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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1956, No. 118

GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT (TOMBSTONE HILL AREA), MT. ISA, QUEENSLAND

by

J. HORVATH and W. J. LANGRON

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NORTHERN PROSPECT
(TOMBSTONE HILL AREA),
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ABSTRACT

At the request of Mt. Isa Mines Ltd., a geophysical survey was made between July and November, 1953 over part of the Company's "Northern Prospect". The survey was made over an area measuring 2,900 ft. by 1,800 ft.

The problem was the location of ore bodies within a broad zone of mineralisation, and it was considered that electrical methods would be the most suitable. Electro-magnetic and self-potential surveys were made, and several diamond drill holes were logged using an electrical bore hole logger. Readings were taken with a magnetic balance along four traverses.

The electro-magnetic survey located two zones of conductivity, one of which is due to a carbonaceous formation and the other to sulphide mineralisation. No differentiation between pyrite and lead-zinc ore could be made from the geophysical results, however. The self-potential and magnetic surveys gave few anomalies; the only distinct self-potential indications obtained were over the carbonaceous beds.

Two drill holes, the sites for which are given, are recommended to test the eastern of the two electro-magnetic anomalies.

1. INTRODUCTION.

In 1951, Mt. Isa Mines Ltd. commenced an exploration programme of geological mapping, diamond drilling and shaft sinking in an area known as the Northern Prospect, near the Mt. Isa-Camooweal road, about 13 miles north of Mt. Isa. The area over which the geophysical survey was made is part of a large prospecting area held by the company, and is centred about Tombstone Hill. The position and general locality of the area investigated are shown on Plate 1.

The investigations made by the company showed that the geological conditions in the area are similar to those at Mt. Isa and that as far as could be judged the mineralisation is located in a zone approximately 500 feet wide. The initial prospecting was conducted over a 5,000-foot length of westerly dipping shales, mineralised in places by pyrite, sphalerite and galena.

It was considered by the geologists of the company that geophysical methods might be of assistance in locating sulphide ore bodies in the mineralised zone, and the Bureau was approached with a request that this possibility be tested.

It was considered that the problem could best be investigated by the use of electrical methods, and in the first instance a programme was decided upon to test various methods under known conditions.

2. FIELD OPERATIONS.

Field work, under the direction of J. Horvath, Senior Geophysicist, commenced on 10th July, 1953. Other members of the party were W.J. Langron, party leader (geophysicist), D.L. Rowston (geophysicist), and two field assistants supplied by Mt. Isa Mines Ltd. J. Horvath left Mt. Isa on 3rd August, and the survey was continued with W.J. Langron in charge. The survey was interrupted from 6th September to 9th November, during which period the party carried out some geophysical tests on other parts of the Cloncurry field. The Mt. Isa work was resumed with one week of electro-magnetic work on an extension of the northern grid and then about 10 days' investigation on the Southern Prospect (Mt. Novit area). Field work terminated on 26th November 1953, on which date the party returned to Melbourne. The survey at the Southern Prospect is described in a separate report (Langron, 1956).

Surveying and pegging of the traverses were carried out mainly by surveyors from Mt. Isa Mines Ltd., and during the last part of the work, by W.F. Darch, surveyor, Commonwealth Department of the Interior.

3. GEOLOGY.

The geology of the Mt. Isa district has been described in reports by Carter (1950, 1953), Knight (1953) and Sullivan (1952).

Broadly, the geological features of the Northern Prospect are as follows (beginning at the western side):-

(i) A prominent quartzite ridge.

(ii) The Mt. Isa shear zone, adjacent to the quartzite ridge. This zone is about 500 feet wide and can be traced on the surface for at least 19 miles. It is occupied by phyllites, sericitic schists and some quartzite and shale, and as far as is known, is barren throughout its length.

(iii) A group of shales, mainly dolomitic or carbonaceous, about 500 feet wide.

(iv) A mineralised zone, consisting mainly of thinly-bedded, slightly dolomitic shales, dipping to the west at about 60°. This zone has a very pyritic hanging-wall section, about 50 feet wide, containing numerous thin seams of galena and sphalerite, and represented at the surface by outcrops of ferruginous jasper. This section is followed by a succession of weakly mineralised beds, intercalated with barren beds. The thickness of the individual mineralised beds decreases to the east. The total width of the mineralised zone, including the weakly mineralised beds, is about 800 feet.

The general strike of the formations is northerly.

Diamond drilling has proved that the main section of the mineralised zone has a length of at least 2,500 feet and an average width of 440 feet. The overall grade of the ore is low, but there are several lodes of commerical grade and size within the zone. Some of the mineralised beds are rich in galena, but in the Northern Prospect generally, zinc ore predominates over lead ore, while at Mt. Isa lead and zinc are present in about equal quantities.

4. THE PROBLEM AND THE METHODS USED.

A. General.

From the geophysicist's viewpoint, the problem was the location of ore bodies within a broad zone of mineralisation. The heavily pyritized hanging-wall presents a difficulty, as the conductivities of the pyrite and the lead ore are of the same order, and it is impossible to differentiate between electrical indications due to the two sulphides. The ratio of zinc to lead is higher than at Mt. Isa, but even so, the ore may be expected to be a good conductor. The zinc and lead ore occurs as thin bands of compact ore in the shales; the pyrite also occurs as thin bands of compact ore intercalated with the zinc-lead mineralisation.

It was decided to commence the geophysical operations on an area that had been tested by drilling and costeaning, and then to extend the survey northwards over the alluvium-covered area.

B. Methods.

Electrical methods, which depend on the conductivity difference between the lode material and the surrounding rock, were mainly used. It was considered that indications due to a large conducting body could be detected by these methods and that the value of the indications could then be determined by geological investigation. To test its suitability in the area, the magnetic method was used along a few traverses.

(i) Electro-magnetic Method.

Of the electrical methods used, the electromagnetic was the more useful. The primary electromagnetic field was supplied by both loops and single cables joining line electrodes; the results obtained from each method of excitation showed little difference and as the single cables with line electrodes were more convenient to use than loops, most of the survey was done by this method.

Traverses 1N to 30N (see Plate 1) were surveyed with the base-line cable in various positions on the grid. Several configurations were tried in an endeavour to eliminate as far as possible the effects of disseminated mineralisation and shear zones. It was also hoped to locate the position of the foot-wall of the conductive zone.

In the electromagnetic investigations an alternating current of 500 cycles per second was used. In the single cable method an improvement on the method of using point electrodes joined by the primary cable is to use "line electrodes". The line electrodes consist of two lengths of bare copper wire, each 1,500 feet long. Each electrode is placed parallel to, and at a distance of at least 1,000 ft. from, the end traverses of the grid being surveyed. The corresponding ends of the lines are joined in turn and thus surveys from either side of the conductor can be made without moving the electrodes. The line electrodes were pegged to the ground with small steel pegs at intervals of approximately 50 ft. and these contacts were then watered.

In the loop method, a rectangular loop measuring approximately 3,000 ft. x 1,800 ft. was laid on one side of the area under investigation. The long side of the loop nearer to the grid corresponds to the primary cable of the single cable method and is called the "base line" of the loop.

In both methods, the field readings were generally made at intervals of 25 feet, along traverses at right angles to the primary cable. The total field (i.e. the combination of primary field and the fields which are set up by good conductors) is investigated by means of a small reception (search) coil and a compensator in which the known e.m.f. induced in the search coil is compared with a constant e.m.f. derived from a feed coil which is inductively coupled to the primary cable. Intensities and phase conditions of the e.m.f. are observed by reading the real (in-phase) and imaginary (out-of-phase) components of both the horizontal and vertical fields. The readings are corrected for distance from, and elevation above, the primary cable before interpretation can be commenced.

(ii) Self-Potential Method.

In this method, measurements are made with a suitable millivoltmeter of the differences in potential due to natural earth currents, between a front electrode moved from point to point along the traverses and a stationary rear electrode. Potential differences at the surface of the ground are caused, in general, by electro-chemical activity in the ground. Such activity may be due to several causes and only rarely is it possible to specify the precise cause of any particular anomaly. It is found, however, that a sulphide body lying partly above ground water level, and partly below, so that part of the body is being actively oxidised, may give rise to a negative self-potential anomaly of a characteristic shape. If such an anomaly be observed in suitable geological conditions, it indicates the possibility of the presence of a sulphide body. Unfortunately, anomalies of very similar type are frequently caused by graphitic beds, and the existence of a self-potential anomaly of the expected type is therefore not necessarily indicative of the presence of a sulphide body.

The measurements are made by using two non-polarising type electrodes. These are porous earthenware pots filled with a saturated solution of copper sulphate in which a copper electrode is immersed. To avoid the disturbing influences of high contact resistance between the electrodes and the ground surface, a Cambridge vacuum-tube millivoltmeter was used for all the self-potential work in the Mt. Isa district.

(iii). Magnetic Method.

Variations in the vertical component of the earth's magnetic field were measured along four traverses using a Watts' vertical component magnetic balance. It was considered that even if the ore could not be detected directly by this method some form of marker bed might be located.

(iv) Well Logging.

Several diamond drill holes were logged using an electrical borehole logger. Both self-potential and resistivity variations were recorded. The logs showed very strong differences in electrical resistivity between country rock and lode, the ore showing the highest conductivity. The many characteristic variations recorded within the lode, and also within the various rock formations, enabled zones of fracturing and shearing, silicification and dolomite veins, and disseminated and vein pyrite to be located.

5. DISCUSSION OF RESULTS.

A. General.

In the electromagnetic survey, the "base line" of a loop was placed initially along 2150E, i.e. on the foot-wall side of the mineralised zone, and traverses 1 to 11 were surveyed from 1900E to 950E. A wide zone of high conducitivity was indicated, but the foot-wall boundary was not defined and no details were shown within the zone. A single cable line was then placed further west at 1100E and traverses 1 to 11 were surveyed from 950E to 100E. With the cable in this position, line electrodes were used. A comparison between the two methods of excitation showed that little advantage would be gained by using a loop, and that the line method was more convenient.

The single cable was then placed along 1400E and the western portions of traverses 12 to 30 were surveyed. The cable was then laid along 900E, i.e. on the hanging-wall side of the mineralised zone and later along 800E for the survey of the northern portion of the grid.

It was considered advisable to conduct the electromagnetic survey from both sides of the mineralised zone, as the current concentration in the zone of good conductivity is on the side near the cable. When surveying from the foot-wall side of the zone, the foot-wall boundary of the good conductor is determined, and when surveying from the hanging-wall side, the hanging-wall boundary is determined. It is thus possible to determine the thickness of a wide, good conductor, by surveying from both sides of the conductor. In the Tombstone Hill area, the mineralised zone has a well-defined hanging-wall, but the foot-wall is not so marked, there being a gradual decrease in mineralisation away from the main lode.

The lack of details within the conducting zone with the cable line in the east may be due to the shielding effect and strong absorption of the field near the cable by the intervening wide zone of good conductivity.

After correction for topographic effects and distance from the primary cable, the field readings were plotted as profiles, and as vector diagrams. Some of these are shown on Plate 4. In the vector diagrams the in-phase and out-of-phase readings at a station are plotted as ordinate and abscissa respectively; the plotted points are then joined to give the vector diagram.

In the vector diagrams, anomalies appear as protuberances on a smooth curve joining the ends of the vectors associated with the stations along the traverse, taken in order. In the diagrams shown on Plate 4, an axial line has been drawn through the portions of each curve identified as anomalies. This line may be taken as roughly parallel to the vector representing the difference between the actual vector associated with the centre of the anomaly and the vector which would have been associated with the same point if no anomaly were present. The inclination of the axial line is therefore the only property of physical significance attached to it, and the line has been called the "vector slope" of the anomaly.

The vector slope of an anomaly is a function of the conductivity of the body causing the anomaly and also of several other factors which would be difficult to evaluate. In the present survey, interpretation has been based mainly on measurements of the horizontal component and it has been assumed that a vector slope approaching 90° (i.e. an anomaly predominantly in the real component) indicates the presence of a very good conductor.

Despite the strong mineralisation, the self-potential survey gave very few anomalies over the mineralised zone. Some self-potential indications were obtained over the western portion of the area, but these are due to a thick bed of graphitic schists. A respresentative selection of self-potential profiles is shown on Plate 5, Fig. 1.

The magnetic measurements gave little information concerning the mineralisation. Only the vertical magnetic component was measured and a selection of the profiles is shown on Plate 5, Fig. 2.

B. Analysis.

(i) Electromagnetic Survey.

The source of the electromagnetic indications is clearly shown on Plates 2 and 3, on each of which two diamond drill hole sections are compared with the corresponding electromagnetic profiles. Sections through D.D.H.6 and D.D.H.10 are shown on Plate 2, together with the electromagnetic profiles along traverse 8, and sections through D.D.H.11 and D.D.H.20 are shown on Plate 3, together with the electromagnetic profiles along traverse 6.

The western zone of high conductivity between 400E and 500E corresponds with a band of carbonaceous shales which can be followed for a considerable distance on the surface and which is shown in the logs of D.D.Hs.10, 11, and 20. The eastern zone of high conductivity corresponds with the broad zone of mineralisation shown east of 1000E on Plate 1. Within this zone the electromagnetic profiles show higher current concentration in several places. The results in this zone can best be studied by reference to the vector diagrams on Plate 4.

The easterly conductive zone follows the zone of mineralisation and represents lines of current concentration most probably within the heavily pyritized hanging-wall side of the lode. With the cable on the hanging-wall side of the lode formation, the hanging-wall boundary of the ore zone was located between 1000E and 1100E. With the cable on the foot-wall side, no definite indication of the foot-wall boundary was obtained; even the most easterly observation points (1900E) still show high electrical conductivity. It appears therefore that either the foot-wall is east of 1900E or there is only a gradual change of the sulphide content between the country rock and the mineralised shale.

The electromagnetic indications indicate a change in the direction of strike of the conductors between traverses 9 and 10 (Plate 1). The same trend is noticeable with the strong indication obtained from the carbonaceous beds between traverses 8 and 9. The swing in the direction of strike may be significant, as Sullivan (1952) considers that such a swing in the contact of the Templeton granite and sedimentary rocks further west has a bearing upon ore deposition. The change in the direction of strike could also be caused by a cross fault. The vector slopes of the diagrams shown on Plate 4 indicate that there is probably a considerable variation in conductivity along both conductive zones shown by the survey. Portions of these conductive zones which are considered to have a particularly high conductivity (on the assumption mentioned earlier) are shown on Plate 1.

As the conductivity of galena is approximately the same as that of pyrite, no special indication of the presence of galena can be expected. Also, the presence of zinc ore cannot be determined, as sphalerite, which has a low electrical conductivity, will lower the conductivity of the ore. It is therefore impossible to differentiate between the indications due to lead ore and those due to pyrite.

The geochemical results (Debnam, 1953) are shown as contours on Plate 1. They show agreement with the mineralisation exposed in the costeans. Although the geochemical contours follow the same direction of swing as the conductive zones, the latter are displaced to the west. It appears that the outcropping lead zone is separate from the main hanging-wall mineralisation and that the electromagnetic indications are due mainly to pyrite (see Plates 2 and 3). Zero or very low readings were obtained near the hanging-wall on most of the geochemical traverses which extended as far as the hanging-wall.

(ii) Self-Potential Survey.

Tests using the self-potential method were begun on the southern portion of the area but no indications were obtained from the known lead-zinc mineralisation (exposed in costean No. 2). Several other traverses throughout the grid were surveyed, readings being confined mainly to those portions of the traverses over which electromagnetic indications due to mineralisation were obtained. However, no self-potential indications were obtained which could be regarded as being due to mineralisation.

The absence of self-potential indications is probably due to the special ground conditions rather than to the nature of the mineralisation. It is possible that the dolomite neutralises the ground water, which is usually acid in the weathered apex of the orebody.

Strong indications were obtained over the carbonaceous and graphitic beds to the west. A selection of self-potential profiles is shown on Plate 6, Fig. 1.

(iii) Magnetic Survey.

Magnetic readings were taken along traverses 2, 8, 20, and part of 11. A selection of the profiles is shown on Plate 5, Fig. 2.

The profiles are mostly undisturbed, except occasionally by pipes or tanks, but towards the western end of each traverse there is a marked rise in magnetic values. This increase may be due to the intrusion of the Templeton Granite (or its derivative) at depth. Sullivan (1952) considers that the Templeton Granite is significant for the occurrence of ore at Mt. Isa, especially as both the Mt. Isa and Northern Lease deposits are associated with marked changes in the direction of the granite/sediment contact.

(iv) Well Logging.

Electric logging tests were performed in order to test the usefulness of this method in the prevailing geological conditions. Tests were made on drill holes 6, 10, and 12 (shown on Plate 1), 14 (to the south of the map area of Plate 1), and 21A and 22 (collared to the east of the map area of Plate 1, and passing through the mineralised zone close to the centre of the layout). Holes 6, 10, 12 and 14 could not be logged due to obstructions, and logging was restricted to the uncased portions of holes 21A and 22.

The only instrument available for the logging was a Widco shot-hole logger. This instrument is not very suitable for investigating diamond drill holes, and had to be specially modified for the work. A major disadvantage is the curvilinear form of the records, which makes direct comparison of the resistivity and self-potential logs difficult. The logs were therefore redrawn on rectilinear co-ordinates. They show some interesting features, which are often quite characteristic, and often show more detail than the geological logs. Such characteristic details were recorded again in repeat runs, and could be used for correlation between boreholes.

The resistivity, self-potential and geological logs of drill hole 21A, from 1000 feet to 1700 feet approximately, are shown on Plate 6. The resistivity section of the log is not complete, in that the lower limit of resistivity shown is determined by the resistivity setting of the recorder, and does not correspond to a measured resistivity value. This value was recorded generally over sections containing sulphide mineralisation, and it is possible that the resistivity values in such sections are considerably lower than the lowest value shown.

The portion of the log above 1000 feet (not shown on Plate 6) shows resistivity values very much greater than the maximum value shown. The general resistivity level drops sharply at 1022 feet, for some reason which is not clear from the geological log. The logs shown on Plate 6 exemplify the following points, which were common to all logs observed.

(1) Massive dolomite, even in thin veins, appears as a definite resistivity high, with generally a corresponding self-potential low.

(2) Sections containing sulphide mineralisation show definite self-potential highs and resistivity lows.

(3) The self-potential log shows clearly the mineralised zone beginning at about 1300 feet and persisting to the lowest depth shown.

The results of the electrical logging were so encouraging that wider use of the technique in ore prospecting is warranted to simplify correlation between drill holes and also to supplement the information from drill cores. If core recovery is poor, an electrical log can be used to determine the exact position and thickness of the ore.

(v) Possibility of gravity measurements.

Formation boundaries and variations in thickness of formation can, if favourable density contrasts exist, be determined by gravity measurements.

A detailed gravity survey, carried out around Mt. Isa by the Oscar Weiss Organisation on behalf of Zinc Corporation Ltd., the results of which were made available to the Bureau by the courtesy of Mt. Isa Mines Ltd., suggests that some, at least, of the major shear zones in the Mt. Isa district are associated with gravity lows. This indicates that the gravity method may be a useful prospecting tool in the Mt. Isa field.

6. CONCLUSIONS AND RECOMMENDATIONS FOR TESTING.

The electromagnetic survey located two zones of high conductivity, the western of which is due to a carbonaceous formation. The other is probably due to sulphide mineralisation, but no differentiation between pyrite and lead-zinc mineralisation can be made from the geophysical results.

No significant anomalies were obtained from the self-potential and magnetic surveys; the only distinct self-potential indications obtained were over the carbonaceous beds.

The electromagnetic indications from the eastern good conductor persist for about 2,000 feet north of the area already tested by diamond drilling, i.e. to the northern limit of the area surveyed. The indications are strong in places and although they could be due entirely to pyrite mineralisation there is a possibility that lead mineralisation is present. If evidence of mineralisation, irrespective of its character, provides sufficient grounds for testing, then the geophysical results should be tested by two drill holes on traverses 12 and 24 respectively. The sites for these are shown on Plate 1 as D.D.Hs. "A" and "B". The holes should be drilled in the azimuth of the geophysical traverses and depressed at an angle of 50 degrees. It is recommended that D.D.H. "A" on traverse 12 be approximately 500 ft. in length and that it be the first drilled. The length of D.D.H. "B" should be approximately 400 feet.

Further testing or geophysical work should be deferred until the results from these two test holes are to hand.

7. ACKNOWLEDGEMENTS.

It is desired to express appreciation to the staff of Mt. Isa Mines for their continual and willing assistance during the survey; in particular to Mr. R. Spratt, the Acting Chief Geologist, for his personal attention to the needs of the party.

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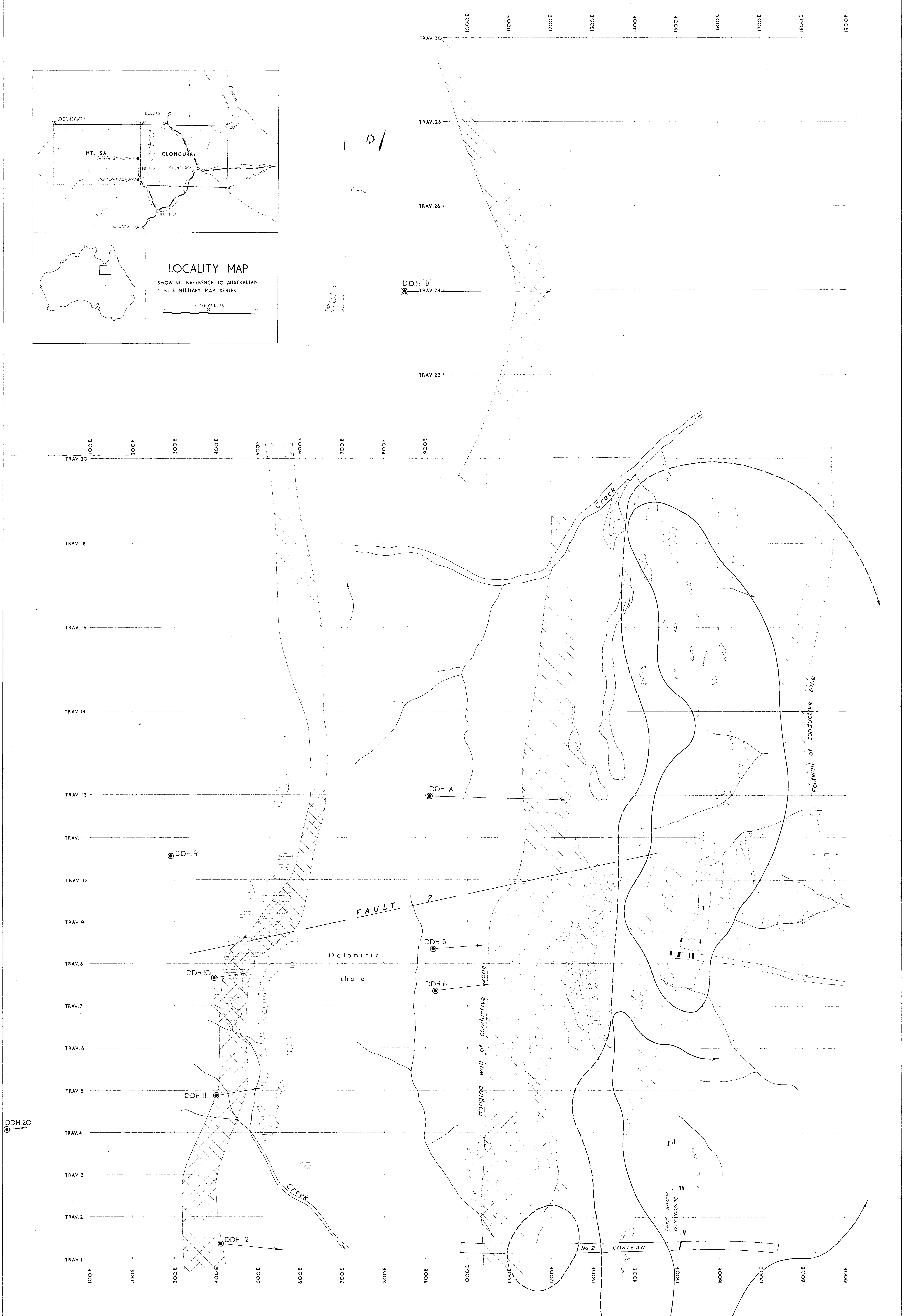


GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT (TOMBSTONE HILL AREA)
MT ISA, QUEENSLAND.

GEOLOGY, GEOPHYSICAL GRID AND ELECTROMAGNETIC INDICATIONS.

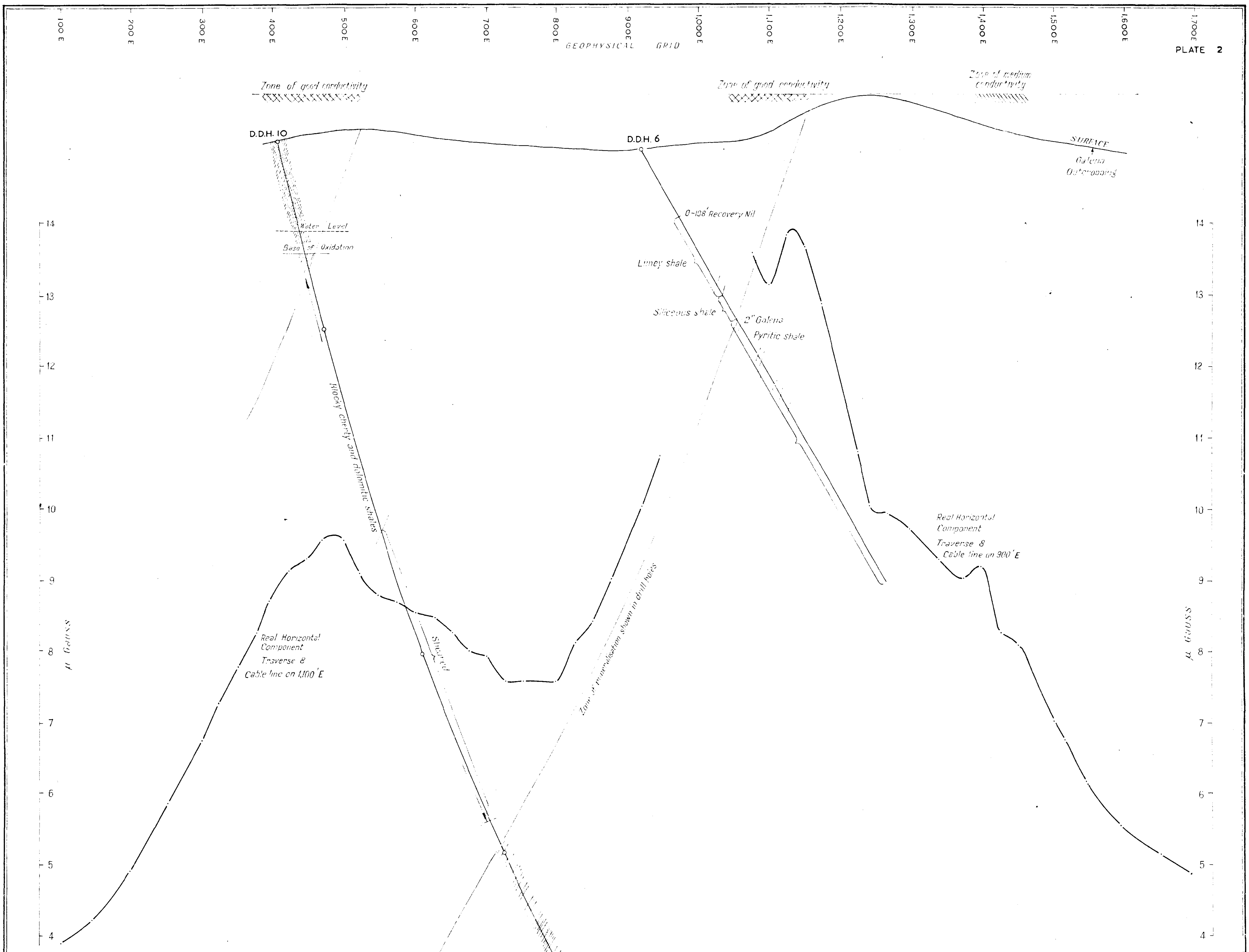
(GEOLOGY AFTER MT ISA MINES LTD.)

LEGEND

- Ferruginous Jasper
- Unmineralised shale. These belong to the groups of beds which contain the ore bodies but at this point are unmineralised.
- Carbonaceous shale
- > 5% Pb in outcrops
- Zone of good electromagnetic indication
- " " medium " "
- Recommended diamond drill hole
- Boundary of strong geochemical anomaly
- " " weak " "
- Existing diamond drill hole

SCALE IN FEET

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G127-2

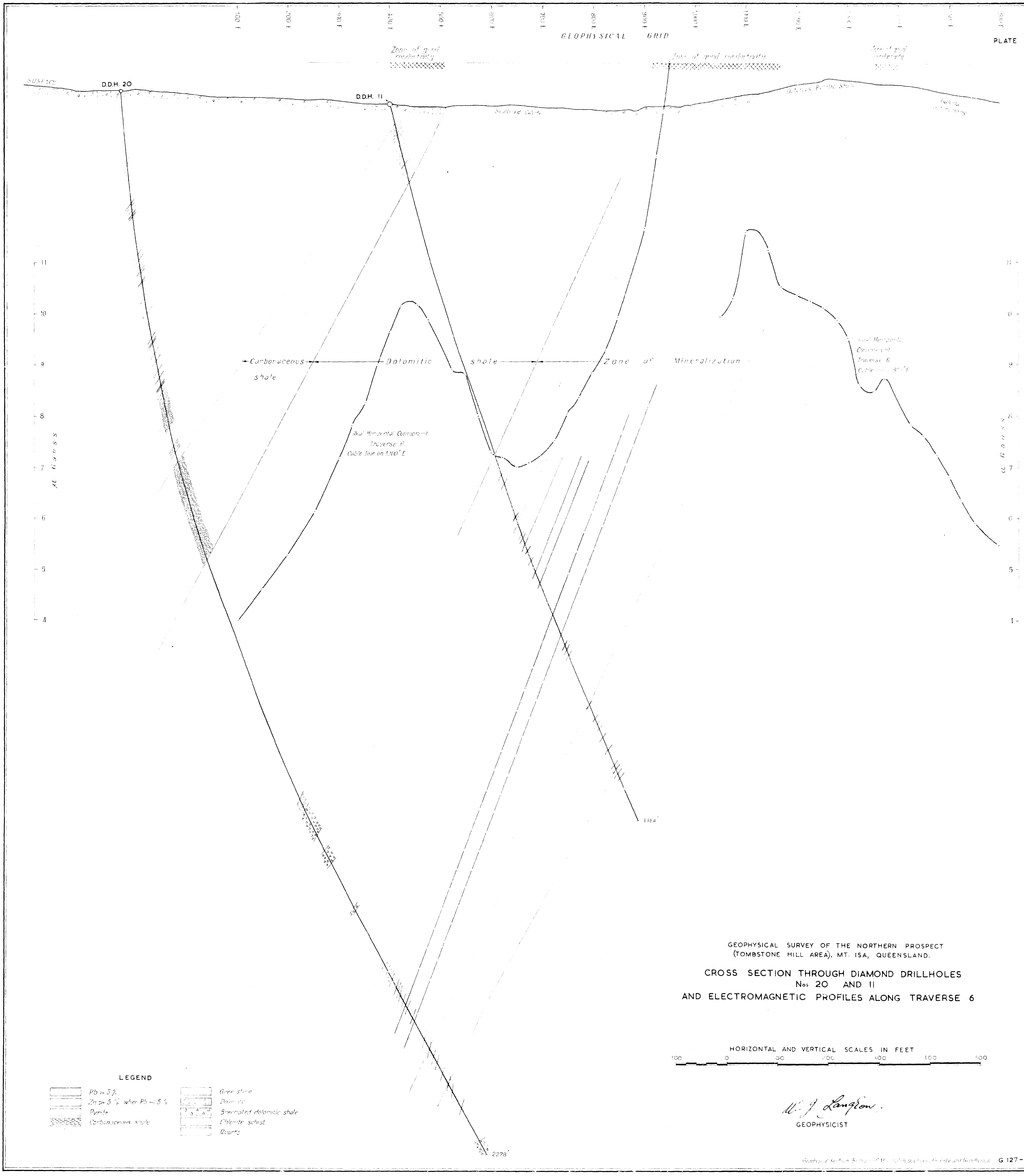


GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT
(TOMBSTONE HILL AREA), MT. ISA, QUEENSLAND.

CROSS-SECTION THROUGH DIAMOND DRILLHOLES
Nos. 10 AND 6
AND ELECTROMAGNETIC PROFILES ALONG TRAVERSE 8

W. J. Langron.
GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G 127- 3

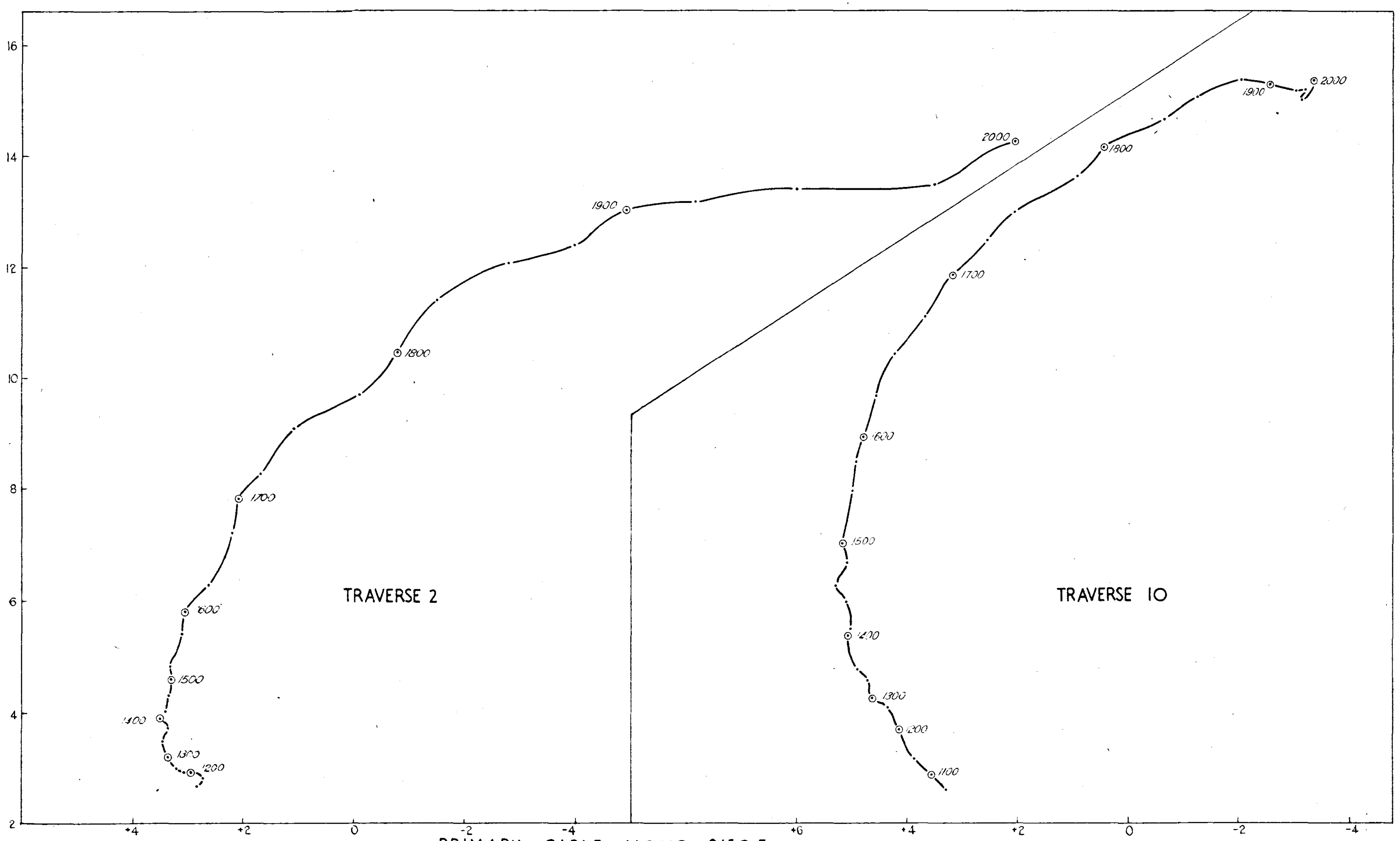


GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT
(TOMBSTONE HILL AREA), MT. ISA, QUEENSLAND.

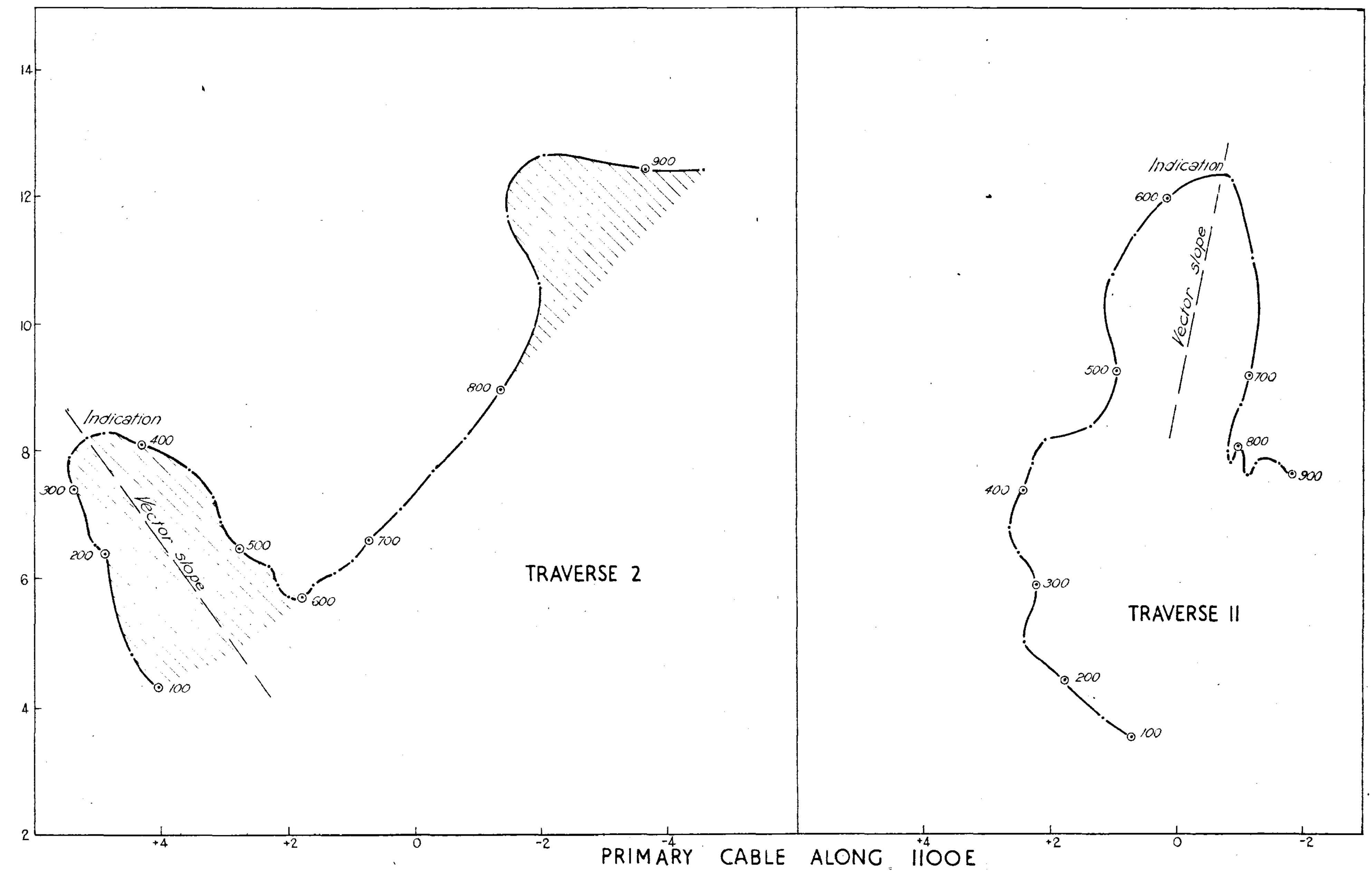
CROSS SECTION THROUGH DIAMOND DRILLHOLES Nos 20 AND 11 AND ELECTROMAGNETIC PROFILES ALONG TRAVERSE 6

W. J. Langron.
GEOPHYSICIST

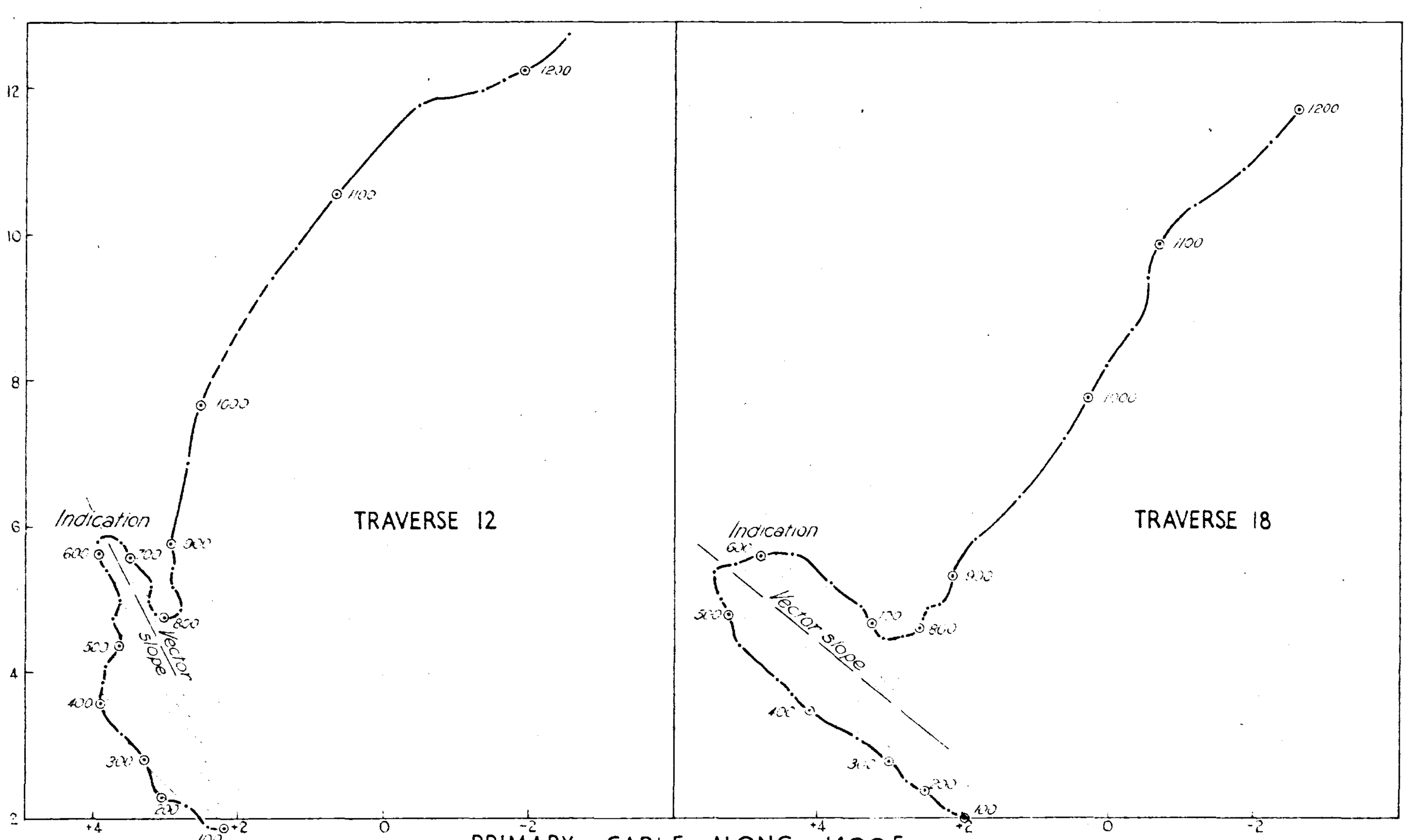
G 127-4



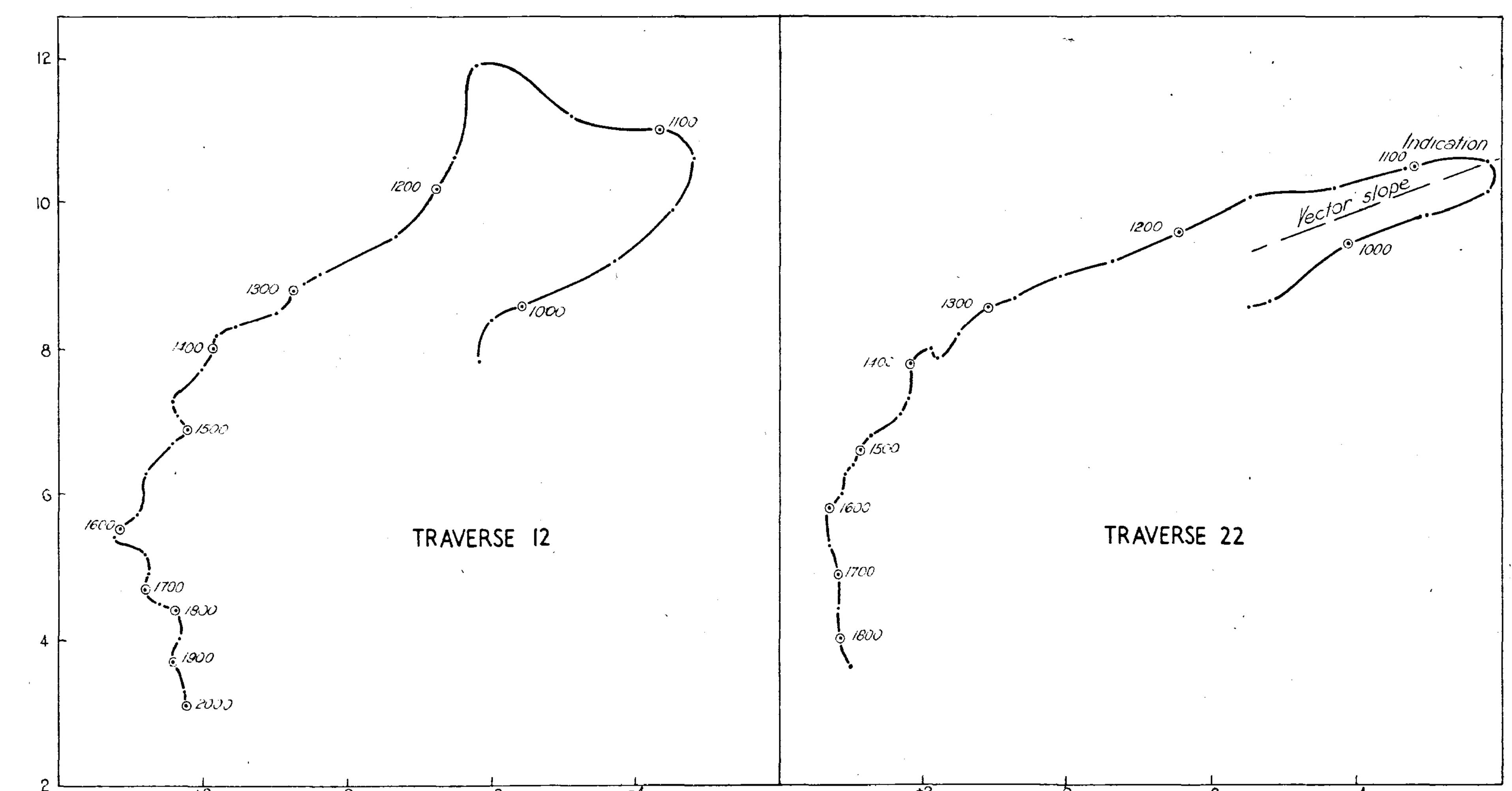
PRIMARY CABLE ALONG 2150 E



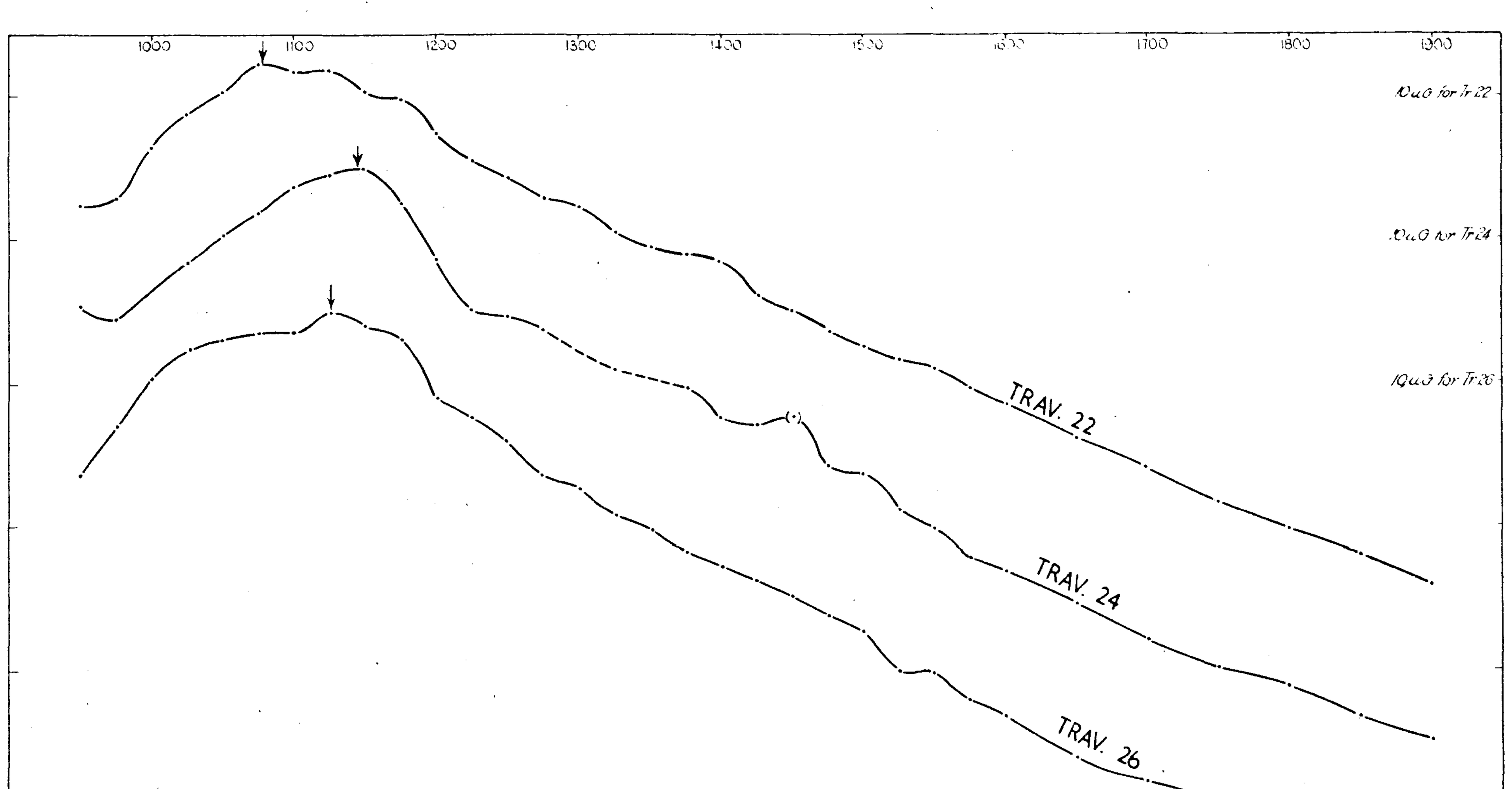
PRIMARY CABLE ALONG 1100 E



PRIMARY CABLE ALONG 1400 E



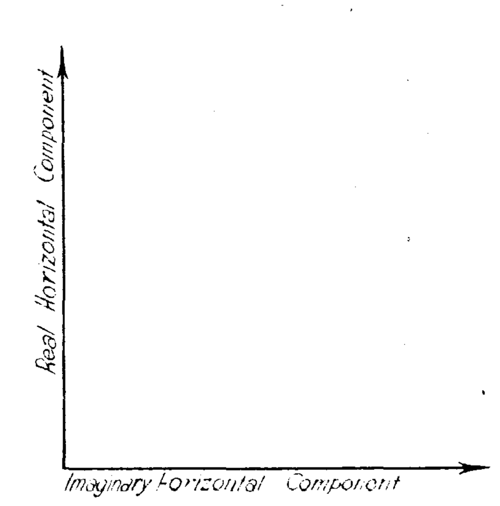
PRIMARY CABLE ALONG 800 E



PROFILES OF REAL HORIZONTAL COMPONENT

Scale: Horizontal : 1" = 100 ft.
Vertical : 1" = 2 u.gauss per ampere of primary current

PRIMARY CABLE ALONG 800 E



Scale: Horizontal and Vertical
1" = 2 u.gauss per ampere of primary current.

GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT (TOMBSTONE HILL AREA)
MT. ISA, QUEENSLAND.

SELECTION OF ELECTROMAGNETIC VECTOR DIAGRAMS AND PROFILES

W. J. Langron
GEOPHYSICIST

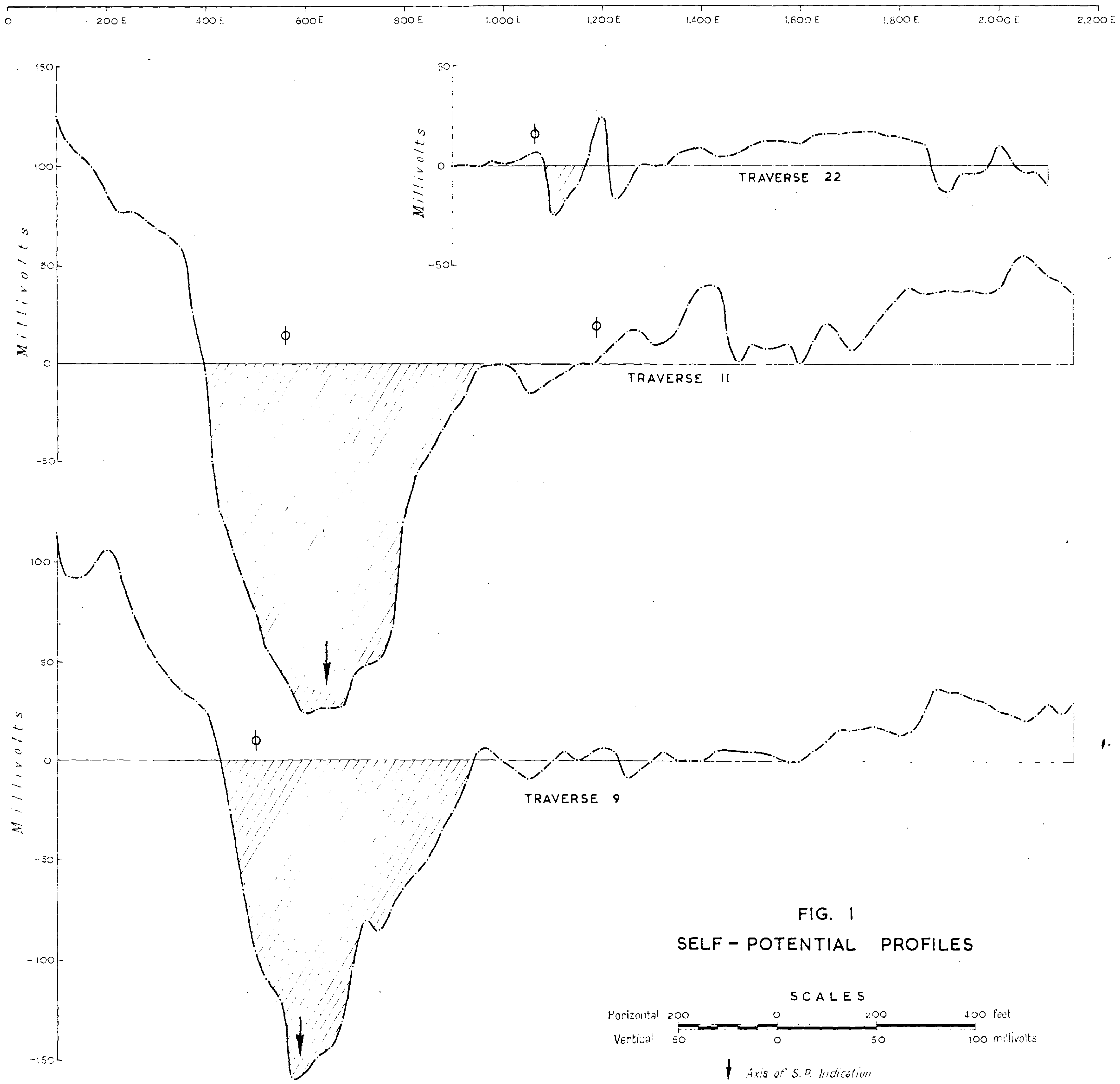


FIG. 1
SELF - POTENTIAL PROFILES

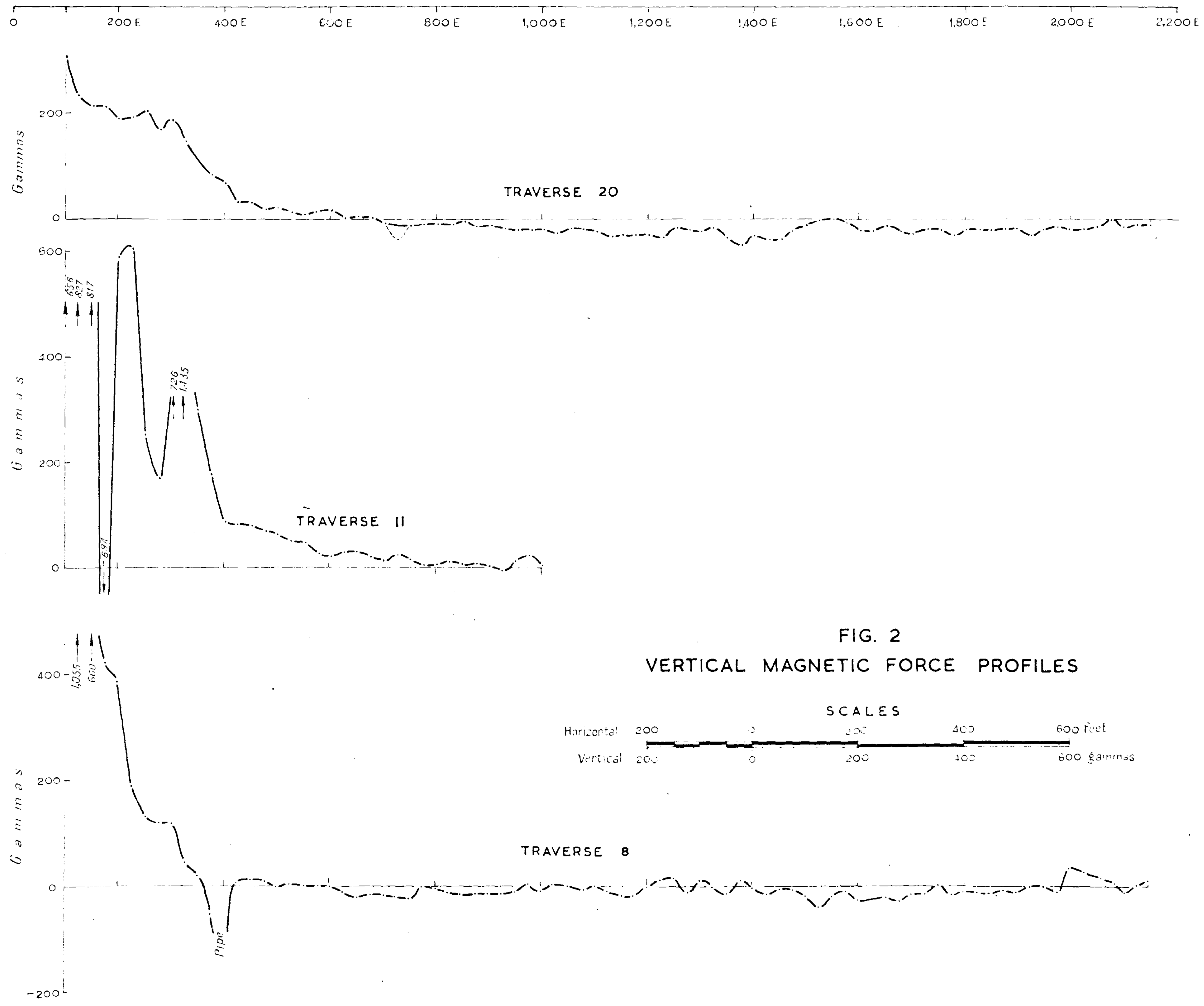


FIG. 2
VERTICAL MAGNETIC FORCE PROFILES

GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT
(TOMBSTONE HILL AREA) MT. ISA, QUEENSLAND.

SELECTION OF SELF - POTENTIAL AND MAGNETIC PROFILES

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GEOPHYSICIST

PLATE 6

LEGEND

- MASSIVE PYRITE
- MINERALIZED SHALE SULPHIDE LEAD-ZINC ORE
- DOLOMITIC AND PYRITIC SHALE
- DOLOMITIC SHALE
- MASSIVE DOLOMITE
- DOLOMITE VEINS
- SILICEOUS DOLOMITIC SHALE

DEPTH SCALE IN FEET

20 0 20 40 60 80

W. J. Langron
GEOPHYSICIST

GEOPHYSICAL SURVEY OF THE NORTHERN PROSPECT, (TOMBSTONE HILL AREA)

MT. ISA, QUEENSLAND

RESISTIVITY, SELF-POTENTIAL AND GEOLOGICAL LOGS, OF D.D.H. 21A

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