COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1953 / 13

GEOPHYSICAL INVESTIGATION AT THE COMMONWEALTH MINE , WELLINGTON , N.S.W.

by

O. KEUNECKE

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RECORDS 1953 No. 13

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C O N T E N T S

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I L L U S T R A T I O N S

Plate

1. Locality Map.

2. Plan showing surface features, geophysical traverses and indications.

3. Self-potential profiles.

4. Self-potential contours.

5. Electromagnetic profiles over known orebody :-

   Fig. 1. Traverse 100N.
   Fig. 2. Traverse 00.
   Fig. 3. Traverse 100S.

6. Electromagnetic profiles over whole area :-

   Fig. 1. Real horizontal component.
   Fig. 2. Real vertical component.
   Fig. 3. Imaginary horizontal component.
   Fig. 4. Imaginary vertical component.

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GEOPHYSICAL INVESTIGATIONS AT THE COMMONWEALTH MINE, WELLINGTON, NEW SOUTH WALES.

I. INTRODUCTION

Wellington is a small town on the Macquarie River about 200 miles north-west of Sydney (see Plate 1). There are several old mine workings - shafts, pits, costeans, etc., - about 7 or 8 miles south-east of the town. They are on a hillside near the Macquarie River and they extend over a length of about 6,000 feet.

Massive sulphide ore has been found and developed in one of these workings, namely, the main shaft of the Commonwealth Mine. A fairly big dump, which shows signs of good ore and some smelted material, is evidence that there was once a good bit of mining activity in the area.

In 1951, the Consolidated Zinc Corporation became interested in the abandoned mine and arranged for the lease owner, Mr. George Wilkins, to de-water it. The Company's geologist inspected the mine and reported (1952 (a) and (b)) that at two levels (53 and 85 feet) massive sulphide ore had been exposed for a length of 160 to 180 feet in the direction of strike. This encouraging result caused the Company to start mining exploration work.

As pointed out in the report of the Company's geologist, nothing is known from the numerous old workings regarding the extent of the sulphide orebody. Therefore, three shallow diamond drill holes were put down by the Consolidated Zinc Corporation to determine the extent and width of the orebody. At the same time, the Bureau of Mineral Resources was asked to carry out a geophysical survey in the area. When the geophysical work started in July, 1952, the Company had nearly finished the first bore hole (see Plate 2).

The purpose of the geophysical investigation was to determine if there is any extension to the known orebody and to provide the Company with drilling targets.

The geophysical field work was carried out from the end of July to the beginning of September, 1952, and it covered the whole of the old mining area, some 6,000 feet in length. The members of the field party were Dr. O. Keunecke and Mr. W. H. Oldham.

The Consolidated Zinc Corporation carried out the necessary surveying work, such as pegging and levelling the traverses, and the Company's drilling party assisted where necessary. The general results of the survey were discussed with representatives of the Company as soon as the field work was completed.

2. GEOLOGY

The area consists of Silurian slates in which porphyry is intruded. Near the main shaft slates and porphyry are interbedded.

The line of mineralization occurs in a zone of sheared porphyry along a hillside of massive porphyry rocks. The width of the sheared porphyry ranges from 50 feet near the main shaft to 100 feet north of the shaft where the strike of the line of mineralization swings towards the west. Mineralization occurs

sporadically over a length of at least 6,000 feet. The southern limit of its occurrence so far as is known seems to be the Macquarie River.

The known orebody, with its massive sulphide mineralization, occurs about 2,700 feet north of the Macquarie River where the general strike (bearing 328° magnetic) swings about 8-10° towards the west. It may be for this reason that the orebody was formed just at this place. The general dip of the slates and of the mineralization is easterly and ranges between 60° and 70°.

Assays of the ore have shown that it contains sulphides of Fe, Pb, Zn, Cu, Sb and As. In general, the percentage of Zn is higher than that of Pb. The percentage of sulphur is high enough for it to be mined economically in addition to the base metals.

Mineragraphic investigation of the ore (C.S.I.R.O., 1952) has shown that the most abundant mineral in the ore is pyrite and the next most abundant is sphalerite. In addition, the ore contains arsenopyrite, chalcopyrite, tetrahedrite, galena and bournonite. Besides these, gold and covellite are observed.

The gangue mineral consists of barite with sporadic distribution of sulphides. Between twenty and twenty-five thousand tons of high grade sulphide ore have been blocked out around the main shaft. Before the mine was de-watered for examination, the water level was about 20 feet below the surface.

3. OUTLINE OF PROCEDURE

An area 2,400 feet long (1,600 feet south and 800 feet north of the main shaft) and 1,000 feet wide was first selected for investigation. Traverses, each 1,000 feet in length and spaced at intervals of 100 feet, were laid out at right angles to the main reference baseline. This baseline crosses the main shaft and has a bearing of 328° magnetic (see Plate 2). Observation points were established at intervals of 25 feet over the mineralized zone and at intervals of 50 feet towards each end of the traverses.

Geophysical measurements were made first along traverse zero (00). This traverse crosses the baseline at the main shaft. The results along this traverse are important as they indicate whether or not the geophysical methods chosen are suitable and show what kind of anomaly or indication can be expected. Such a test survey over known geological conditions makes the interpretation of the results obtained in adjacent areas more certain.

When the first selected area around the main shaft had been investigated, the survey was extended a further 1,000 feet towards the south as far as the Macquarie River. The spacing between traverses in this part of the area is 200 feet.

The Consolidated Zinc Corporation had, in the meantime, made a geological examination of the area of old mining activities to the north of the main shaft. It was decided to include this northern part of the area in the present survey too.

Because the general strike of the zone of mineralization swings towards the west, the baseline in the northern area was laid down with a bearing of 320° magnetic. The traverses

are at right angles to this strike. They are laid out between 1200 North and 3000 North of the main shaft at 200-feet intervals.

4. GEOPHYSICAL METHODS

The survey was carried out with both self-potential and electromagnetic measurements, and some tests were made with the magnetic method.

(a) Self-potential method.

Self-potential measurements reveal anomalies where sulphide mineralization extends above the ground-water level. Because of the acidity of the water, chemical reactions arise as a result of which an electric current is set up and this produces potential differences. These can be measured at the surface and they may show a negative centre of up to several hundred millivolts over an oxidized sulphide orebody. Since the chemical processes associated with oxidation arise mainly above ground-water level, the self-potential method indicates only the oxidized portion of a deposit and not the possible continuation in depth of the primary orebody. The interpretation of self-potential anomalies has, moreover, to be made with caution because pyritized fault and shear zones, graphitic slates, etc. can sometimes cause anomalies of comparable order.

(b) Electromagnetic method.

Electromagnetic inductive measurements make use of the good electrical conductivity which is a property of many sulphide minerals. Experience suggests that the electromagnetic method is the most suitable one for geophysical investigation of an ore deposit of the type found at Wellington. Several variations of this method have been developed and applied in the past 30 years.

The method used in this survey employs a large rectangular loop (at least 3,600 feet by 1,800 feet) laid out on the ground with an alternating current flowing through it. The horizontal and vertical components of the resulting alternating electromagnetic field are measured by means of a compensator which is a form of alternating current bridge. The measurements are made along traverses at right angles to one long side of the loop. Using the compensator, in conjunction with a search coil, it is possible to resolve the magnetic field in any direction into two components, one in phase with the primary field (called the real component) and one 90° out of phase with the primary field (called the imaginary component). Thus it is usual to measure four components at each observation point, namely, real and imaginary horizontal components and real and imaginary vertical components.

In any good conductor lying below the surface, such as a massive sulphide body, a secondary current is induced by the primary current in the loop. This secondary current produces a secondary magnetic field which is superimposed on the primary magnetic field thus producing departures from the normal values. These departures are observed as anomalies which indicate the presence of the good conductor below the surface. They are determined in the following manner.

The primary field which would exist under conditions of uniform electrical ground conductivity, with no disturbing good conductors present, can be calculated. This is deducted from the observed total field, thus leaving only the anomalous secondary field components resulting from the secondary currents induced in the good conductors (e.g., sulphide bodies) in the

ground.

Pyritized fault zones, shear zones and other zones of high conductivity can also produce anomalies if their conductivity is higher than that of the surrounding country rock. These possibilities must, therefore, be taken into account when the geophysical results are being interpreted so as to avoid, as far as possible, making a wrong geological interpretation of the electromagnetic indications.

(c) Magnetic method.

Magnetic measurements were carried out on a few traverses even though it was not expected that the method would be applicable to the area. There were no useful indications and the use of the method was discontinued.

Plate 2 shows the traverses marked by symbols according to whether they were surveyed by the self-potential or the electromagnetic method or by both. It will be seen that self-potential measurements were carried out on traverses 200.S to 1800.N, and electromagnetic measurements on traverses 2700.S to 400.N and 2000.N to 3000.N.

5. RESULTS AND THEIR INTERPRETATION.

(a) Over the known orebody.

Both the self-potential and the electromagnetic measurements show a well pronounced indication near the main shaft. This indication is caused by the known orebody.

Plate 3 shows the self-potential profiles and Plate 4 the self-potential contours. It can be seen that a minimum of -182 millivolts appears on traverse 00 over the known orebody and that the intensity of this anomaly decreases to -140 millivolts at 100 feet south and to -110 millivolts at 100 feet north of the shaft. The anomaly decreases further to -53 millivolts at 150 feet south and to -100 millivolts at 150 feet north of the mine, and has practically disappeared at a distance of 200 feet north and south of the main shaft.

The position of the anomaly relative to the position of the known orebody (see Plate 3) proves that the self-potential results indicate the top part of the orebody, the oxidized zone. Also, the shape of the anomaly indicates a steep easterly dip.

Plate 5 shows the corresponding electromagnetic results. Both the real (in phase) and imaginary (90° out of phase) components of the horizontal and vertical electromagnetic field are shown after deduction of the calculated primary field. These measurements, also, each show a well pronounced indication on traverse 00 which decreases rapidly in strength at 100 feet to the north and south of the main shaft. The maximum value of the electromagnetic indication on traverse 00 is offset slightly to the north-east of the maximum value of the self-potential anomaly. This is to be expected. The electromagnetic measurements indicate mainly the primary ore because the primary sulphide is a better electrical conductor than the oxidized ore. As this ore lies at a greater depth, and the orebody has an easterly dip, the electromagnetic indication

must appear farther to the east than the self-potential indication. The fact that the electromagnetic indication on traverse 100.N and 100.S almost coincides with the self-potential anomaly can possibly be interpreted to mean that the mineralization lies nearer the surface on these traverses.

Besides showing the indications caused by the orebody, the results of the electromagnetic measurements also show the very strong influence of the wire fences which cross the area. Fortunately, the disturbances caused by the fences do not interfere with the indications caused by the mineralization in the sheared porphyry.

These geophysical results show that the orebody which has been developed in the main shaft must thin out about 200 feet north and 150 feet south of the main shaft. The results further indicate that the orebody is lenticular and is rather limited in horizontal extent. Also, it can be seen that the geophysical methods used are capable of detecting the occurrence, anywhere in the adjacent area, of any mineralization of similar extent and quality to that already developed in the mine.

(b) <u>In adjacent areas</u>.

Plate 6 shows some of the curves of the electromagnetic results in the areas north and south of the mine. Only a few typical curves have been chosen for presentation since these are fairly representative of the whole. Unfortunately, no further well pronounced indications were obtained within the area tested either by the self-potential or by the electromagnetic method. This can be noticed if the curves of the traverses of Plate 6 are compared with those of traverse 00 shown in Plate 5 (Fig. 2).

The small and weak indications which appear in the curves are presumably caused mainly by the sheared porphyry zone which includes the line of mineralization. All the other irregularities in the curves are due to the changing geological strata which consist of slates, sheared porphyry and massive porphyry. It is probable that the moisture content of these beds increases towards the Macquarie River and that they will therefore have an increasing electrical conductivity. This characteristic is noticeable in the trend of the electromagnetic curves.

The positions at which self-potential anomalies and electromagnetic indications were obtained are shown in Plate 2. The magnitudes of the indications are represented by different symbols (see legend). As can be seen, self-potential anomalies are observed only near the main shaft between traverses 200.S and 200.N. The strength of the anomalies is never really great. Therefore, only the extreme value of -182 millivolts on traverse 00 has been marked as fairly strong. The anomalies on the other traverses are marked as medium or weak as the case may be.

The electromagnetic results show no really strong indications either. The well pronounced indication on traverse 00 has been marked only as fairly strong. The other indications obtained were all weaker than this and have been marked accordingly. In the southern portion of the area, weak indications have been observed on traverses 1400.S (at 950.E) and 1600.S (at 1075.E). A medium indication was observed on 1900.S at 1100.E. This last indication could be caused by an orebody of the same type as the one in the Commonwealth Mine but at a greater depth. Its length cannot be estimated because traverses 100 feet north and south of 1900.S were not surveyed. However, its length

cannot be great because only weak indications were obtained on traverses 200 feet north and south of 1900.S. All three indications listed above occur near the line of mineralization observed at the surface.

In the area to the north of the Commonwealth Mine, weak electromagnetic indications were observed on traverses 300.N and 400.N. These indications lie on the line of mineralization and they confirm the swing of this line, through some 8° towards the west, that is indicated by the surface geology. In the most northerly part of the area a single weak indication was observed on traverse 2200.N at 450.E near the scene of some old mining activities. All these indications are considered to be of no importance and most probably caused by sporadic mineralization of no economic value.

(c) Comparison with drill hole results.

The results of the geophysical investigation near the main shaft agree with the results of the three drill holes that have been sunk by the Consolidated Zinc Corporation Ltd.

Drill hole No.1, on traverse 00, struck ore (pyrite, marcasite, chalcopyrite, galena, etc.) extending from 182 to 195 feet vertical depth. The result of this bore indicates that the thickness of the orebody, which is about 26 feet at the 85-feet level, decreases to some 12-15 feet at a depth of 190 feet.

Drill hole No.2 near traverse 100.N struck only flecks of sphalerite, galena, etc. at a level of about 240 feet, but no payable orebody.

Drill hole No. 3 near traverse 100.S showed scattered coarse pyrite stringers at a level of 212-220 feet having no economic value.

These bore results have proved the lenticular shape of the orebody and this agreed with the geophysical results. These results showed anomalies of diminishing strength on traverses 100.N and 100.S and also indicated that the mineralization does not extend as deeply there as it does on traverse 00.

The agreement between the geophysical results and the results of the drilling makes it possible to deduce with some certainty that the weak geophysical indications obtained in the areas to north and south of the Commonwealth Mine are caused by sporadic mineralization of no economic value.

Therefore, no recommendation can be made for further exploration work.

6. SUMMARY

There are some old mining workings extending over a length of 6,000 feet in an area about 7 or 8 miles south-east of Wellington, New South Wales. The abandoned main shaft of this area (the Commonwealth Mine) shows two levels at 53 and 85 feet in which some 20,000 tons of massive sulphide ore are developed. The ore contains mainly pyrite, sphalerite and galena and occurs in a sheared porphyry zone.

A geophysical survey has been carried out with self-potential and electromagnetic measurements in an attempt to locate further mineralization. Both methods show a well pronounced indication over the known orebody, but the results 100 feet north and south of the orebody reveal that the strength of the indications decreases rapidly. An analysis of the results prove that the known orebody must be lenticular and that it is limited in horizontal extent.

This geophysical result agrees with the results of three drill holes sunk recently by the Consolidated Zinc Corporation Ltd. Only the hole near the main shaft struck ore while the other two, each 100 feet from the mine, showed only traces of mineralization.

In the whole area extending 3,000 feet north and 2,700 feet south of the Commonwealth Mine, the only other indications obtained were a few weak ones. These almost certainly represent only unimportant mineralization of no economic value, with the possible exception of the indication on traverse 1900.S.

7. REFERENCES

C.S.I.R.O., 1952 - Mineragraphic Investigations, Report No.497, 16/4/52.

Zinc Corporation Ltd.,
1952(a) - Memorandum No.246, dated 28/4/52.
1952(b) - Memorandum No.250, dated 8/5/52.

(O. Keunecke)
Geophysicist.

Melbourne.
January, 1953.

Distribution :

1. Library - File 38N/2.
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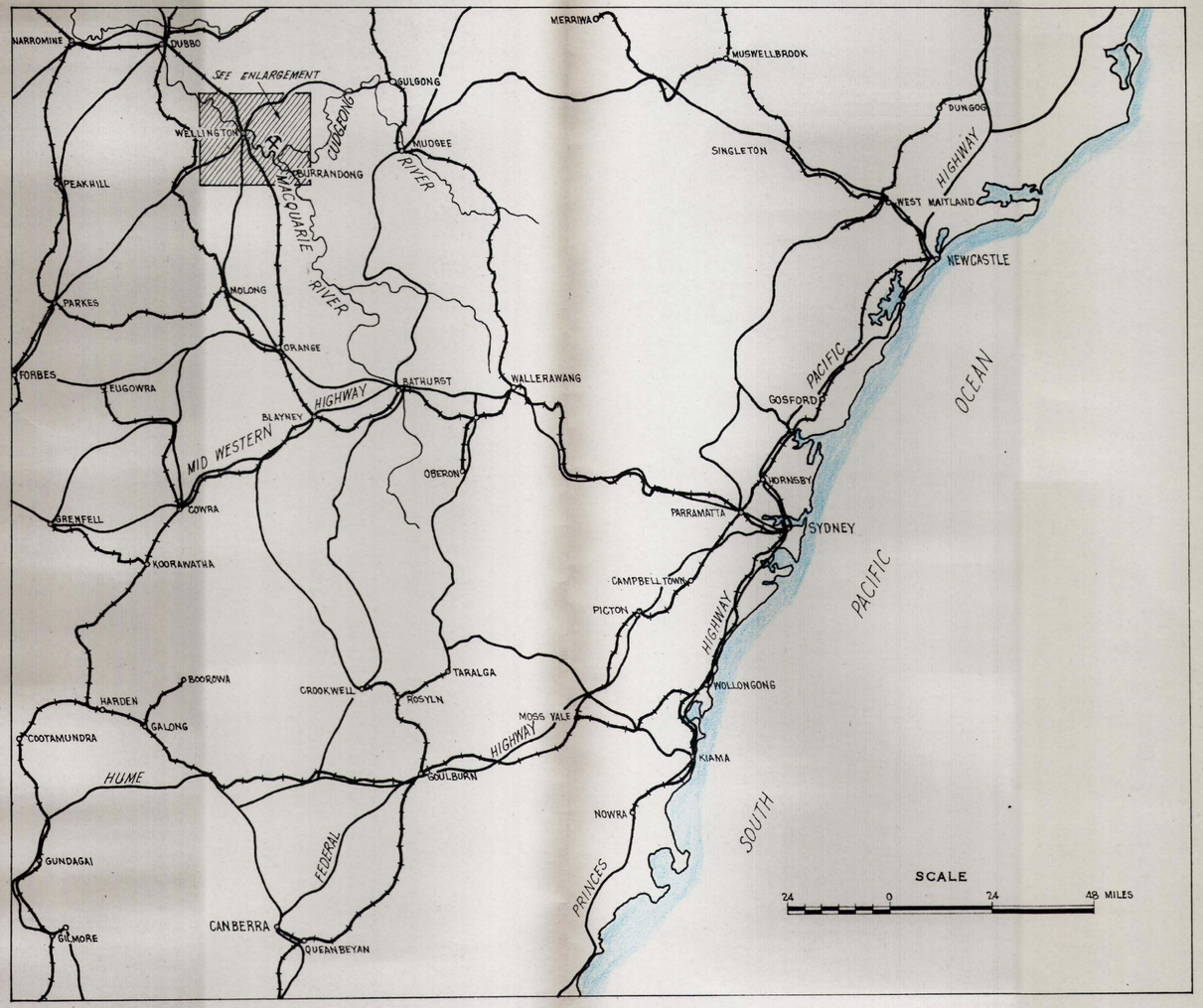
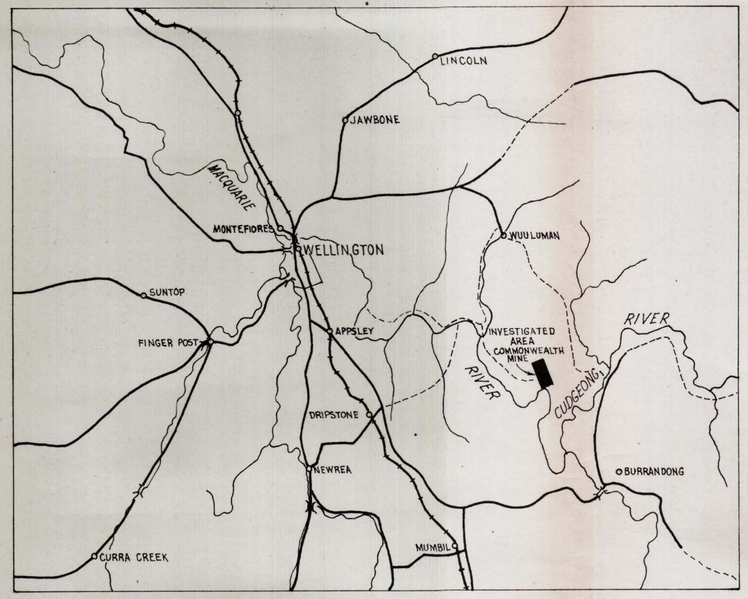
PLATE 1



ENLARGEMENT



SCALE

4 0 4 8 12 MILES

LEGEND

ROAD

TRACK

RAILWAY

LOCALITY MAP

GEOPHYSICAL INVESTIGATION AT COMMONWEALTH MINE, WELLINGTON, N.S.W.

GEOPHYSICIST Kennedy

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics

G124-1

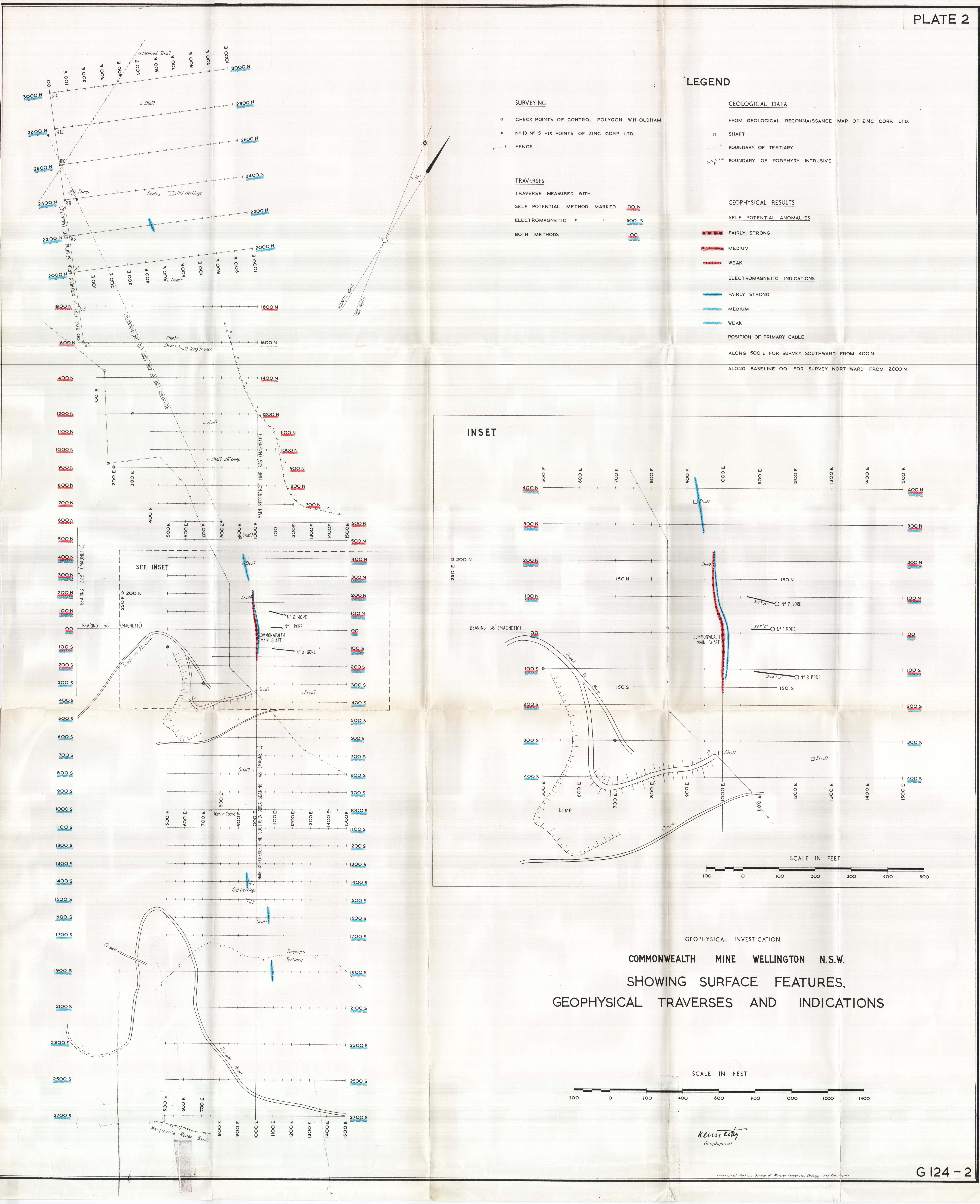
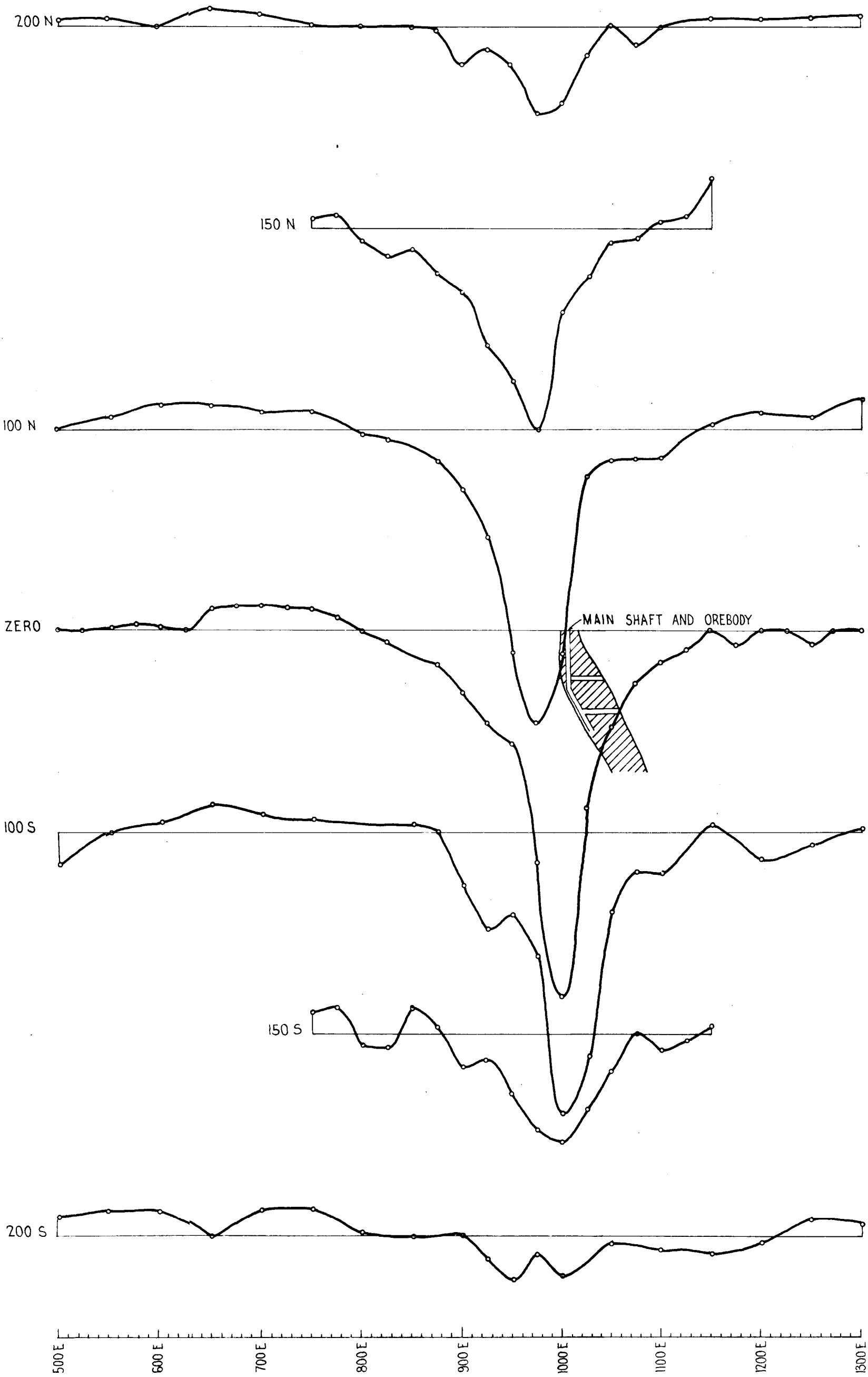


PLATE 2
LEGEND
SURVEYING
CHECK POINTS OF CONTROL POLYGON W.H. OLDHAM
No 13 No 15 FIX POINTS OF ZINC CORP. LTD.
FENCE
TRAVERSES
TRAVERSE MEASURED WITH
SELF POTENTIAL METHOD MARKED 100 N
ELECTROMAGNETIC " " 500 S
BOTH METHODS 00
GEOLOGICAL DATA
FROM GEOLOGICAL RECONNAISSANCE MAP OF ZINC CORP. LTD.
SHAFT
BOUNDARY OF TERTIARY
BOUNDARY OF PORPHYRY INTRUSIVE
GEOPHYSICAL RESULTS
SELF POTENTIAL ANOMALIES
FAIRLY STRONG
MEDIUM
WEAK
ELECTROMAGNETIC INDICATIONS
FAIRLY STRONG
MEDIUM
WEAK
POSITION OF PRIMARY CABLE
ALONG 500 E FOR SURVEY SOUTHWARD FROM 400 N
ALONG BASELINE 00 FOR SURVEY NORTHWARD FROM 2000 N
MAGNETIC NORTH
TRUE NORTH
BASE LINE OF NORTHERN AREA BEARING 320° (MAGNETIC)
MAIN REFERENCE LINE 328° (MAGNETIC)
MAIN REFERENCE LINE SOUTHERN AREA BEARING 148° (MAGNETIC)
BEARING 328° (MAGNETIC)
BEARING 58° (MAGNETIC)
SEE INSET
COMMONWEALTH MAIN SHAFT
No 1 BORE
No 2 BORE
No 3 BORE
Track to Mine
Inclined Shaft
Shaft
Dump
Old Workings
10' long trench
Shaft 26' deep
Water Basin
Porphyry
Tertiary
Creek
Private Road
Macquarie River Bank
INSET
DUMP
SCALE IN FEET
100 0 100 200 300 400 500
GEOPHYSICAL INVESTIGATION
COMMONWEALTH MINE WELLINGTON N.S.W.
SHOWING SURFACE FEATURES,
GEOPHYSICAL TRAVERSES AND INDICATIONS
SCALE IN FEET
200 0 200 400 600 800 1000 1200 1400
Geophysicist
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics
G 124 - 2

PLATE 3



SCALES

GEOPHYSICIST Kennedy

HORIZONTAL 100 0 100 200 300 FEET

VERTICAL 50 0 50 100 150 MILLIVOLTS

GEOPHYSICAL INVESTIGATION AT COMMONWEALTH MINE WELLINGTON, N.S.W.

SELF POTENTIAL PROFILES

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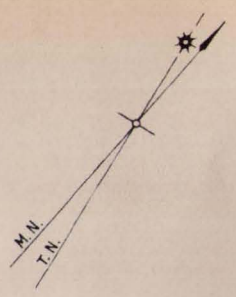
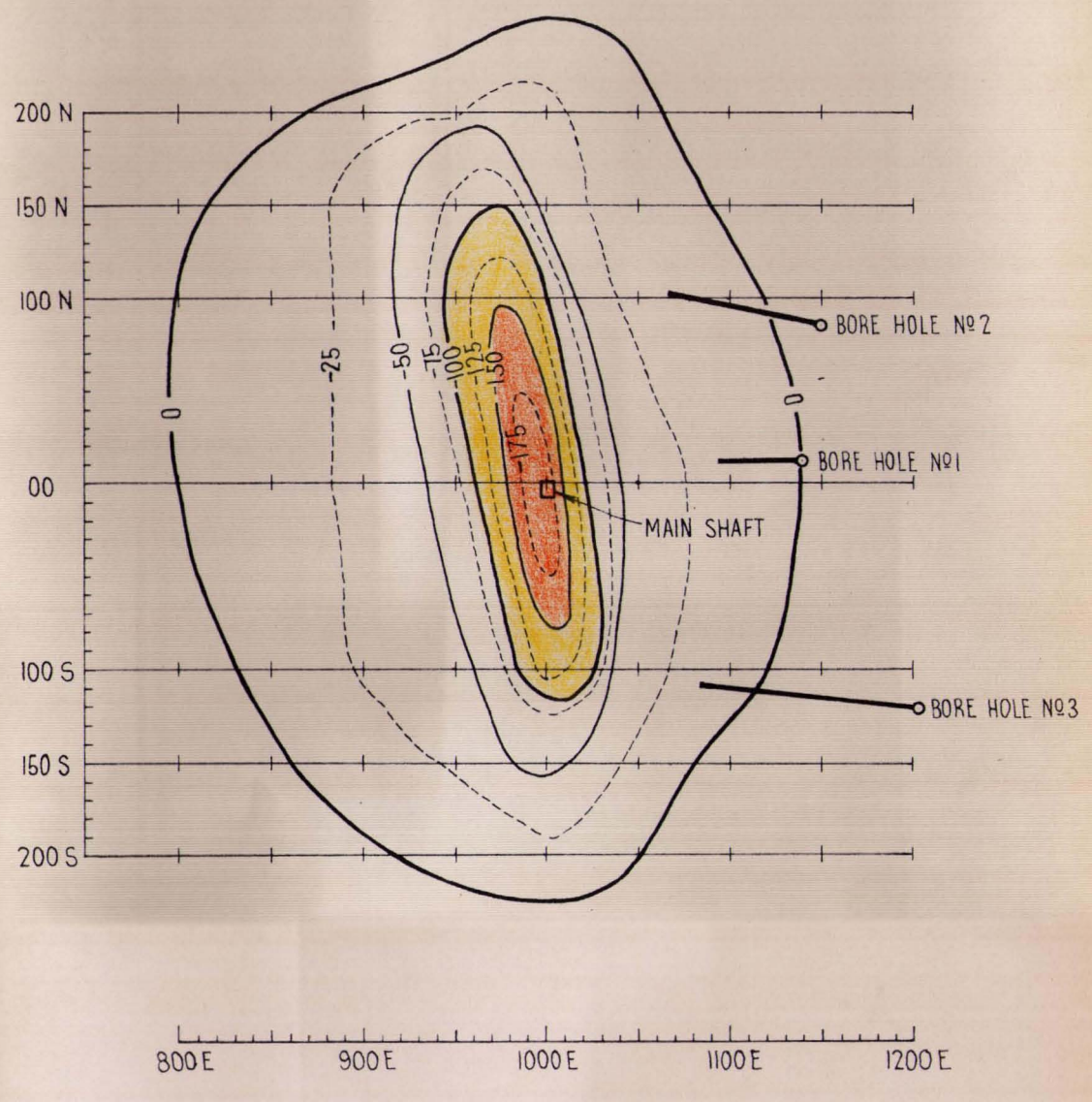
PLATE 4





SCALE

100 0 100 200 FEET

CONTOUR INTERVAL, 25 MILLIVOLTS

Kunetty
Geophysicist

GEOPHYSICAL INVESTIGATION AT COMMONWEALTH MINE WELLINGTON, N.S.W.

SELF POTENTIAL CONTOURS

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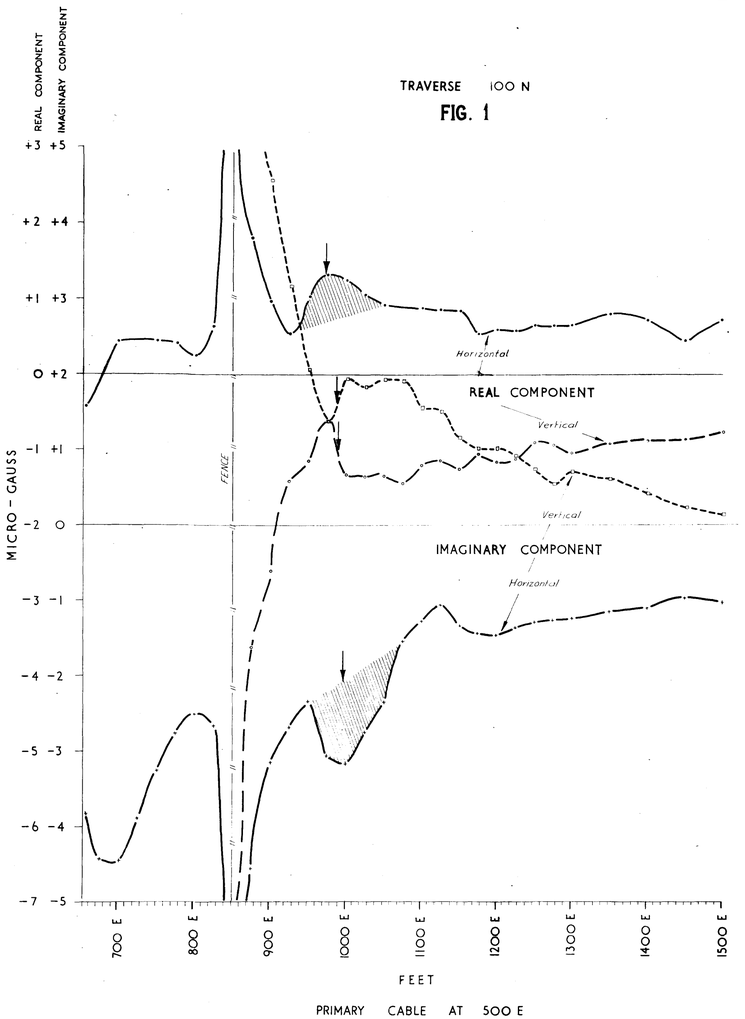
PLATE 5

TRAVERSE 100 N

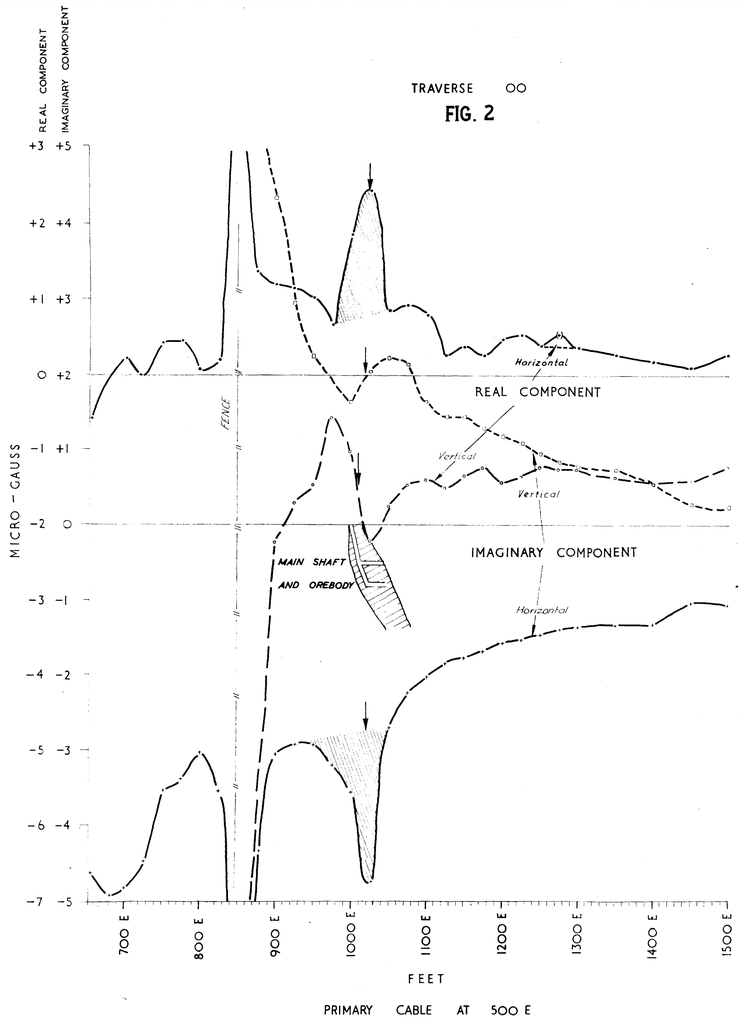
FIG. 1



PRIMARY CABLE AT 500 E

TRAVERSE 00

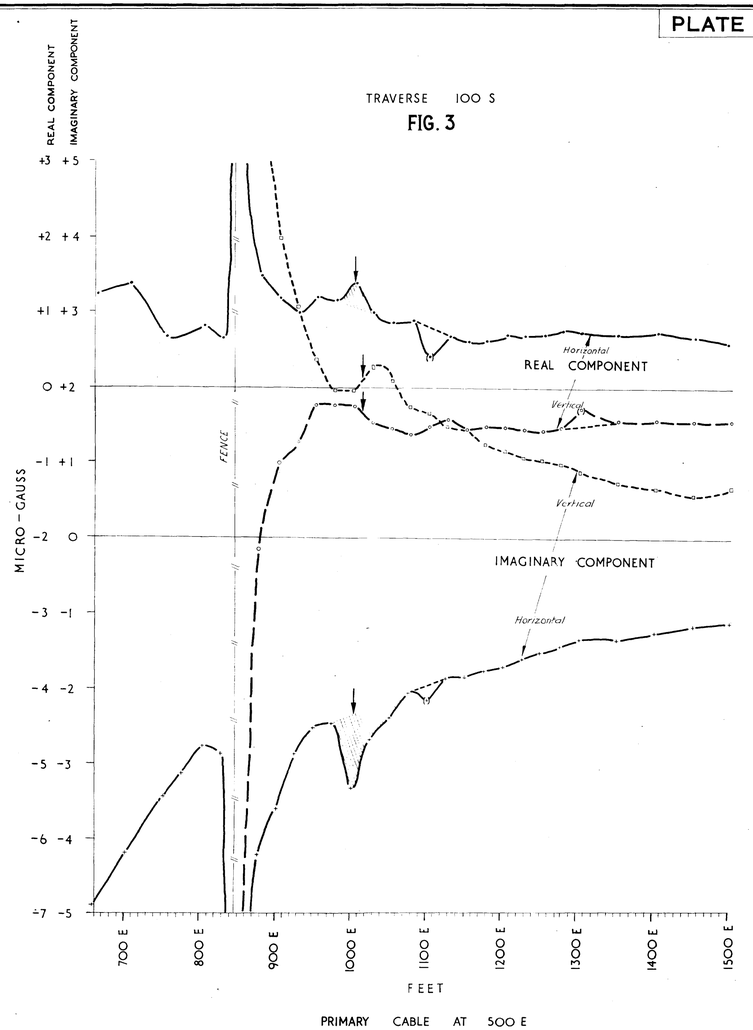
FIG. 2



PRIMARY CABLE AT 500 E

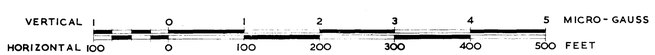
TRAVERSE 100 S

FIG. 3



PRIMARY CABLE AT 500 E

SCALES



GEOPHYSICAL INVESTIGATION AT COMMONWEALTH MINE WELLINGTON, N.S.W.

ELECTROMAGNETIC PROFILES

GEOPHYSICIST Kennedy

ELECTROMAGNETIC ANOMALY

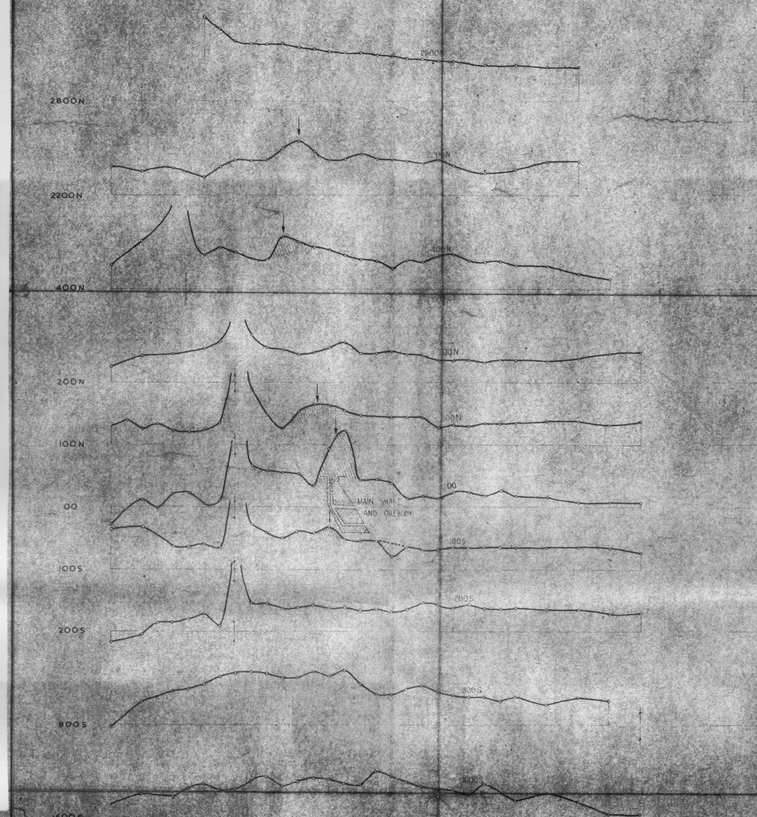
POSITION OF E.M. INDICATION

Geophysical Section: Bureau of Mineral Resources, Geology and Geophysics

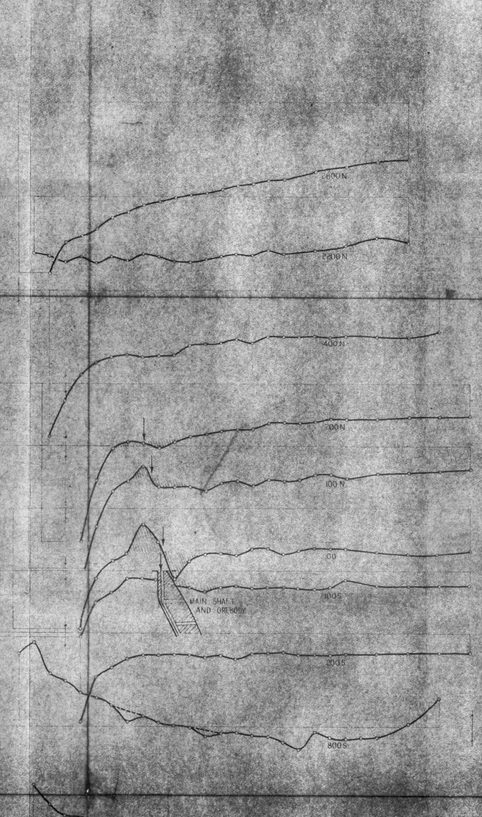
G 124-5

PLATE 6.

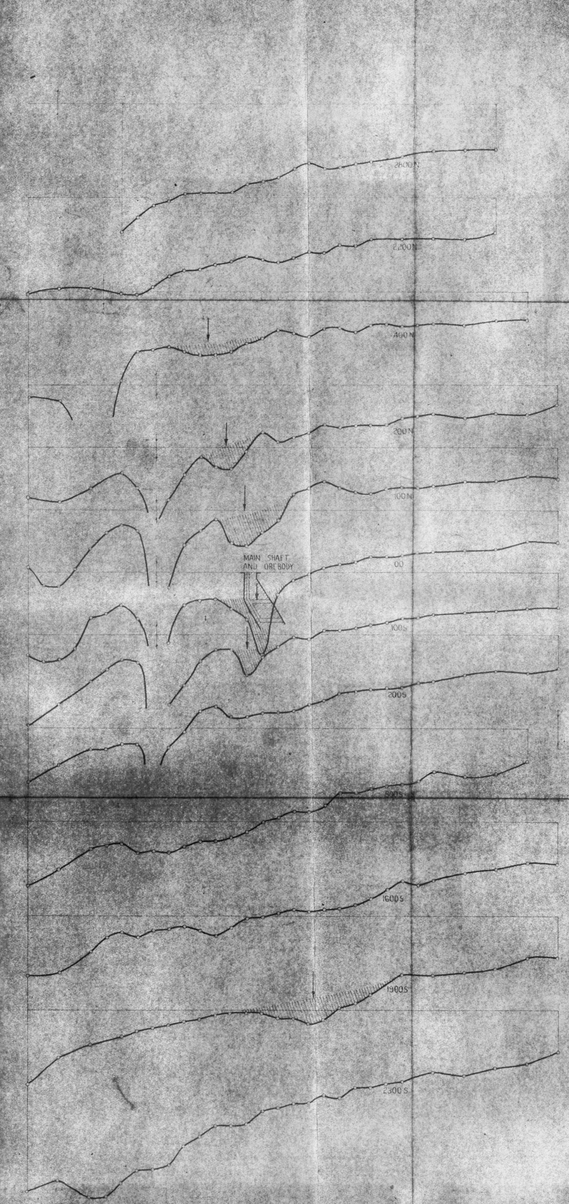
REAL HORIZONTAL COMPONENT
FIG. 1



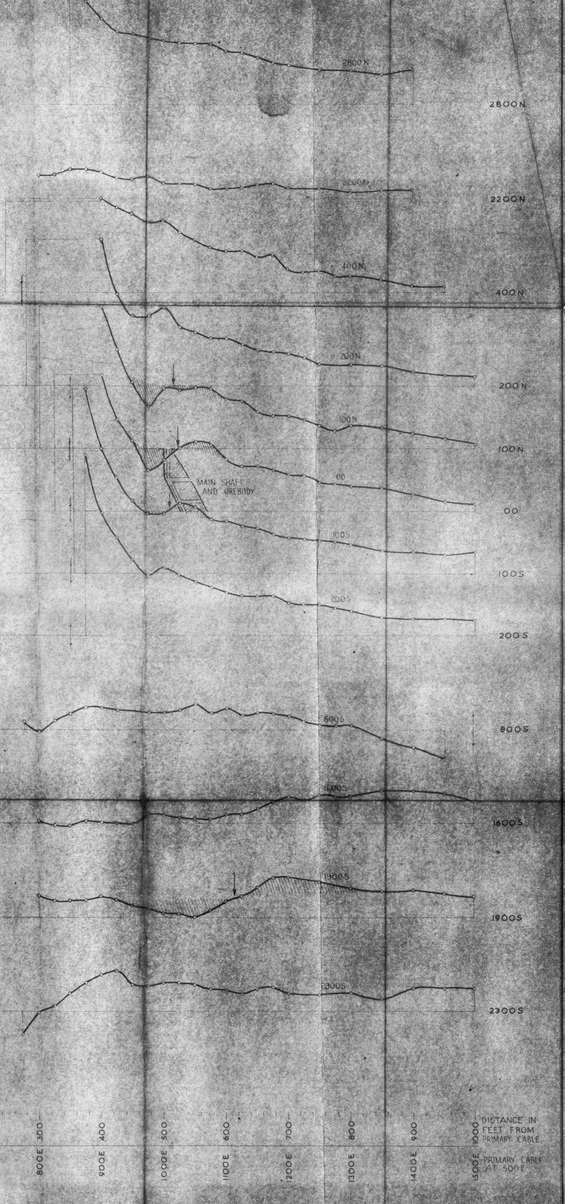
REAL VERTICAL COMPONENT
FIG. 2.



IMAGINARY HORIZONTAL COMPONENT
FIG. 3



IMAGINARY VERTICAL COMPONENT
FIG. 4.



LEGEND
- FENCE
- POSITION OF ELECTROMAGNETIC INDICATION
- ELECTROMAGNETIC ANOMALY

SCALES
HORIZONTAL 100 0 100 200 300 400 FEET
VERTICAL 2 0 2 4 6 8 MICRO-GAUSS

GEOPHYSICAL INVESTIGATION

COMMONWEALTH MINE WELLINGTON, N.S.W. Kennedy GEOPHYSICIST

ELECTROMAGNETIC INDUCTIVE PROFILES