158	160	2		·017	·22
									7	160	162	2		·019	·22
									8	162	164	2		·051	·24
									9	164	166	2		·040	·21
									1720	166	168	2		·039	·23
									1	168	170	2		·042	·20
									2	170	172	2		·063	·26

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA Belhelvie	O.S. Map No. N.J. 92 SW	Grid Ref. 93110E 20309 N	Page no 1		D.D.H. No. B 7
COLLAR CO ORDINATES	COLLAR ELEVATION 84.21 m.	ORIENTATION 006° GRID	INCLINATION OF HOLE −45°	TOTAL DEPTH 195.99 Metres	OVERALL RECOVERY 97.3 %
Drilled by O.P.I. Logged by C.R.F.B.	Date started 2/5/72 Date completed 9/5/72				REMARKS

CORE SIZES	FROM	TO
NQ	13.72	45.72
BQ	45.72	195.99

GEOLOGICAL LOG — ASSAY RECORD: Not Assayed.

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec.
0	13.72	13.72	0	DRIFT.		Unconsolidation sand, gravel and boulders.							
13.72	16.00	2.28		CONTAMINATED OLIVENE NORITE.		Highly altered, chloritised olivine norite. Blotchy texture.	45°						
16.00	48.84	32.84		OLIVINE NORITE.		Medium to fine grained leucocratic 'spotted' olivine norite. Consists of numerous, but variable amounts, of small altered magnetitised olivine crystals in a matrix of grey felspar and orthopyroxenes. Many small steatite veins present associated with small faults and fractures. Only traces amounts of pyrite, pyrrhotite and chalcopyrite present throughout.	35°						
48.84	49.46	0.62		CONTAMINATED NORITE.		Highly contaminated chloritic olivine norite containing medium to coarse, (35 mm), blebs and disseminated pyrrhotite and lesser amounts of chalcopyrite. Texture indicates some autobrecciation.							
49.46	103.60	54.14		OLIVINE NORITE.		Massive medium grained 'spotted' olivine norite. The percentage of olivine is variable. Between 62.30 and 72.00 m the norite is more equigranular with olivines occuring in the matrix. In some small zones the olivines are altered to haematite.							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 2   D.D.H. No. B·7

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.
						Steatite veins are numerous throughout. Generally only trace amounts of pyrrhotite and chalcopyrite.							
103·60	127·00	23·40		OLIVINE NORITE.		Spotted olivine norites as above but containing variable amount of white flecks of felspar. This represents slight contamination. The olivines are haematitised from 107·26 - 110·50. Trace amounts of disseminated sulphides. This zone is gradational from the uncontaminated norites above to the highly contaminated norite below.							
127·00	148·62	21·62		CONTAMINATED NORITE.		Olivine norite highly contaminated by siliceous and felsic material. The percentage of olivines present is variable. Olivine rich between 135 - 144 m. Numerous fault and fracture zones. Badly fractured with quartz veins between 144 - 148·62 m. Generally small to trace amounts of finely disseminated pyrite and chalcopyrite with occasional coarser blebs of pyrrhotite, pyrite and chalcopyrite at 132·34 and 132·88 m. 20 cm granite vein at 141·00 m.							
148·62	170·20	21·58		GABBRO		Course grained massive to partly fractured biotite gabbro. The biotite crystals have been extensively altered							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE. Page no. 3 D.D.H. No. B·7

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec
						to chlorite. The matrix is mainly felspar with some free quartz. Steatite and serpentinite veins are common, often containing haematite. A small 25 cm dyke of olive green chloritic lamprophyre occurs at 162·38 m.							
						Further thin 'stringers' of this dyke rocks also occurs at 164·78 and 155·70	20°						
						V. Coarse grained pegmatitic gabbro occurs in thin bands between 165.00 – 166·00 m and 169·00 m. They contain small amounts of disseminated medium grained chalcopyrite and pyrite. The rest of the gabbro only contain trace amounts of sulphides. From 167·00 m the gabbro becomes finer grained with an increase in the biotite content. It is also contaminated by siliceous material from 169·75 m.							
170·20	195·99	25·79		HORNFELS.		Medium to fine grained banded siliceous biotite and chlorite rich hornfels with bands of mica schist and biotite gneiss. These are infected by numerous quartz veins and irregular lenses of fine grained chloritised igneous rock. Granite veins occur between 186·86 – 187·44 and 195·20 – 195·99 m. Banding and foliation is well development, but with no fixed dip or direction.							

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA BELHELVIE	O.S. Map No. NJ 91 NW	Grid Ref. 92935E 19785N		Page no 1	D.D.H. No. B 8
COLLAR CO ORDINATES	COLLAR ELEVATION 86·50m	ORIENTATION 241° Grid	INCLINATION OF HOLE −45°	TOTAL DEPTH 105·55 Metres	OVERALL RECOVERY 93·76 %
Drilled by D.P.I. Logged by C.A.F.B.	Date started 10/5/72 Date completed 12/5/72				REMARKS

CORE SIZES	FROM	TO
NX	3·05	4·57
NQ	4·57	35·20
BQ	35·20	105·55

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %					
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec	Cu	Ni
0	3·05	3·05	0	DRIFT		Unconsolidated sand, gravel and boulders.									
3·05	17·37	14·32		PICRITE		Badly fractured and broken serpentinised picrite. Numerous small soft sand infilled fracture zones causing poor core recovery down to 13·00m. Only trace amounts of visible disseminated sulphides. 13·00 – 17·00m. Massive serpentinised picrite with small amounts of disseminated and fracture infil pyrrhotite and pyrite; mainly associated with thin serpentine veins. 17·00 – 17·37m. Soft brecciated serpentinite in fracture/fault zone.			1739	14	16	2m.		·026	·21
17·37	34·02	16·65		DUNITE / PICRITE		Massive to partly fractured serpentinised dunites with bands of serpentinised picrite. The latter contains coarse grey segregations of bronzite. Interstitial grey serpentinite and felspar give a pseudo-banding effect down to 21·20m. 21·20 – 23·00. Highly serpentinised dunite heavily fractured and veined with a 25cm granite vein @ 22·00m. From 25·60m the rock is mainly picrite with large crystals of bronzite.									
34·02	35·11	1·09		GRANITE		Leucocratic partly brecciated coarse grained granite vein with xenoliths of picrite.	30°								

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 2   D.D.H. No. B 8

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD %						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
35·11	48·90	13·79		PICRITE.		Medium grained dark serpentinised picrite composed of olivine and interstitial felspar and ortho pyroxenes. Only trace amounts of finely disseminated pyrhotite visible.									
48·90	62·15	14·25		PERIDOTITE.		Massive medium grained serpentinised peridotite with only trace amounts of finely disseminated sulphides visible. Composed of altered olivines and interstitial orthopyroxenes. Between 52·15 – 53·15. Peridotite is highly serpentinised with soft clay infilled fractures and a 30 cm serpentinised granite vein	40°								
62·15	63·00	0·85		SERPENTINITE		Massive green serpentinite with pseudo banding and rewelded brecciated structures. ? Shear zone.	35°								
63·00	105·55	42·55		DUNITE/ PICRITE		Moderate to highly serpentinised sequence of dunites, picrites and peridotites.			SC 1740	64	66	2 m		·003	·16
						Individual bands are indistinct and only recognized by the varying % of interstitial felspar and orthopyroxenes.			SC 1741	102	104	2		·003	·20
						present; the latter often forming large crystals. Sequence mainly unfractured with few steatite veins. 30 cm pegmatite vein with ? biotite hornfels xenoliths occur @ 95·78. Only trace amounts of fine grained sulphides visible	50°								

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA BELHELVIE	O.S. Map No. NJ-91 NW	Grid Ref. 94360E 16928N		Page no 1	D.D.H. No. B9
COLLAR CO ORDINATES	COLLAR ELEVATION 58·00 m	ORIENTATION 258° GRID	INCLINATION OF HOLE -45°	TOTAL DEPTH 133·78 Metres	OVERALL RECOVERY 93·08 %
Drilled by D.P.I	Date started 15/5/72				REMARKS
Logged by C.A.F.B.	Date completed 18/5/72				

CORE SIZES	FROM	TO
H.T.	9·14	10·67
N.Q.	10·67	32·12
B.Q.	32·12	133·78

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	GEOLOGICAL LOG: ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	ASSAY RECORD: Sample no.	From	To	Rep	Sample core rec
0	9·14	9·14	0	DRIFT.		Unconsolidated sand gravel and boulders.							
9·14	21·06	11·92		DUNITE		Very badly shattered and broken highly serpentinised dunites. Only small sections of massive core collected down to 18·00m. The dunite is medium grained composed of serpentine and talc minerals giving a mottled dark green/white texture. The numerous fractures are infilled with sandy serpentine minerals. White serpentine veins common often containing small stringers of pyrite and pyrhotite. Pyrite, pyrhotite and chalcopyrite also occur in thin hair line fractures through not in any concentration. Magnetite is relatively abundant.							
21·06	26·97	5·91		TROCTOLITE / ANORTHOSITE		Alternating banded sequence of serpentinised troctolites and fine grained anorthosites. The troctolites contain ~~some~~ variable amounts of altered olivine in a fine grained matrix of felspar and serpentine minerals. The olivines often show faint crystal banding. The anorthosite is a leucocratic rock composed of felspar & serpentine minerals. Trace amounts of visible disseminated pyrhotite and chalcopyrite.	25°						

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DIAMOND DRILL CORE RECORD

Area BECHELVIE. Page no. 2 D.D.H. No. B·9

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD				
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.
26.97	30.46	3.49		ANORTHOSITE		Fine medium and course grained leucocratic anorthosites. Composed of felspar and serpentine minerals with occassional patches containing olivine crystals. Pseudo-banding due to alignment of the serpentine minerals. 10 cm dyke rock occurs @ 27.90 Small to trace amounts of disseminated pyrite and chalcopyrite visible.	60°						
30.46	33.60	3.14		TROCTOLITE.		Serpentinised and magnetitised Troctolite similar to previous section. The rock is partly fractured and steatitised with rewelded brecciated texture from 32.34 - 32.84 m							
33.60	34.81	1.21		SERPENTINITE.		Fine grained soft broken & shattered steatitised and serpentinised zone with 10 cm chloritised dyke rock. The zone contains fragments of anorthosite.	30°						
34.81	38.01	3.20		ANORTHOSITE.		? Chloritised, serpentinised and steatitised anorthosite. with occassional stringers of pyrite.							
38.01	61.20	23.19		ANORTHOSITE / TROCTOLITE.		Complex sequence of alternating bands of anorthosite and troctolite. The anorthosites are mainly fine grained with only traces of disseminated chalcopyrite. The bands of troctolite are irregular and only recognised by their olivine content, which is very variable.	45°						

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 3 D.D.H. No. B·9

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD % Sample no	From	To	Rep	Sample core rec	Cu	Ni
						throughout the sequence small dark									
						green serpentinite zones occur containing	35								
						hair line fractures infilled with pyrite and									
						also serpentine veins with small stringers									
						of pyrite									
						The banding dips @ 35-40° C/A									
61.20	62.80	1.60		DUNITE.		Dark green massive highly serpentinised	35°								
						dunite. Partly net veined by white									
						serpentine. pyrite is moderately abundant									
						in the upper section within the veins									
						occurring as thin stringers and also									
						in thin fractures.									
62.80	68.96	6.16		ANORTHOSITE/		Fine grained massive sequence of			SC 1742	66	68	2m		·014	·066
				TROCTOLITE		anorthosites and troctolites similar			3	68	70	2		·039	·052
						to previous sections. Thin dark green			4	70	72	2		·051	·11
						serpentinite bands contain thin stringers			5	72	74	2		·047	·12
						and infilled fractures of pyrite. at			6	74	76	2		·060	·12
						63.90-64.10 and 66.13 – 66.70.	35°		7	76	78	2		·041	·16
						The contact between this sequence and			8	78	80	2		·045	·17
						underlying dunites is sharp due to a	20°		9	80	82	2		·048	·12
						thin steatitised shear zone making an			1750	82	84	2		·041	·11
						angle of 90° C/A									
									1751	110	112	2		·043	·20
68.96	133.78	64.82		DUNITE		Massive to partly fractured moderate	90°		1752	130	132	2		·047	·15
						to highly serpentinised dark green to black									
						dunite. The texture is very uniform									
						throughout.									
						From 68.96 – 69.62. The dunites contain thin									
						stringers and thin fracture infil pyrite.									
						69.62 – ± 84.00. Numerous thin hairline fractures									
						are infilled with pyrrhotite. Coarse blebs of									

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DIAMOND DRILL CORE RECORD

Area BELHELVIE

Page no. 4.

D.D.H. No. 8·9.

INTERSECTION DEPTHS [Metres]				GEOLOGICAL LOG					ASSAY RECORD										
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep.	Sample core rec.						
						of pyrhotite also occur in thin white serpentine veins eg 76·20m. 78·30m and 81·10m													
						From 84·00m the dunites contain only trace amounts of very fine grained pyrhotite and ? chalcopyrite mainly associated with the altered olivine crystals.													
						T.D. 133·78m.													

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA BELHELVIE	O.S. Map No. NJ·91·N·W	Grid Ref. 94435E 16705N	Page no 1·	D.D.H. No. B·10	
COLLAR CO ORDINATES	COLLAR ELEVATION 51·82m·	ORIENTATION 358° GRID	INCLINATION OF HOLE −44°	TOTAL DEPTH 76·78 Metres	OVERALL RECOVERY 91·23· %
Drilled by D·P·I·	Date started 19/5/72·			REMARKS	
Logged by C·A·F·B·	Date completed 23/5/72				

CORE SIZES	FROM	TO
TNX	12·98	13·78
NQ	13·78	37·80
BQ	37·80	76·78

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no.	From	To	Rep	Sample core rec	Cu	Ni
0	12·98	12·98	0	DRIFT·		Unconsolidated sand, gravel and boulders.									
12·98	18·66	5·68		DUNITE/PICRITE		Badly shattered and broken sequence of highly serpentinised dunites and picrites with numerous soft sandy serpentinite infilling fractures. Small amounts of fracture infil and thin stringers of pyrite present.			1753	16	18	2·0		·042	·128
18·66	24·52	5·86		PICRITE		Partly fractured dark medium course grained serpentinised picrite with bands of fine grained serpentinised and partly haematitised dunites. Trace amounts of disseminated pyrrhotite and chalcopyrite and fracture infil pyrite.									
24·52	29·50	4·98		DUNITE		Badly broken and shattered serpentinised dunites with thin bands of picrite. The dunites are partly haematitised. Trace amounts of disseminated & fracture infil pyrite and chalcopyrite present.			1754	26	28	2·0		·032	·119
29·50	37·05	7·55		DUNITE·		Massive to partly fractured serpentinised and partly haematitised dunites with bands of picrite. Banding is irregular and indistinct. 5 cm vein of anorthosite occurs at 35·15 containing abundant medium grained disseminations and blebs of chalcopyrite and pyrrhotite.									

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE   Page no. 2   D.D.H. No. B·10

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD										
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni				
						Towards the end of the run the dunites are coarsely net veined by serpentinised and anorthositic material.													
37·05	40·35	3·30		BRONZITE ANORTHOSITE		Alternating bands of medium to course grained bronzite anorthosite and medium grained troctolite. The anorthosite contains irregular lenses of dunitic/serpentinite material and is cut by numerous steatite veins. Medium to fine grained disseminated chalcopyrite and pyrhotite occurs throughout with occasional coarser blebs and fracture infil. The troctolites contain only trace amounts of sulphides.	30°, 20°		1755	38	40	2·0		·033	·089				
40·35	49·04	8·69		DUNITE/ PICRITE		The above sequence grades down into serpentinised dunites and picrites. There are partly banded due to difference in interstitial felspar content. 5cm vein of bronzite anorthosite at 47·70 contains course blebs of pyrhotite and some chalcopyrite. The dunites and picrites contain only trace amounts of sulphides			1756	46	48	2·0		·061	·168				
49·04	51·14	2·10		BRONZITE ANORTHOSITE		Medium to course grained highly serpentinised bronzite anorthosite with thin bands of serpentinised and haematitised dunites. The coarser section produce a distinctive rock type composed of course sub-hedral bronzite crystals	25°												

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area: BELHELVIE — Page no. 3 — D.D.H. No. B10

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
						and irregular felspar lathes in a matrix of semi-opaque serpentine. Course blebs of pyrhotite and some Chalcopyrite occurs throughout though <5% overall.									
51.14	57.49	6.35		DUNITE		Massive to partly fractured serpentinised dunite and picrite. Mainly fine grained. Trace amounts of disseminated and fracture infil pyrite and pyrhotite.			1757	56	58	2.0		.078	.115
57.49	63.12	5.63		SERPENTINITE/ DUNITE.		FAULT ZONE - composed of soft sandy serpentinite with bands or ? blocks of massive to partly fractured serpentinised dunite. Steatite and serpentinite veins are abundant some containing thin stringers of pyrite and pyrhotite.									
63.12	76.79	13.66		DUNITE/ PICRITE		Irregularly banded sequence of serpentinised dunites and fine grained picrite extensively injected by amorphositic and serpentinite material in the form of lenses and coarse net-veins. Only trace amounts of pyrite and pyrhotite occur infilling thin fractures and in stringers in serpentinite veins.			1758	68	70	2.0		.041	.147
						T.D. 76.78 m.									

EXPLORATION VENTURES LTD DIAMOND DRILL CORE RECORD	AREA BELHELVIE	O.S. Map No. NJ·91·NW	Grid Ref. 94447E 16436N	Page no 1	D.D.H. No. B·11
	COLLAR CO ORDINATES	COLLAR ELEVATION 51·82m	ORIENTATION 035° GRID	INCLINATION OF HOLE -45° / TOTAL DEPTH 170·02 Metres	OVERALL RECOVERY 87·67 %
	Drilled by D·P·I· Logged by C·A·F·B	Date started 25/5/72 Date completed 5/6/72			REMARKS

CORE SIZES	FROM	TO
H.T.	25·0 ft	29·3 ft
NQ	29·3 ft	123·4" ft
BQ	123·4 ft	157·9" ft

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	GEOLOGICAL LOG ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength
0	7·62	7·62	0	DRIFT		Unconsolidated sand and gravel.		
7·62	29·40	21·78		DUNITE.		Rounded pebbles, fragments and small sections of dunites interbedded with sand and silt. Probably represents either a dunite boulder/gravel bed or highly fragmented bed rock.		
29·40	31·55	2·15		DUNITE		Shattered and broken serpentinised dunite with numerous small net veins of white serpentine some containing finely granular pyrrhotite		
31·55	134·65	103·10		DUNITE.		Moderate to highly serpentinised dunite. Massive to partly fractured dark green to black. Extreemly uniform dense texture throughout. The sequence down to ≃ 35·00m is cut by thin veins and lenses of massive, granular and micaceous green and grey serpentine.	90	
						Thin highly altered and serpentinised ? troctolite bands occur between 60·76 m and 63·58 m.		
						Only trace amounts of very fine grained sulphides are visible throughout the sequence.		
						Serpentine veins become more numerous from ≃ 131·00 m to the end of the run sometimes containing thin stringers of pyrrhotite.	40°	
						The contact is sharp, though broken and unmineralised		

ASSAY RECORD Sample no.	From	To	Rep	Sample core rec.	Cu	Ni
1759	32	34	2·0		·009	·139
1760	57	59	2·0		·026	·188
1761	82	84	2·0		·005	·222
1762	105	107	2·0		·008	·189
1763	130	132	2·0		·022	·218

EXPLORATION VENTURES LTD

DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 2 D.D.H. No. B·11·

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD									
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec					
134·65	146·21	11·56		NORITE.		Medium to fine grained serpentinised and Uralitised olivine norites. Consists of totally altered olivine crystals in a matrix of felspar and serpentine. In the finer grained bands the alteration is less pronounced with interstital ferromagnesium minerals occurring between the felspar. Steatite veins are abundant. Between 143·50 – 143·90 the olivines are totally haematised forming fine bands. The norites is predominantly fine grained from 145·60 to the end of the run. The crystal banding dips ≈ 35° while the contacts between fine & coarser bands dip ≈ 50°. No mineralisation present. (sequence = to norite sequence at base of D.D.H. B·4.)	50° 60°											
146·21	148·35	2·14		SERPENTINE.		FAULT ZONE. Soft clay gouge with fragments and small sections of Serpentinite. Small amounts of very fine grained sulphides visible in the sections.												
148·35	152·66	4·31		DUNITE./ PICRITE		Highly serpentinised partly broken dunite and picrite. extensively invaded by steatite and serpentine veins. Trace amounts of fine grained sulphides visible with occassional thin stringer of pyrrhotite. Lower contact sharp.	60°											

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE   Page no. 3   D.D.H. No. B.11.

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
152.66	160.31	7.65		ANORTHOSITE		Alternating succession of fine grained anorthosites with medium to course grained troctolite. The matrix is similar in both types being fine grained to dense leucocratic felspar and serpentine. The troctolites contain medium to course grained olivine crystals - partly altered. The contact between the bands are mainly well defined. Only scattered traces of disseminated sulphides visible. From 159.02m the sequence is mainly fine grained finely banded anorthosites. The contact appear gradational in the sequence below.	60°		1764	155	157	2.0		.007	.027
							55°								
160.31	165.86	5.55		NORITE		Fine grained grey norite. Partly serpentinised and uralitised consisting of fine grained felspar and serpentine with interstitial ferromagnesium minerals. The sequence contains occassional irregular lenses and ? bands of siliceous material. Contact is gradational. Occassional fine blebs and stringers of pyrrhotite and chalcopyrite present.	55°								
165.86	170.02	4.16		BIOTITE GNEISS.		Complex sequence of 'contaminated' hornfels and biotite gneiss. The rocks are partly laminated with course to medium grained biotite, muscovite, quartz and felspar.	50°								

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

AREA: BELHELVIE	O.S. Map No. NJ·91·NW	Grid Ref. 93729E 15925N	Page no 1·	D.D.H. No. B·12.	
COLLAR CO ORDINATES:	COLLAR ELEVATION: 74·68 m.	ORIENTATION: 240° GRID	INCLINATION OF HOLE: −45°	TOTAL DEPTH: 178·31 Metres	OVERALL RECOVERY: 92·16 %
Drilled by: D·P·I·	Logged by: C·A·F·B·	Date started: 8/6/72·	Date completed: 14/6/72·	REMARKS:	

CORE SIZES	FROM	TO
NQ	30·0 ft	145·0 ft
BQ	145·0 ft	585·0 ft

INTERSECTION DEPTHS (Metres) FROM	TO	REP	REC	ROCK TYPE	Graphic log	GEOLOGICAL LOG Description	Intersec angle	Rock strength	ASSAY RECORD Sample no.	From	To	Rep	Sample core rec	Cu	Ni
0	9·14	9·14	0	DRIFT·		Unconsolidated sand and gravel.									
9·14	18·90	9·76		DUNITE.		Badly fractured and broken serpentinised and haematitised dense reddish coloured dunite. Trace amounts of fine grained disseminated sulphides visible.	40°								
18·90	21·00	2·10		SERPENTINITE.		Badly fractured and broken felspathic, highly serpentinised grey banded rock with scattered large plates and crystals of biotite and pyroxene. The lower contact is soft and brecciated representing a fault or shear. The rock probably represents a hydrothermally altered and sheared dyke or serpentinite vein.	45°								
21·00	43·00			DUNITE·		Partly to badly fractured dark, dense serpentinised dunite. Numerous soft sandy fracture zones occur. Only scattered traces of visible fine grained disseminated sulphides present. Thin picrite bands occur near the end.									
43·00	59·32	16·32		PICRITE		Moderate to highly serpentinised picrite with bands of serpentinised dunite. Generally unfractured. Visibly disseminated magnetite abundant throughout, with only trace amounts of sulphides.	70°		1765	50	52	2·		·031	·171

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE Page no. 2 D.D.H. No. B·12

INTERSECTION DEPTHS (Metres)				GEOLOGICAL LOG					ASSAY RECORD						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni
59·32	63·06	3·74		SERPENTINITE.		Green and grey massive soft serpentinite			1766	60	62	2·0		·017	·097
						irregular rewelded brecciated texture.									
						Abundant disseminated magnetite with									
						trace amounts of disseminated sulphide.									
						Probably represents a shear zone.	50°								
63·06	136·62	73·56		DUNITE/PICRITE.		Mainly massive dark moderately to									
						highly serpentinised dunite with									
						picrite bands down to 93·00m. Thin			1767	75	77	2·0		·068	·188
						smears of graphite occur on fracture									
						and joint planes.									
						From 93·00m the dunite contain									
						gradually more felspar. This is fine									
						grained interstitial down to 103·00m									
						From 103·00 – 126·24. The succession is	55°		1768	100	102	2·0		·026	·216
						mainly medium grained highly serpentinised									
						picrite.			1769	125	127	2·0		·034	·225
						From 126·24 – 136·62. – Highly serpentinised									
						dark grey and green dense dunite.	50°								
						Throughout the succession only small									
						to trace amounts of fine grained									
						sulphides are visible.									
136·62	144·87	8·25		TROCTOLITE/		Complex irregularly massive banded									
				ANORTHOSITE/		sequence of olivine rich troctolites, dunites			1770	140	142	2·0		·040	·126
				DUNITE.		anorthosites and picrites. This zone									
						may be the result of continual remobilisation									
						during cooling and separation of the magma.									
						The sequence is moderately to strongly									
						serpentinised and contains small amounts									
						of fine disseminated pyrrhotite and chalcopyrite									
						with some thin and medium sized pods &									
						stringers of pyrrhotite mainly associated with									
						later serpentinite veins.									

EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE. Page no. 3 D.D.H. No. B·12

INTERSECTION DEPTHS [Metres]				GEOLOGICAL LOG					ASSAY RECORD						
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec.	Cu	Ni
						From 143·87 – 144·87 the rock is badly shattered and highly serpentinised and steatitised. This represents a shear zone.									
144·87	152·85	7·98		TROCTOLITE		Massive serpentinised fairly uniform olivine rich medium grained troctolite. This contain large segregation of bronzite. Felspar and bronzite also occur interstitially.			1771	150	152	2·0		·033	·160
						Only trace amounts of fine dissem[inated] sulphides visible with occassion thin stringer of pyrhotite.	50°								
152·85	157·90	5·05		TROCTOLITE / ANORTHOSITE.		Irregularly banded sequence of olivine rich highly serpentinised troctolites and serpentinised bronzite anorthosite. The anorthosite bands contain small to moderate amounts of medium grained disseminated chalcopyrite and pyrhotite. The troctolite bands only contain trace amounts.									
157·90	163·63	5·73		ANORTHOSITE.		Medium to fine grained highly serpentinised bronzite anorthosite contaminated by large and small lenses and blebs of green and black serpentinite.									
						The sequence gradually becomes compact foliated and sheared towards the end of the run with moderate amount of haematite occuring as thin stringers within the foliation planes and generally impregnating the rock. Moderate amounts of chalcopyrite and pyrhotite occur in parts			1772	160	162	2·0		·011	·016

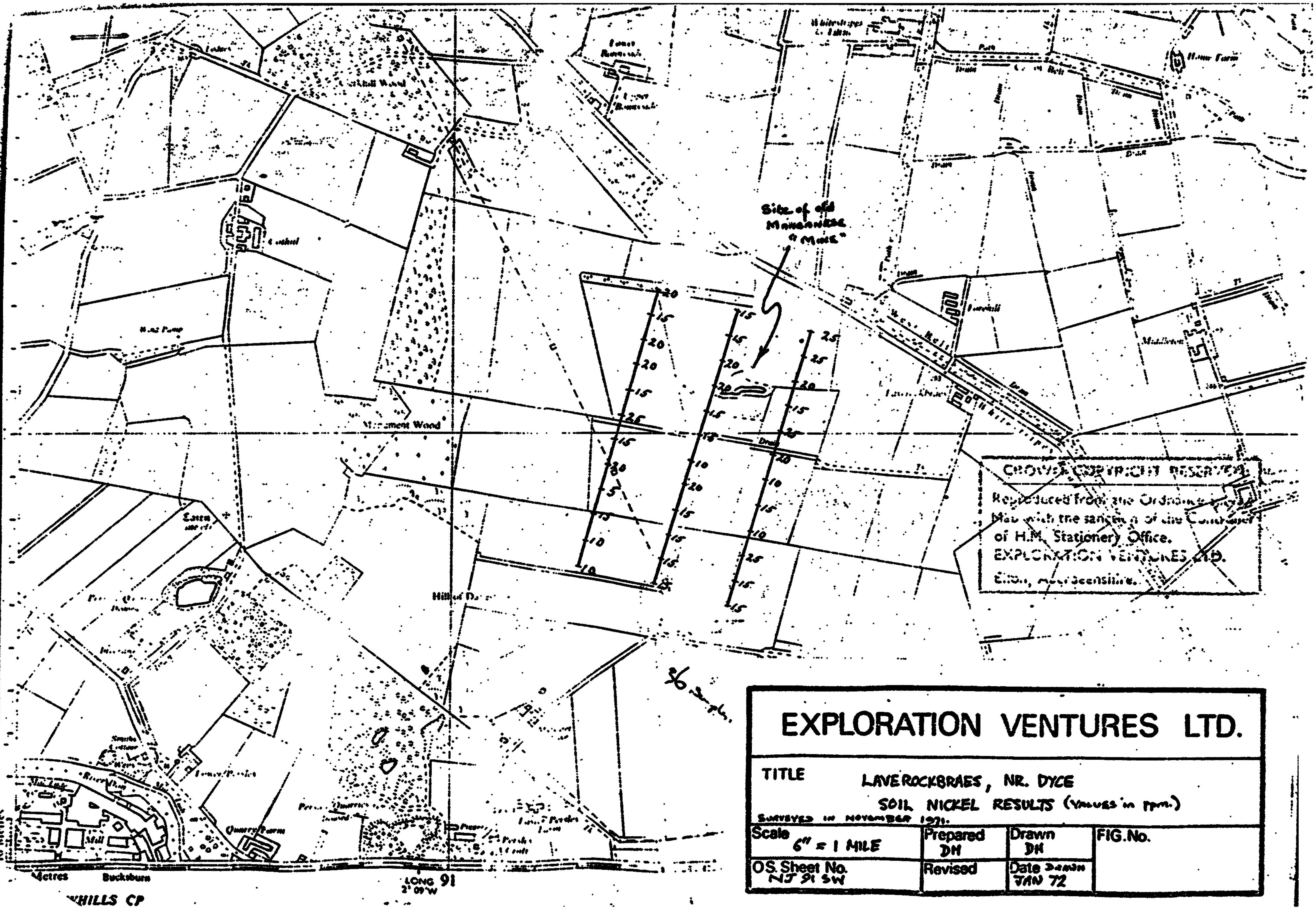
EXPLORATION VENTURES LTD
DIAMOND DRILL CORE RECORD

Area BELHELVIE

Page no. 4

D.D.H. No. B-12

INTERSECTION DEPTHS [Metres]				GEOLOGICAL LOG					ASSAY RECORD										
FROM	TO	REP	REC	ROCK TYPE	Graphic log	Description	Intersec angle	Rock strength	Sample no	From	To	Rep	Sample core rec	Cu	Ni				
						of the anorthosite. The lower contact is marked by a thin 6 cm clay gouge zone.	60°												
163.63	178.31	14.68		Siliceous schist		Siliceous leucocratic highly banded metamorphic country rock. It is badly shattered and broken and contains abundant dark red, orange and yellow oxides in bands and in fracture / joint infil. The banding lies between 65-80° to the core axis. This is probably // to a major shearing direction.			1773	170	172	2.0		.003	.006				



Site of old Manganese "Mine"
Monument Wood
Hill of Dyce
Quarry Farm
Mill
Bucksburn
Metres
LONG 91
2° 09'W
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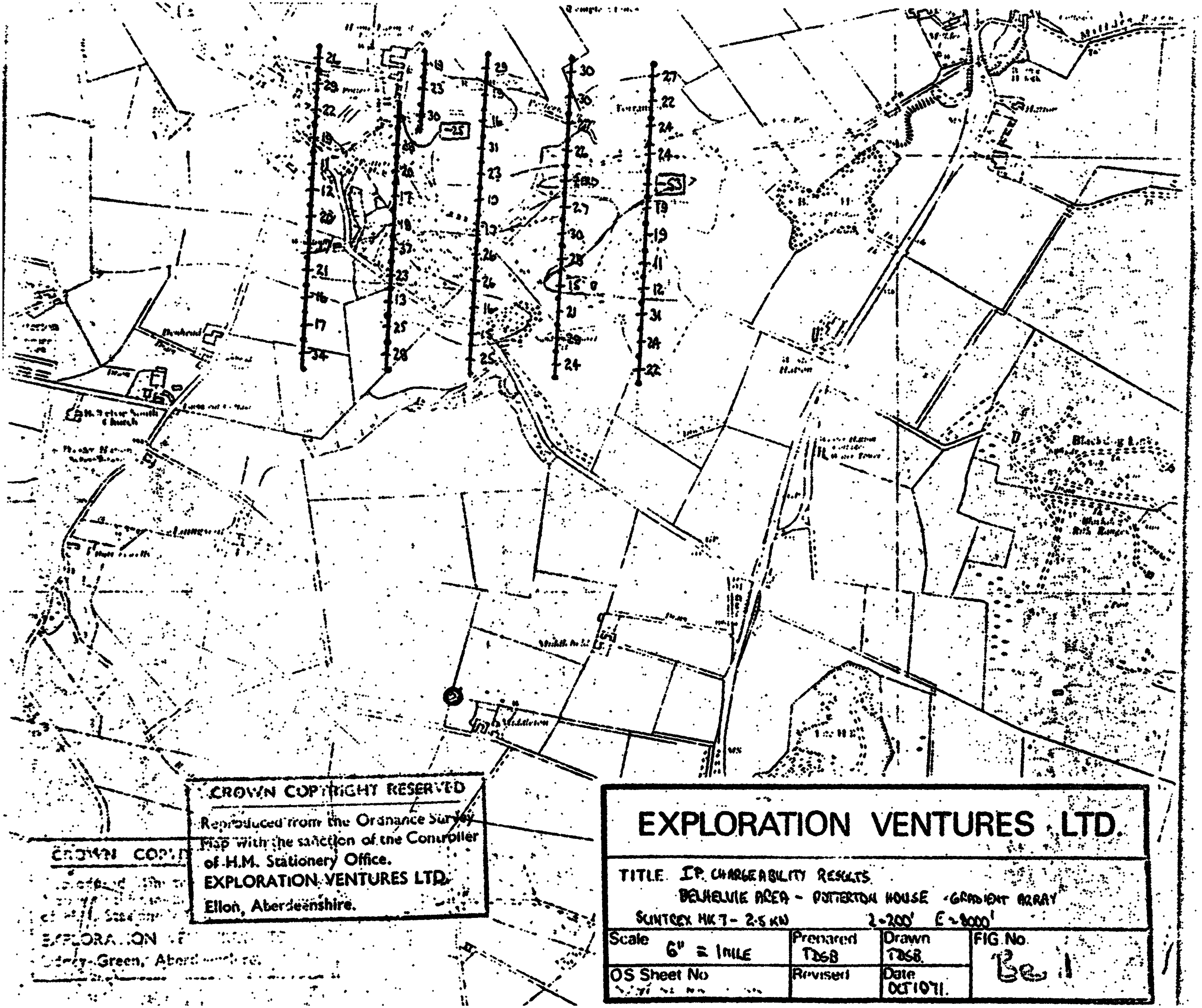
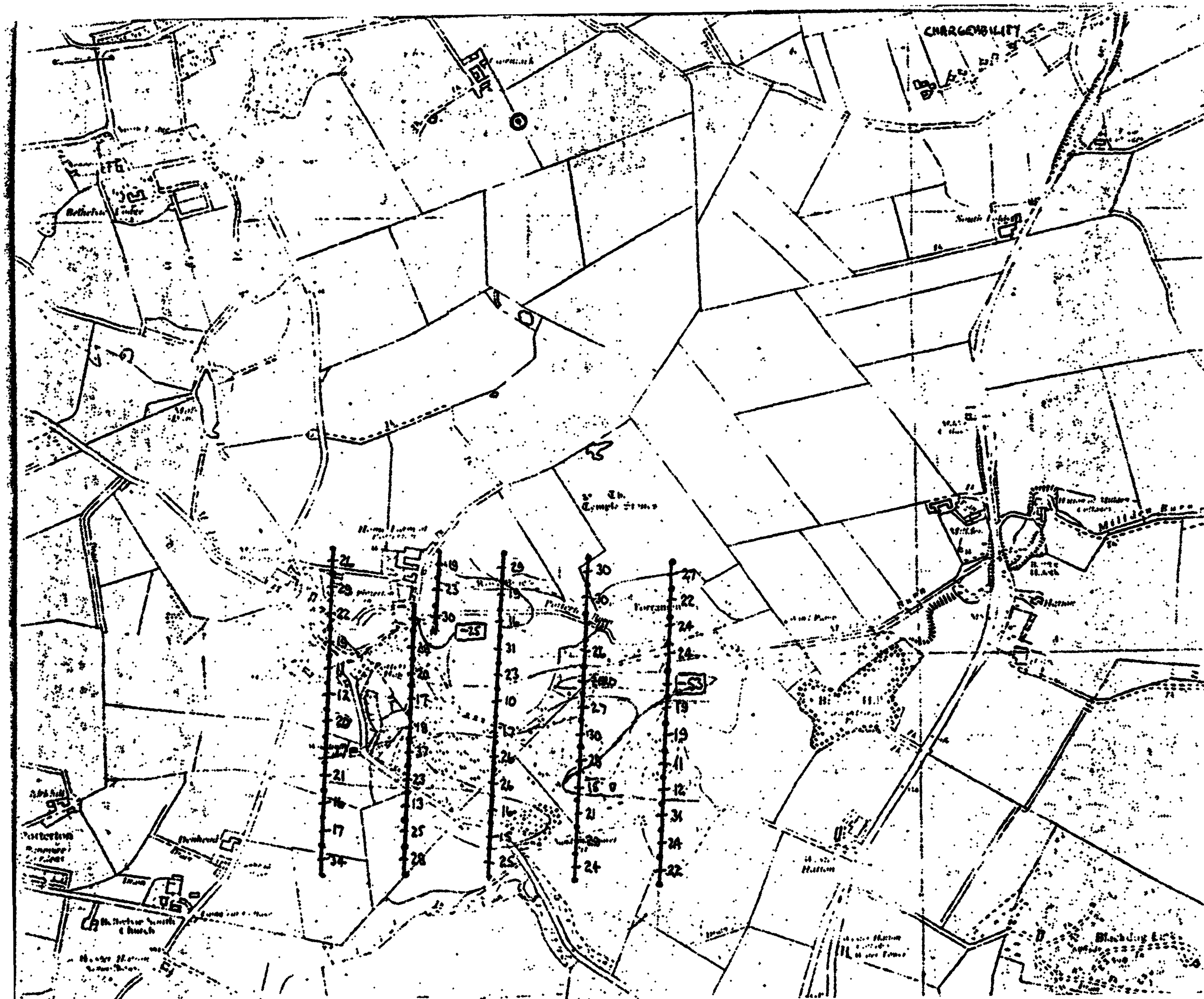
TITLE
LAVEROCKBRAES, NR. DYCE
SOIL NICKEL RESULTS (values in ppm.)
SURVEYED IN NOVEMBER 1971.
Scale
6" = 1 MILE
Prepared
DH
Drawn
DH
FIG.No.
OS Sheet No.
NJ 91 SW
Revised
Date Drawn
JAN 72



EXPLORATION VENTURES LTD.

TITLE I.P. CHARGEABILITY RESULTS
BELHELVIE AREA - POTTERTON HOUSE - GRADIENT ARRAY
SCINTREX MK 7 - 2.5 KW 2=200' E=8000'

Scale	Prepared	Drawn	FIG No.
6" = 1 MILE	TDSB	TDSB	Be. 1
OS Sheet No	Revised	Date OCT 1971.	


CHARGEABILITY
26
29
22
18
11
12
20
27
21
16
17
34
19
23
30
-25
38
20
17
18
37
23
13
25
28
29
19
16
31
23
10
12
26
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16
15
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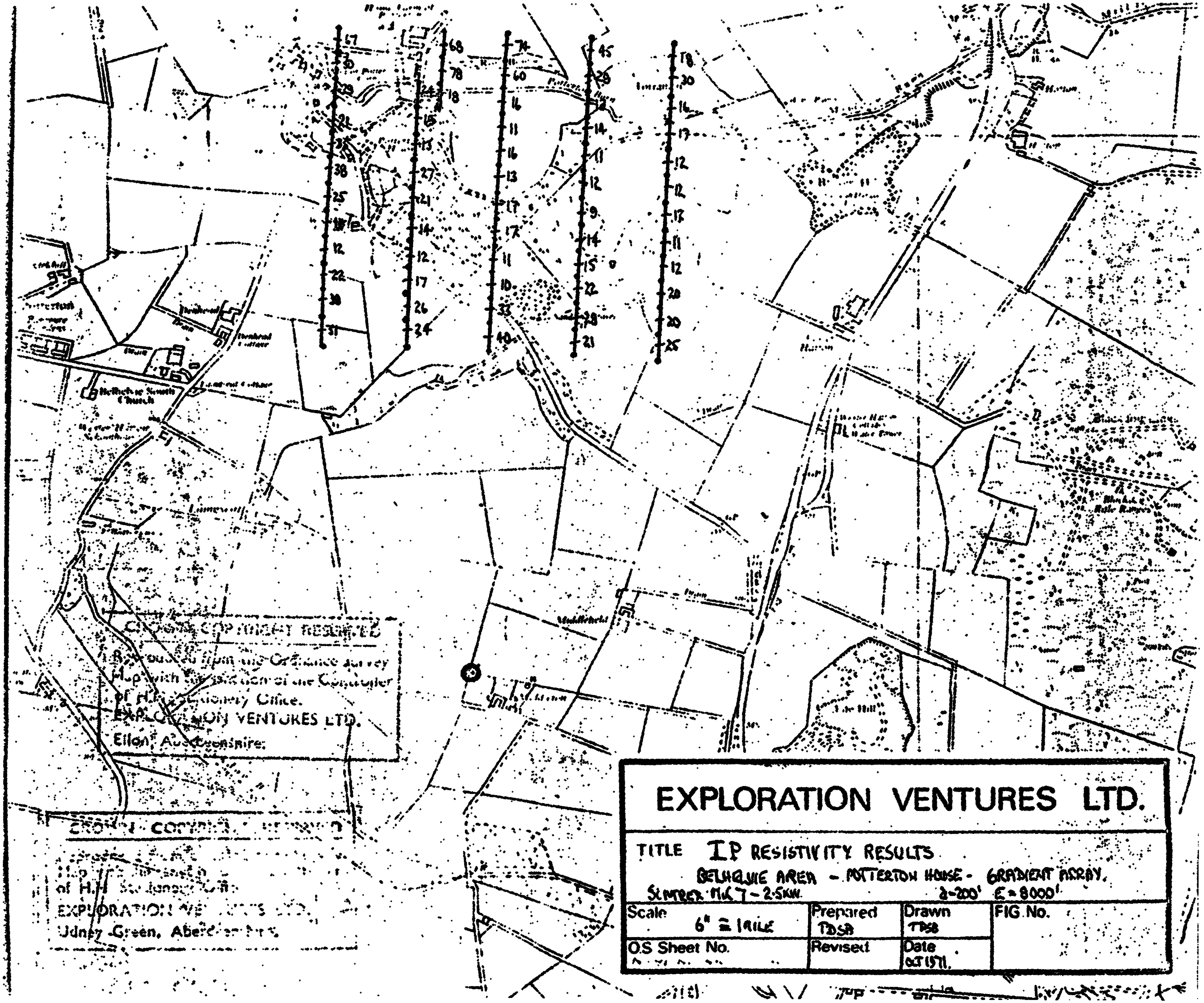
11
12
31
24
22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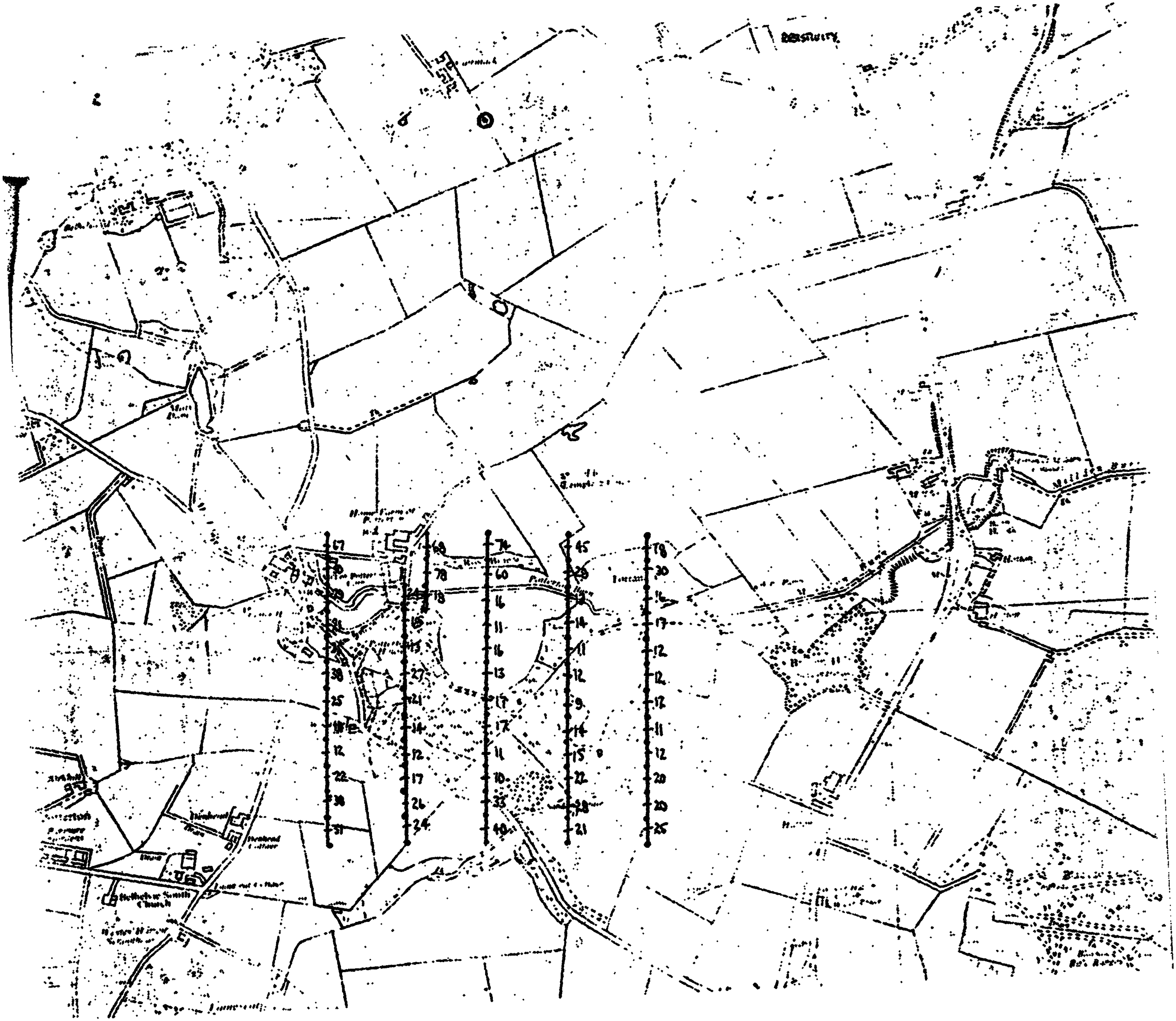
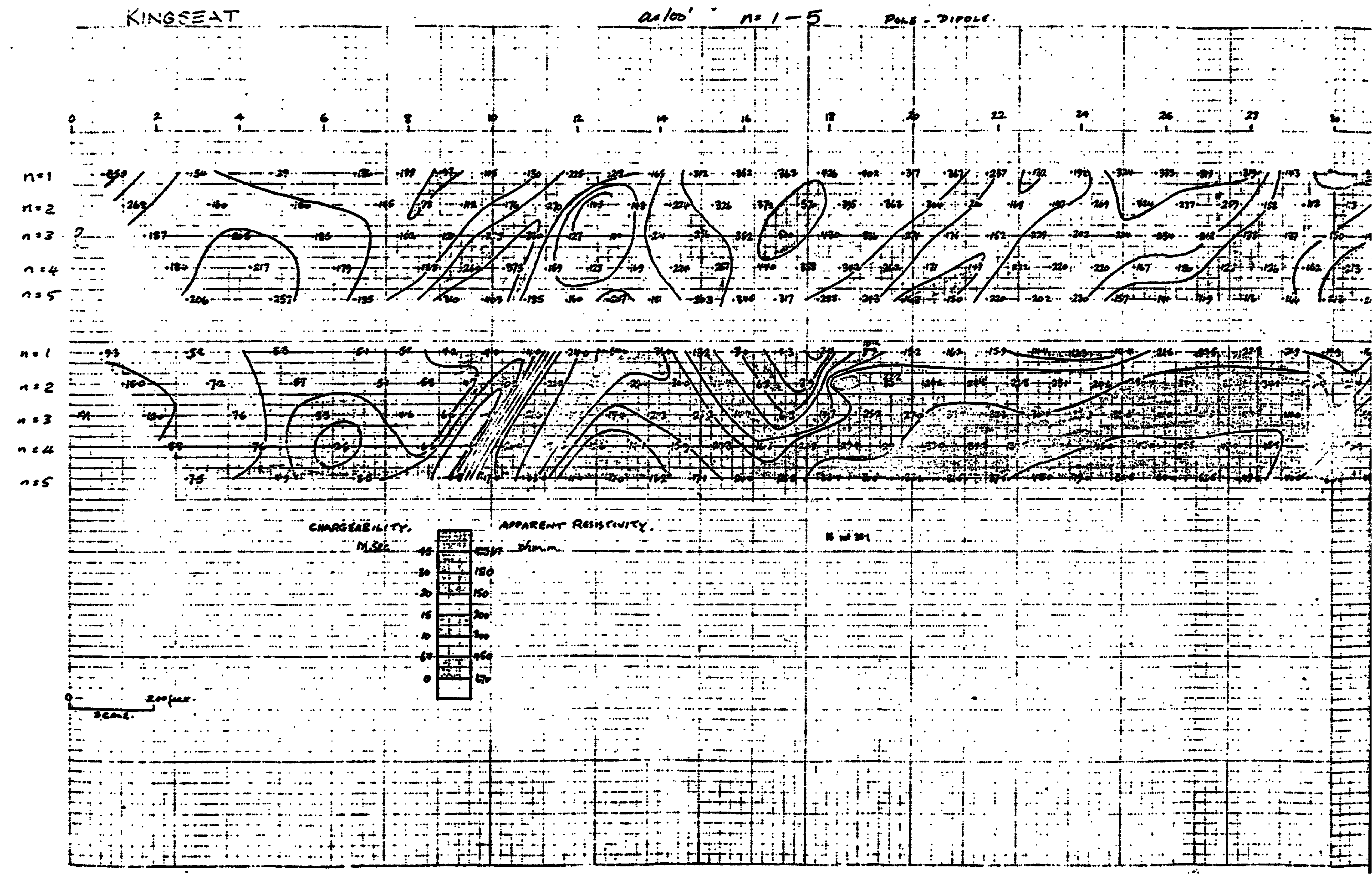
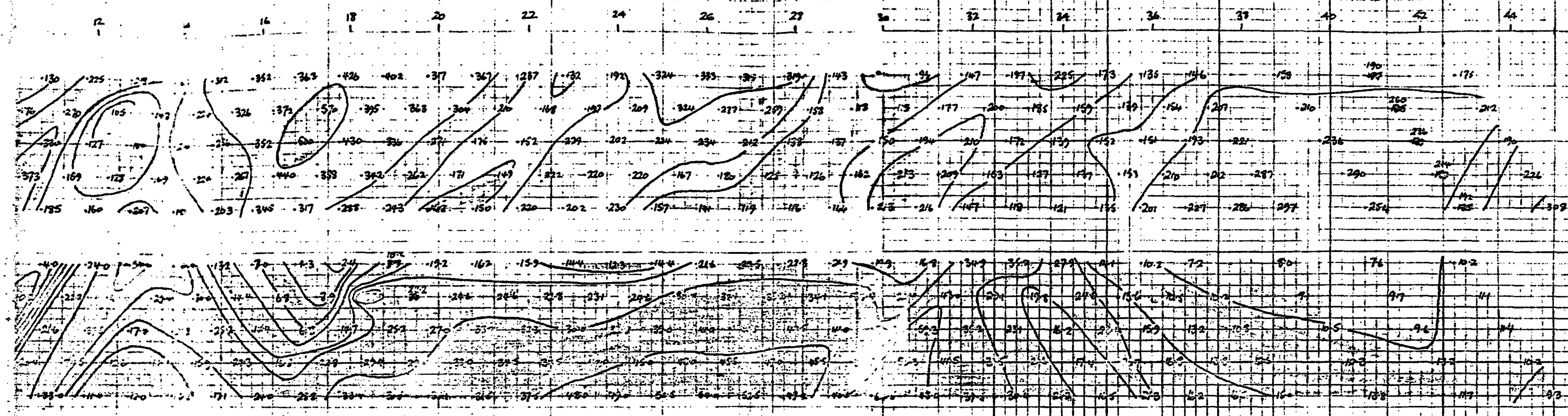
Ellon, Aberdeenshire.
Udny Green, Aberdeenshire
EXPLORATION VENTURES LTD.
TITLE IP RESISTIVITY RESULTS
BELHELVIE AREA - POTTERTON HOUSE - GRADIENT ARRAY.
SCINTREX MK7 - 2.5KW. a=200' L=8000'
Scale 6" = 1 MILE
Prepared TDSB
Drawn TDSB
FIG. No.
O.S Sheet No.
Revised
Date OCT 1971.





KINGSEAT
a=100'
n=1-5
POLE-DIPOLE.
n=1
n=2
n=3
n=4
n=5
CHARGEABILITY.
M.Sec
APPARENT RESISTIVITY.
Ohm.m.
SCALE.

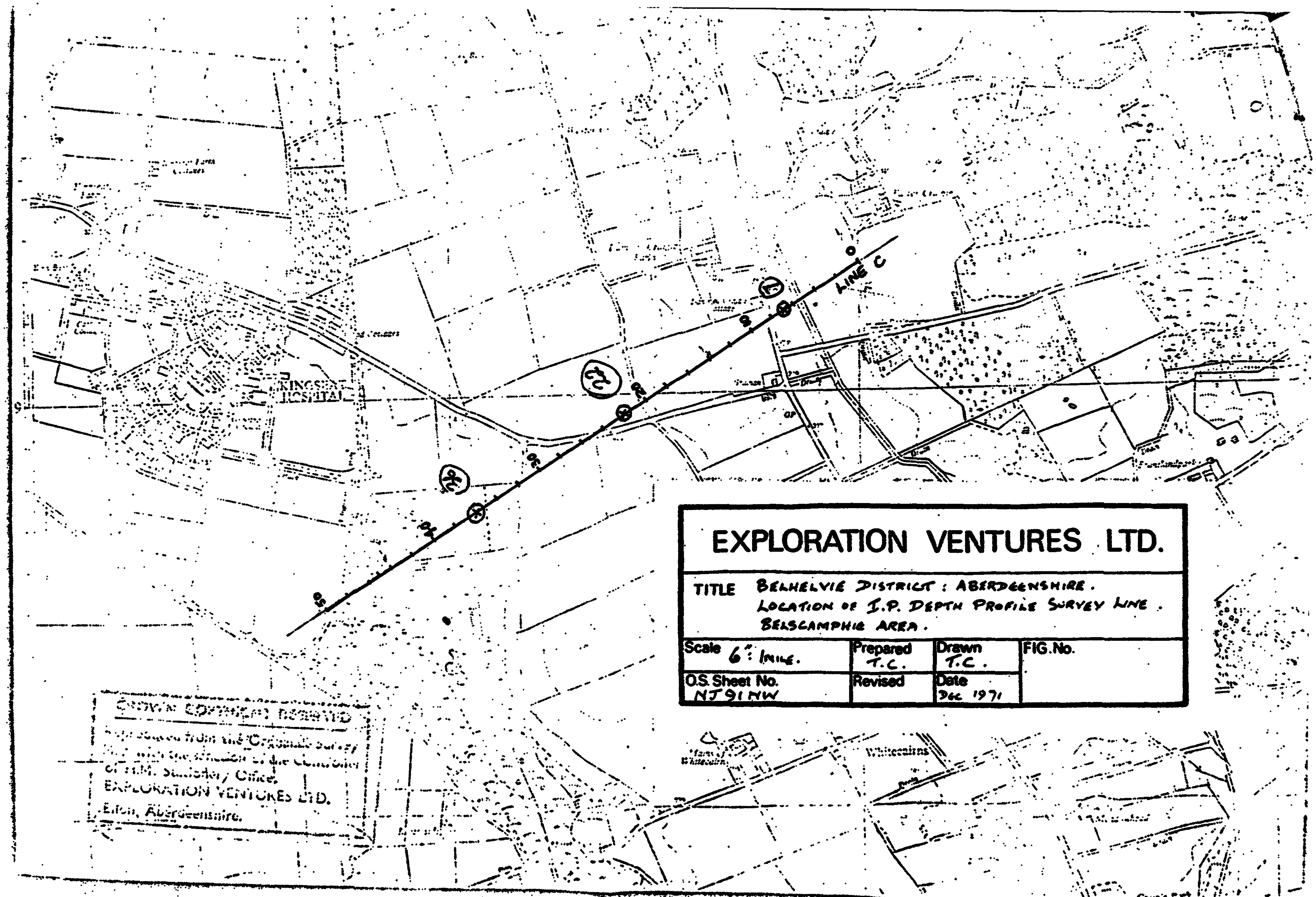
n= 1—5 POLE - DIPOLE

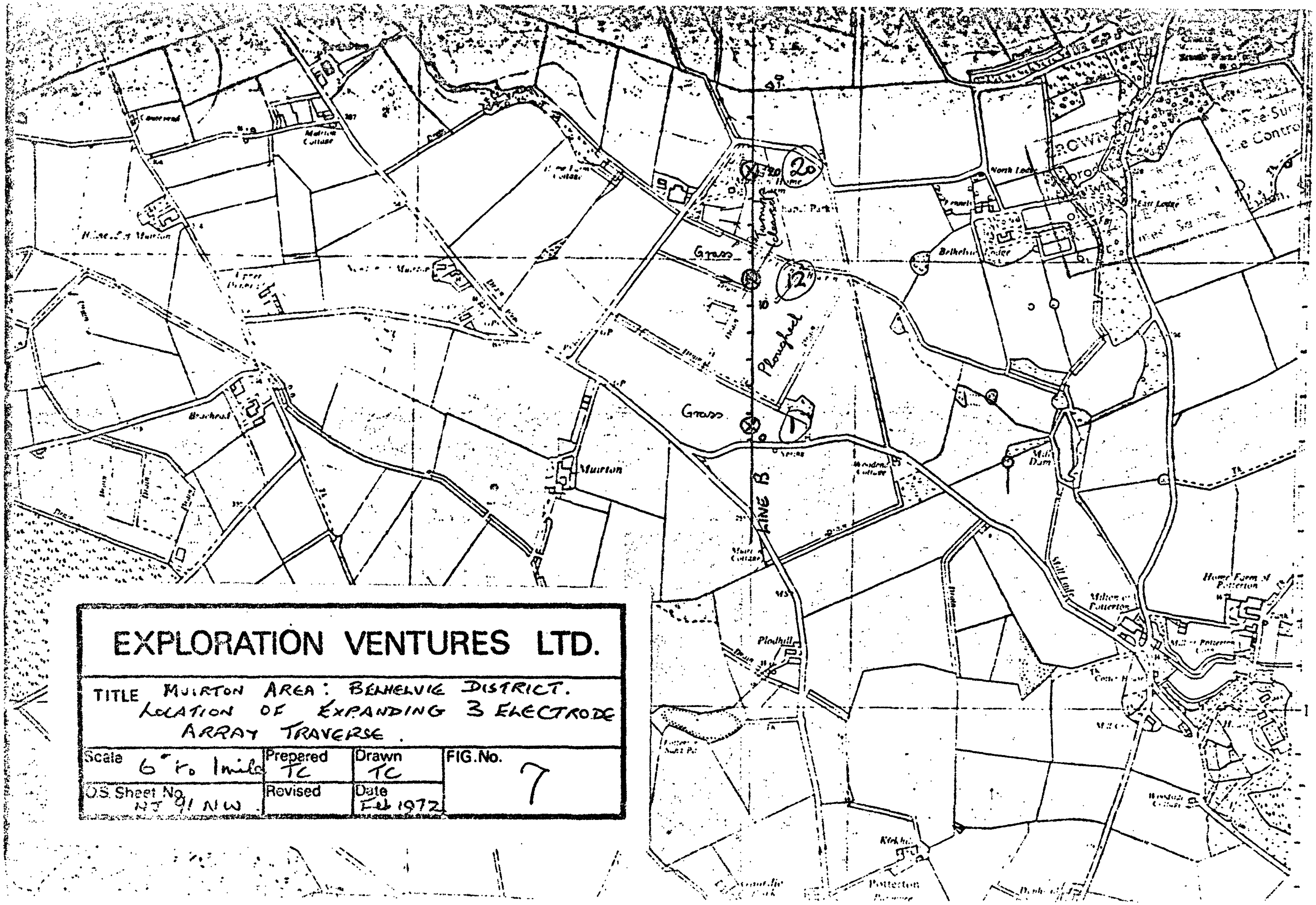


APPARENT RESISTIVITY.
ohm.m

EXPLORATION VENTURES LTD.

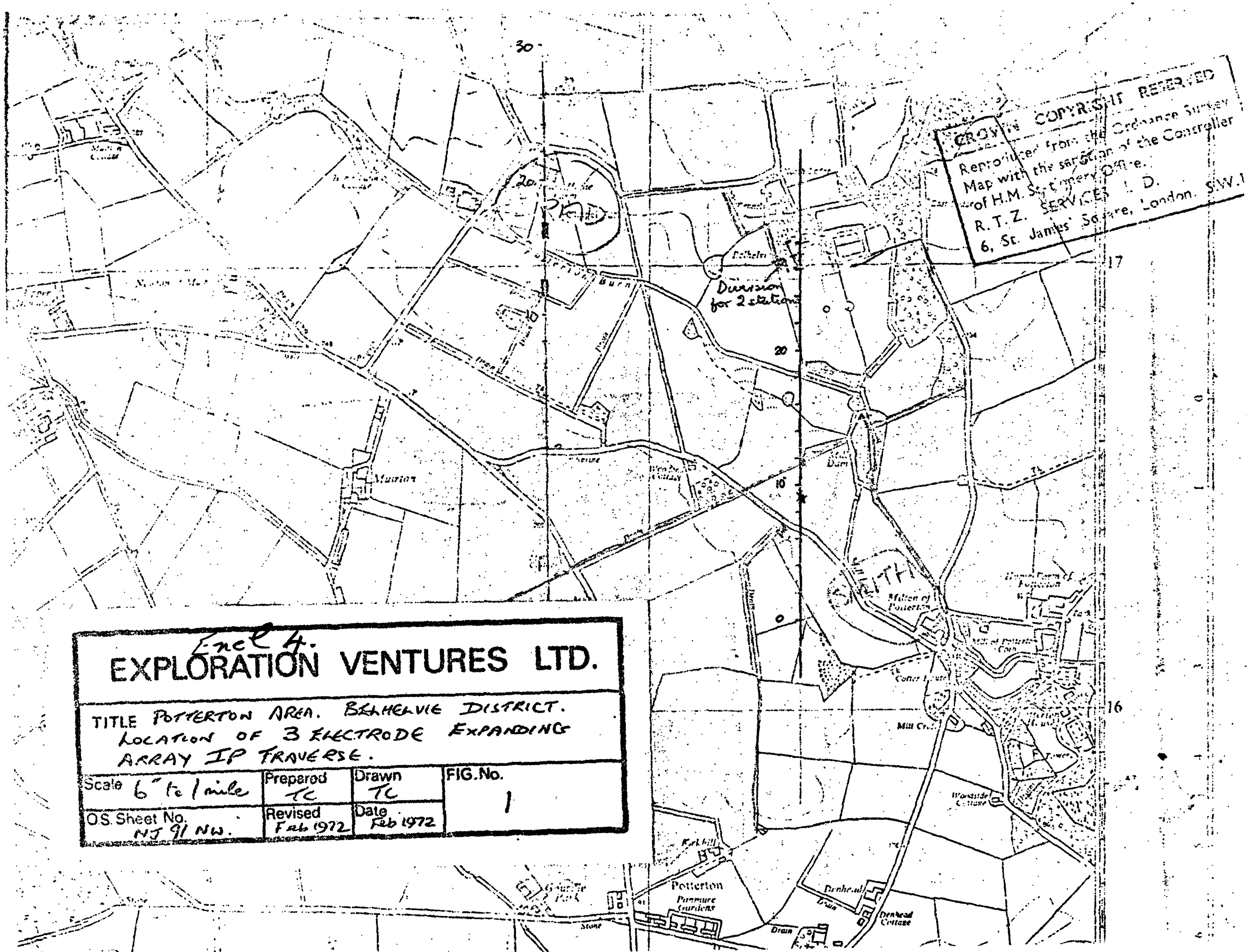
TITLE BELHELVIE DISTRICT: ABERDEENSHIRE. INDUCED POLARISATION DEPTH PROFILES BELSCAMPHIE AREA.			
Scale	Prepared T.C.	Drawn T. CUMPSTEY	FIG. No.
O.S. Sheet No. LOCATED ON NJ 91 NW.	Revised	Date DEC 1971	


LINE C
KINGSEAT HOSPITAL
Whitecairns
EXPLORATION VENTURES LTD.
TITLE BELHELVIE DISTRICT : ABERDEENSHIRE.
LOCATION OF I.P. DEPTH PROFILE SURVEY LINE.
BELSCAMPHIE AREA.
Scale 6": 1MILE.
Prepared T.C.
Drawn T.C.
FIG.No.
O.S. Sheet No. NJ91NW
Revised
Date DEC 1971
EXPLORATION VENTURES LTD.



EXPLORATION VENTURES LTD.

TITLE MUIRTON AREA: BELHELVIE DISTRICT. LOCATION OF EXPANDING 3 ELECTRODE ARRAY TRAVERSE.			
Scale 6" to 1mile	Prepared TC	Drawn TC	FIG. No. 7
O.S. Sheet No. NJ 91 NW	Revised	Date Feb 1972	

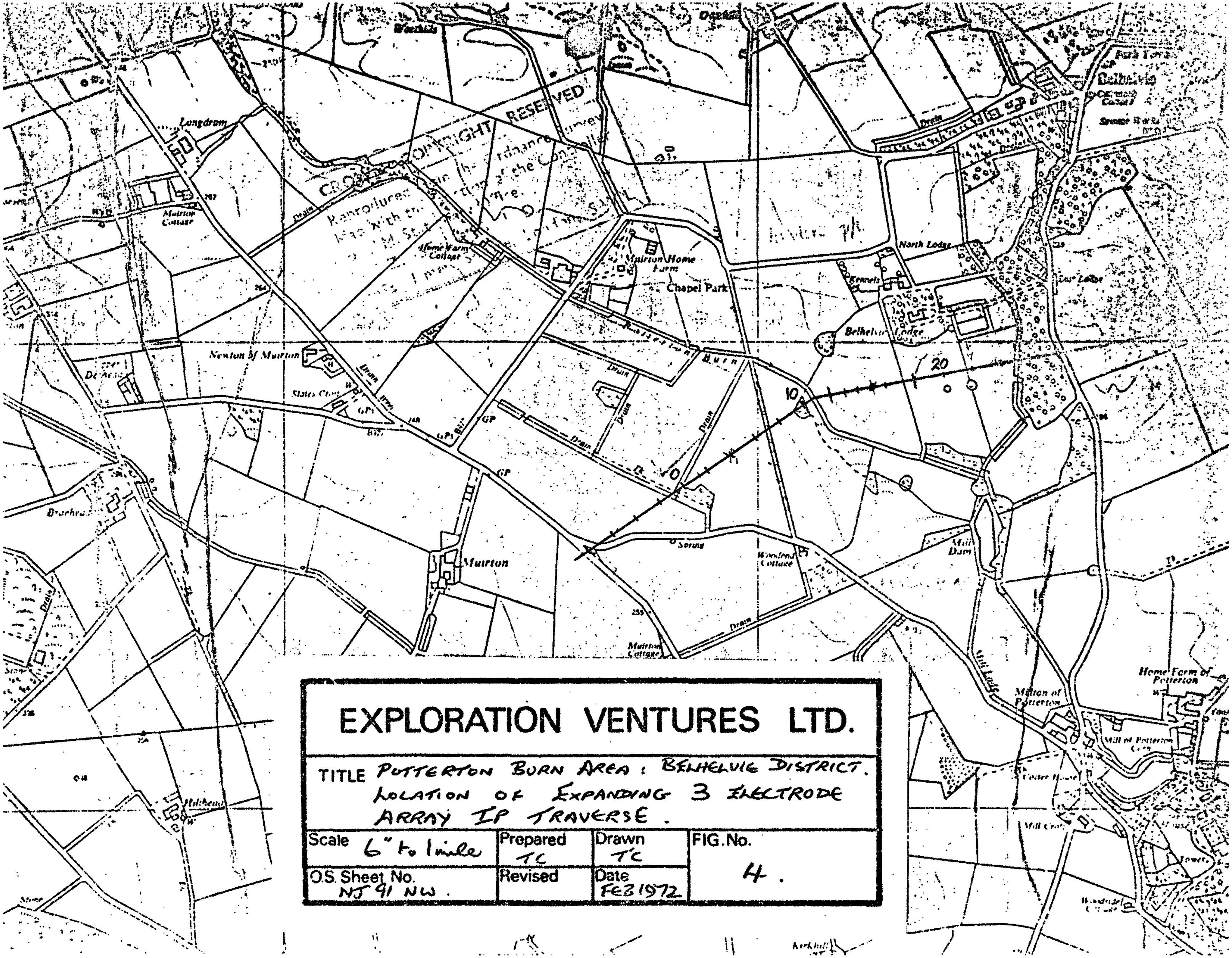


Encl 4.

EXPLORATION VENTURES LTD.

TITLE POTTERTON AREA. BELHELVIE DISTRICT.
LOCATION OF 3 ELECTRODE EXPANDING ARRAY IP TRAVERSE.

Scale	Prepared	Drawn	FIG. No.
6" to 1 mile	TC	TC	1
O.S. Sheet No.	**Revised**	**Date**	
NJ 91 NW.	Feb 1972	Feb 1972	



EXPLORATION VENTURES LTD.

TITLE POTTERTON BURN AREA : BELHELVIE DISTRICT.
LOCATION OF EXPANDING 3 ELECTRODE
ARRAY IP TRAVERSE.

Scale	Prepared	Drawn	FIG. No.
6" to 1 mile	TC	TC	4.
O.S. Sheet No.	**Revised**	**Date**	
NJ 91 NW.		FEB 1972	