Copy 2

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

RECORDS.

1953/144

GEOPHYSICAL REPORT ON THE ELLA CREEK RADIOACTIVE DEPOSIT, NORTHERN TERRITORY.

by

I.A. Mumme.

DARWIN, N.T.

GEOPHYSICAL REPORT ON THE ELIA CREEK RADIOACTIVE DEPOSIT, NORTHERN TERRITORY.

by

L.A. Hume.

RECORDS

CONTENTS.

PLANS.

Plate No.		Scale.
1	Survey grid and radiometric contours.	1 inch - 100 feet.
2	Self-potential profiles.	1 inch - 100 feet.
3	Self-potential contour plan.	1 inch - 100 feet.
4	Magnetometer profiles.	1 inch - 100 feet
5	Radiometric and self-potential profiles along costeans.	1 inch - 20 feet.
6	Geological plan constructed from geophysical work and geological mapping	1 inch - 100 feet.

INTRODUCTION.

Ella Creek radioactive prospect is one of the first order radioactive anomalies located during airborne surveys conducted by the geophysical section of the Bureau of Mineral Resources in 1952.

Geological, geophysical and geochemical ground surveys have been carried out to ascertain the type and cause of the radioactive mineralization.

The geophysical programme was carried out by I.A. Munro assisted by D. Pritchard and E.T. Hadley.

SUMMARY.

Intense radioactivity was recorded in shallow pits in areas of highest surface activity where intensely radioactive hematite quartz rocks injected into grey and purple slates were exposed. Subsequently costeans were bulldozed exposing zones of radioactivity which were again found to be associated with hematite milky quartz veins. Often the hematitic quartz injections were found to be brecciated.

Self potential surveys revealed zones of anomalies which appear to represent graphitic or carbonaceous slates. It is possible sulphides are also present. The masses of surface hematite in the hematitic siliceous slates suggest that pyritic material may occur at depth. (The reference here is made only to the hematite associated with the hematitic siliceous slates and not to the hematitic quartz breccia which outcrops 800 feet to the south of the 00 peg.)

Magnetometer surveys revealed lines of anomalies. Some lines of anomalies probably represent contacts between different types of sedimentary formations.

The contact surface between different sedimentary rock formations possessing different magnetic susceptibilities is a zone of anomalous magnetic force intensities.

Other lines of anomalous magnetic vertical force intensities possibly represent shear, fold or fault zones.

Hematite and magnetite grains in sedimentary rocks at the time of formation of the rock are orientated in the direction of the earth's magnetic field and the rock formation is polarized. Faulting, folding and shearing produces zones in which rapid changes in polarization occur. Lines of anomalous magnetic vertical force intensities occur along these zones of abrupt changes in magnetic polarization.

SELF-POTENTIAL RESULTS.

Nineteen self-potential traverses have been completed. These have been plotted on a horizontal scale of 100 feet to the inch with a potential scale of 20^{0} millivolts to the inch. (See plate No. 2.)

Interesting conclusions can be drawn from the self-potential profiles.

There are two zones of major self-potential anomalies. (See plate Nos.2 and 3.)

These major anomalous zones are broad and show generally only a gradual increase in negative potential towards their centres. However on traverses 350W and 400W at distances of 200 feet north of the base line there are quite well defined negative ee centres.

Here the potentials at the ground surface at the centre of the self-potential negative zones are approximately 600 millivolts lower than the potentials at the northern ends of these traverses.

The self potential profiles on the northern side of the base line along traverses 300W, 400W, 500W and 550W are quite asymmetrical.

The self potential profiles along traverses 600W and 700W are tending towards symmetry, but the northern ends of the profiles are at potentials higher than those encountered at the positive centres located at distances of approximately 500 feet to the south of the base line.

Self potential profiles along traverses 200E, 300E, 400E and 500E have negative anomalous areas. The negative anomalous areas are not very well defined.

From previous experience on similar geophysical problems at Rum Jungle and at Brodribb and from the nature of the exposed rocks it is considered by I.A. Mumme that the negative anomalous self potential areas represent areas of graphite or carbonaceous slates and possibly contain some pyrite.

However it is likely that if pyrite is present it occurs beneath the water table surface, as in the presence of oxygen in the aerated zone, pyrite in contact with carbonaceous or graphitic slates would rapidly undergo oxidation to hematite and possibly limonite. This results from electro-chemical processes.

The water table surface referred to is the lowest water table surface for the year as the water table surface varies through wide amplitudes from the dry season to the wet season. From surface geological investigation it appears that similar conditions have prevailed for an appreciable interval of geological time.

In the dry season the depth of the water table is approximately 60 to 100 feet below ground surface, but in the wet season the water table is from 40 feet to zero feet below ground level. These are only generalizations.

Most of the self potential traversing was carried out in this area after a heavy down pour of rain so that the surface contacts with the self potential pots were very good. Also self potential work was carried out during a period in which the average water table was low so that a most effective thickness of suitable rock matter was present for generating self potential differences.

The asymmetrical self potential profiles on traverses 350W, 400W, 450W etc. on the northern side of the base line (assuming that this represents a graphitic (or carbonaceous) sedimentary rock, which appears probable), show that the contact of the carbonaceous or graphitic slates located approximately along AB (See plte No. 6), dips towards the base line.

It is not likely that dissemination of uranium minerals will occur in the graphitic (or carbonaceous) slates to any extent. Diamond drilling of the Brodribb radioactive prospect has shown that no intense radioactivity occurred over wide zones in the graphitic slates.

It is considered by I.A. Mumme that the radioactivity at Ella Creek and Brodribb occurs near milky quartz injections along shear or fault zones. The milky quartz injections appear to have been brecciated by tectonic movements.

The brecciation may have allowed the entrance of radioactive minerals which may have been precipitated adjacent to carbonaceous slates.

It is probable that the carbonaceous (or graphitic) slates have played some part in the positioning of the radioactivity. This part may involve :-

1. Precipitation of radioactive minerals in sedimentary rocks adjacent to carbonaceous (or graphitic) rocks from milky quartz injections.

2. Graphitic slates would readily undergo intense folding and shearing in virtue of the graphite content when subjected to tectonic forces "Structural traps" may have been developed during the processes of folding and shearing. The hematite siliceous slates show indications of brecciation, also the presence of the hematite quartz breccia suggests that severe diastrophic movements have taken place and hence the carbonaceous (or graphitic) slates are probably themselves strongly folded.

Large numbers of quartz injections occur in the area in the slates and in the hematitic siliceous slates.

Beneath the water table primary radioactive minerals may occur and in the zone of aeration may have been oxidised and converted to an oxide associated with hematite.

Very often uranium secondary minerals occur distributed in graphitic or carbonaceous rocks replacing some of the host rock. However this does not appear to be the case at the Brodribb or Ella Creek radioactive prospects. Hence as no uranium secondary minerals have been recognised, it is possible that not uranium but thorium, actinium or a daughter product of uranium occurs.

RADIOMETRIC INVESTIGATIONS.

Three radioactive anomalous zones occur:-

1. The most easterly zone occupies a surface area of 1,100 square feet as measured within the twice background contour interval. This anomaly occurs on hematitic siliceous slates. Barren quartz reefs occur injected into the hematitic siliceous slates. The highest activity occurs on traverse 1,000 E on the northern side of the base line at a distance of 325 feet from it.

This small zone gives values equivalent to three times background count with a portable type of ratemeter (type 10116 manufactured by the Cinema Television Company of England). The background count was obtained at the Brodribb Radiometric Base Station.

2. The central radiometric anomalous zone covers an area of 2,600 square feet (as measured within the twice background contour line). The most active part occurs on traverse 100E at a distance of 90 feet north of the base line.

The anomaly occurs on siliceous hematitic rocks, soil covered areas and slates. The siliceous hematitic rocks outcropping in this radiometric anomalous zone appear to be brecciated.

A minor self potential anomaly crosses this radiometric anomalous zone suggesting -

(a) Sulphides at depth in the hematitic siliceous slates.

(b) Graphitic slates and sulphides underlying the hematitic siliceous slates. From a study of the geological strata and the self potential profiles, it appears that the graphitic (or carbonaceous) slates occurring to the north dip under the hematitic siliceous slates or possibly are faulted against the slates by a process of dip slip reverse faulting.

3. The most westerly anomalous area occupies a surface area of 1,150 square feet as measured within the twice background contour line.

In this radioactive area, two small areas giving 6 and 9 times background count occur, in which pits were sunk by I.A. Munne and E.T. Hadley exposing quartz hematite rocks which exhibited intense radioactivity.

The area giving 6 times background reading with a portable 10110 type of ratemeter was located between traverses 350W and 400W at a distance of 500 feet south of the base line, and the area of 9 times background was located adjacent to traverse 300W at a distance of 570 feet south of the base line.

Readings of 6,000 and 10,000 counts per minute were obtained with P.R.M. 200 in the respective pits.

The low radioactive intensity values at the surface may be due to leaching of the radioactive minerals from the soil. It is more probable the low radioactive intensity values at the surface are due to soil creep and drift, resulting in a blanketing of the activity of the quartz hematite rocks. The pits are located on a hillside and soil creep would be appreciable over long periods of time.

Shallow pits at two other areas located adjacent to traverse 500W at a distance of 40 feet to the south of the base line and on traverse 400W at a distance of 100 feet to the south of the base line were sunk. However the pits did not expose bedrock, and hence no conclusions can be drawn from the results.

Hematite rich siliceous floaters occur on the surface adjacent to these last two mentioned pits. They appear to have been derived from hematitic siliceous slate outcropping to the south at a distance of approximately 100 feet.

Four costeans were bulldozed. (See Plate No. 6.)

In Costean No. 1, a zone of radioactive rocks was located between 80 and 100 feet from the northern end of the costean. This activity was found to correspond with a zone of milky quartz injections during radiometric profiling of the costean. The rocks adjacent to the milky quartz veins are hematitic (See plate No. 5).

Costean No. 2 showed more interesting results. Radioactive rocks were exposed between the 100 foot and the 120 foot mark of the costean (as measured from the northern end of the costean). The zone of strongest radioactivity gave a value corresponding to 21 times the background count. For results see Plate No. 5. The general value of radioactivity in the costean corresponded to 4 times background. Brecciated milky quartz injections were observed in the radioactive zone. The hematite was found to be intensely radioactive.

However, at depth beneath the water table primary uranium mineral may be found or possibly thorium minerals.

Now, uranium minerals are precipitated by carbonaceous or graphitic matter. These injections appear to be confirmed to the graphitic (or carbonaceous) slates and it is possible that the uranium minerals (if carried up on the milky quartz intrusions) were precipitated in those portions of the intrusions which cut across the graphitic (or carbonaceous) slates.

However,, as yet there is some doubt as to whether uranium minerals are present. No fluorescent mineral can be identified under ultra violet light, but, not all uranium minerals are fluorescent. It is possible that thorium minerals may occur.

I.A. Mumme has requested the following set of tests to be carried out in Melbourne and Canberra:-

1. Radiometric Assays for Uranium and Thorium.
2. Fluorimeter tests.
3. Absorption tests.
4. Phosphate tests.
5. Solubility tests in Sodium Peroxide and Acid.
6. Chemical tests for Thorium and Uranium.

This set of tests should aid in the determination of the radioactive element or elements present.

Geochemical tests carried out by A. Debman have shown that copper, lead and zinc are not present in the radioactive specimens.

MAGNETOMETER ANOMALIES AND THEIR RELATION TO SELF-POTENTIAL ANOMALIES.

Fifteen magnetometer traverses have been completed. These were done with a Watt's vertical force Magnetometer No. 69140. The vertical force variations were plotted on a scale of 500 gammas per inch and a horizontal scale of 100 feet to the inch was used.

Several lines of anomalies have been located. These anomalous zones of vertical force variation are generally clearly marked.

The magnetic discontinuities result from contacts between geological strata, abrupt changes in the magnetic susceptibility of rocks, AND physical discontinuities brought about by shearing, folding, AND injections of milky quartz.

Tentatively I have divided the magnetometer anomalies into the following groups:-

1. Anomalies resulting from physical contacts between different rock types.

The magnetic anomaly marked AB on Plate No. 6 occupies a position close to the edge of the self potential anomaly CD.

This appears to represent the contact of carbonaceous (or graphitic) slates with hematitic siliceous slates. In the vicinity of the anomaly AB (or CD) no outcropping rocks can be seen although to the south grey slates occur (often injected with milky quartz reefs) and to the north there are 'floaters' of fine grained quartzite and some hematite.

2. Anomalies resulting from faulting and shearing.

The magnetic anomaly EF runs adjacent to the edge of the self potential anomalous zone GH and it possibly represents a physical discontinuity. Soil cover obscures the geology in the neighbourhood of this anomalous zone but siliceous hematitic rocks outcrop to the south of these anomalies. The siliceous hematitic rocks show strong inherent magnetism on testing specimens with the Watt's vertical force magnetometer No. 69140.

The shape of the self potential profiles on traverses 400W, 450W, 500W between the negative centres located at about 225 feet to the north of the base line suggests that the graphitic slates here dip under the siliceous hematitic slates. Faulting and shearing possibly occur along an east west direction as grey slates (surface weathered product of carbonaceous slates at depth) were found in situ to occur within the general zone of the hematitic siliceous slates.

In one area pyritic casts were found in the hematitic siliceous slates which suggests that the hematite resulted from oxidation of pyritic material.

Folding and brecciation are evident in the hematitic siliceous slates.

A negative potential anomalous zone occurs on the self potential profiles on traverse 0 at 00 peg, traverse 50W at the 0 peg, traverse 100W at the 0 peg and on traverse 150W at the 0 peg. Hematitic siliceous slates outcrop along this area. The negative anomalous zone may result from:-

(a) Small amounts of pyrite occurring at depth along the negative centres of the above self potential profiles, i.e. along the base line from (00) to (0,150W).

(b) Graphitic or carbonaceous slates may occur at a shallow depth beneath the hematitic siliceous slates, or it is possible that the hematitic siliceous slates are surface alteration products of pyritic carbonaceous slates and by brecciation, folding, surface hematization and silicification a hematitic siliceous rock has been produced.

(c) Structural self potential anomaly resulting from faulting and shearing. A self potential anomaly may be produced in this case by circulating water and air along a fault zone.

3. A well defined magnetometer anomaly runs approximately E.W. about 300 feet to the south of the base line from traverse 9W to traverse 1.E. At traverse 1E it appears to branch into several lines of anomalies. A line of positive self potential anomalies EF occurs along a zone coincident with the magnetic anomaly (See Plate No. 6). This positive zone runs from 450 feet south of the base line on traverse 700W through 400S on traverse 600W, 375S on traverse 550W, 375S on traverse 500W, 400S on traverse 450W, 430S on traverse 400W continuing through to 200S on traverse 0. At the surface in this area are outcropping fine grained purple slates which contain argillaceous, siliceous and hematitic material.

An interpretation of the geology, showing axes of magnetic anomalies and self potential anomalies is shown on Plate No. 6.

RADIOMETRIC ASSAYS.

A radiometric assay of a quartz hematite rock obtained from the pit which gave 10,000 counts per minute was 1.0% U_3O_8 equivalent.

Specimens have been forwarded to Melbourne for Absorption tests as it is possible thorium or other radioactive elements may occur.

Provisional Absorption tests have been carried out by I.A. Munro and values corresponding to radioactive element thorium have been obtained.

RESULTS.

A. Specimens contain uranium oxide (U_3O_8)

Specimen No.	Percent Transmission.
1	24.8
2	26
3	29
4	29
5	28
6	27
7	25.3

Average 27 percent.

B. Specimens contain copper and calcium phosphates and uranates.

Specimen No.	Percentage Transmission.
1	26
2	29
3	28
4	27
5	29

Average 28%

C. Specimens contain thorium oxide.

Specimen No.	Percent Transmission.
1	30
2	35
3	29
4	41
5	32
6	28
7	33
8	37

Average 33%

D. Specimens from Ella Creek.

Specimen No.	Percent Transmission.
1	39
2	36
3	31
4	30
5	33
6	34
7	34

Average 34%

Fluorimeter tests have been carried out by I.A. Humme. No fluorescent minerals could be observed under ultra violet light conditions.

CONCLUSIONS.

Ella Creek radioactive prospect appears to be very similar to the Brodribb radioactive deposit.

At Ella Creek the radioactive source is a hematitic quartz rock. The radioactivity appears to be associated with the hematite.

The radioactive hematite quartz injections which transgress the slates and the quartz often exhibit brecciation. The hematitic material is often intensely radioactive. One specimen of quartz hematite rock assayed 1.0% e U_3O_8 or 2.3% e ThO_2.

Absorption tests have been carried out at Brodribb and values equivalent to a thorium mineral have been obtained. However the absorption tests are only tentative as only improvised radiometric equipment was used.

Drilling is not warranted until it is known what radioactive element or elements are present.

Provisional tests suggest that a thorium mineral is causing the radioactive properties of the hematitic rocks.

No secondary uranium mineral can be observed which tend to confirm the radiometric tests.

If a drilling programme is carried out then close control will possibly be necessary and the following factors borne in mind:-

1. The radioactivity does not appear to be uniformly distributed throughout the whole width of the slate beds, possibly graphitic at depth, although it occurs in quartz hematite injections transgressing these slates.

2. Drilling should intersect the zone of activity beneath the lowest water table surface. The quartz hematite veins may contain a definite radioactive mineral beneath the zone of aeration which may have been leached or oxidized above the surface of the water table.

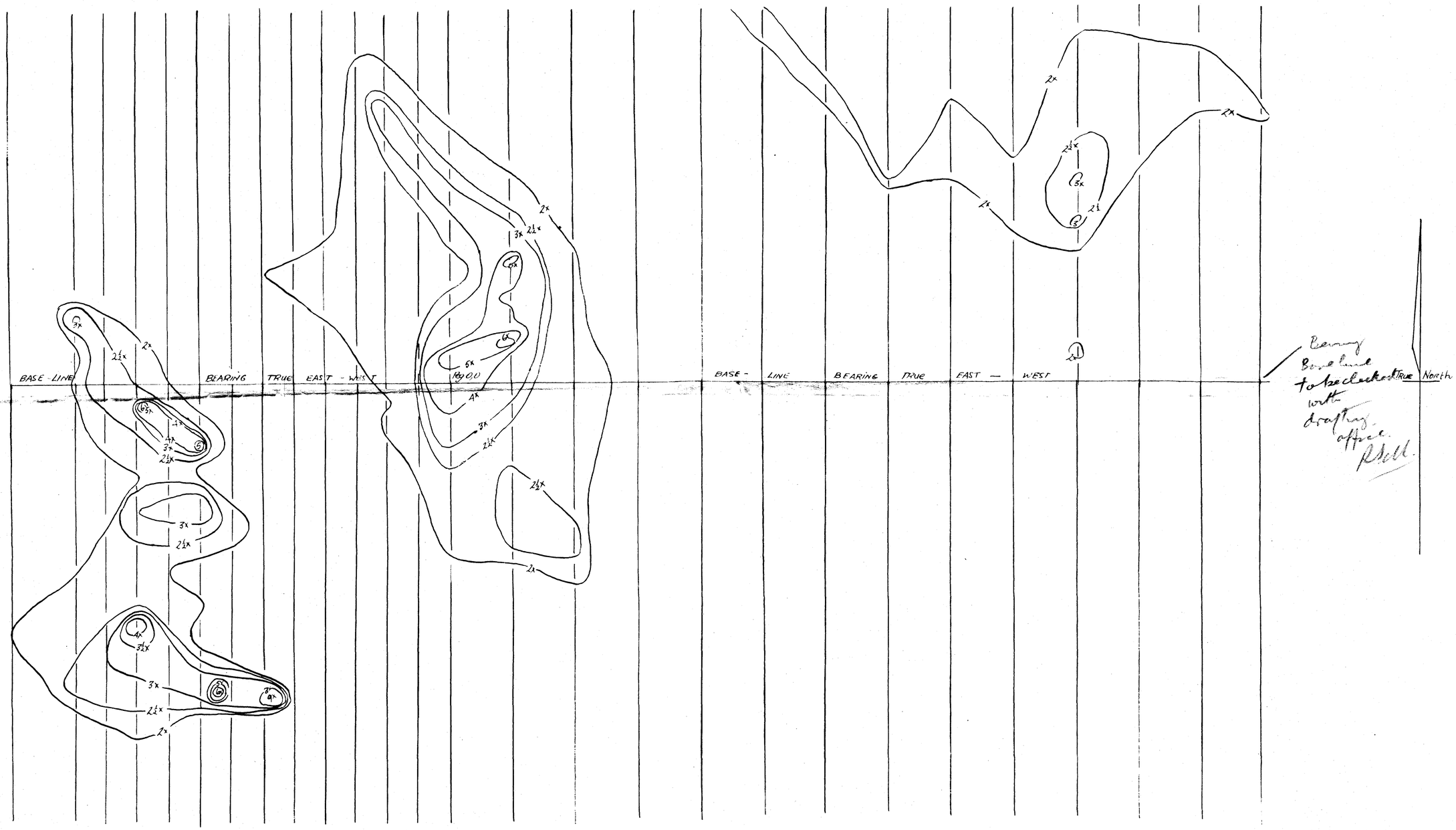
If the activity is confined to the quartz injections at depths as it appears to be at the surface then it must be borne in mind that the radioactive zones are not very wide and unless pinch and swell structures can be proved such that larger ore bodies may occur, an extensive programme of diamond drilling would not be warranted. It is possible that at depth the radioactive minerals may be disseminated through the country rock.

It is considered by I.A. Humme that the radioactive properties of the rocks at Ella Creek are due to either thorium silicate or thorium phosphate.

ELLA CREEK AREA

PLAN SHOWING RADIOMETRIC CONTOURS AND SURVEY TRAVERSES

TRAV 700W
TRAV 600W
TRAV 550W
TRAV 500W
TRAV 450W
TRAV 400W
TRAV 350W
TRAV 300W
TRAV 250W
TRAV 200W
TRAV 150W
TRAV 100W
TRAV 50W
TRAV 0
TRAV 100E
TRAV 200E
TRAV 300E
TRAV 400E
TRAV 500E
TRAV 600E
TRAV 700E
TRAV 800E
TRAV 900E
TRAV 1000E
TRAV 1100E
TRAV 1200E
TRAV 1300E



J. A. Cumming

PLATE N° 1

SELF POTENTIAL PROFILES
ELLA CREEK AREA

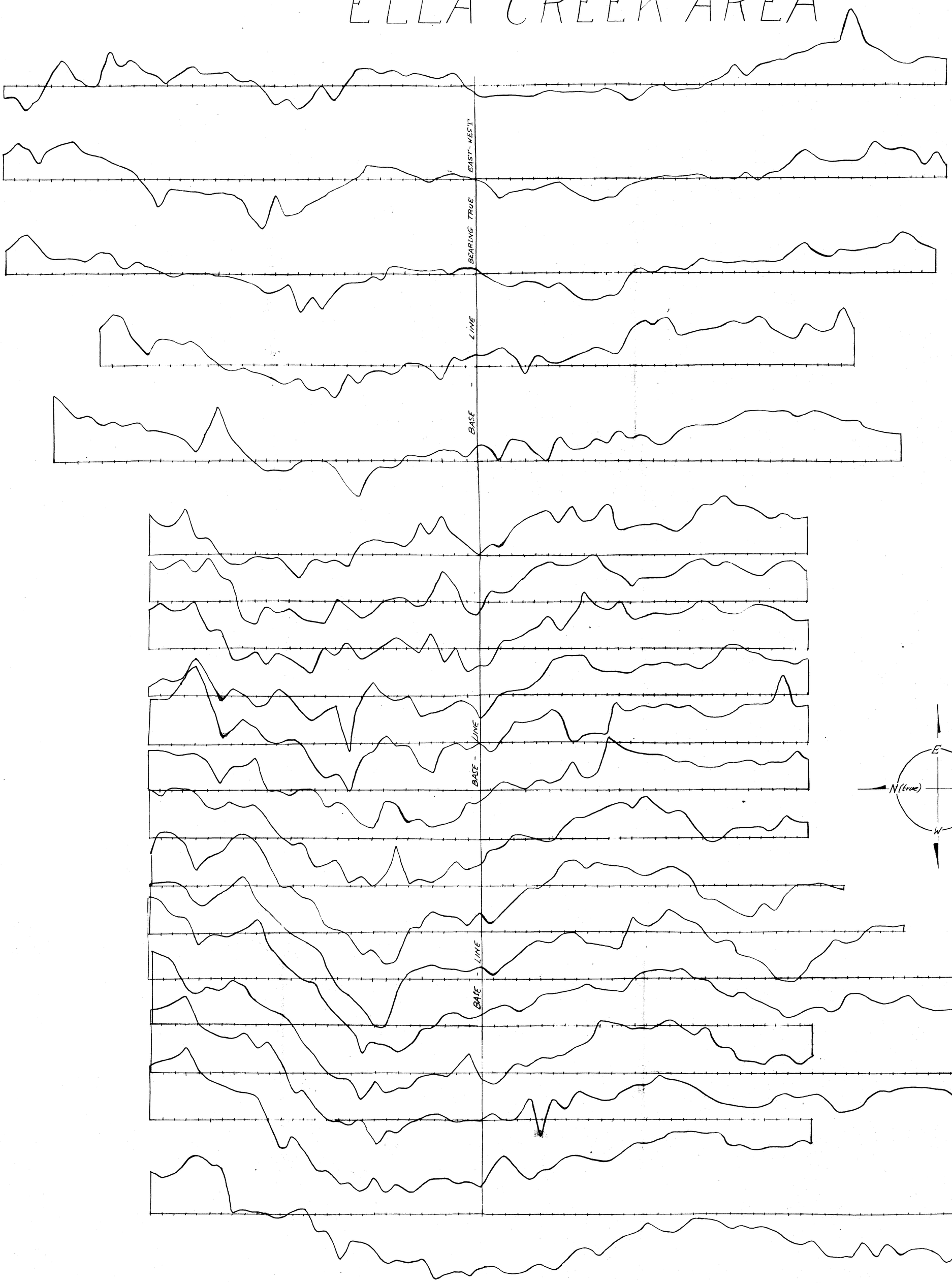


PLATE 2

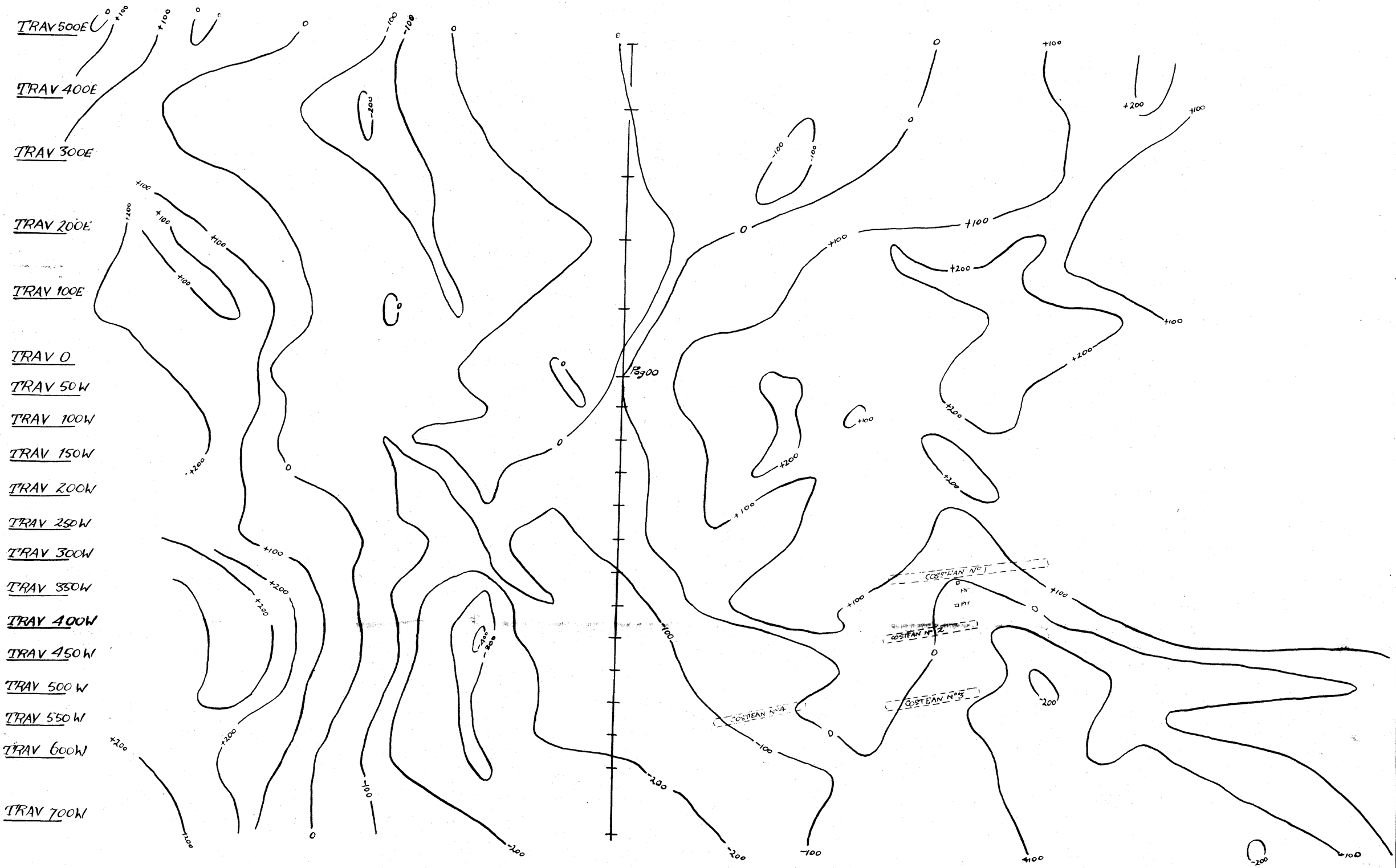
HORIZONTAL SCALE 0 50 100 200 300 feet

VERTICAL SCALE 0 100 200 400 600 MILLIVOLTS

NOTE TRAVERSES ARE SEPARATED TWICE HORIZONTAL DISTANCE FOR CLARITY

J. A. Mumme

SELF-POTENTIAL CONTOUR PLAN
ELLA CREEK AREA



Scale
0 100 200 300 Feet

NOTE SELF POTENTIAL CONTOUR INTERVALS ARE 100 MILLIVOLTS

J. A. Mumme

PLATE N° 3

ELLA CREEK AREA

MAGNETOMETER PROFILES

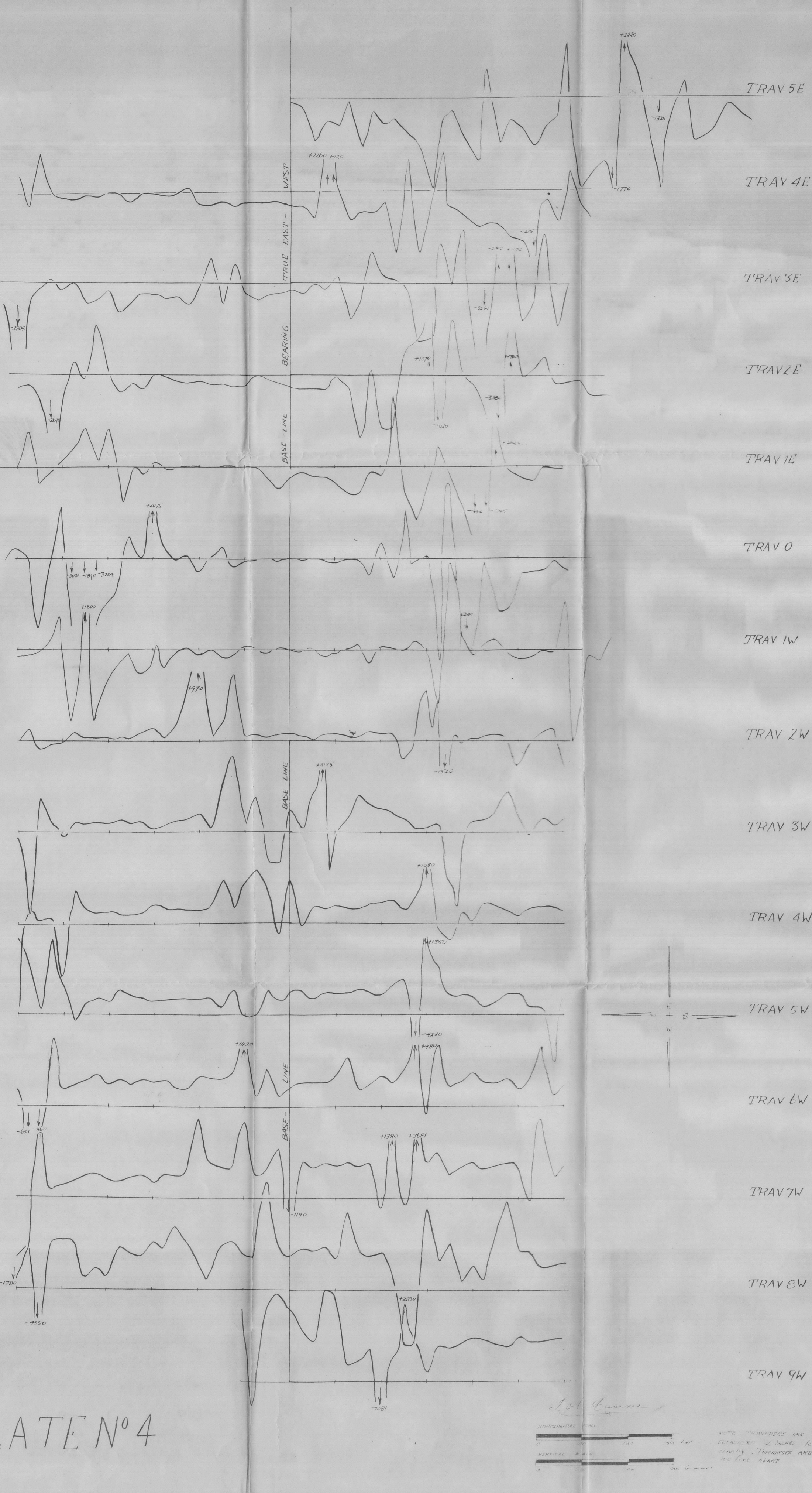


PLATE Nº 4

HORIZONTAL SCALE

0 100 200 300 feet

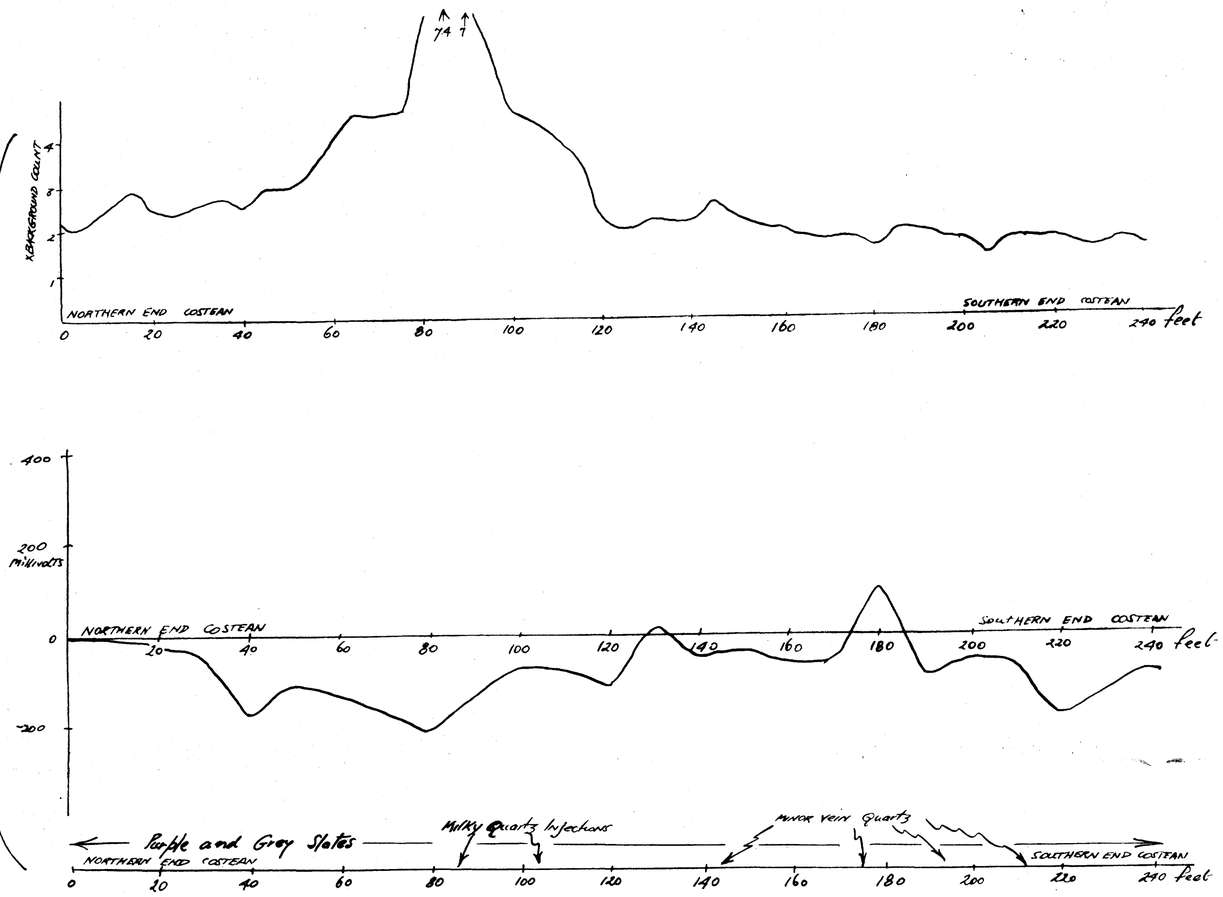
VERTICAL SCALE

0 500 1000 feet (or similar)

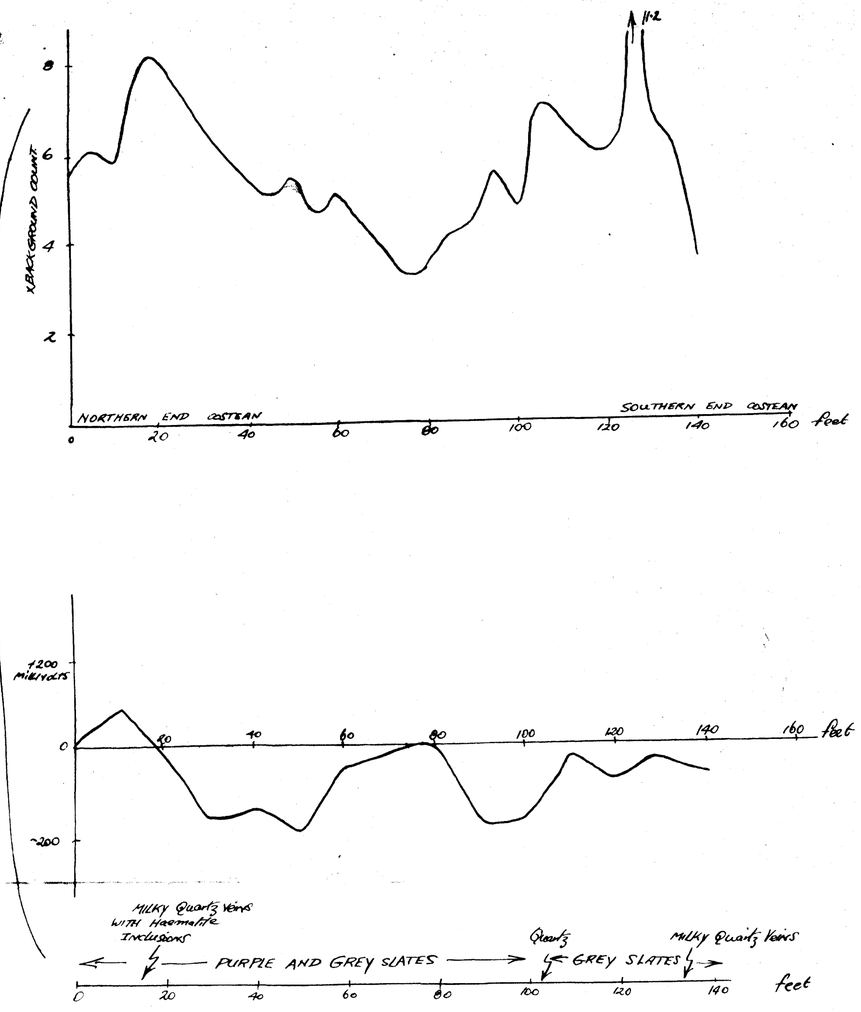
NOTE: TRAVERSES ARE SEPARATED 2 INCHES FOR CLARITY. TRAVERSES ARE 100 feet APART.

RADIOMETRIC AND SELF POTENTIAL PROFILES
ELLA CREEK AREA

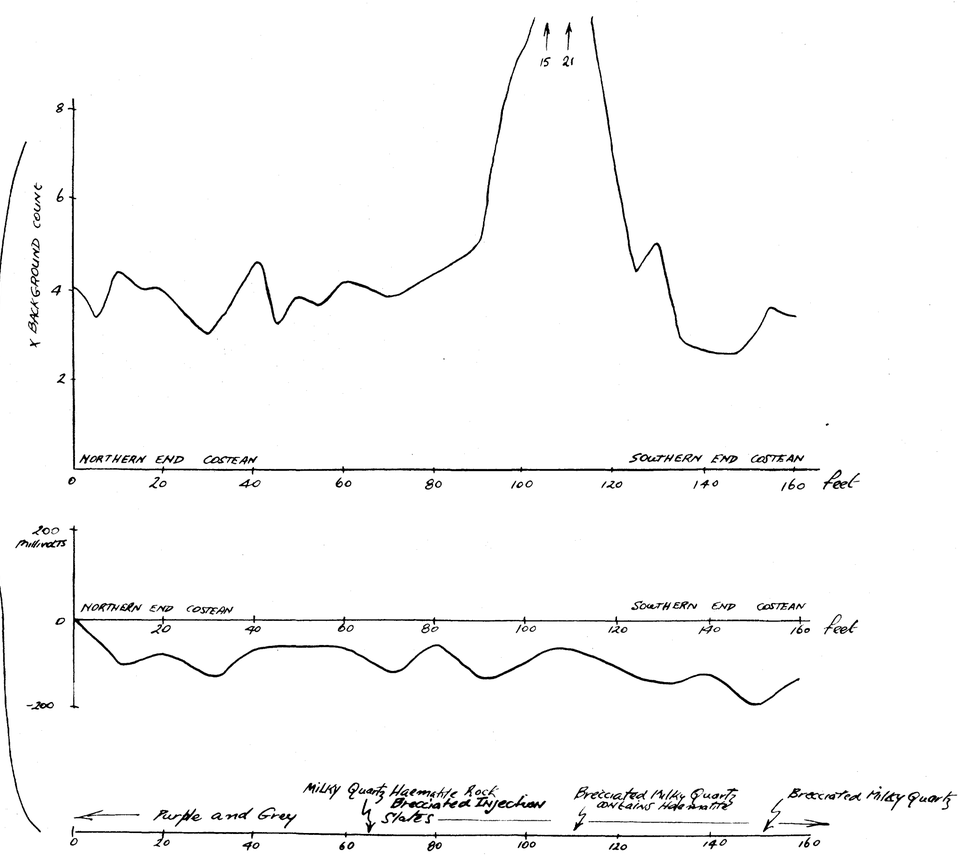
RESULTS FOR COSTEAN N° 1



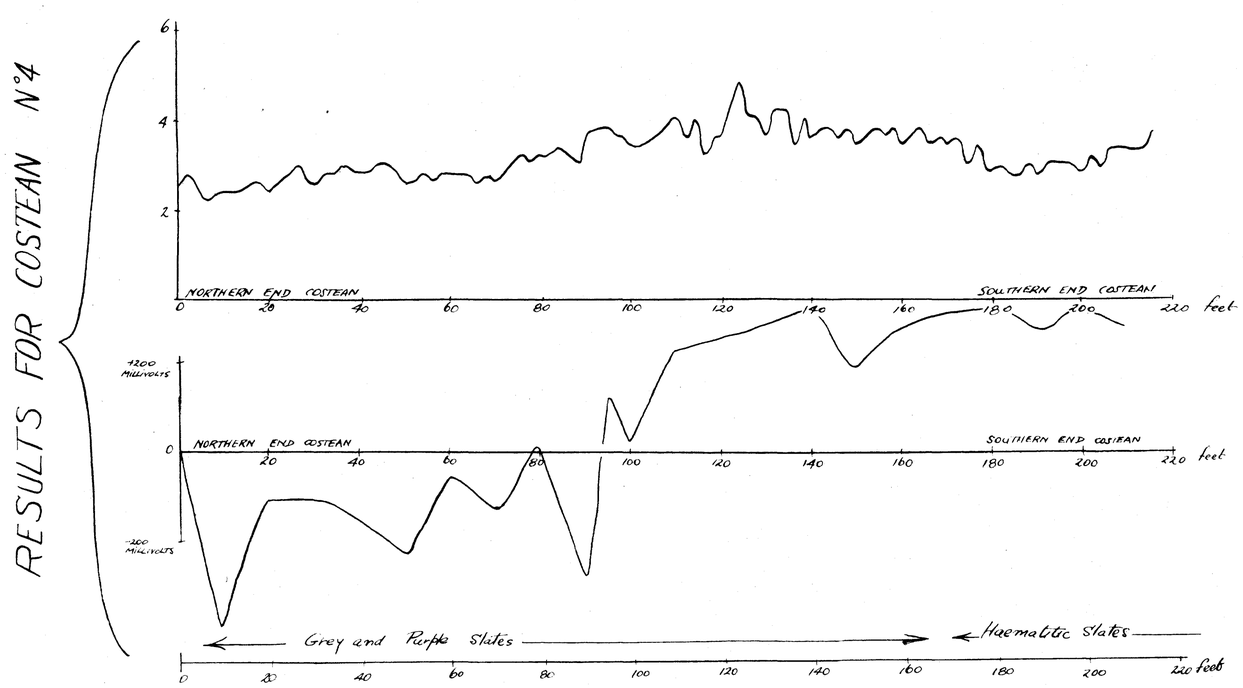
RESULTS FOR COSTEAN N° 3



RESULTS FOR COSTEAN N° 2



RESULTS FOR COSTEAN N° 4



J. A. Mumme

PLATE N° 5

INTERPRETATION OF ELLA CREEK RADIOACTIVE PROSPECT

BASED ON GEOLOGICAL MAPPING BY K. SMITH AND K. CRANK AND GEOPHYSICAL MAPPING BY I. A. MUMME

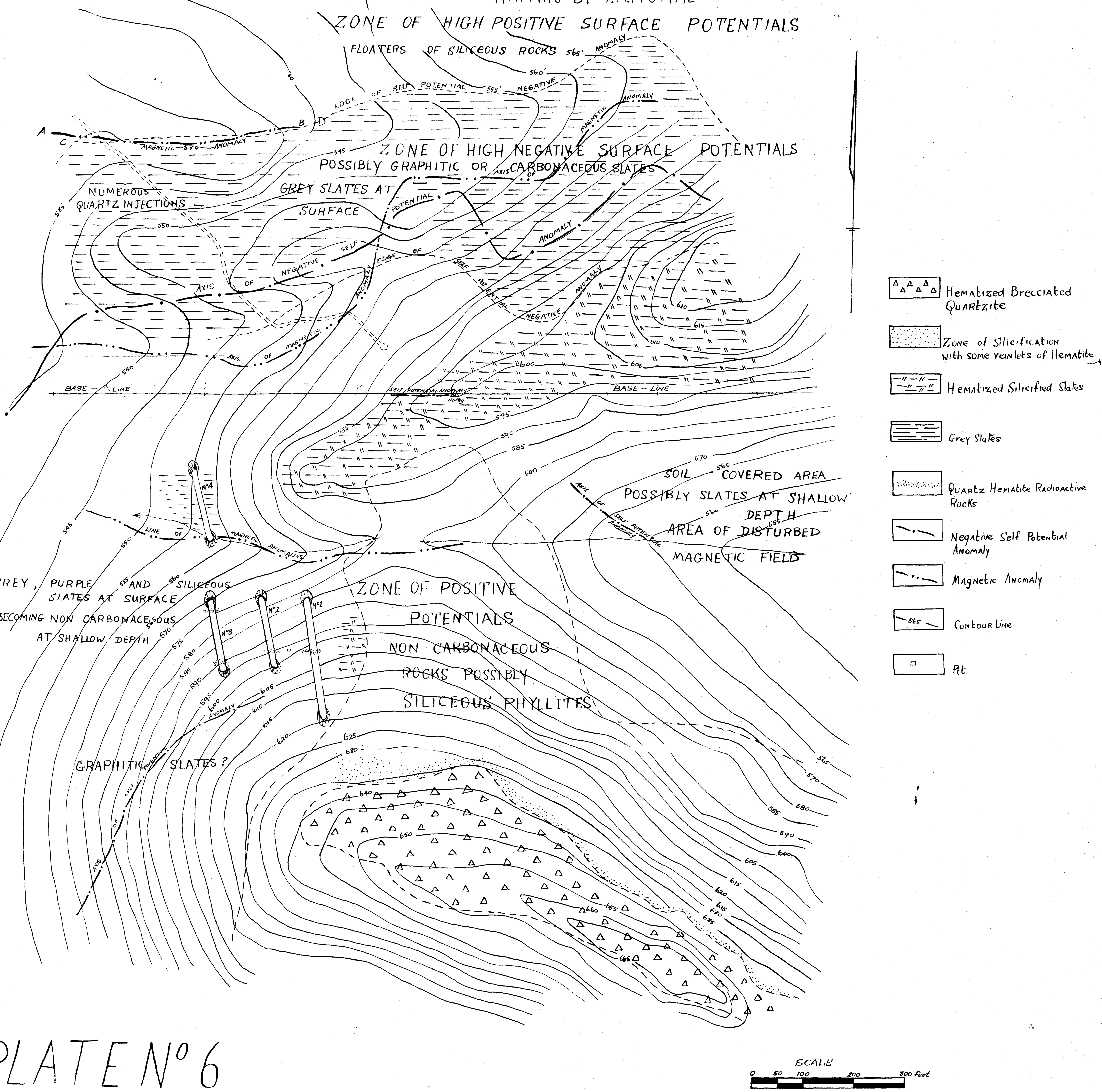


PLATE N° 6

I. A. Mumme