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COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1954 No. 2

GEOPHYSICAL SURVEY AT LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND

by

J. HORVATH and K. H. TATE

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C O N T E N T S

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

A B S T R A C T

A geophysical survey, comprising self-potential and electromagnetic methods, was made during the 1952 and 1953 field seasons at the Labour Victory Copper Mine, about 7 miles north-north-west of the Mt. Elliott Copper Mine, near Selwyn, Northern Queensland. The self-potential survey covered an area of 2,400 feet x 900 feet, but owing to other operational commitments during the 1953 season, the electromagnetic survey was confined to the southern part of the area. The primary object of the work was to determine the extent of the mineralisation associated with the known lode, which strikes north-south through the centre of the surveyed area.

The self-potential survey revealed a well-defined anomaly nearly 1,000 feet long, in the northern part of the area. The axis of this anomaly is parallel to, but about 75 feet west of, the known lode. The disused main shaft of the now idle mine is at the southern end of the anomaly, which in this vicinity deviates slightly towards the south-east, i.e. towards the known lode. No workings exist in the area of the indication, and no outcrops were found, the rock formations being hidden for the most part by alluvium.

The electromagnetic results confirmed those of the self-potential survey, but the electromagnetic indication extends farther to the south. The results suggest that the indication may be caused by lenticular bodies and that these are disturbed by cross faults.

No mineralised deposits were indicated by the electrical results in the southern part of the area.

It is recommended that some trenching and geological and geochemical work be done in the area of the strong electrical indication. If the results of the testing show that the indication is not due to graphitic or pyritic schists, it is recommended that a number of diamond drill holes be put down. Suggested locations for five such drill holes are given. If the anomaly is due to ore the geophysical results suggest an ore body of considerable size.

1. INTRODUCTION

The Labour Victory Mine is situated about six miles north-north-west of Selwyn and two miles to the west of Kongula siding on the Cloncurry-Selwyn railway line (see Plate 1). The mine can be reached from the Cloncurry-Selwyn road, which runs alongside the railway, by a track which is negotiable by light vehicles in dry weather.

The mine has not been worked for many years, but the production of 1,467 tons of high-grade copper-gold ore, assaying about 26% copper, has been recorded.

A geophysical party was stationed near Selwyn in September-November, 1952 and again in October, 1953, with the primary object of making a survey of the area surrounding the Mt. Elliott Copper Mine, about one mile south of Selwyn. Honman (1938) suggested that the Labour Victory and Mt. Elliott mines are probably on the same shear zone, and Horvath (1952), after a short preliminary test, recommended that a geophysical survey of the Labour Victory Mine area be included with that of the Mt. Elliott area.

The 1952 party consisted of W.H. Oldham (party leader) and K.H. Tate, and the 1953 party of W.J. Langron (party leader) and D.L. Rowston, with two assistants. In both years W.F. Durch, surveyor, and one chainman from the Department of the Interior, Brisbane, did the necessary pegging and survey work. An important factor in the decision to survey the Labour Victory area was that the known reserves of the Mt. Elliott Mine are of very low grade and the discovery of any higher grade ore would be of great importance in the re-establishment of the copper industry in the district. Broken Hill South Pty. Ltd. has an option on some leases at Mt. Elliott and is at present diamond drilling there. As far as is known, the area of the Labour Victory Mine is not leased to anyone, although any ore found there could be considered as additional reserves for the company working the Mt. Elliott Mine.

There are no houses or mine plants left, and no water bores exist near the mine. Some small water courses cross the area, but these are usually dry. The general elevation is about 1,250 feet and the vegetation is sparse, consisting mainly of gidya, spinifex and some gum.

2. GEOLOGY

A zone of shearing and some lode formation are visible at the Labour Victory Mine along a line striking approximately north, which is marked by several pits and small shafts. The ore deposit is not now accessible underground. The lode lies in dark slates, which dip to the east at about 75°. Outcrops are very few, most of the area being covered by detritus. The lode has the same direction of strike as the sediments and also appears to have an easterly dip, but there is not sufficient evidence to show that the two are conformable. The band of slates ranges in width from 50 to 200 feet; mica schists lie to the west and east, and still further away are some quartzites. All the strata appear to have similar strike and dip. No evidence could be found near the mine of amphibolite, which is much in evidence on the hanging wall of the Mt. Elliott Copper Mine.

To the authors' knowledge, no maps of the mine workings have been published, but it is known that the mine was worked to shallow depth only. Honman (1938) expresses the opinion that the Labour Victory and Mt. Elliott Mines are situated on the same fault or shear zone, and that ore deposition was localised at the intersection of complementary cross fractures with the main fault. Searl (1952), however, states that surface indications of the shear diminish north of the Mt. Elliott Mine and only slight traces of its continuation could be observed at a distance of 1½ miles.

Further references to the geology of the area are to be found in the report by Honman (1938). Some geological observations were also made by J. Brooks of the Queensland Geological Survey, who accompanied J. Horvath on the 1951 test, but it is not known if these have been published.

3. SELECTION AND APPLICABILITY OF GEOPHYSICAL METHODS.

The geophysical surveys in the Cloncurry district are being undertaken with the main object of locating large primary ore bodies which may have been neglected or overlooked by the small prospector or syndicates who concentrated on the exploitation of only the rich, oxidised and easily accessible portions of the copper deposits. Primary copper ore with 4% or less of copper was of little interest to them. If the development of the Mt. Elliott Mine becomes of positive economic value, the discovery of additional ore bodies in the surrounding area would be of major importance, particularly as the copper ore at Mt. Elliott is of low grade. Because a relatively small amount of ore has been produced from the Labour Victory Mine, it is possible that some rich oxidised ore might still be present, in addition to primary ore.

As the preliminary test by Horvath (1952) had given favourable results using the self-potential method, this method was also used in the later surveys. The presence of sulphide minerals of high electrical conductivity also favoured the use of the electromagnetic method, although this technique was not used over the whole area.

The first task was to survey the area immediately surrounding the mine workings and then to extend the survey in both directions along the strike, as long as results were sufficiently encouraging. The area surveyed was also wide enough to include any possible deposits on parallel shears in the neighbourhood of the known ore body.

4. SELF- POTENTIAL SURVEY

(a) Method.

The self-potential (S.P.) method utilises the natural flow of current in the earth caused by a sulphide body undergoing oxidation. Ground water in contact with a sulphide body absorbs oxygen from the surface and acts on the sulphides as an oxidizing agent. This oxidation process creates a natural, large-scale galvanic cell, with the upper portion of the body as the positive pole and with the weak acid formed in the process as the electrolyte. The electric current usually flows downward within the body and then outward and upward through the surrounding earth. The return currents spread outwards for considerable distances, but a centre of negative earth potentials is usually produced directly above the sulphide body. These negative values may be as great as 500 millivolts, their magnitude depending primarily upon the size and shape of the sulphide body, the electrolytic properties of the ground water and the depth of both the body and the ground water below surface. As these and other minor factors have to be considered in the interpretation of results, it is very difficult to isolate the effect of each and to estimate the significance of a self-potential anomaly. Self-potential anomalies can also originate from graphitic bodies and their cause and economic significance can only be determined by drilling or other testing.

The method used by the Bureau to locate such S.P. anomalies is to determine the potential difference between a fixed rear station and observation points along a series of traverse lines. Contact with the ground at the observation points and at the rear station is made with non-polarising electrodes, to prevent serious errors that might be caused by dissolved salts present on the earth's surface. The potential differences are measured with a direct current potentiometer. As it is essential not to disturb the natural flow of the earth currents during measurement, a compensating type of instrument is used, whereby the potential difference between observation point and rear station is opposed by a known, adjustable potential from a standard cell. The null position, at which the natural potential is balanced by the cell potential, is observed on a sensitive galvanometer and the magnitude of the potential is read from the calibrated potentiometer.

(b) Work done and results obtained.

Measurements by the self-potential method were made during both field seasons in 1952 and 1953. The base-line for the grid was laid at a true bearing of 172°27', on the western side of the area to be surveyed. Traverses at 100-foot intervals were laid from 1200.S to 1200.N and observation points were pegged at 50-foot intervals along each traverse, although actual observations were usually made at 25-foot intervals. Plate 2 shows the geophysical grid in relation to the topography of the area. Unfortunately, at the time of the survey the northern part of the area, from 400.N to 1200.N, had not been levelled, and the topographical data on Plate 2 are consequently incomplete.

The first self-potential survey was made a few days after heavy rain had moistened the ground sufficiently to ensure good ground contact at all observation points. During this phase of the work traverses 1200.S to 400.N were surveyed. In August, 1953, after several months of dry weather, the opportunity was taken to repeat two traverses (300.N and 400.N) to determine whether surface conditions had any effect on the results. During this work observation points had to be watered before readings could be taken. The watering was done some time before taking the readings, in order to eliminate possible errors due to electromotive forces caused by filtration of water into the dry ground. As illustrated by the two profiles on traverse 400.N (Plate 3), the results from the repeated traverses showed such good general agreement with those of the first survey that the effect of surface conditions was assumed to be insignificant. The final part of the self-potential work, during which traverses 300.N to 1200.N were surveyed, was completed in October, 1953.

The self-potential profiles along each traverse are shown on Plate 3 and a plan of the self-potential contours is given on Plate 4.

(c) Discussion of results.

The contour plan on Plate 4 is drawn with contour intervals of 20mv. It shows clarity and simplicity rarely attained in self-potential work.

The northern part of the area shows one large anomaly with a negative centre of more than 160 millivolts at 325.E/700.N. This strong anomaly extends from about 100.N to 1000.N, with its direction of strike the same as that of the lode. The anomaly suggests a lenticular or vein-like body, with steep easterly dip. The shape of the anomaly is very regular, the only deviation from the normal north-south direction being towards the east at the southern end of the anomaly, near the main shaft.

Plate 4 clearly shows that the axis of the anomaly is parallel to, but about 75 feet west of, the known line of lode as shown by the ahafts between 500.S and 100.N. It is possible therefore, that the deviation between 100.N and 200.N towards the known line of lode is the result of a fault which displaced the southern part of the lode towards the east, relative to the northern part. The fault would appear to lie between 100.N and 200.N. No mine-workings or outcrops which might help to trace the cause of the indication were observed in the area covered by the anomaly. Nowhere in the district has an ore body of such dimensions been found, and the very size of the anomaly demands a cautious approach and suggests that it might be due to a geological feature of large dimensions such as a graphitic schist or a pyritic slate. On the other hand, one would expect an anomaly caused by such a geological feature to extend over the whole of the area surveyed, whereas in actual fact the indication is confined to a limited length, with a sharp decline in the anomaly at both the northern and southern ends.

Even if the absence of any signs of mineralisation in the talus is somewhat unfavourable, the presence of such a well-defined anomaly, in close proximity to a known ore deposit, warrants further investigation of that anomaly.

The observations in the southern portion of the area between traverses 100.S and 1200.S show very little variation and are almost devoid of self-potential anomalies, apart from a small negative indication on traverses 900.S and 1000.S, between 300.E and 400.E. This anomaly is approximately on the southern continuation of the known line of lode and may therefore be worthy of further investigation. No S.P. indications were obtained in the vicinity of the existing shafts in the southern part of the area, but these shafts show very little signs of mineralisation, and the lack of anomalous S.P. readings is not surprising. It is possible that the indication on traverses 900.S and 1000.S corresponds to a better mineralised portion of the lode not tested by the shafts. Although not in itself worthy of further investigation, because of its small extent and comparative weakness (about 40 millivolts), the indication should be borne in mind if the tests recommended on the main anomaly are encouraging.

5. ELECTROMAGNETIC SURVEY

(a) Method.

Electromagnetic measurements make use of the fact that most sulphide minerals possess high electrical conductivity. Although many variations of the method have been developed during the past 30 years, the basic principles underlying these are the same. By passing an alternating current through a long cable, an electromagnetic field is set up around the cable. This field causes a secondary current to flow in any good conductors lying below the earth's surface, this secondary current in turn setting up a secondary magnetic field. By measuring, at selected points, the total electromagnetic field and subtracting from it the calculated value of the primary field, the residual value obtained is the secondary field due to the effect of the good conductor.

The method used in this survey is to pass the primary current through a large rectangular loop of wire laid out on the ground. At observation points on traverses at right angles to the longer side of the loop, a search coil is set up vertically (with the plane of the coil perpendicular to the traverse) to measure the horizontal component of the total magnetic field, and then horizontally to measure the vertical component. The E.M.F. produced in the search coil in each of the two positions is then measured on an A.C. potentiometer which determines the value of the component in-phase with the primary current (real component) and the component 90°out-of-phase with the primary current (imaginary component). This is done by comparing each component in turn with the current induced in a coil set up directly at the primary loop. In all, therefore, four components are measured at each observation point, namely the real and imaginary horizontal components and the real and imaginary vertical components.

(b) Work done and results obtained.

Traverses 1200.S to 400.N were surveyed by the electromagnetic method at the same time as the corresponding part of the self-potential survey was made. Unfortunately, the encouraging results obtained in the northern part of the area by the second S.P. survey could not be confirmed by the electromagnetic method because of lack of time, owing to other operational commitments during 1953.

Profiles of the real horizontal component of the electromagnetic force are shown on Plate 5 and of the real vertical component on Plate 6. A contour map of the real horizontal component is drawn on Plate 7 and finally vector diagrams of the horizontal components are illustrated on Plate 8.

Because of the high electrolyte content of the moisture contained in the ground, the components of the electromagnetic field are considerably affected by the rather high general conductivity. As it can be assumed that these ground conductivity conditions change only slightly and very gradually throughout the area, their effect was determined on some otherwise undisturbed profiles such as 600.S and adjacent ones and subtracted from the observed values. The profiles shown on Plates 5 and 6 were derived in this manner.

The real components were selected for the contour map (Plate 7) because they show the effect of any electrical conductors better than the imaginary components. This is due to the fact that the conductivity is very high and the indication is shown mainly on the real component because the secondary currents induced are 180° out-of-phase with the primary current. The real horizontal component shows a maximum over a good conductor and the real vertical component shows an inflexion point there. These points are indicated by small arrows on the curves in Plates 5 and 6.

(c) Discussion of results.

The profiles on Plate 5 show how a pronounced anomaly gradually emerges towards the north from the almost undisturbed profiles 800.S to 500.S. The maximum on nearly all profiles is near 350.E and the strength on profiles 00 to 400.N. is approximately 2 microgauss.

Plates 5, 6 and 7 show the following interesting features:-

(i) The electromagnetic results confirm the main S.P. anomaly as far as 400.N which was the limit of the electromagnetic survey. The electromagnetic indications, however, continue farther south than the S.P. anomaly.

(ii) The contour map gives the impression of lenticular shape of the good conductor, with three lens-shaped maxima along the line of indications.

(iii) The southernmost of the three maxima, between 100.S and 400.S, has no corresponding S.P. anomaly. Some old pits and small workings exist in this area, but do not indicate any mineralisation of importance. No geophysical explanation can be given for this discrepancy, but it has been noticed in other surveys that on occasions no S.P. anomaly was obtained where electrochemical activity could reasonably be expected.

(iv) The maximum of the electromagnetic indications is slightly east of the S.P. maximum. This is to be expected, as the electromagnetic indication originates mainly from below the ground water table, whilst the S.P. anomaly arises from the zone of oxidation nearer to the surface. This factor, together with the steep easterly dip of the known lode would result in the electromagnetic indication appearing down dip, i.e. further to the east.

(v) The position and strike of the electromagnetic indications on traverses 00 and 100.N do not agree with those of the S.P. anomaly as well as they do further north. This may possibly be due to a fault or some similar geological feature.

The vector diagrams as shown on Plate 8 are used mainly to detect the influence of the various good conducting bodies producing the secondary field. The real component is plotted as the ordinate, the imaginary component as the abscissa and the points thus obtained connected to produce a diagram which is characteristic for the electrical condition prevailing along each particular traverse. Vector diagrams of the horizontal components only are reproduced in this report, as their changes from one traverse to the next are slightly more characteristic and easier to follow than those of the vertical component diagrams.

Comparison of the vector diagrams obtained in the present survey with those obtained from model tests and theoretical calculations shows the influence of the ground conductivity as a characteristic curve, e.g. the diagrams of 600.S or 800.S, where no electromagnetic anomalies were recorded. On traverse 300.S however, the influence of the local good conductor becomes noticeable and continues through to traverse 400.N (the last traverse surveyed by the electromagnetic method), with some variations in strength, probably caused by varying depth. The effects caused by the good conductor probably originate at a depth of about 150 feet.

Attention is drawn to the position of the self-potential anomaly and the electromagnetic indication in relation to the position of the lode as indicated by the old workings. (Plate 7). The displacement of the indications to the west of the lode outcrop is somewhat difficult to explain, especially if the assumption of an easterly dip of the lode is correct. The vector diagrams, however, do not show a high, well-defined, good conductivity such as would be caused by massive sulphide bodies, but rather a broad zone of slightly better conductivity than the surrounding country rock such as would be caused by a slate impregnated by sulphide minerals over a considerable width.

6. CONCLUSIONS AND RECOMMENDATIONS

Well-defined, strong anomalies were revealed in the northern part of the area by both the self-potential and electromagnetic surveys, although the electromagnetic indications continue further south than those obtained from the self-potential work. The old mine is situated at the southern end of the S.P. anomaly.

It is considered that these anomalies might arise from low-grade sulphide ore bodies of large dimensions, and if this is so, the results are of importance. It seems logical to suppose that such ore bodies would, like the known ore body, contain copper. However, because of the large size of the anomalies, the possibility exists that they are due to a large scale geological feature such as a large lens of graphitic or pyritic slate or schist. Testing alone can determine the true cause of the anomalies.

In the first place, it is recommended that the indications be checked by detailed geological examination and geochemical tests for copper. Some trenching would also be desirable and this, in the first instance, should be confined to:-

Traverse	200.N:	275.E - 325.E
"	500.N:	310.E - 340.E
"	700.N:	260.E - 340.E
"	900.N:	310.E - 340.E

If this testing establishes beyond doubt that the anomalies are due to causes other than ore bodies, no further testing would be warranted. If, on the other hand, the results of such testing are inconclusive or suggest the presence of ore bodies, then diamond drilling would be warranted. In this case it is recommended that a number of diamond drill holes be sunk, about 200 feet in length, with an angle of depression of 45°-50°. Suggested sites for five drill holes are shown on Plate 4 and are listed below in order of preference:-

D.D.H. No.	Location	True Bearing	Angle of Depression	Approx.Lgth.
1	475E/250N	262°	45°	220 feet.
2	450E/700N	262°	45°	190 "
3	475E/500N	262°	45°	230 "
4	450E/50N	262°	50°	170 "
5	450E/300S	262°	50°	230 "

As the core recovery in the Cloncurry area is usually much less than 100%, it is also recommended that the drill holes be electrically logged. This would give informstion regarding the variation of electrical conductivity in the rock and lode formation if present, and would supplement core analysis data in determining the width of any lode formation, should core recovery be poor.

The drilling target of the first three drill holes is primarily the self-potential anomaly, whilst the suggested locations for the others are based upon the electromagnetic indications only.

If the testing recommended reveals that the anomalies are due to ore bodies, further geophysical work would be warranted both to the north and south of the area covered by the present survey.

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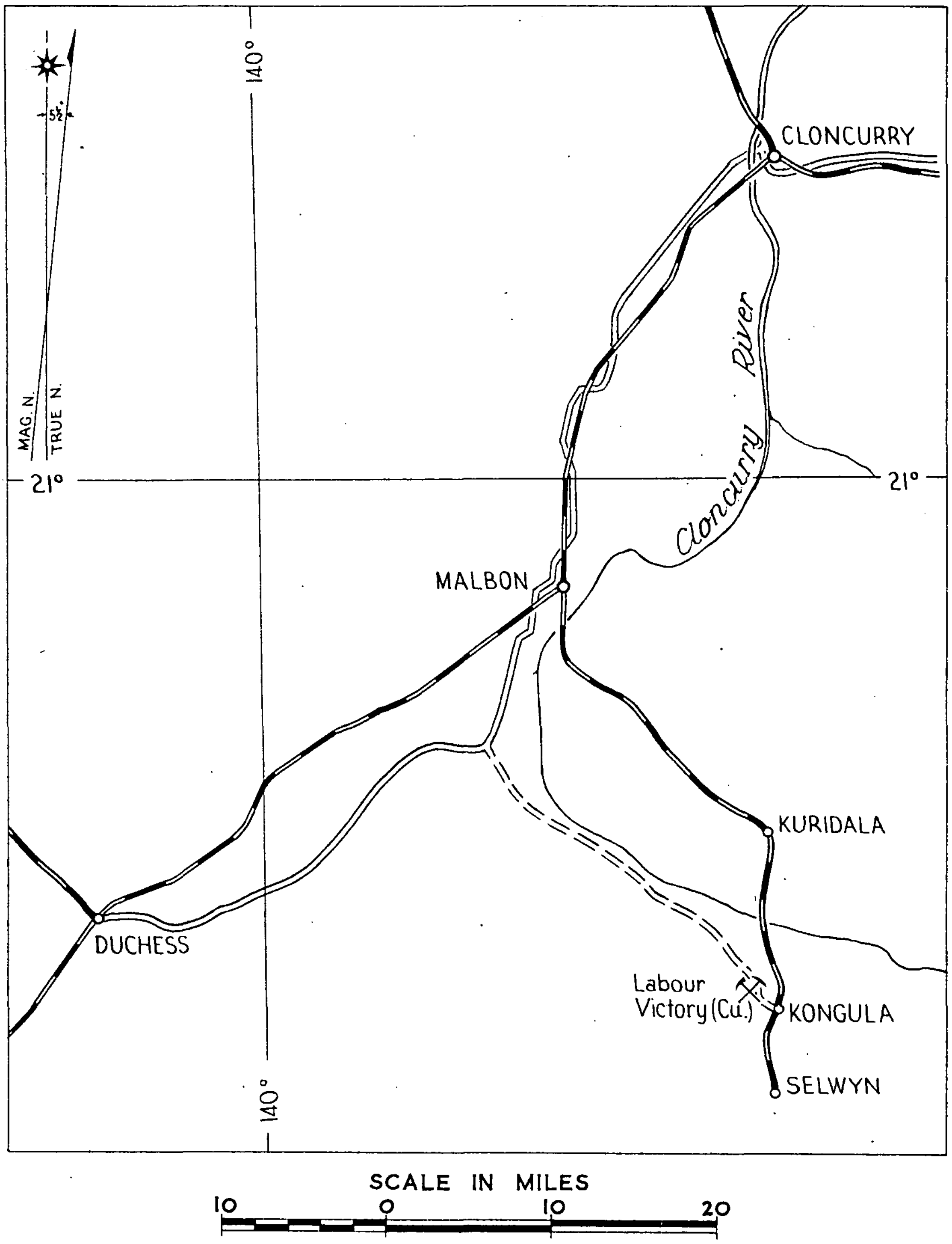
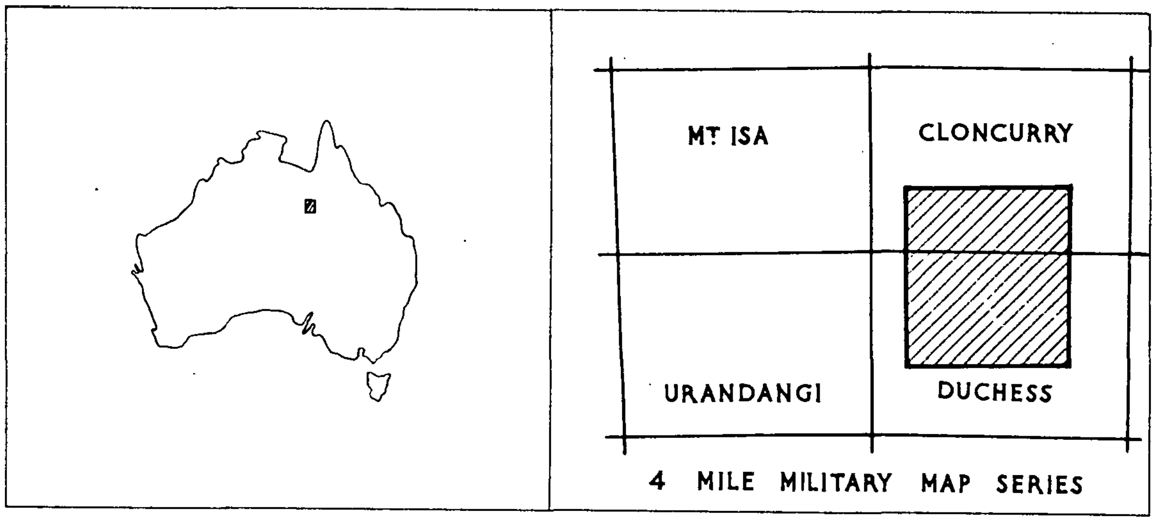
PLATE 1





GEOPHYSICAL SURVEY
LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.
LOCALITY MAP

G151-1

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics.

PLATE 2

GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

GEOPHYSICAL TRAVERSES AND TOPOGRAPHY

CONTOUR INTERVAL 5 FEET

SCALE

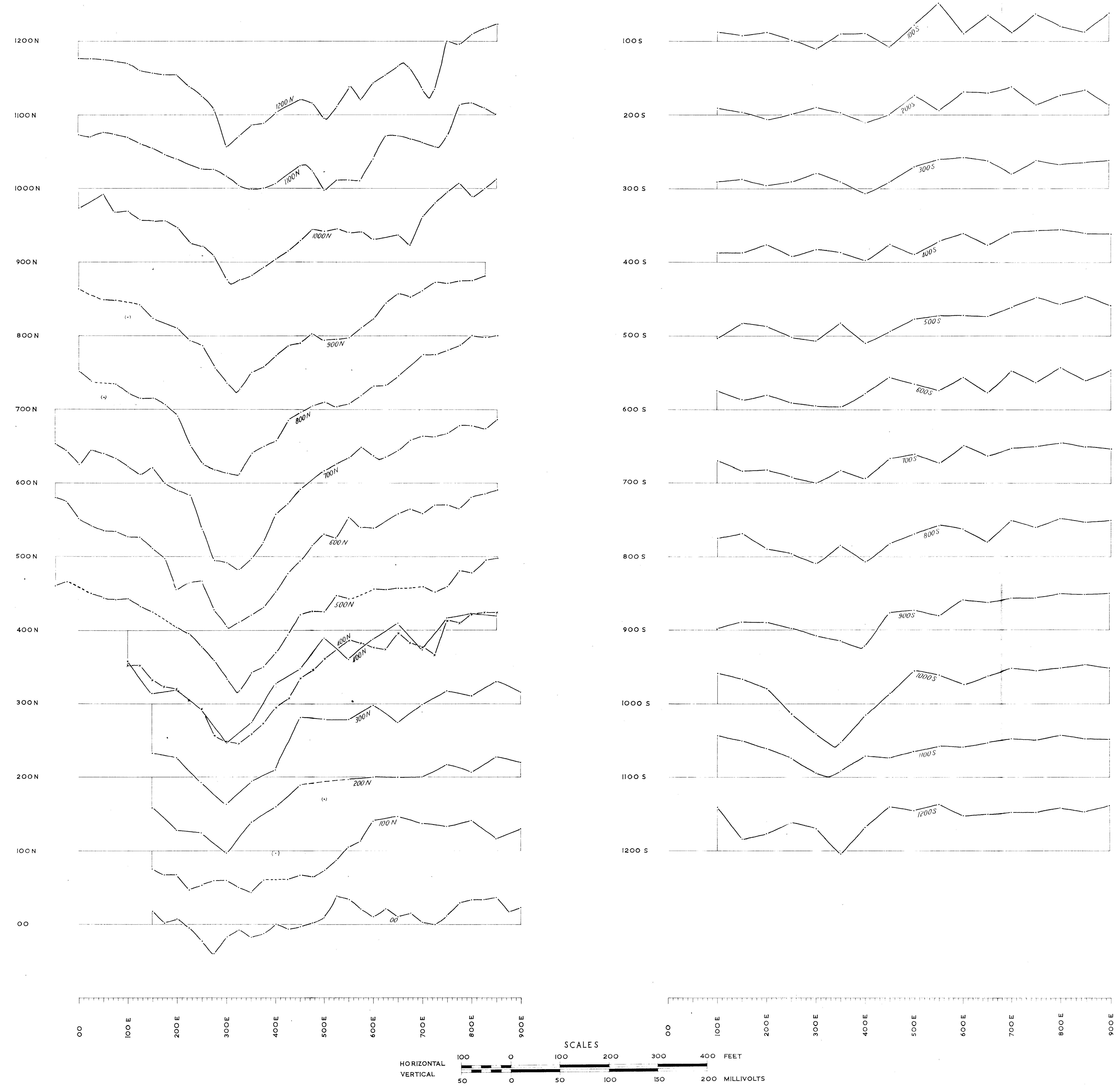
100 0 100 200 300 400 FEET

GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics.

G151-2

PLATE 3



GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

SELF – POTENTIAL PROFILES

GEOPHYSICIST

G151–3

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics

PLATE 4

GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

SELF – POTENTIAL CONTOURS

CONTOUR INTERVAL 20 MILLIVOLTS

SCALE

100 0 100 200 300 400 FEET

GEOPHYSICIST ....

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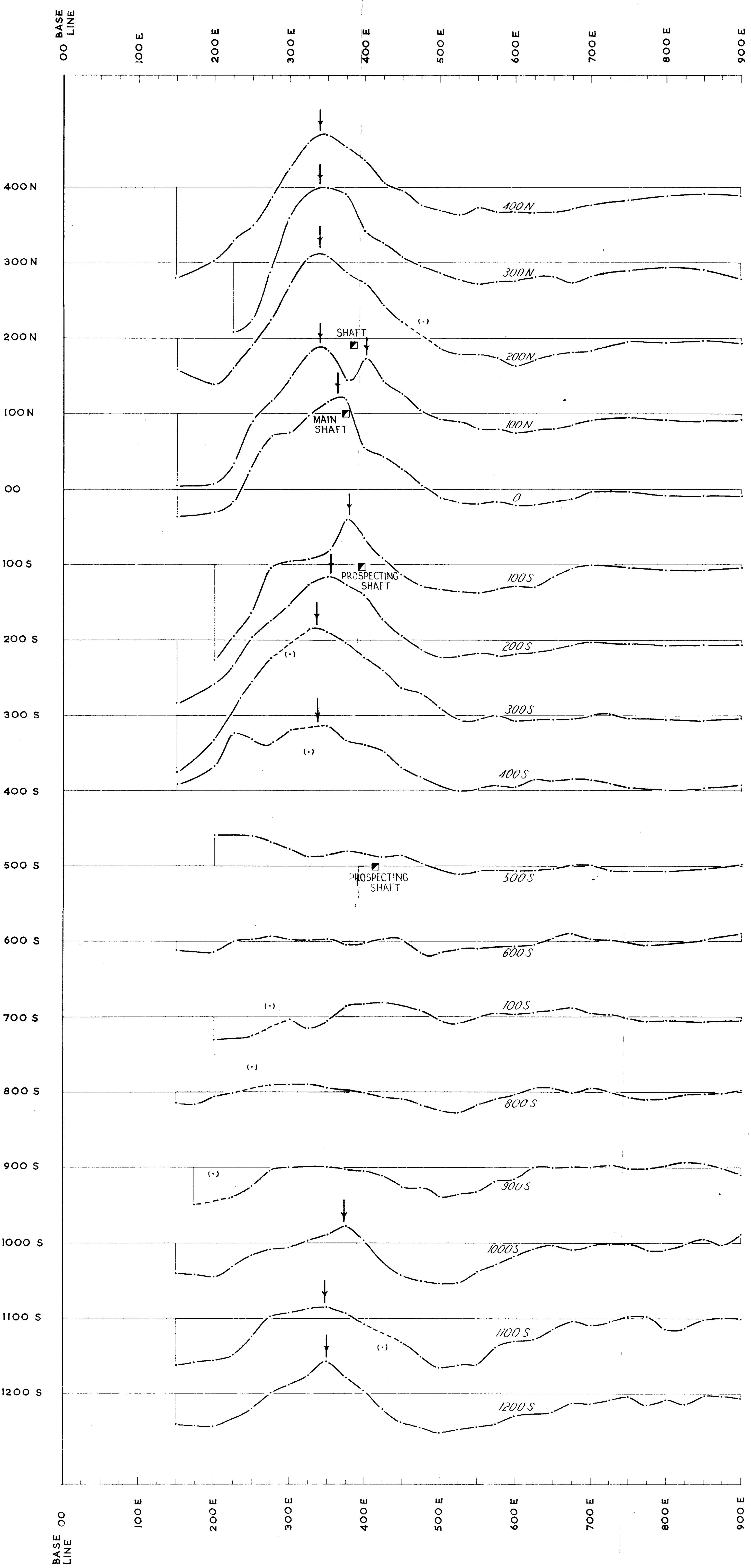
G151-4

PLATE 5



GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

PROFILES OF REAL HORIZONTAL COMPONENT OF ELECTROMAGNETIC FIELD

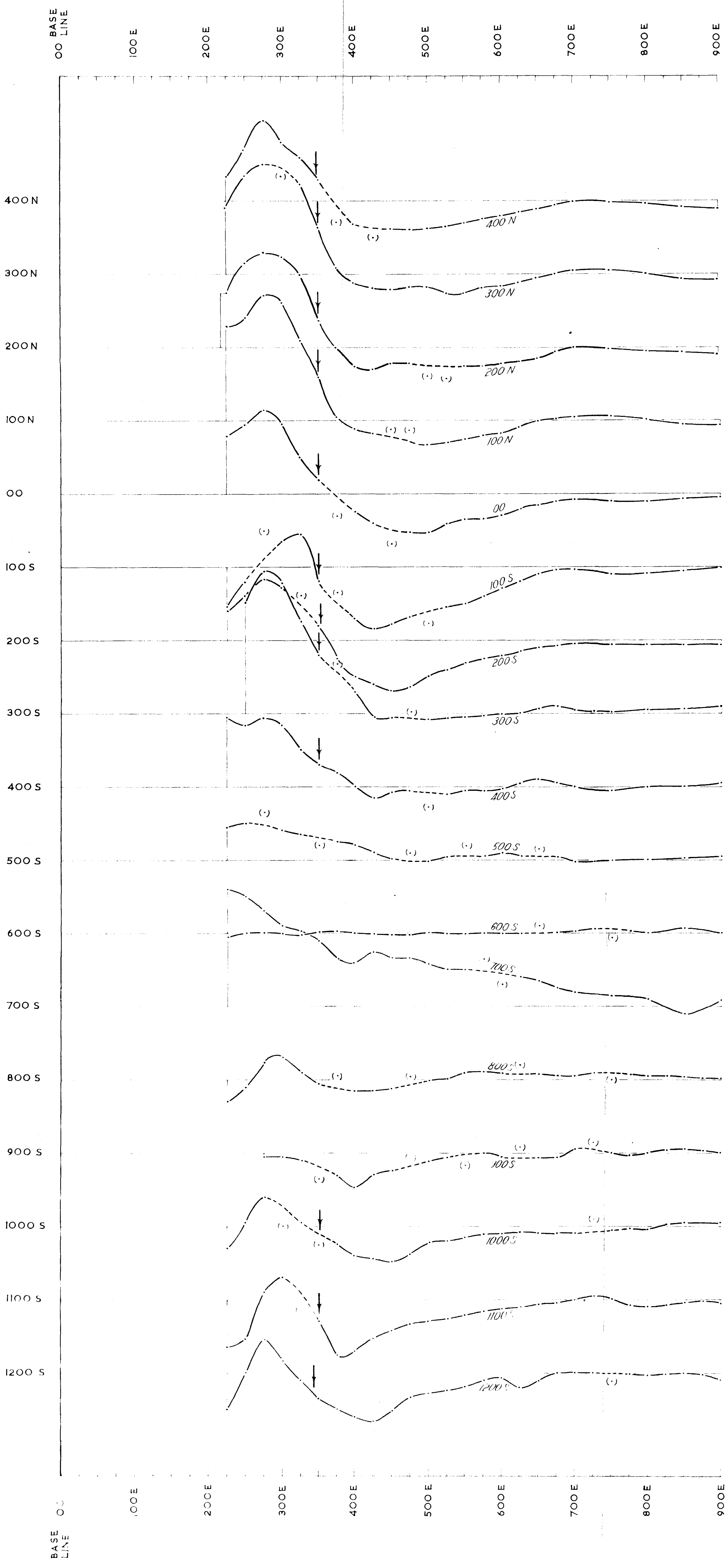
(AFTER DEDUCTION OF FIELD DUE TO GENERAL GROUND CONDUCTIVITY)

SCALES

HORIZONTAL 100 0 100 200 300 400 FEET

VERTICAL 2 0 2 4 6 8 MICROGAUSS

GEOPHYSICIST



GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

PROFILES OF REAL VERTICAL COMPONENT OF ELECTROMAGNETIC FIELD

(AFTER DEDUCTION OF FIELD DUE TO GENERAL GROUND CONDUCTIVITY)

SCALES

HORIZONTAL 100 0 100 200 300 400 FEET

VERTICAL 2 0 2 4 6 8 MICROGAUSS

GEOPHYSICIST

GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

CONTOUR PLAN OF REAL HORIZONTAL COMPONENT OF ELECTROMAGNETIC FIELD

(AFTER DEDUCTION OF FIELD DUE TO GENERAL GROUND CONDUCTIVITY)

CONTOUR INTERVAL 0·5 MICROGAUSS

SCALE

100 0 100 200 300 400 FEET

GEOPHYSICIST

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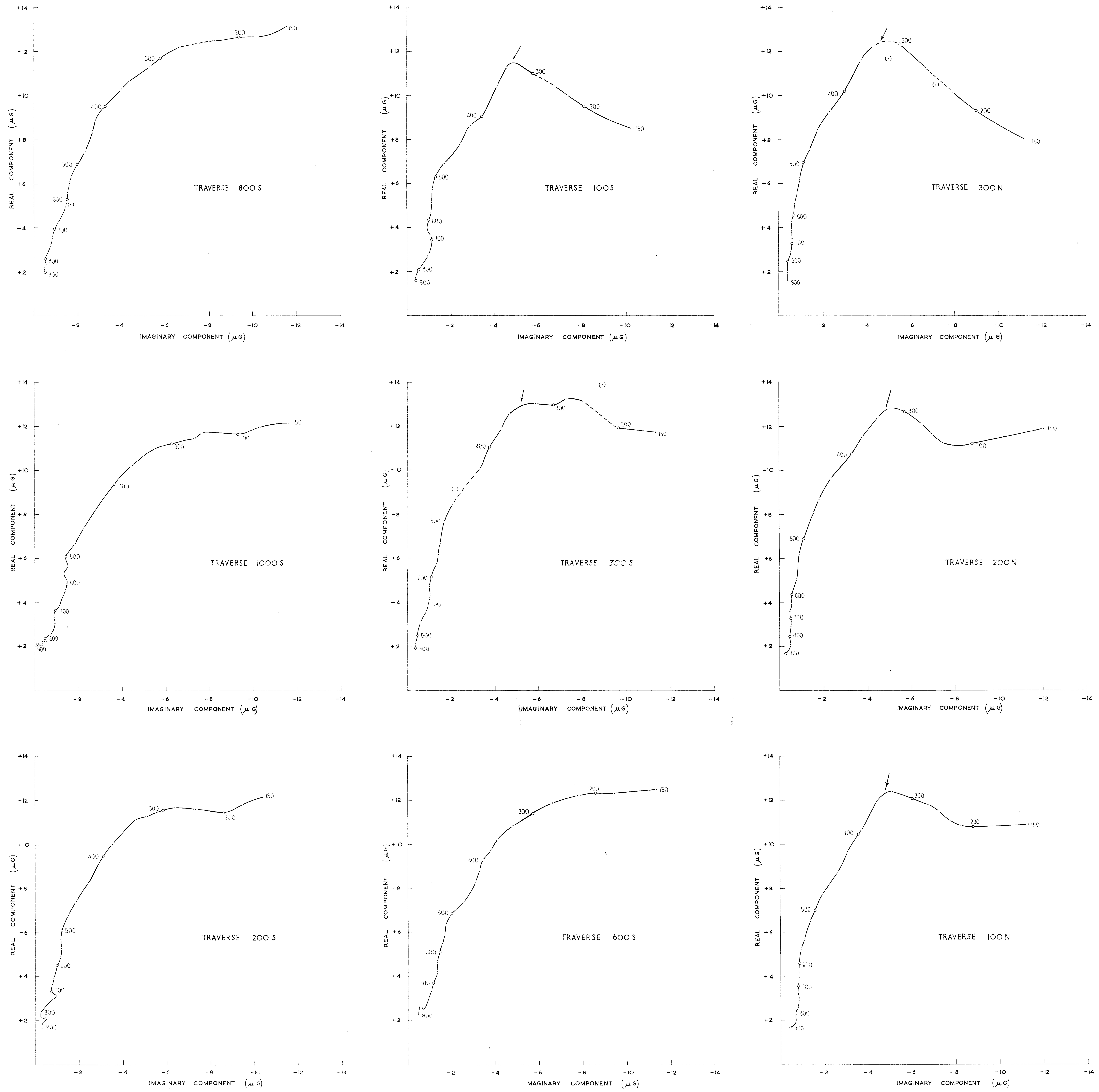
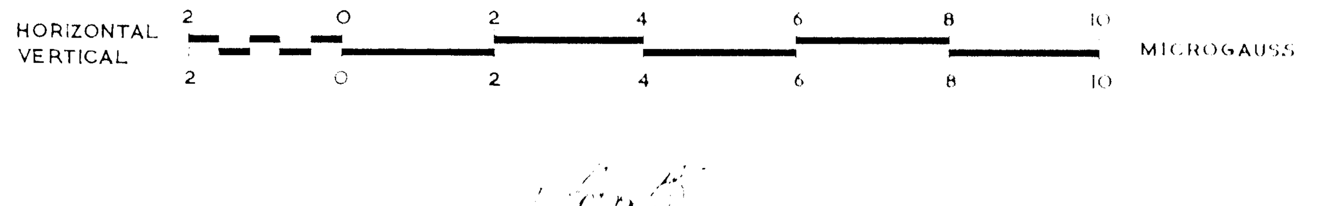
G151-7



SCALES



GEOPHYSICIST

GEOPHYSICAL SURVEY

LABOUR VICTORY MINE, NEAR SELWYN, QUEENSLAND.

VECTOR DIAGRAMS OF THE HORIZONTAL COMPONENTS OF THE ELECTROMAGNETIC FIELD

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics

G151-8