DEPARTMENT OF MINES
SOUTH AUSTRALIA

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PROGRESS REPORT
FRAZER'S COPPER PROSPECT
ALBERGA
Kenmore

by

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C.H.H. CONOR

and

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Geologists
Mineral Resources Division

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Rept.Bk.No. 71/73
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ABSTRACT

Copper carbonates and sulphides occur in thin lenses of basic granulite at several localities on the Kenmore 1:63,360 sheet. The largest basic granulite outcrop occurs in the keel of a tight syncline, where three occurrences of visible copper mineralisation were seen. This area was selected for more detailed work and an orientation geochemical survey was carried out over an area of three and half square miles. Rock chip samples were then taken from the main area of basic granulite outcrop using a grid spacing of 100 ft.

The results are sufficiently encouraging to warrant further exploration and an induced polarisation survey is recommended over the area of the grid. Drilling is also recommended to sample the basic granulite below the zone of weathering, and to test any induced polarization targets.

INTRODUCTION

During a mapping programme in the Kenmore 1:63,360 map area a small outcrop of plagioclase - pyroxene - amphibole granulite in the south-eastern part of the area was found to be stained by copper carbonates. As mapping progressed, other outcrops of this rock type were found to contain small amounts of copper sulphide (chalcopyrite and bornite) as well as azurite and malachite staining. A programme was initiated to sample as many outcrops of this rock type as possible.

One of the larger known outcrops of basic granulite occurs about two miles southeast of Frazer's bore and has since become known as Frazer's Copper Prospect. It was selected for more detailed work because of the presence of copper mineralisation, the size of the outcrop and its structurally favourable location in the keel of a tight syncline.

After a brief programme of orientation geochemistry, involving stream, soil, biogeochemical and rock chip sampling it was decided to sample the outcrop by taking rock chips from regularly spaced points 100ft. apart on a grid which was surveyed by J. Erkelens over the basic granulite. Field assistants G. Macleman and R. Westoe carried out the rock chip sampling.

LOCATION, ACCESS AND PHYSIOGRAPHY

Frazer's Copper Prospect is located about two miles southeast of Frazer's Bore and about 10 miles northeast of Kenmore Park homestead. (See locality on plan 71-223). Access is from the Victory Downs - Kenmore Park road along a bush track towards Frazer's Bore via the old well, turning south about a mile east of Frazer's Bore.

The area consists of a gently undulating, sandy, grass-covered plain, cut by prominent dolerite dykes and north-south ridges and sporadic outcrops of banded or massive gneiss. The basic granulite occurs in the gneiss sequence and forms a low rise covered by thin pale coloured calcareous soil. This soil and the sandy red soil around its margins is strewn with small cleavage fragments of pyroxene. The characteristic glittering effect produced in sunlight has been used in other areas to locate small outcrops of similar basic granulite.

GEOLOGICAL SETTING

The geology of the area is shown on the Kenmore 1:25,000 special map (in preparation) and is discussed by Barnes, Conor, and Pain (1971a). A simplified geological plan of the area has been used as a base plan for plotting data obtained from the orientation geochemical survey.

The rocks in the area consist predominantly of quartz-feldspar-biotite gneisses which are generally well banded. Within the sequence there are lenses of garnet bearing gneiss, intermediate granulite (quartz - feldspar - 2 pyroxene - amphibole granulite) and basic granulite (plagioclase - 2 pyroxene - amphibole granulite).

It is thought that there are two types of basic granulites. Some occur as lenses associated with intermediate granulites and it is suggested that these represent metamorphosed calcareous shale sediments. Serpentinite bodies discovered on the Kenmore sheet have basic granulites associated with them. These are considered to have an igneous origin. (Barnes, Conor and Pain, 1971b). Further sampling will be carried out in an attempt to differentiate the two types geochemically.

The trend of banding in gneisses and granulites in the area is approximately north-south. The rocks are isoclinally folded about axes which plunge southwards at between 25° and 40°. The axial planes are sinuous so that the dip of gneissic banding changes from steep easterly to steep westerly along strike in the limbs of folds. The structure of this area is more fully detailed in Barnes, Conor and Pain (1971a).

Dolerite dykes up to 10ft. wide are common throughout the area. They trend W.N.W. to N.N.W. and generally dip southwesterly at between 30° and 50°. In places they have been cut by later shearing. Their particular abundance in areas where copper has been found suggests they may have some geochemical control over the distribution of copper. However, unlike the Moorilyanna copper prospect (Warne, 1968), where copper mineralisation is confined to a gabbroic dyke, no copper minerals have been observed in the dykes in the Frazer's area.

Small, coarse-grained allanite bearing graphic quartz - feldspar pegmatites occur in many places on the Kenmore sheet. Two such pegmatites cut the granulite in the gridded area.

The detailed geology of the gridded area is shown on plan 71-313.

ORIENTATION GEOCHEMISTRY

An area of approximately three and a half square miles around Frazer's Copper Prospect was used for orientation geochemistry. This was designed to determine the best method of sampling the large basic granulite outcrop known as Frazer's Prospect, and also to gather data in case further geochemical work is required in the area.

Stream Sediment Sampling

Stream sediment samples were taken from 23 localities in two creeks draining northwards through the area (plan 71-223). These samples were sieved and the -80 mesh fraction submitted to AMDEL for copper, nickel, cobalt, and chromium analyses.

Copper: see plan 71-224

Copper concentrations in stream sediments vary from 10 ppm. to 30 ppm, the average being 15 ppm. The highest copper concentrations occur in the eastern stream which runs through a large dolerite dyke outcrop. The copper values diminish downstream from the dyke in spite of basic granulite outcrops which extend along the western bank. Thus, the highest copper values are probably due to mechanical dispersion from the dyke.

Nickel: see plan 71-226

In the eastern stream, nickel values diminish from 65 near the dyke to 25 ppm. further downstream. Thecomparative uniformity of nickel values in the western stream is probably due to numerous dykes which flank the sampled part of the stream.

Cobalt: see plan 71-225

Cobalt values are uniformly low (15 to 20 ppm) in both streams and no useful conclusions can be drawn from the data.

Chromium: see plan 71-227

Chromium values vary from 35 ppm. to 210 ppm, and are erratic. Contributions in the form of detrital fragments could come from dykes, basic granulites and gneisses.

Dolerite dykes appear to be the controlling factor in dispersion patterns which were observed in stream sediment sampling. Stream sediment sampling would not offer much assistance in locating small mineralised occurrences of basic granulite in areas such as this where basic dykes are sufficiently numerous to have a masking effect.

Plant Geochemistry

Large areas of the Kenmore 1:63,360 sheet are covered by calcrete, which renders ordinary soil geochemistry ineffective. The roots of large plants often penetrate calcrete, and so plant geochemistry may be an effective method of locating geochemical anomalies. With this in mind, a small experimental programme of sampling Acacea kempeana (mulga) leaves was devised in this area.

Nickel and cobalt values, although low (1 to 3 ppm) were slightly higher over the outcrop of basic granulite. Copper values were higher than those of the other elements, and ranged from 8 to 75 ppm. The high value of 75 ppm. from sample point 84 near a known occurrence of copper mineralisation is an encouragement for further work to be done by this method.

Soil sampling

The location of soil samples is shown on plan 71-223 accompanying this report. The most important part of this programme consisted of sampling soil from the bottom of 9 inch deep pits in a line across the main occurrence of basic granulite. These samples were sieved into +12, - 12 + 80, and -80 B.S.S. fractions, and the results are shown graphically on the accompanying plans 71-224 to 71-227.

Soil Samples from 9 inch deep pits.

Copper: (see graph on plan 71-224) The +12 fraction has a reasonably smooth curve and shows strong contrast between soils over acid gneiss and granulite.

The -12 + 80 fraction is characterised by the sporadic distribution of a wide range of values, and would not be of much use in a geochemical survey.

The -80 mesh fraction shows good contrast between soils above acid gneiss and soils above granulites. This fraction would appear the most satisfactory for use in a geochemical survey designed to locate basic granulites with a high copper content.

Nickel (see graph on plan 71-226). The broad high over the basic granulite is apparent in all three fractions, but values obtained from near the dyke at the western end of the line exceed those from samples taken over the granulite.

Cobalt: (see graph on plan 71-225) Cobalt in the -80 fraction has a fairly uniform distribution with values of 10 to 20 ppm. The contrast between values from samples over acid gneiss and basic granulite is greater in the -12 + 80 fraction, but the best contrast is seen in the +12 fraction. In this fraction, however, the values from samples near the large dyke exceed those taken from pits over the granulite outcrop, and so the presence of dykes would have a strong masking effect.

Chromium: (see graph on plan 71-227) The highest chromium values occur in the +12 fraction, indicating mechanical dispersion. The pattern of chromium distribution does not reflect the presence of underlying basic granulite.

Surface Soil Sampling

In addition to the samples taken from 9 inch deep pits, a small number of samples were taken from surface soil near known occurrences of basic granulites. Cleavage fragments of pyroxene are the main constituents of these samples. As expected, the highest values for all four elements occurred in the +12 size fraction, and for Ni, Co and Cr the lowest values werein the -80 fraction. The distribution of chromium tends to be more erratic than the other elements.

Summary of Soil Sampling.

The profiles for Ni, Cu, and Co from the 9 inch deep pits generally define the outcrop of basic granulites, copper showing a distinct broad high. The surrounding area is covered with wind blown and alluvial material and metal concentrations are lower. Soil geochemistry can be used to define copper bearing basic granulites where a residual soil is developed, as is the case at Frazer's Copper Prospect. Residual soils are easily recognised by geological inspection. Outcrop is associated with residual soils and hence the basic granulite can also be sampled directly to determine its copper content.

Regional Rock Chip Sampling

Following the discovery of the Frazer's Copper Prospect, a programme was initiated to sample basic granulite occurrences in the Kenmore 1:63,360 map area.

Most of the known outcrops are in the southern half of the sheet, where they occur as thin bands of lenses within the well banded acid gneiss sequence. To the north the gneisses show more irregular, contorted plastic styles of folding reflecting different metamorphic conditions which in places have caused partial or complete anatexis. Thus outcrops of basic granulite are much less conspicuous in the northern part of the 1:63,360 map area.

Plan 71-384 shows the localities at which basic granulites were sampled, and the assays for copper and nickel at each locality. With the exception of samples showing conspicuous copper mineralisation, the copper content of basic granulites is fairly low, averaging only

40 ppm. Nickel has a fairly wider range of values within the basic granulites, and assays range from 15 ppm to 370 ppm.

Apart from Frazer's Copper Prospect, all of the known occurrences of basic granulite appear too small to support any economic concentrations of copper, although copper carbonates and sulphides were found in similar rocks a mile to the west and two miles to the south. Within the area of basic granulite outcrop at Frazer's Copper Prospect, copper minerals have been observed in three places. This large outcrop occupies the keel of a tight, southerly - plunging syncline which may be a favourable location for concentration of copper mineralisation.

DETAILED GEOCHEMISTRY

Rock Chip sampling of the grid area.

For the following reasons, preference was given to rock chip sampling rather than soil sampling at Frazer's Copper Prospect.

(a) Many small dolerite dykes up to 15 ft. wide outcrop in the vicinity of the basic granulite, and these may have a masking effect on the results of soil sampling.

(b) With rock chips taken on a closely spaced grid (100ft.) the contoured plan of assay values could be correlated directly with the geology.

(c) Outcrop of basic granulite is very extensive in the grid area.

A 100ft. grid was surveyed in to cover the area of basic granulite outcrop.

In places where outcrop occurred close to a peg, eight or ten small chips totalling about 250 grammes were taken at random from an outcrop area of approximately two square yards. Where no outcrop was available pits 2 ft. by 1 ft. were dug until bedrock was reached and then the bottom of the pit was sampled. The pits were of assistance in mapping the area, and locating the boundaries of the basic granulite.

Rock chip samples were taken from all dolertite dykes outcropping along two north-south lines.

Plan 71-313 shows sample points and the type of rock which was sampled. Assay results of copper and nickel have been plotted on this plan.

Apart from one copper assay of less than 5 ppm, the dykes vary between 45 and 140 ppm and the twenty four samples average 85 ppm. Slightly higher concentrations of copper in the dykes do not appear to be spatially related to high concentrations in the basic granulite.

The copper concentrations in the basic granulite and acid gneisses have been contoured on plan 71-314. This treatment is an empirical one and the contour interval is arbitrary and serves only to show areas of higher copper concentration. It can be seen that the contour plan defines an area of higher copper concentration which follows the outcrop margin of basic granulite. The presence of ten values above 1000 ppm including one over 5000 ppm is sufficiently encouraging to warrant further work as is the visible occurrence of disseminated copper sulphide.

Rock chips taken from pits appear more weathered and calcreted and are lower in copper than samples taken from outcrops. It will be necessary to drill the granulite to obtain samples from below the weathered zone.

CONCLUSIONS AND RECOMMENDATIONS

The results from the rock chip sampling are sufficiently encouraging to warrant the investigation of fresh material at depth. This could be obtained by a series of Mayhew drill holes around the outcrop. Such drill holes would also be of value in determining the attitude and structure of the basic granulites.

Accordingly ten 100 ft. drill holes are recommended on this prospect.

As sulphide has been recorded, an induced polarisation survey should detect sulphide mineralisation at depth. An induced polarisation survey of eight spreads 400 ft. apart, using a dipole-dipole spacing of 200 ft. is recommended over the area of the existing grid.

Some shallow I.P. targets could be tested in the above drilling programme and additional Mayhew holes may be required. Diamond drilling will be necessary to test any deeper I.P. targets.

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5/5/71.

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APPENDIX

PETROGRAPHIC REPORTS

Sample P.407/70: TS 25509

Location:
Kenmore 1-mile, Run 8. - Frazer's Copper Prospect.

Rock Name:
Plagioclase - two pyroxene granulite.

Hand Specimen:
A coarse grained crystalline rock of dark greenish grey pyroxene and white to pale brown feldspar. Occasional xenoliths of pyroxene with a bronze tint occur.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Plagioclase	40-45
Hypersthene	30-35
Opaques	2-3
Spinel	trace
Clinopyroxene	25-30

The section examined appears to contain a microfault, but the major rock types on both sides are comparable. In one place the rock texture and mineralogy is different to the bulk of the rock and this appears to represent a nodule of somewhat different composition.

The main rock contains an equigranular (1-2 mm) xenoblastic intergrowth of plagioclase and pyroxenes. Two pyroxenes are present, the first is a distinctly pleochroic orthopyroxene probably hypersthene, and the other a pleochroic in green variety. This pyroxene is occasionally simply twinned. The plagioclase (labradorite) is complexly twinned as it contains Albite and Pericline Law Twins which are both strongly developed.

The nodule does not contain clinopyroxene and the grain size of the dominant plagioclase and hypersthene is smaller, typically 0.5mm.

Opaque grains, some of which contain small amounts of green spinel, occur throughout the section.

The fault commented on above does not appear to greatly disturb adjacent grains. It is marked by a thin seam of dark brown, unidentified material.

This rock is probably formed by high grade regional metamorphism of a basic rock. The nodule may represent a slightly different original composition or it may be caused by localised changes in metamorphic conditions.

Sample P408/70: TS25510

Location:
Kenmore 1-mile, Run8. - Frazer's Copper Prospect

Rock Name:
Pyroxene-hornblende granulite.

Hand Specimen:
A massive, coarse grained rock of white feldspar and dark ferromagnesian minerals.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Clinopyroxene	65-70
Hornblende	10
Plagioclase	10-15
Opaques	5
Scapolite	1
Spinel	trace
Orthopyroxene	trace

Large porphyroblasts of clinopyroxene occur in an equigranular, xenomorphic intergrowth dominantly of hornblende, plagioclase and opaques 1-2 mm in size. In places scapolite crystals occur and a few grains of pink-green orthopyroxene are noted.

The clinopyroxene is faintly pleochroic in pale greens and some grains have lamellar twins. Plagioclase is labradorite and is twinned on the Albite Law with minor development of Pericline twins. Scapolite has moderate birefringence and is probably the calcium variey, meionite.

Green spinel is generally closely associated with the opaque grains.

This rock is the product of high grade regional metamorphism of a basic rock.

Sample P409/70: TS25511

Location:
Kenmore 1-mile, Run8. Frazer's Copper Prospect.

Rock Name:
Pyroxene-scapolite-plagioclase granulite.

Hand Specimen:
A massive dark grey, coarse grained crystalline rock with bright green copper staining.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Orthopyroxene) Clinopyroxene)	75-80
Hornblende	1-3
Scapolite	10-15
Plagioclase	2-5
Spinel	trace
Opaques	3

The rock consists mainly of an equigranular, xenoblastic intergrowth of pyroxene, plagioclase and scapolite. A faintly pleochroic in pale green clinopyroxene is the most abundant mineral. Also present is a subordinate orthopyroxene with distinctive pink to green pleochroism. In general, grain size is between 1 and 3 mm. Plagioclase and a calcium scapolite, meionite occur in complex, veriform intergrowths. It is thought that scapolite is replacing plagioclase.

Hornblende is not abundant and forms small grains and in places appears to replace some of the orthopyroxene. Opaque grains and their alteration products (? geothite) occur throughout the rock and the small amounts of spinel are associated with them.

This is similar to other rocks of this suite but the presence of scapolite indicates a more calcic original rock.

Sample P411/70: TS 25513

Location:
Kenmore 1-mile, Run 9. Sample taken from large dyke approximately one mile southeast of where it cuts the southern end of Frazers Copper prospect.

Rock Name:
Plagioclase - Pyroxene rock

Hand Specimen:
A massive dark grey-black crystalline rock.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Plagioclase	45-50
Clinopyroxene	50-55
Olivine	trace
Goethite	trace
Opaques	trace

The rock consists of anhedral grains of pale green clinopyroxene approximately 0.5 to 1 mm. in size surrounded by and enclosed by plagioclase grains up to 5 - 6 mm. in size. A few grains of cracked olivine 2 mm. across occur. The cracks are filled with goethite and tiny bundles of opaque material probably evolved from olivine occur along ? crystallographic planes in the olivine crystals.

Plagioclase has strongly developed Albite Law Twins and in places Pericline twins are also important. The mineral has an andesine composition and has a distinct brownish tint.

The rock appears to have igneous affinities, however it is very different to P410/70 texturally. Mineralogically, and therefore chemically, it appears to be a little more basic than P410/70.

Reduce to 7½ inches

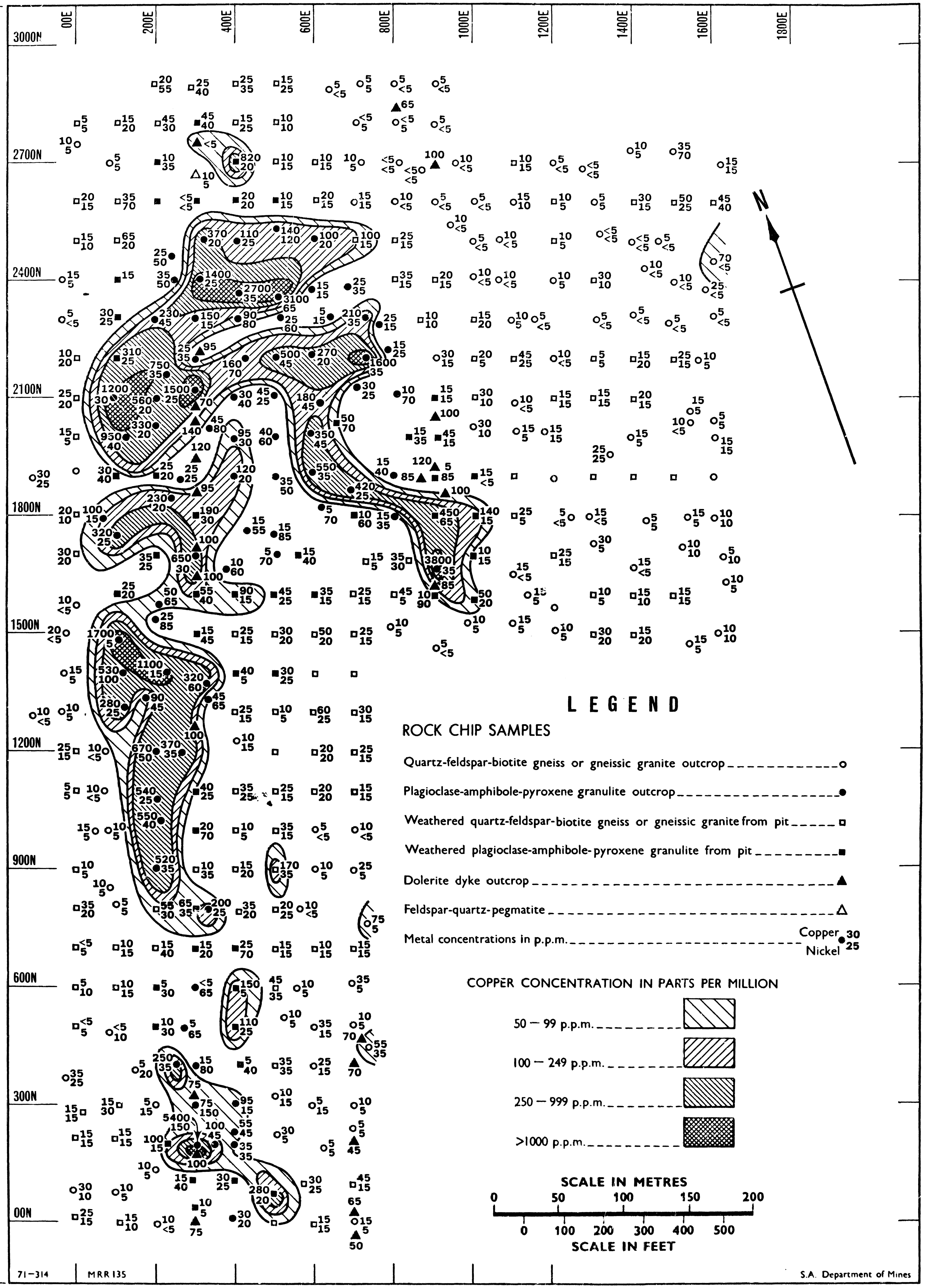
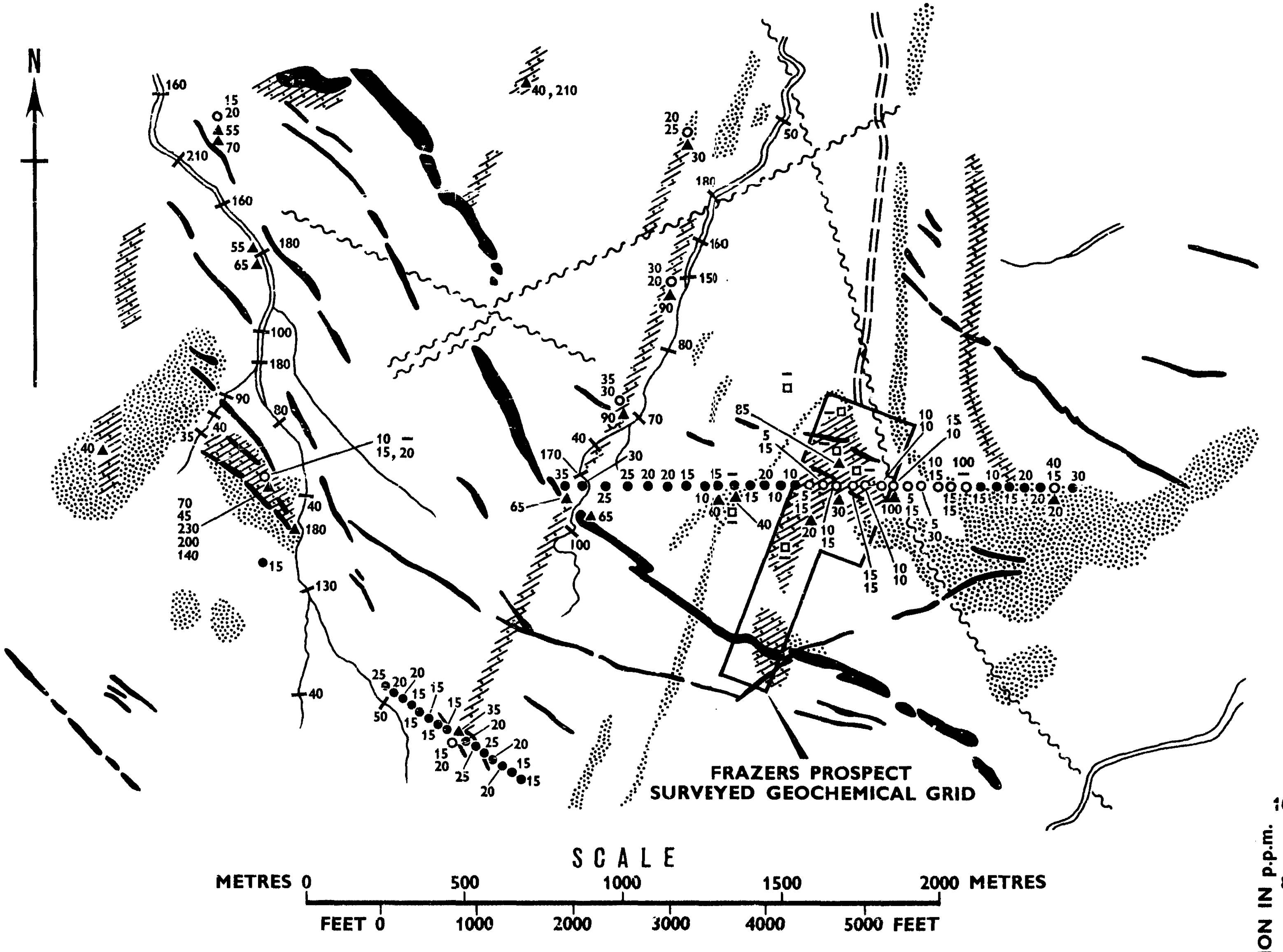


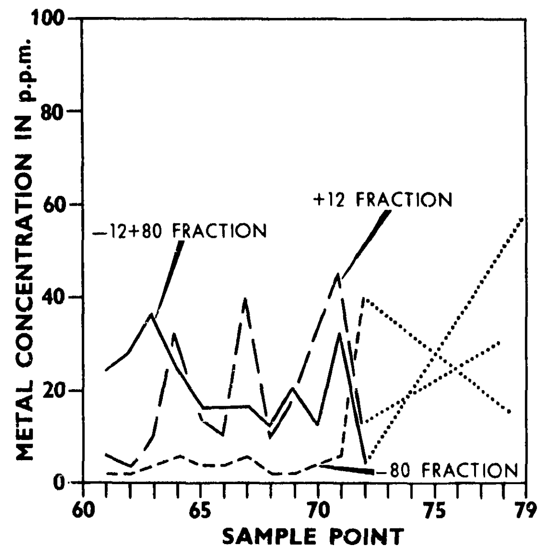
Fig 8 PLAN SHOWING COPPER & NICKEL IN ROCK CHIP SAMPLES FRAZERS COPPER PROSPECT

M.R.R. 135

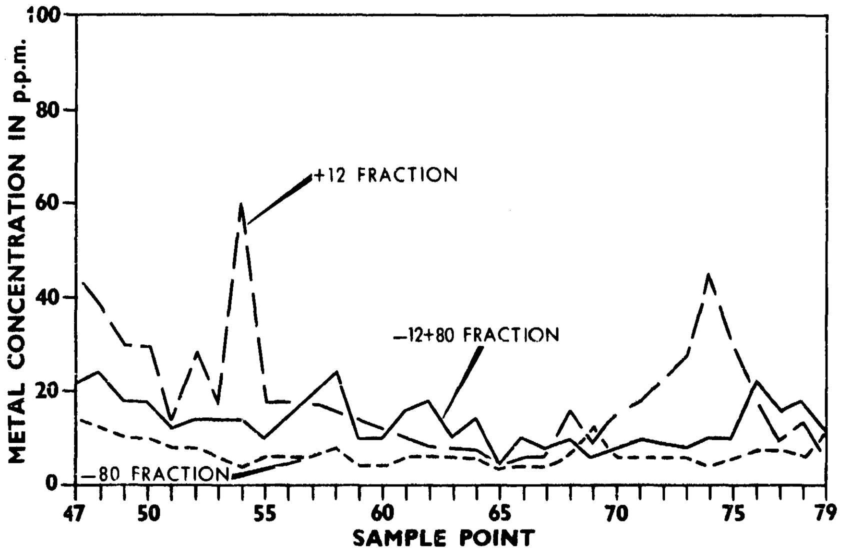
Fig. 1 FRAZERS COPPER PROSPECT
GEOCHEMICAL GRID AND GEOLOGICAL PLAN

T.S. 71-313/4
MRR 135
9 Jan 1973





GRAPH SHOWING VARIATION IN **CHROMIUM** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SURFACE SOIL



GRAPH SHOWING VARIATION IN **CHROMIUM** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SOIL SAMPLES TAKEN FROM 9 INCH DEPTH

LEGEND

Dolerite and gabbro dykes

Outcrop of amphibolite-pyroxene-hornblende-plagioclase granulite

Outcrop of quartz-feldspar-biotite gneisses and granitic gneisses

Shear

ALL METAL CONCENTRATIONS IN p.p.m.

Stream sediment sample — 180

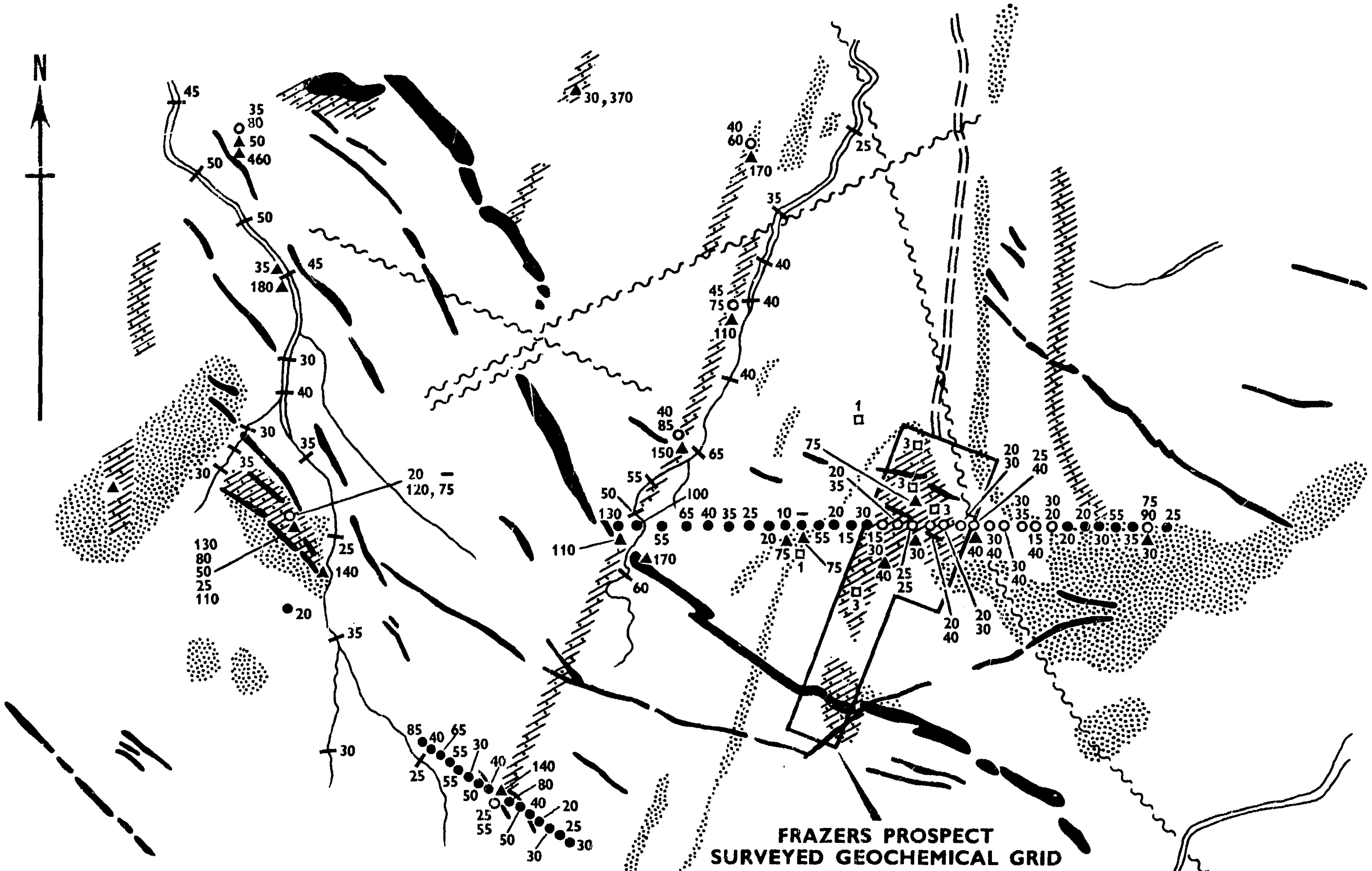
Soil sample (from 9 inch depth)* — 25

Soil sample (from 9 inch depth and surface soil)* — 10 / 15

Rock chip or whole rock sample — 60

Geobotanical sample (*Acacia kempeana* leaves) — 2

* NOTE:— All metal concentrations from -80 mesh fraction of soil samples



SCALE

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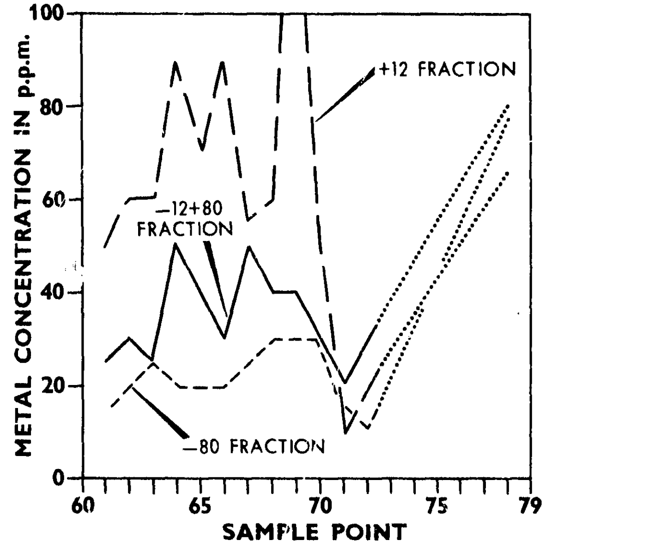
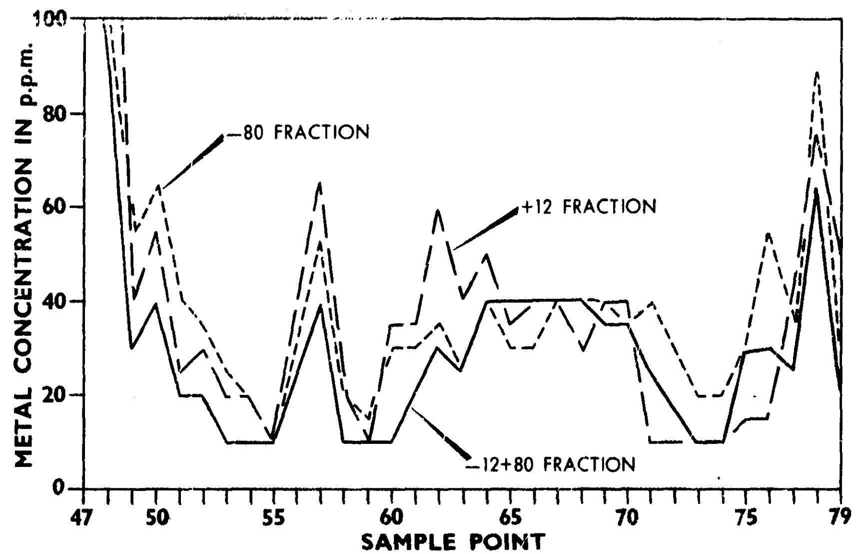


GRAPH SHOWING VARIATION IN **NICKEL** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SURFACE SOIL



GRAPH SHOWING VARIATION IN **NICKEL** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SOIL SAMPLES TAKEN FROM 9 INCH DEPTH

LEGEND

Dolerite and gabbro dykes

Outcrop of amphibolite-pyroxene-hornblende-plagioclase granulite

Outcrop of quartz-feldspar-biotite gneisses and granitic gneisses

Shear

ALL METAL CONCENTRATIONS IN p.p.m.

Stream sediment sample — 45

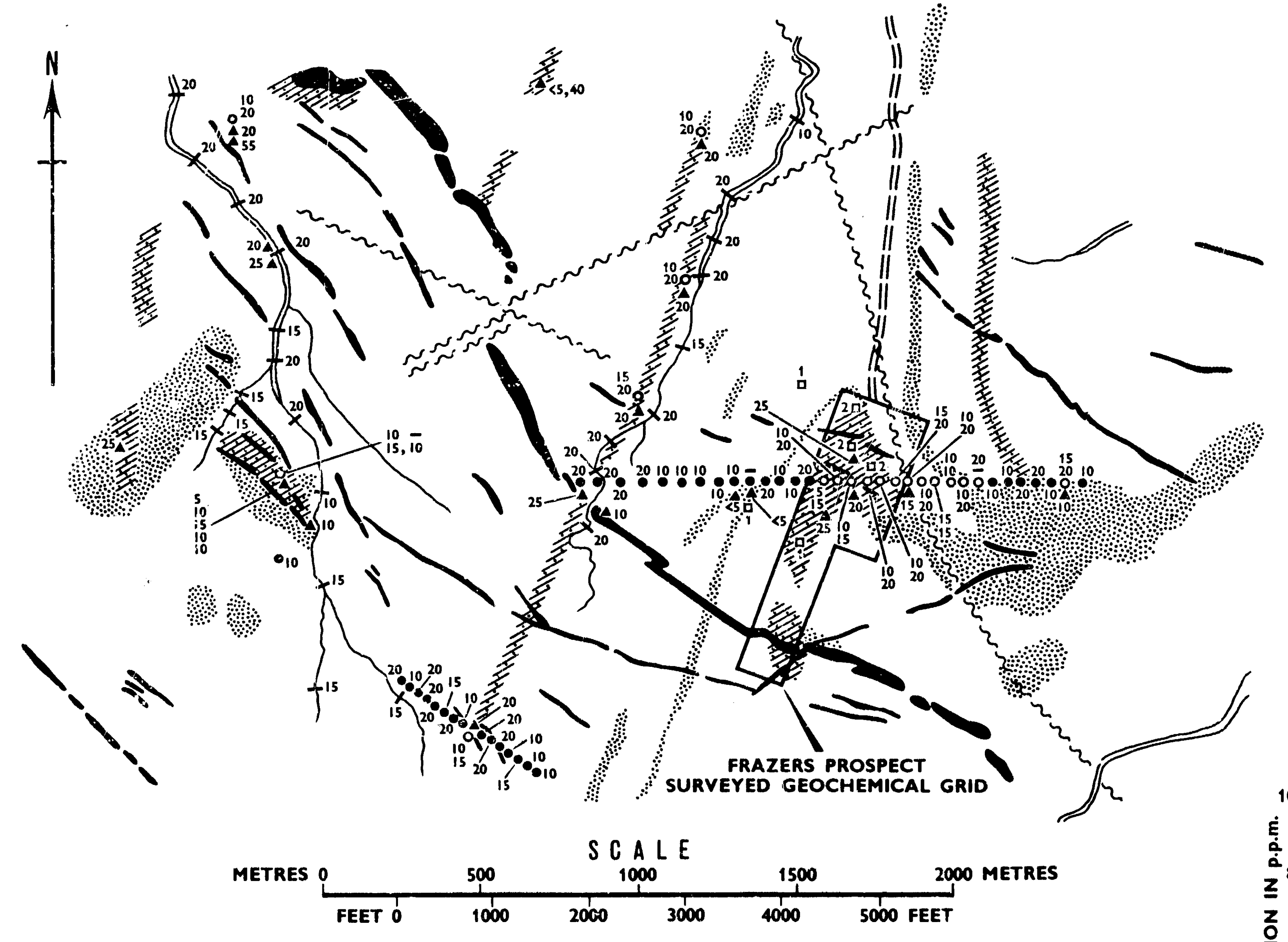
Soil sample (from 9 inch depth)* — 65

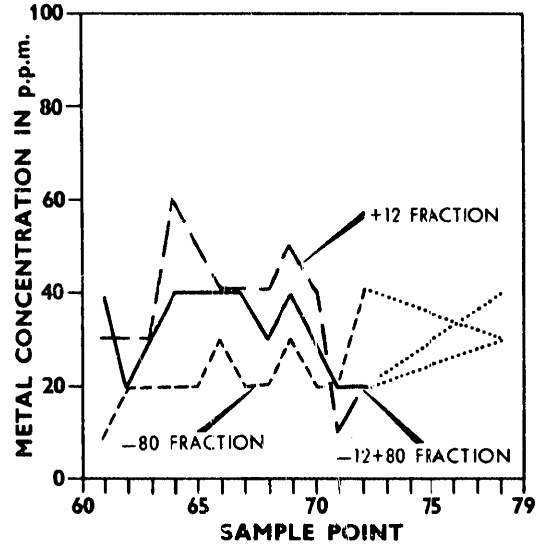
Soil sample (from 9 inch depth and surface soil)* — 30 / 40

Rock chip or whole rock sample — 75

Geobotanical sample (*Acacia kempeana* leaves) — 1

* NOTE:— All metal concentrations from -80 mesh fraction of soil samples





GRAPH SHOWING VARIATION IN **COBALT** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SURFACE SOIL

LEGEND

Dolerite and gabbro dykes

Outcrop of amphibolite-pyroxene-hornblende-plagioclase granulite

Outcrop of quartz-feldspar-biotite gneisses and granitic gneisses

Shear

ALL METAL CONCENTRATIONS IN p.p.m.

Stream sediment sample — 10

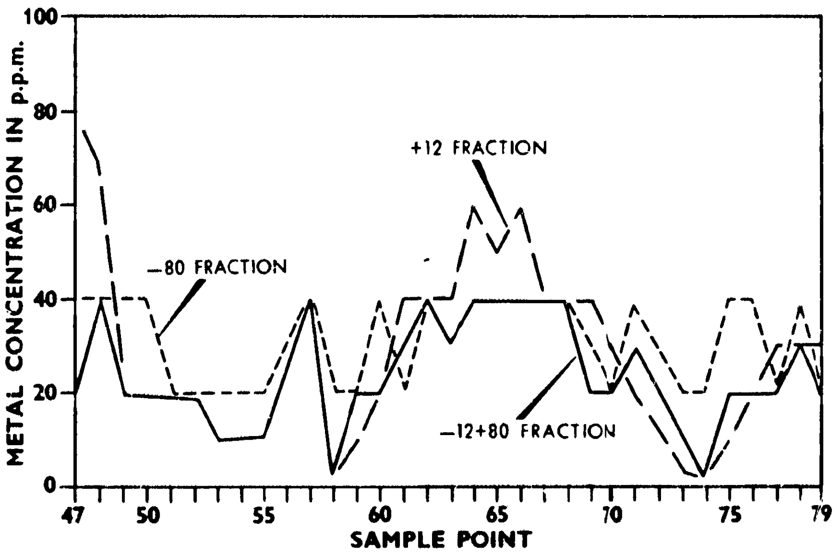
Soil sample (from 9 inch depth)* — ● 20

Soil sample (from 9 inch depth and surface soil)* — ○ 10 15

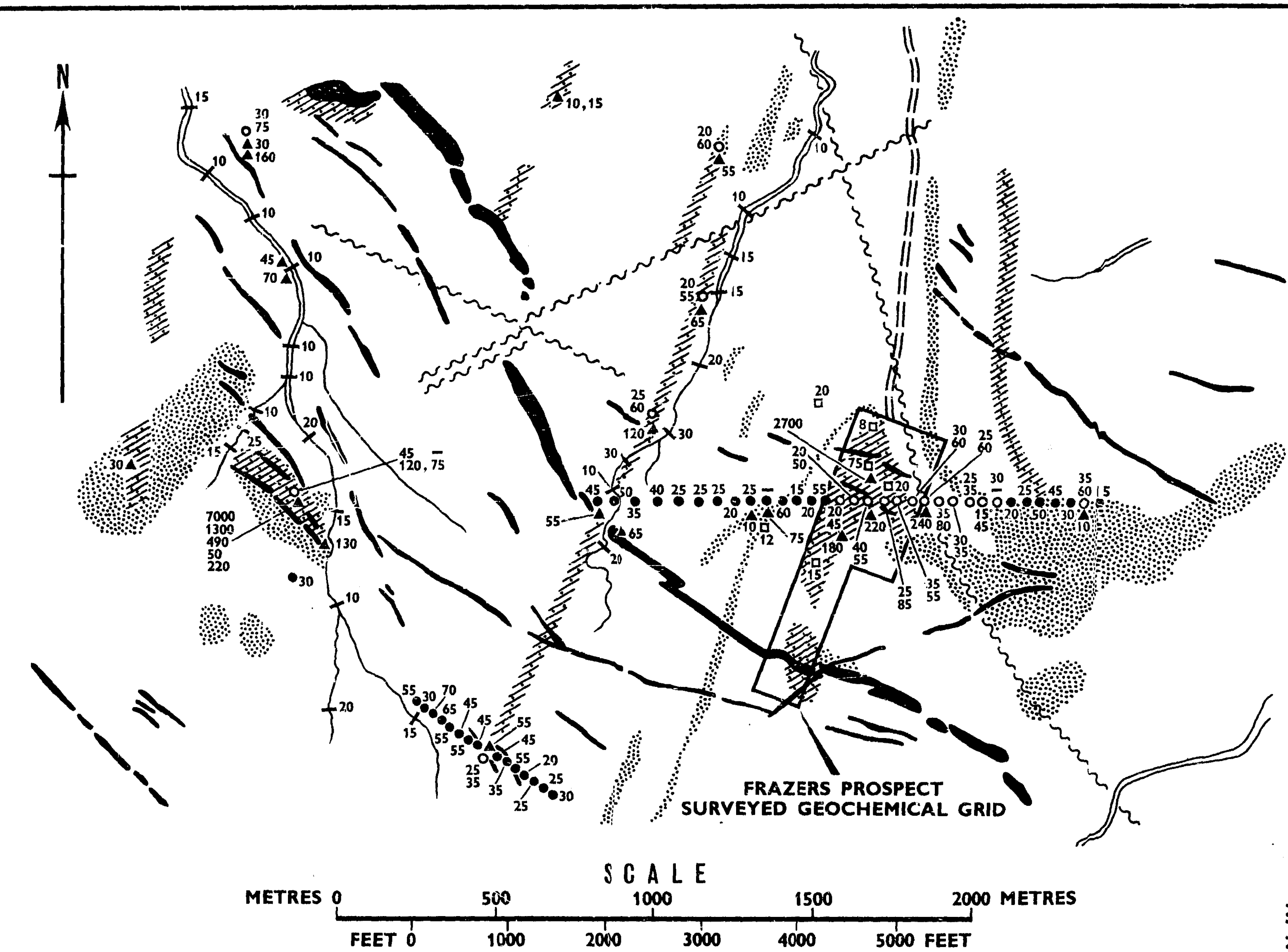
Rock chip or whole rock sample* — ▲ 20

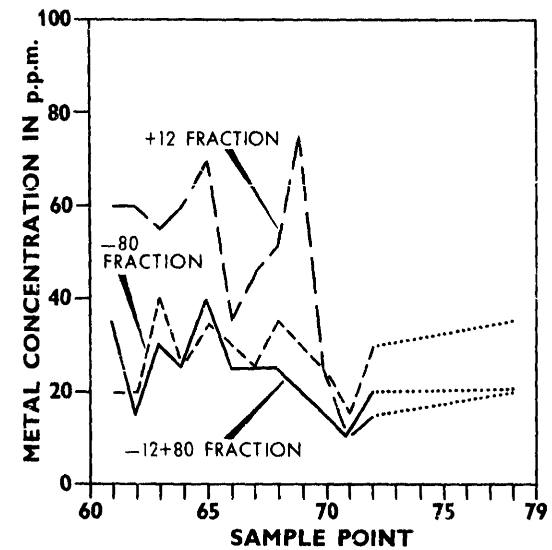
Geobotanical sample (*Acacia kempeana* leaves) — □ 2

* NOTE:— All metal concentrations from -80 mesh fraction of soil samples

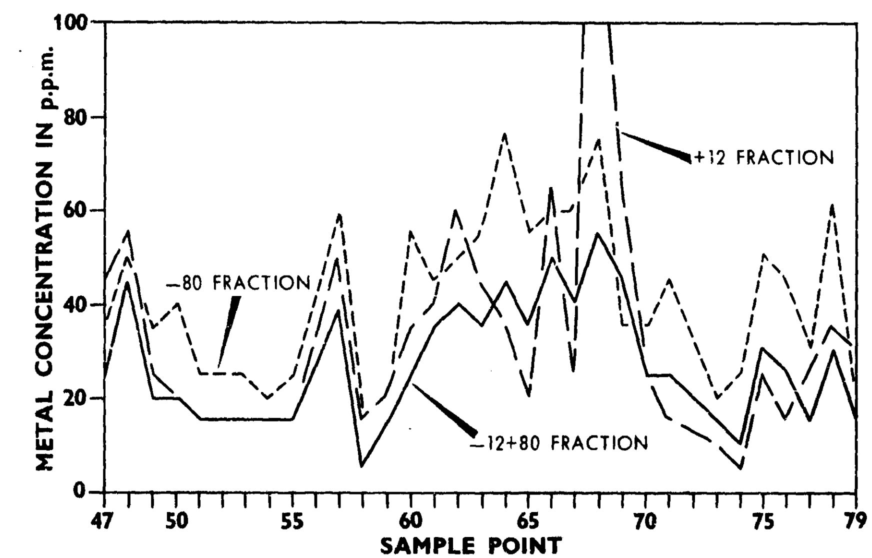


GRAPH SHOWING VARIATION IN **COBALT** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SOIL SAMPLES TAKEN FROM 9 INCH DEPTH





GRAPH SHOWING VARIATION IN **COPPER** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SURFACE SOIL



GRAPH SHOWING VARIATION IN **COPPER** CONCENTRATION IN DIFFERENT MESH FRACTIONS OF SOIL SAMPLES TAKEN FROM 9 INCH DEPTH

LEGEND

Dolerite and gabbro dykes

Outcrop of amphibolite-pyroxene-hornblende-plagioclase granulite

Outcrop of quartz-feldspar-biotite gneisses and granitic gneisses

Shear

ALL METAL CONCENTRATIONS IN p.p.m.

Stream sediment sample — 10

Soil sample (from 9 inch depth)* — 45

Soil sample (from 9 inch depth and surface soil)* — 35 / 55

Rock chip or whole rock sample — 60

Geobotanical sample (*Acacia kempeana* leaves) — 75

* NOTE:— All metal concentrations from -80 mesh fraction of soil samples

71-224 MRR 135 Del. T.S.

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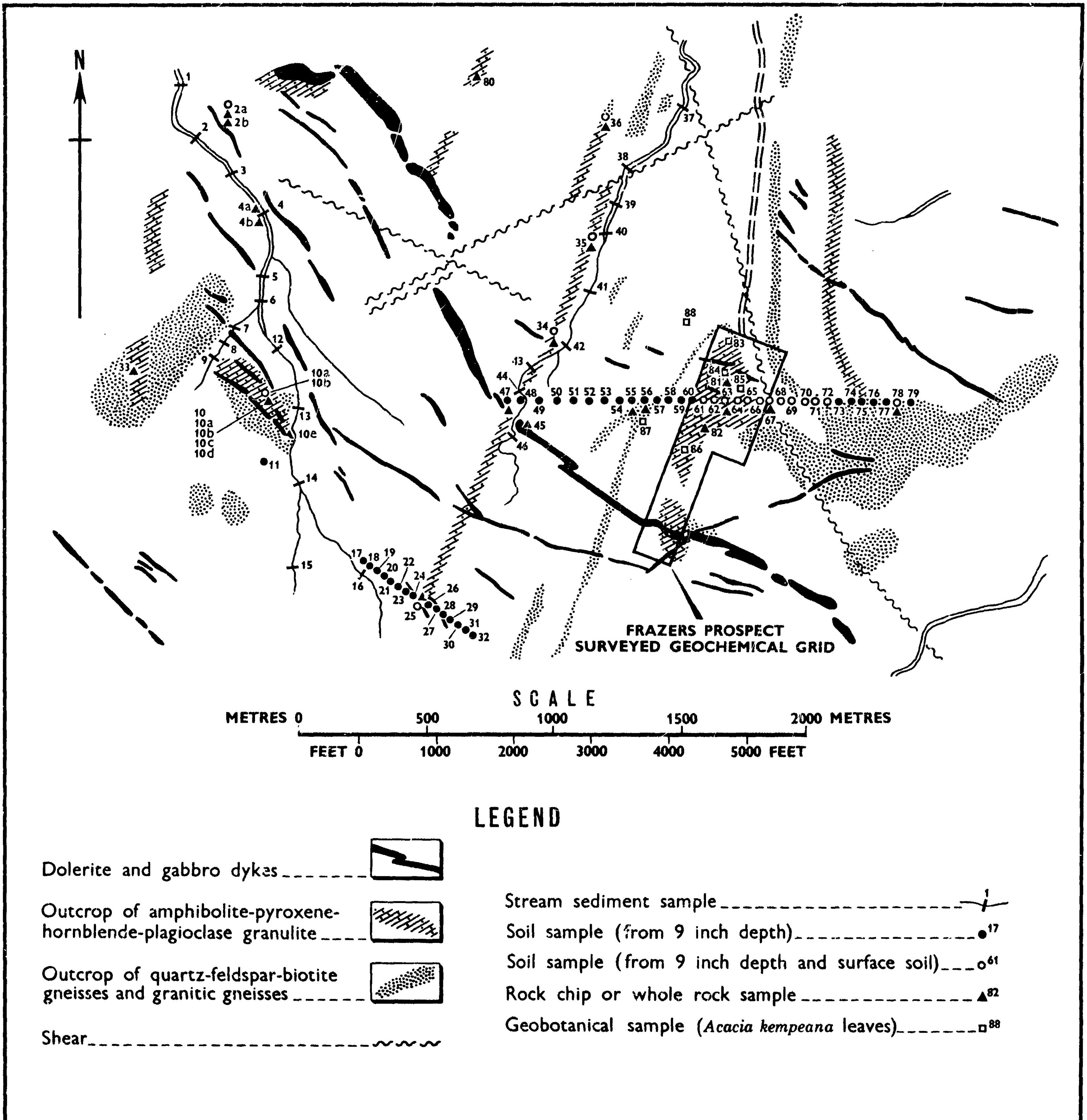
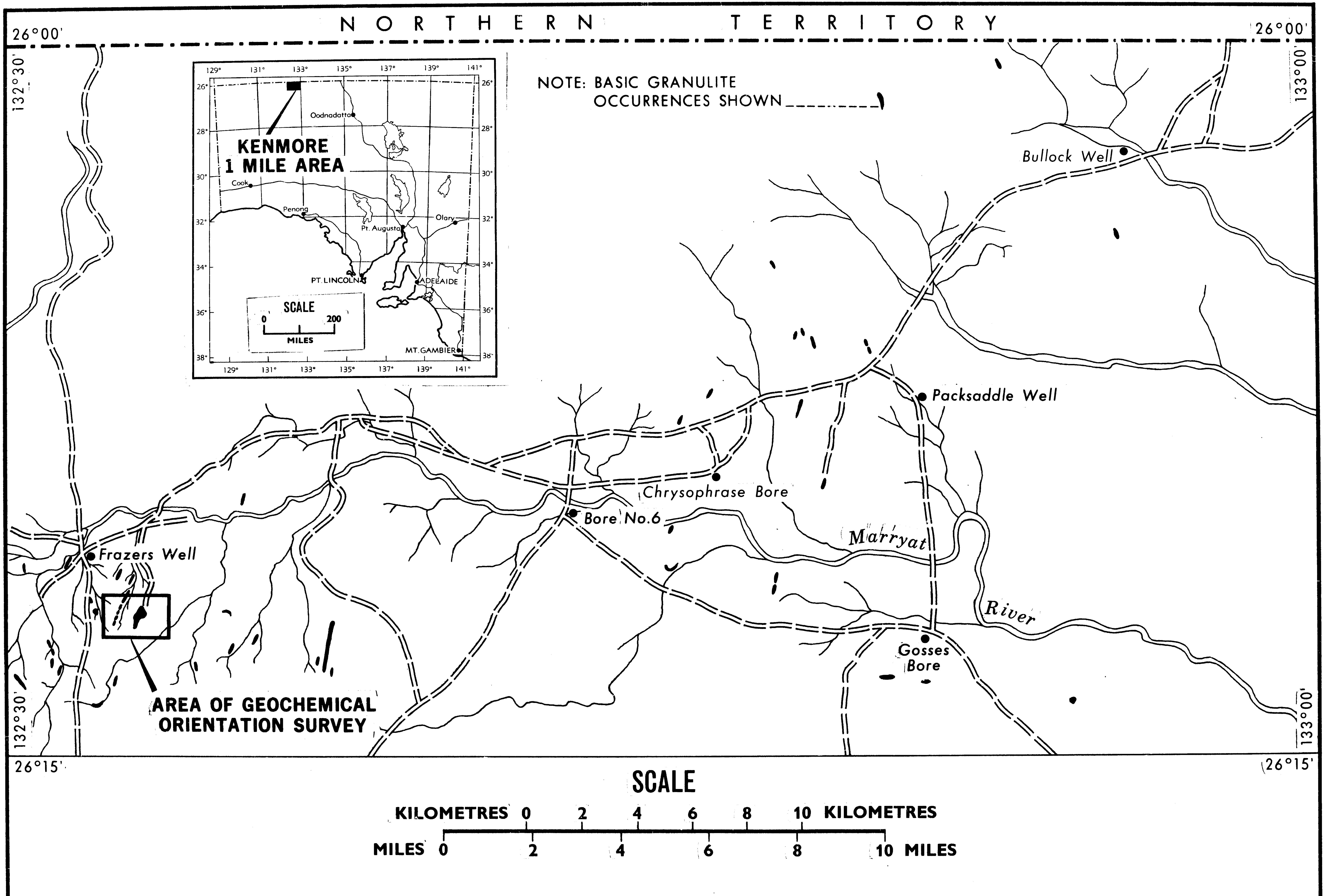

N
FRAZERS PROSPECT
SURVEYED GEOCHEMICAL GRID
SCALE
METRES 0 500 1000 1500 2000 METRES
FEET 0 1000 2000 3000 4000 5000 FEET
LEGEND
Dolerite and gabbro dykes
Outcrop of amphibolite-pyroxene-hornblende-plagioclase granulite
Outcrop of quartz-feldspar-biotite gneisses and granitic gneisses
Shear
Stream sediment sample
Soil sample (from 9 inch depth)
Soil sample (from 9 inch depth and surface soil)
Rock chip or whole rock sample
Geobotanical sample (*Acacia kempeana* leaves)



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