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GEOPHYSICAL SURVEY OF THE RENISON BELL TIN FIELD, TASMANIA

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CONTENTS.

ILLUSTRATIONS.

ABSTRACT.

In response to an application by Renison Associated Tin Mines N.L., supported by the Department of Mines, Tasmania, a geophysical survey of the Renison Bell Tin Field was started by the Bureau of Mineral Resources, Geology and Geophysics in 1950 and continued during 1951 and 1952. The field is situated in the West Coast region of Tasmania, and, up to 1955, had yielded concentrates containing about 3,000 tons of metallic tin. The object of the survey was to assist in the finding of additional ore-bodies in the field.

In a survey of portion of the field by the Imperial Geophysical Experimental Survey in 1929-30, the magnetic and self-potential methods were the most successful of those tested, and these methods were therefore used by the Bureau. The work done in 1950 was mainly over known ore-bodies, and the results obtained confirmed the applicability of the methods, as well as proving anomalies that could indicate sulphide bodies containing pyrrhotite.

In 1951 and 1952, the survey was extended to the south and east of the area surveyed in 1950. Numerous intense, well-defined anomalies were obtained by each method, and in many places the anomalies obtained by each method agreed generally in position. These anomalies provide strong indications of sulphide mineralization containing pyrrhotite, but testing will be necessary to determine the extent and nature of the mineralization and the tin content thereof.

Recommendations are made for the testing of the indications by drill holes and trenches, and for the extension of the survey to other parts of the field, but not until the results of this testing of anomalies are available.

INTRODUCTION.

The township of Renison Bell is in the West Coast region of Tasmania, about 9 miles north-east of Zeehan, to which it is connected by road and rail. It is also connected by rail with the seaport of Burnie, about 78 miles to the north and on Bass Strait, and with the seaport of Strahan, about 35 miles to the south and on Macquarie Harbour (Plate 1).

The country is of very high relief and is dissected by numerous rivers and creeks. The rainfall is about 100 inches per annum, and occurs mainly during the winter months. The surveys to be described were made, when possible, during the drier summer season.

Tin ore was discovered at Renison Bell in 1890, and for many years work was confined to the alluvial and detrital tin ore. The main lode system was discovered when a large cutting was being made on the Renison Bell lease during the construction of the Emu Bay Railway in 1900. Capital was not available for development of the property, and operations were confined to the erection of batteries to treat the detrital material and oxidized ores which were free-milling. The oxidized ore was eventually worked out and it was not until 1935 that Renison Associated Tin Mines, N.L. started treating the sulphides. Further development of the field will almost certainly depend on the working of the sulphide ores. Up to 1955, nearly 3,000 tons of metallic tin were contained in the concentrates produced from the Renison Bell field.

In 1950, Renison Associated Tin Mines, N.L., through the Department of Mines, Tasmania, applied to the Commonwealth Bureau of Mineral Resources, for a geophysical survey to be made. The object of the survey was to explore for additional ore-bodies in the area south and south-east of the mill (see Plate 1).

A previous geophysical survey was made over an area which included the Cable, Luck's and Battery Workings (previously known as Old Mill Workings) by the Imperial Geophysical Experimental Survey (Edge and Laby, 1931). The survey described in the present report was carried out by the Bureau during the field seasons of 1950, 1951 and 1952. Details of the areas surveyed and the composition of the field parties are as follows:—

(i) 1950 *Survey.*—Between April and June, 1950, a survey was made over an area which extends southwards for about 2,000 feet from the Emu Bay Railway near where it passes the mill, and westwards for about 1,500 feet from Renison Bell Creek (see Plate 1). The geophysical party consisted of L. W. Williams and A. J. Barlow (geophysicists) and K. S. Swan (field assistant). Most of the topographic surveying was done by B. L. Taylor, Tasmanian Department of Mines.

(ii) 1951 *Survey.*—During the period between November, 1950, and June, 1951, a survey was made over an irregular-shaped area to the south and south-east of that described in (i) above. The base-line used for the 1950 survey was extended southwards for 1,000 feet and traverses at right angles to this line were surveyed for distances up to 4,000 feet (see Plate 1). The geophysical party was in charge of R. P. Loh, who was assisted for various periods by L. W. Williams and J. H. Quilty (geophysicists), R. Green (cadet geophysicist), R. J. O'Neill (field assistant) and four university vacation students.

(iii) 1952 *Survey.*—The area surveyed during the period between February and May, 1952, was to the south-east of those surveyed during 1950 and 1951 and included the Federal open-cut on Stebbins Hill, the larger part of Montana South workings and the northern part of Dunn's workings to the south-west of Stebbins Hill (see Plate 1). The geophysical party comprised O. Keunecke (party leader), A. F. Alle (geophysicist), and P. B. Tenni and M. J. O'Connor (cadet geophysicists). Assistance was given during the first part of the survey by two university vacation students and later by two field assistants provided by Renison Associated Tin Mines, N.L.

The results of the three surveys and drilling recommendations based on the results were communicated to the Department of Mines, Tasmania, and to Renison Associated Tin Mines, N.L. in unpublished reports by Williams (1950), Loh (1951), and Horvath and Keunecke (1953).

It is considered desirable that the results of the surveys be assembled in one report and made public for the following reasons:—

1. The nature of the ore-bodies is such as to make them readily detectable by geophysical methods.
2. Although surveys performed to date have covered only a relatively small area, they provide a considerable number of indications of possible ore-bodies. It appears possible that a vigorous exploration programme, based on the results of these surveys, would lead to the discovery of ore reserves which would warrant the establishment of mining operations on a major scale.

GEOLOGY.

GENERAL.

The Renison Bell field forms the major portion of the North Dundas tin field, the geology of which has been described by Ward (1909), Conder (1918), and Reid (1925). The particular area around the Renison Bell field has been described in detail by Fisher (1943) and summarized by Fisher (1953, pp. 1179-84). The geological map on Plate 1 is essentially that contained in the report by Fisher (1943).

The country rock of the field consists predominantly of Cambro-Ordovician slates and grits, with occasional tuffs and fine conglomerates, referred to under the general name of Dundas slates. Subsequent upon faulting and regional metamorphism, the slates were intruded by a series of basic igneous rocks ranging from gabbro to serpentine, and later, possibly in Devonian time, by quartz-porphyries. It is generally considered that the quartz-porphyries have been directly associated with the source of the mineral-bearing solutions.

The Dundas slates strike north or north-west and dip to the north-east at 10 degrees to 30 degrees over most of the field, but steepen towards the Dreadnought line of lode. A definite anticlinal axis runs between the Cable and Battery workings towards the junction of Montana and Dalcoath Creeks (Plate 1), with a corresponding syncline to the west.

A traverse of the field from west to east gives an ascending series as developed in the Renison Bell locality. In railway and road cuttings west of the Renison Bell lode, massive beds of fine sandstone and shale sometimes up to two or three feet thick alternate with thinner beds. The quartz-porphyry dyke exposed on the Zeehan road has been intruded along the crest of a local anticline.

Overlying these beds is perhaps 300 feet of well-bedded shale. Though generally uniform in character, this section includes occasional coarser beds, coarse quartz sandstone of typical shoreline facies, and one band coarse enough to be called a conglomerate. This shale is the host rock of nearly all the sill-like ore-bodies (known as " floors "), near which it is, as a rule, well silicified.

Above the laminated shale is a band of red shale and sandstone, including several massive beds and some tuffaceous horizons. As they are resistant to weathering and dip with the slope of the hill, these rocks constitute the outcrop over a large part of the eastern side of Renison Bell Hill.

Above the red beds, which seem to mark the upper limit of the floor-bearing horizons, are further bedded shale and mudstone. The sediments appear to become more massive and felspathic in character towards the east, as the country rock along the Dreadnought-Federal line of lode is quite distinct from the more westerly outcrops.

ECONOMIC GEOLOGY.

Lode structure and ore types in the field vary greatly and have been described in detail by Ward (1909) and Conder (1918). The mineral constitution of the ores has been investigated and reported on by Stillwell (1942).

There are two main types of lode formation:—

1. Narrow, fissure lodes, which dip steeply and, in general, strike roughly north-west. These lodes are known as " feeders " and many can be traced continuously for considerable distances. They occur in line, or en echelon, commonly with lesser sub-parallel or branching fissures, and are from 5 to 12 feet wide, with occasional bulges as great as 45 feet. Lenticular ore-bodies occur at intervals along the fissures. The largest individual ore-shoot is the Federal Lode, which has been worked over a continuous length of 750 feet.
2. Massive, flat-lying, sill-like ore-bodies, known as " floors." These bodies appear to be intruded between the bedding planes of the sediments and may occur on either the footwall or hanging-wall side of the fissure lodes.

The ore-bodies are distributed along two parallel zones trending north-west, i.e., parallel to the strike of the sediments. The south-west zone, which is the more important one, contains the Renison Bell, Montana, Dunn's, Battery, Cable, Luck's and Dalcoath Lodes. The north-east zone includes the Dreadnought and Federal Lodes. The floors are confined to the south-west zone and appear to be restricted to a horizon of laminated slate and fine sandstone which dips north-east to cut the Dreadnought-Federal line of lode at an undetermined depth.

The Renison Bell Main Lode extends for more than 3,000 feet from north of the Argent River to the top of Renison Bell Hill, and passes through the area surveyed in 1950. The lode is not continuous, and is known variously, from north to south, as the Main Lode, the Lead Lode (near the railway line, where the galena content is high), the Blow Lode and the Upper Blow Lode. Most of the ore mined from this lode system has been oxidized ore obtained from open cuts, and the only underground development consists of a few short drives.

The other ore-bodies in the south-west zone (Montana, Dunn's, Battery, Cable, Luck's and Dalcoath) are irregular bodies of different size, form and composition, and are in, or just outside, the area surveyed during 1952. The Battery ore-body is the largest of these, and has been the main source of production in recent years.

The Federal and Dreadnought Lodes, which form the north-east zone, extend over a total distance of 1,500 feet and are situated mainly in the areas surveyed during 1951 and 1952. The Dreadnought Lode ranges up to 10 feet in width, and has been worked only in the oxidized zone. Oxidation in the Federal Lode, which is a strong, well-defined double fissure lode, extends deeper than anywhere else on the field and oxidized ore is found 100 feet from the surface.

The chief minerals in the ore-bodies are pyrite, pyrrhotite, cassiterite and arsenopyrite, with quartz as the chief gangue material. Much of the gangue formed in the later stages of mineralization is a manganese-iron-magnesium carbonate of varying composition.

The ore as mined ranges mainly between 0·7 and 0·9 per cent. tin, though in places, as in the Battery Lode feeder, the grade is as high as 5 per cent. Most of the tin occurs as cassiterite, embedded in the quartz and in the sulphides. The cassiterite is grey, fine-grained and seldom visible to the naked eye, except where it occurs in rich shoots in the sulphides.

METHODS.

GENERAL.

As stated in the Introduction, a survey was carried out in 1930 by the Imperial Geophysical Experimental Survey (I.G.E.S.) near the Cable, Luck's and Old Mill (Battery) Workings (Edge and Laby, 1931), i.e., in the area to the south of Stebbins Hill (see Plate 1). In the course of that survey, the electromagnetic, equi-potential line, self-potential and magnetic methods were used. In general, there was fairly good agreement between the results of the four methods, and also between the geophysical indications and bore-hole evidence. The magnetic method was the most successful of those used, and the self-potential method, although not used as extensively, showed well-defined anomalies over the known sulphide bodies in the Battery Workings. It was decided, therefore, that these two methods would be used in the survey carried out by the Bureau. A brief description of the methods is given below.

MAGNETIC METHOD.

Of the geophysical methods which are applicable to the search for sulphide ore-bodies, the magnetic method is one of the most widely used, as such ore-bodies frequently contain magnetic minerals such as magnetite, pyrrhotite, ilmenite, &c. Conditions at Renison Bell were considered favourable for the application of the method because the ore-bodies there contain a high percentage of pyrrhotite, which has a high magnetic susceptibility. Moreover, the experience of the I.G.E.S. showed that the ore-bodies are of sufficient size to produce intense anomalies in the magnetic field at the surface.

Although it is possible to measure both the horizontal and vertical components of the earth's magnetic field, experience has shown that measurement of the vertical component is usually sufficient, and this method was used in the present survey. The instrument used was a Watts Vertical Force Variometer.

SELF-POTENTIAL METHOD.

The self-potential method is the only electrical method utilizing a natural field, that is, one supplied by spontaneous electrical phenomena. There are other electrical methods using artificial electrical fields. The self-potential method involves measurement on the earth's surface of electrical potentials developed in the earth by electrochemical action between minerals and the solutions with which they are in contact. If the solutions and/or minerals are different at the upper and lower parts of a mineralized body, a difference in potential exists. This potential difference ($\triangle E$) depends on:—

(i) The concentration differences of electrolytic solutions in contact with the mineral bodies.

(ii) Chemical differences of the minerals coming in contact with the solution.

The magnitude of $\triangle E$ is proportional to log $\frac{P_1C_2}{P_2C_1}$ where C_1 and C_2 are the ion concentrations of the solution in the upper and lower parts and P_1 and P_2 the electrolytic solution pressures of the upper and lower materials in the ore-body.

The potentials arising from (i) appear to be related to those arising from (ii) as cause and effect. Water containing absorbed oxygen seeps down from the ground surface and forms an aerated zone rich in oxygen, while at the lower portion of the mineralized body the solutions are either deficient in oxygen or may even be reducing in nature. Sulphide minerals in the upper portion of the mineralized body are oxidized by the oxygen in the ground water and in the process the electrolytic composition of the ground water is further changed. Thus, in a body containing sulphide minerals the upper part of which is undergoing oxidation, not only are the concentrations of the solutions in contact with the upper and lower parts different, but the mineral composition of the body itself is different in the upper and lower parts. The minerals contained in the oxidized zone in contact with ground water solutions give rise to lower potentials than those resulting from the contact of the unaltered minerals in the lower part of the body with oxygen-deficient solutions.

Due to the potential difference between the upper and lower parts of the body, current passes downwards through the body to its lowest extremity and the circuit is completed by current flowing outwards and upwards through the surrounding rocks. The current flow is investigated by making potential measurements at the surface and is of such a nature that a potential minimum or " negative centre " is produced in the ground above the ore-body. Although the strongest potentials of this kind are incited in sulphide ores such as pyrite, several other minerals such as pyrrhotite and graphite give rise to self-potential effects observable at the surface.

The previous work at Renison Bell by the I.G.E.S. showed that the ore-bodies produced very intense self-potential effects as a result of the active nature of the oxidation, the high pyrite content and the proximity of the bodies to the surface.

RESULTS AND INTERPRETATION.

GENERAL.

The results of the magnetic and self-potential surveys are shown in the form of contours on Plates 2 (magnetic) and 3 (self-potential). These plates show that with each method several intense anomalies were observed, providing strong indications of mineralization. The self-potential gradients, in particular, are very steep in places, but it must be remembered that the strength of a self-potential indication is controlled more by the activity of oxidation than by the size of the ore-body, and conditions at Renison Bell are, because of the high rainfall, extremely conducive to vigorous electro-chemical activity.

In most instances there is fairly good agreement in position between the magnetic and self-potential anomalies, but in a few instances a magnetic anomaly has no corresponding self-potential anomaly and vice versa. Rather than discuss separately the results obtained, it is considered preferable to discuss each anomalous area in turn, and for convenience of reference these have been numbered from I. to XXVII., irrespective of whether they represent a magnetic anomaly only, a self-potential anomaly only, or both.

Comparison between the map showing the position of the known ore-bodies (Plate 1) and the magnetic and self-potential contour maps (Plates 2 and 3) reveals that several of the anomalies coincide fairly accurately in position with known ore-bodies. It is proposed, therefore, to discuss first of all anomalies such as these which were observed during the survey carried out during the first field season (1950), as they are convincing evidence of the applicability of the geophysical methods used.

RESULTS OVER KNOWN ORE-BODIES (1950 SURVEY).

It should be stressed at this point that, as the mining prior to 1950 had been limited mainly to the oxidized ores, the information available regarding the full extent of the ore-bodies was, and still is, far from complete. The irregular form of both the magnetic and self-potential contours may be attributed to the complex shape of the ore-bodies, as well as to the effects of the rugged topography. These factors render it virtually impossible to apply any theoretical treatment to the observed results.

Geophysical anomalies observed during the 1950 survey, which appear to be related to known ore-bodies, occur on anomalous areas I. to VI., and these are discussed below.

Area I.—Both the magnetic and self-potential anomalies lie on the line of the Renison Bell Main Lode and occur over a massive pyrrhotite body known as the Black Face, which is exposed on the surface, and continues south to the Glory Hole. A floor which has been worked just to the east and south-east of the Glory Hole is probably a continuation or offshoot of this mineralization and represents the low-grade down-dip section. This would appear to be the cause of the south-easterly extension of both the magnetic and self-potential anomalies.

Area II.—The anomalies here occur over the Blow Lode, and there is good agreement between the axis of each anomaly and the strike of the lode. The magnetic maximum of nearly 4,000 gammas is localized and is centred on traverse 800S. The self-potential contours show an elongated negative centre of –400 millivolts extending from 800S to 900S.

The self-potential contours show a well-defined " axis " connecting the negative centres of Areas I. and II. This coincides roughly with a gap about 300 feet in length between the surface exposures of the Lead Lode and the Blow Lode and would appear to indicate a continuation of the mineralization between the two bodies. The axis of the self-potential indications continues south to Area III., and there is a similarly placed, but less-defined, elongation of the magnetic contours.

Area III.—A self-potential negative centre and a magnetic maximum occur on traverse 1500S, and coincide with the northern part of the Upper Blow Lode. The form of each anomaly is such as would be caused by a narrow steeply-dipping body such as a fissure lode.

Area IV.—In this area there are strong self-potential and magnetic anomalies corresponding to the Upper Blow Lode between traverses 1790S and 1990S and the pyrrhotite floor exposed in No. 5 Workings. A large amount of pyrrhotite ore has been uncovered, and the complex nature of the contour pattern may be due largely to variations in the thickness of the overburden. There is evidence from the magnetic contours that the floor exposed in No. 5 Workings extends to about 300E on traverses 1790S and 1890S. A vertical drill hole (G5) at 1790S/275E would reveal to what extent this supposition is true.

Area V.—The self-potential and magnetic anomalies correspond in position to the Cross Lode, where the control feature is a cross fissure almost at right angles to the main fissure direction. A large irregular oxidized floor is associated with the fissure, especially on the northern side. From the shape of the self-potential and magnetic anomalies, it would appear that the ore-body, as mapped by Fisher (1943) from exposures on the surface and in the open cut, represents only the northern portion of a more extensive body, and that there is a considerable extension to the south-east and south of the previously known limits. To the south-east, the self-potential anomaly is particularly intense, with a negative centre of about –500 millivolts at 875E on traverse 1100S. This anomaly should be tested by a drill hole (G10) at 1000S/900E, depressed at 30 degrees on a true bearing of 187 degrees.

Area VI.—A localized self-potential anomaly of about –200 millivolts is present at about 175E on traverse 800S, but there is no corresponding magnetic indication of appreciable magnitude. A small fissure lode and floor, possibly an extension of the irregular oxidized floor referred to under Area V. above, occur just to the east of the anomaly.

APPLICABILITY OF THE METHODS.

As stated earlier, the above anomalies were observed during the 1950 survey, and showed that the known ore-bodies in the area surveyed during that year produce, almost without exception, strong magnetic and self-potential anomalies. It was apparent, therefore, that the two methods used would be applicable to the search for other ore-bodies in the Renison Bell area.

Although there is, in general, good agreement in position between the indications obtained from the two methods, it is apparent that, with regard to detailed features of the anomalies, the magnetic and self-potential indications do not always show close correspondence. This is only to be expected however, as the bodies, consisting of combinations of floors and fissures, are very irregular in shape, and the pyrrhotite and pyrite contents of the lodes are far from uniform. Furthermore, the self-potential effects are influenced by the depth of the oxidation zone, which, although generally shallow, has a considerable range throughout the area. As measured at the surface, both the magnetic and self-potential anomalies produced by an ore-body are likely to be affected by the irregular topography. For these reasons, it is difficult to deduce from the geophysical results the exact boundaries and structures of the ore-bodies. In some instances, however, such as at the Federal open-cut, the shape of the anomalies does give a rough indication of the outline of the ore-body concerned.

DISCUSSION AND INTERPRETATION OF RESULTS.

Renison Bell Section.

In the following discussion, the anomalous areas are discussed in numerical order. Anomalies VII. to XIII. were observed during the 1950 survey, XIV. to XXIII. during 1951, and the remainder (XXIV. to XXVII.) during 1952.

Area VII.—In this area, which is to the south-east of anomalous Area VI., the magnetic and self-potential anomalies are in close agreement as regards both position and shape. The anomalies are fairly intense (magnetic more than 4,000 gammas and self-potential more than –250 millivolts) and elongated, and suggest that the mineralization persists for a distance of about 700 feet. The most likely interpretation is a fissure lode striking west-north-west and extending from the negative self-potential centre on 1000S along the axis of the self-potential anomaly towards the negative centre of Area XI. There is also the possibility of floors being associated with such a fissure lode.

Recommendations were made that the anomalous area be tested by drill holes G1, G2 and G3. Hole G1, sited at 1050S/180E, should be drilled vertically, to test for a possible floor and G2 (at 1200S/475E) and G3 (at 1400S/575E) should be depressed at 30 degrees (bearing 247 degrees) and 45 degrees (bearing 187 degrees) respectively to test for a fissure lode. If drilled far enough, G2 would test the ground below the secondary magnetic high (1200S/300E) at not too great a depth.

Area VIII.—A strong magnetic anomaly of more than 4,000 gammas occurs at about 200E on traverses 1300S and 1400S and is most likely due to an isolated pyrrhotite body, probably a fissure lode, nearly 200 feet long. A relatively weak self-potential anomaly was observed over the same area.

A drill hole (G4) collared at 1400S/225E and depressed at 45 degrees on a true bearing of 202 degrees would adequately test the magnetic anomaly.

Area IX.—In this area the magnetic and self-potential contours do not match very well and, although there is definite evidence of mineralization, little can be deduced from the geophysical results of the extent and strike of the ore-body. However, the 1950 survey terminated at traverse 1990S and it was clear that the anomalies extend further to the south. This was substantiated by the results of the survey made during 1951, which showed a considerable extension, particularly of the magnetic indications. Although this southern extension was numbered XVI., the two areas can conveniently be discussed as one.

The elongated magnetic anomaly extends as far south as 2600S and shows three distinct magnetic highs. Two separate self-potential negative centres correspond only roughly to the magnetic anomaly. There appears to be little relation between the magnetic anomaly and the tuffaceous horizon which has been plotted on the I.G.E.S. geological plan between 800E and 900E, and shown by Conder (1918) to occur immediately west of the Montana South workings.

Analysis of the self-potential anomaly centred at 2500S/900E indicates that it is probably due to an oxidizing body at a depth of about 30 feet. The old adit at 2400S/1000E may have intersected this body, and geological examination of the adit and its dump material may yield useful information. The more pronounced anomalies to the north-west could be tested by an inclined drill hole (G20) collared at 2050S/725E, bearing 210 degrees, angle of depression 45 degrees, and by a trench along 2100S near 650E.

Drill hole G6 at 1890S/600E, depressed at 45 degrees in the direction of the traverse would test the magnetic high and the self-potential negative centre in Area IX.

Area X.—In this area there is a magnetic anomaly only. As the area is close to Renison Bell Creek, it is possible that the sulphide body does not extend above the ground-water level, in which case oxidation would not be taking place and no self-potential effect would be expected. The magnetic indication is persistent in length, and as it continues to the north-west as far as traverse 00, it is probably due to a body forming part of the Renison Bell main lode system. The magnetic anomaly could be tested by a drill hole collared at 500S/775E and depressed at 45 degrees on a true bearing of 202 degrees (G9).

Area XI.—Anomalies in this area were obtained during the 1950 survey but extension of the survey to the south and east in 1951 showed the full extent of the anomalies near the Montana North workings. The pattern of the anomalies is very complex and it is difficult to see any definite relationship between the results of the two methods. In the northern part of the area, the magnetic high is mainly to the east of the self-potential negative centre. At 1690S/950E, where the indications coincide, a pyritic floor has been exposed by shallow workings, and a westward continuation of this floor would explain the character of the self-potential anomaly which is intense and shows several radiating axes, suggesting fairly extensive sulphide mineralization. The most pronounced of the axes is in line with the probable fissure lode of Area VII. and a reasonable interpretation would be a fissure lode with an associated floor of considerable extent. The high magnetic values near 1890S/1050E may be related to this fissure lode and are considered worthy of testing by a drill hole such as G21 collared at 1890S/1000E, and depressed at 45 degrees on a true bearing of 50 degrees. A second hole, G7, at 1650S/960E (angle of depression 45 degrees, bearing 187 degrees) would be suitable for testing the pronounced self-potential anomaly.

Areas XII. and XIII.—Self-potential anomalies only were observed over these two areas. In Area XII., there are two negative centres, suggesting a subsidiary fissure branching from the Blow Lode. Drill hole G11, collared at 500S/40W, and depressed at an angle of 60 degrees on a bearing of 247 degrees, would test the southern, and stronger, anomaly. In Area XIII., the anomaly is not as intense, but covers an appreciable area and appears to indicate an occurrence of mineralization isolated from the main Blow Lode system. Testing by drill hole G8, at 800S/400W (angle of depression 60 degrees, bearing 277 degrees), is recommended.

Area XIV.—This anomalous area is situated near the top of Renison Bell Hill and extends approximately from traverse 1690S to traverse 3010S and from 600W to 100E. It includes Area IV. referred to earlier and the two areas are now discussed together in greater detail. The anomalies observed during 1950, and which were associated with the Upper Blow Lode and No. 5 Workings, were traced southwards during 1951 and developed into the very complex pattern shown by both the magnetic and self-potential contours. The strike of the body or bodies producing the anomaly is roughly parallel to the baseline of the geophysical grid.

The magnetic anomalies are particularly intense, with very steep gradients. An interesting feature of the magnetic results is the large number of intense negative values, particularly on traverse 2200S where, over a distance of 200 feet (150W to 350W), the vertical component of the magnetic field is at least 5,000 gammas below the normal undisturbed value. There is a corresponding region of abnormally high positive values to the east of the negative region. These extreme positive and negative values are interpreted as being caused by a strongly magnetic body at shallow depth. Theoretical analysis of the anomaly is not possible, however, because of its irregular form and the fact that it appears to be due mainly to abnormal polarization rather than to magnetization by induction in the earth's field.

In general, there is good agreement between the magnetic and self-potential results throughout most of Area XIV. An exception is the self-potential centre at 2600S/425W which is not accompanied by any marked magnetic anomaly. Analysis of this self-potential anomaly indicates that it is probably due to a sulphide body about 150 feet below the surface and dipping to the north at about 40 degrees to 50 degrees.

The intense localized self-potential negative centres at 500W on traverses 2100S and 2300S suggest shallow mineralization. In the central part of the area, although the pronounced magnetic anomalies appear to originate from shallow depths, the more moderate self-potential gradients indicate deeper mineralization.

The magnetic anomaly whose axis roughly follows the baseline between 2600S and 2900S coincides fairly closely with a well-defined self-potential anomaly, and both suggest an almost vertical lode approaching close to the surface. The magnetic anomaly appears to terminate at the southernmost traverse surveyed (3010S), but the self-potential anomaly continues further south.

To summarize the discussion on Area XIV., it may be stated that both methods indicate a strongly mineralized zone about 1,300 feet long and several hundred feet wide. It is obvious that there are strongly mineralized bodies close to the surface, and there is also evidence that in parts of the area mineralization continues to considerable depth. It is probable that a fissure lode, forming a continuation of the Upper Blow Lode, extends south beyond the summit of Renison Bell Hill, and that associated with it are subsidiary ore bodies which cause the individual anomaly centres shown by the geophysical results.

On the basis of the above interpretation, this area is a very promising one for detailed testing. Although diamond drilling would be required to locate deeper bodies and to follow up known lodes, the terrain favours trenching for testing the nature of shallow bodies.

The testing recommended to make a preliminary investigation of the significance of the geophysical results is shown on Plates 2 and 3 and is included in the table on page 15. Trenches are recommended at 2050S from 475W to 550W (G12T), along traverse 2300S from 400W to 500W (G13T), and along traverse 2200S from the base line to 500W (G14T). Should trench G14T show good values, it could advantageously be deepened so as to obtain a cross-section of the lode structure while obtaining economic ore. A long inclined drill hole (G16) directed into the hillside along the line of traverse 2200S and at an angle of depression of 20 degrees, would adequately test the depth extent of the mineralization. A vertical hole (G15) at 2550S/400W should intersect, at a depth of 150 to 200 feet, the body responsible for the self-potential anomaly near that point. Drill hole G17, collared at 2900S/50E and depressed at 20 degrees on a true bearing of 270 degrees, is recommended to test for a vertical lode which is considered to be indicated by the well-defined self-potential and magnetic anomalies in that locality.

Area XV.—A self-potential anomaly with two negative centres extends from 2200S to 2550S. A magnetic anomaly, of much smaller magnitude than those in Area XIV., coincides in position with the stronger (northern) of the self-potential centres. Both methods indicate a fairly deep-seated body, which should be intersected at a depth between 60 and 100 feet by the recommended drill hole G18, collared at 2300S/425E and depressed at an angle of 45 degrees on a true bearing of 247 degrees.

Area XVI.—As stated earlier, this "anomalous area" is a continuation of Area IX., and was discussed on page 9.

Area XVII.—A weather-resistant outcrop of "red rock" (Fisher, 1943) striking N30 degrees W can be traced through 2200S/1400E and appears to be related to the elongated magnetic anomaly which, during the 1951 survey, was traced from 1600S to 2500S, and during the 1952 survey was shown to continue south-east to link up with Area XXVI. No self-potential anomaly is present in Area XVII., and a comparison can be made with Area X., which also showed an elongated magnetic anomaly with no appreciable self-potential anomaly.

occurring in an area of " red rock." Samples of " red rock " from Area XVII. show intense magnetism due to included magnetite. The absence of self-potential effects is possibly due to a high water table near the Montana Creek which could prevent oxidation of the sulphides if any are present. Test hole G9, which was recommended to test the magnetic anomaly in Area X., should prove whether this type of anomaly is likely to indicate the presence of ore.

Area XVIII.—This is another example of a magnetic anomaly occurring with no associated self-potential anomaly over an outcrop of magnetic " red rock," and calls for no further comment.

Area XIX.—This area is adjacent to the Montana South Workings, which constitute the most extensive workings in the area surveyed. A series of three floors is intersected by two fissure lodes, and the complex structure has been systematically sluiced over the eastern face of the spur which projects from the main Renison Bell Hill. The 1951 survey, during which " anomalous area " XIX. was discovered, extended only to the western and northern margins of the workings, traverses 2500S to 3010S crossing the spur referred to above and terminating at the edge of the sluiced workings.

The magnetic results obtained along these traverses between the baseline and the workings are shown in the form of profiles on Plate 4. The profiles show an anomaly, which, although much weaker than those on Renison Bell Hill, indicates a deep-seated magnetic body striking roughly parallel to the baseline and lying between 500E and 600E. The anomaly is such as would be caused by a tabular body with vertical or near-vertical dip and could therefore indicate a fissure lode. Theoretical calculations show that, with certain limitations, the depth below the surface of such a magnetic body is equal to the horizontal distance over which the magnetic anomaly falls from the maximum value to half that value. Application of this principle to the six profiles (Plate 4) indicates that the top of the body is probably near the 1,000-foot level. This is the same level as the middle of the floor system of the Montana South Workings.

The self-potential contours show a negative anomaly, which indicates a westerly extension of the floor system into the hill, possibly as far as 700E. As stated previously, the 1951 survey extended only to the western and northern margin of the workings; the extension of the survey to the east during 1952 revealed that the self-potential anomaly continues in that direction to constitute anomalous Area XXVII., which is discussed later. Summing up the anomalies which constitute Area XIX., the most probable interpretation appears to be that of a floor associated with a fissure lode. An inclined hole (G22), collared at 2800S/800E and depressed at 45 degrees on a true bearing of 247 degrees, was recommended to test the validity of this interpretation.

Dreadnought-Federal Section.

As a result of adverse weather, only a limited number of traverses in the Dreadnought-Federal section could be extended eastwards during 1951 to cross the Dreadnought-Stebbins ridge. These traverses were chosen so as to give a general indication of the trend of the self-potential and magnetic values on an east-west cross section of the Dreadnought-Federal lode system. It was necessary to terminate the 1951 field work even though there were gaps in the coverage of the area and some of the anomalies were only partly delineated. During 1952, the survey was extended southwards from 2000S to 3200S, but it was not possible to complete the survey of the area between Evenden's Workings and the Federal Workings.

The results in the Dreadnought-Federal section are, in general, of a different character from those in the Renison Bell section. The gradients of both the self-potential and magnetic anomalies are more gentle. Also, the average level of the magnetic values is about 1,000 gammas higher than in the Renison Bell section, an effect which may be related to the change (referred to earlier) in the type of sedimentary rocks. Along the Dreadnought-Federal line of lode, these are quite distinct from the more westerly outcrops. The rocks on the Dreadnought-Stebbins ridge appear to become more massive and felspathic in character going eastwards from the " red rock " beds and are slightly tuffaceous in aspect. The anomalies in this area are now discussed in detail.

Areas XX. and XXI.—Situated on the ridge leading to the summit of Dreadnought Hill, both of these areas show magnetic and self-potential anomalies. Area XXI. has not been fully delineated, as the anomalies obviously continue to the north beyond traverse 1000S, the most northerly traverse surveyed in this section. Traverses 1000S to 1500S show a broad self-potential trough, which could be due to a sulphide body extending through both areas, and with its upper limit at a depth of about 200 feet. A single body of this type does not explain the magnetic anomalies however, as these appear to be due mainly to mineralization at shallow depths.

Area XXII.—Four traverses, 1000S to 1300S inclusive, were extended over the eastern slopes of Dreadnought Hill in order to investigate the Dreadnought line of lode south-east of Evenden's Workings. The self-potential results indicate the presence of a sulphide body east of Evenden's Cut, dipping to the east at a steep angle (60 degrees to 80 degrees), with the limit of the unoxidized zone about 150 to 200 feet below 2500E. The continuation upwards of this body would cause it to crop out at the position of Evenden's Cut. The body appears to strike south, and may therefore link up with the Federal lode. The existence of such a body would be consistent with the views of Ward (1909, page 158) and Conder (1918, page 73), who considered that the Federal lode forms part of the Dreadnought lode system. Fisher (1943, page 21) considers this unlikely, however, unless considerable faulting has taken place, as their strikes are somewhat different and the characteristics of the lodes, on the whole, are quite distinctive. Completion of the geophysical survey between 1300S and 1800S would probably clarify this point.

Area XXIII.—During the 1951 season three traverses were surveyed across the northern end of the Federal open cut and each method revealed a well-defined anomaly. The extension of the survey to the south in 1952 verified the existence of the anomalies and traced their continuation to about 2400S where the intensity of each decreases sharply, indicating the termination of the lode near this traverse. Considerable information is available about the Federal ore-body and is illustrated in sections accompanying the report by Fisher (1943). In the northern part of the workings, the oxidized ore has been removed by open cut and stoping, and a sulphide body about 40 feet wide dips to the east at about 67 degrees. The theoretical magnetic profile calculated for such a body, assuming the susceptibility to be of the order of 0·1, agrees very closely with the observed profiles. The self-potential results indicate that active oxidation is taking place, but the survey should be continued eastwards to obtain sufficient data to enable a quantitative determination to be made of the depth extent of the body. However, on the basis of the magnetic and self-potention profiles as they stand at present, it is estimated that the body extends for at least 200 feet, that is, down to the level of the Boulder tramline.

Completion of the survey between 1300S and 1800S, as recommended earlier, would determine with considerable certainty the length of the Federal ore-body along its strike, and in particular should clarify the point on which geological opinion is divided, namely whether the ore-body is pinched out or faulted beneath Dreadnought Creek.

The self-potential profiles indicate the possibility of another lode system parallel to, and about 200 feet west of, the main Federal lode. The outcrop of rock in this locality has been investigated by three small trenches located, by coincidence, on traverses 1790S, 1900S and 2000S.

Montana South-Dunn's Section.

The remaining anomalies, XXIV. to XXVII., were found during the 1952 survey, which covered the Montana South and Dunn's Workings, as well as the southern portion of the Federal cut, referred to previously under anomaly XXIII. In general, there are fewer anomalies in this area, but most of those shown are well pronounced and of considerable extent, particularly in the eastern portion.

Area XXIV.—This indication is very well-defined and extensive on the self-potential map (Plate 3), but appears only as a very weak local anomaly on the magnetic map. The self-potential anomaly starts at about 2350E on traverse 2600S, increases rapidly in intensity to a maximum value on traverse 2700S, continues at almost undiminished strength to a second maximum on traverse 3100S, and is still prominent on the southernmost traverse surveyed (3200S). The profiles indicate that the source is nearest to the surface near 2325E on traverse 2700S, whilst further south the anomaly appears to originate from greater depth. The anomaly, which is situated directly on Stebbins Hill, indicates that the body responsible dips to the west and strikes slightly west of north.

The weak magnetic anomaly is confined to traverse 2800S, the traverses to the immediate north and south showing only small, poorly-defined variations in intensity.

The extent and strength of the self-potential anomaly warrants further investigation. A recommendation was made to the company that the anomaly be tested by drill holes G23 and G24, the former to be collared at 2275E on traverse 2700S, and drilled at an angle of depression of 45 degrees on a true bearing of 67 degrees, i.e., in the direction of the traverse, and the latter to be a vertical hole at 2315E on traverse 3100S.

Area XXV.—This anomaly, which coincides with Dunn's Workings, is well-defined on both the self-potential and magnetic contour maps. Indications are that the lode does not extend much beyond the northern end of Dunn's Workings, but the survey did not extend sufficiently far south to reveal the extent of the ore-body in that direction.

Area XXVI.—This anomaly is to the north-west of Dunn's Workings, from which it extends for several hundred feet. The self-potential values are not as high as those of the other self-potential anomalies, and the magnetic values are not as high in the area of the self-potential maximum as they are to the immediate north-west, where, as stated earlier, they link up with Area XVII. Nevertheless, the indications were considered sufficiently strong to warrant further investigation, particularly as the source does not appear to be deep-seated. A recommendation was therefore made that a drill hole (G25) of 100 to 150 feet depth be put down at 1550E on traverse 2700S, on a bearing of 67 degrees (true) and depressed at 45 degrees.

Area XXVII.—This anomalous area covers the extensive Montana South Workings and, as stated earlier, can be associated with anomaly Area XIX., particularly as regards the self-potential values. The pattern on both contour maps is very irregular and there are several negative self-potential centres and magnetic highs so close together that it would be virtually impossible to consider each one individually. A remarkable feature of the self-potential results is the way in which three well-defined minima in the usual direction of strike suggest the presence of three narrow mineralized zones which may be obscured in the zone of weathering. As the survey did not cover the southern part of the Montana Workings, no indication can be given of the extent of the ore-body in that direction.

SUMMARY OF TESTING RECOMMENDATIONS.

The table below summarizes the drill holes and trenches which were recommended on the basis of the geophysical results.

D.D.H /Trench.	Co-ordinates of Collar/Trench Ends.	Anomaly Area.	True Bearing of Hole/Trench.	Depression of Hole.
G1	1050s 180E	VII.	Vertical	90°
G2	1200s 475E	VII.	247°	30°
G3	1400s 575E	VII.	187°	45°
G4	1400s 225E	VIII.	202°	45°
G5	1790s 275E	IV.	Vertical	90°
G6	1890s 600E	IX.	247°	45°
G7	1650s 960E	XI.	187°	45°
G8	800s 400W	XIII.	277°	60°
G9	500s 775E	X.	202°	45°
G10	1000s 900E	V.	187°	30°
G11	500s 40W	XII.	247°	60°
G12T	2050s 475W–550W	XIV.	67°	..
G13T	2300s 400W–500W	XIV.	67°	..
G14T	2200s 00–500W	XIV.	67°	..
G15	2550s 400W	XIV.	Vertical	90°
G16	2200s 00	XIV.	247°	20°
G17	2900s 50E	XIV.	270°	20°
G18	2300s 425E	XV.	247°	45°
G19T	2100s 700E–625E	XVI.	67°	..
G20	2050s 725E	XVI.	210°	45°
G21	1890s 1000E	XI.	50°	45°
G22	2800s 800E	XIX.	247°	45°
G23	2700s 2275E	XXIV.	67°	45°
G24	3100s 2315E	XXIV.	Vertical	90°
G25	2700s 1550E	XXVI.	67°	45°

Information available from the company at the date of writing is that the only geophysical anomaly which has been investigated by drilling is that embracing Hetherington's Workings (or Cross Lode). Bores which have been put down there over a distance of 150 feet eastwards from the exposure in the open-cut, have shown that the occurrence is a sill dipping gently to the east.

CONCLUSIONS AND RECOMMENDATIONS.

The results of the surveys show that the magnetic and self-potential methods are capable of locating with considerable certainty the type of sulphide body which occurs at Renison Bell. The usefulness of the two methods was established during the 1950 survey when it was shown that all the known ore-bodies surveyed produced fairly well-defined anomalies, and the later work, as well as confirming this, revealed several significant indications in parts of the field where ore-bodies had not previously been known.

The most promising areas, apart from those which have already been worked, or are being worked, would appear to be:—

(1) Area XIV., near the top of Renison Bell Hill, where an area of intense anomalies was outlined, giving evidence of a strongly mineralized zone (probably a continuation of the Upper Blow lode) about 1,300 feet long and several hundred feet wide.

(2) Areas XIX. and XXVII., near the Montana South Workings, where the results indicate the probability of a substantial extension of the lode system westwards into Renison Bell Hill.

(3) Area XI., south of the Montana North Workings, where there are also indications of a westward extension of the lode system.

(4) Area XXIV., on Stebbins Hill, where the self-potential survey indicated a fairly extensive zone of mineralization.

It is considered that the recommendations made for testing the above anomalous areas would afford the greatest chances of discovering additional ore-bodies of economic value. Such testing should be carried out before any additional geophysical work is contemplated, as the results would serve to verify the conclusions which have been drawn from the surveys carried out, and would provide valuable data for the interpretation of the results of any subsequent surveys which may be made.

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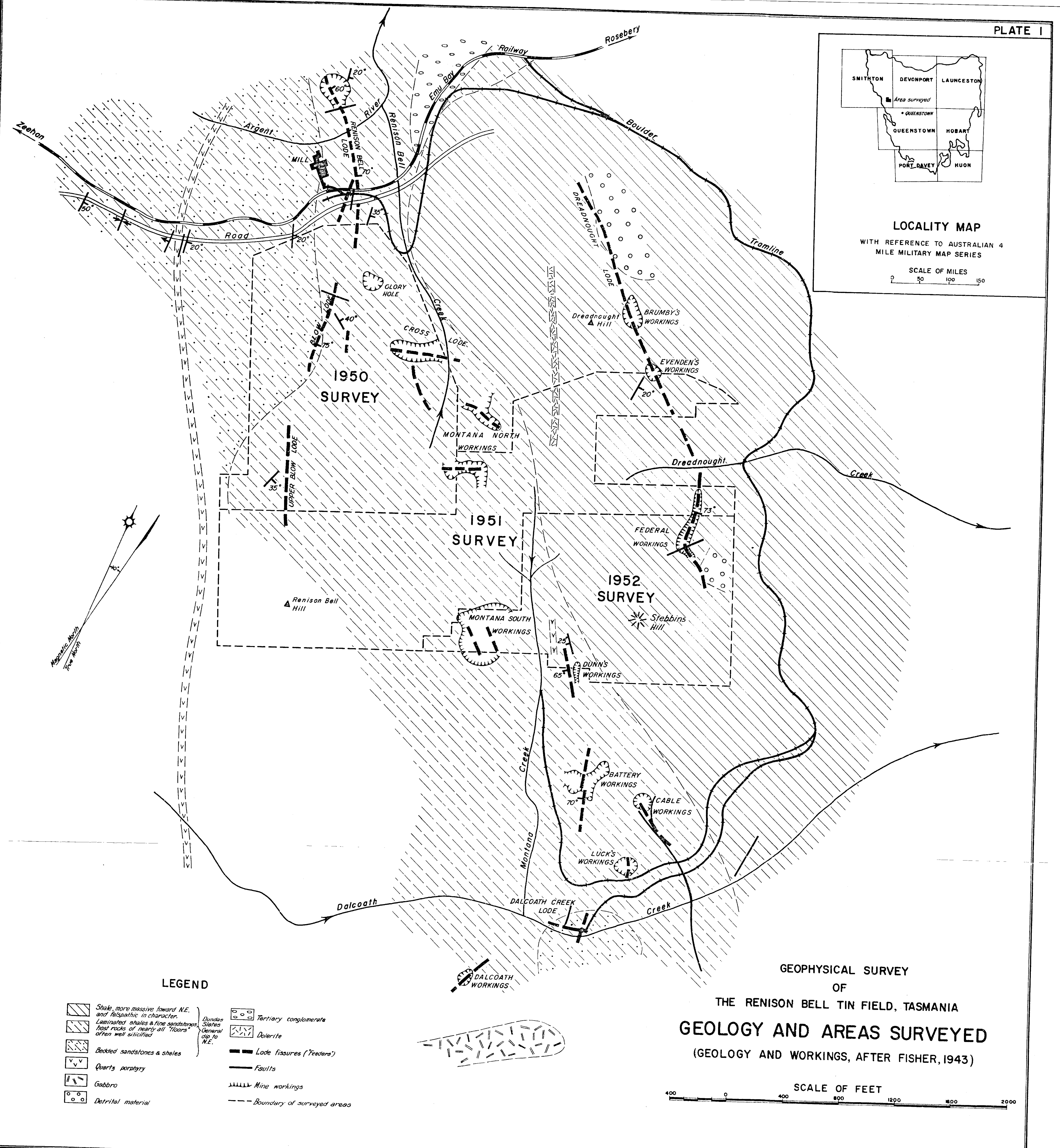

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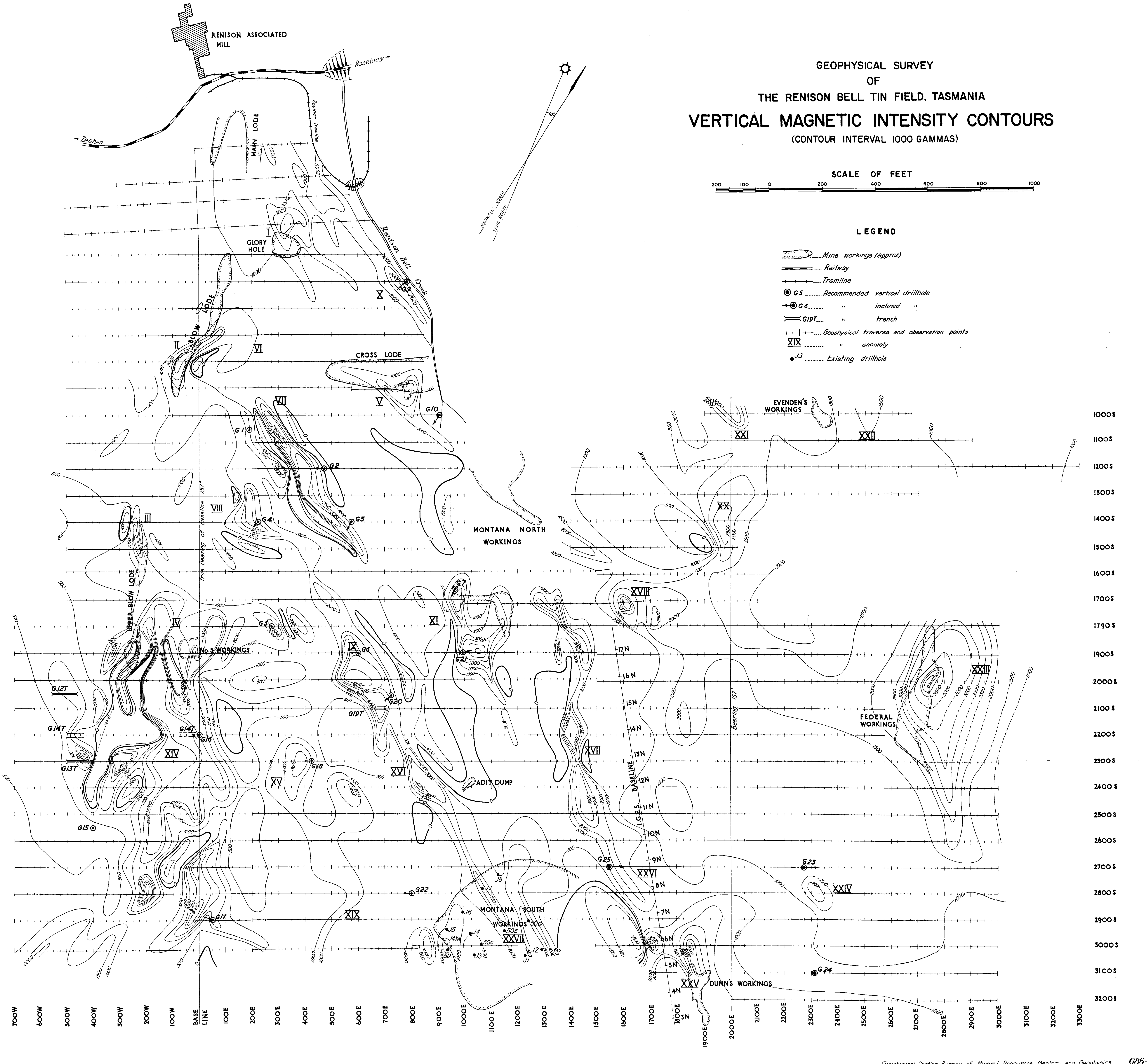

GEOPHYSICAL SURVEY
OF
THE RENISON BELL TIN FIELD, TASMANIA
VERTICAL MAGNETIC INTENSITY CONTOURS
(CONTOUR INTERVAL 1000 GAMMAS)
SCALE OF FEET
LEGEND
Mine workings (approx)
Railway
Tramline
G5 Recommended vertical drillhole
G6 inclined
G19T trench
Geophysical traverse and observation points
XIX anomaly
J3 Existing drillhole
RENISON ASSOCIATED MILL
Rosebery
Zeehan
MAIN LODE
GLORY HOLE
BLOW LODE
CROSS LODE
Renison Bell Creek
EVENDEN'S WORKINGS
MONTANA NORTH WORKINGS
UPPER BLOW LODE
No.5 WORKINGS
FEDERAL WORKINGS
ADIT DUMP
MONTANA SOUTH WORKINGS
DUNN'S WORKINGS
I.G.E.S. BASELINE
True Bearing of Baseline 157°
MAGNETIC NORTH
TRUE NORTH
BASE LINE

PLATE 3

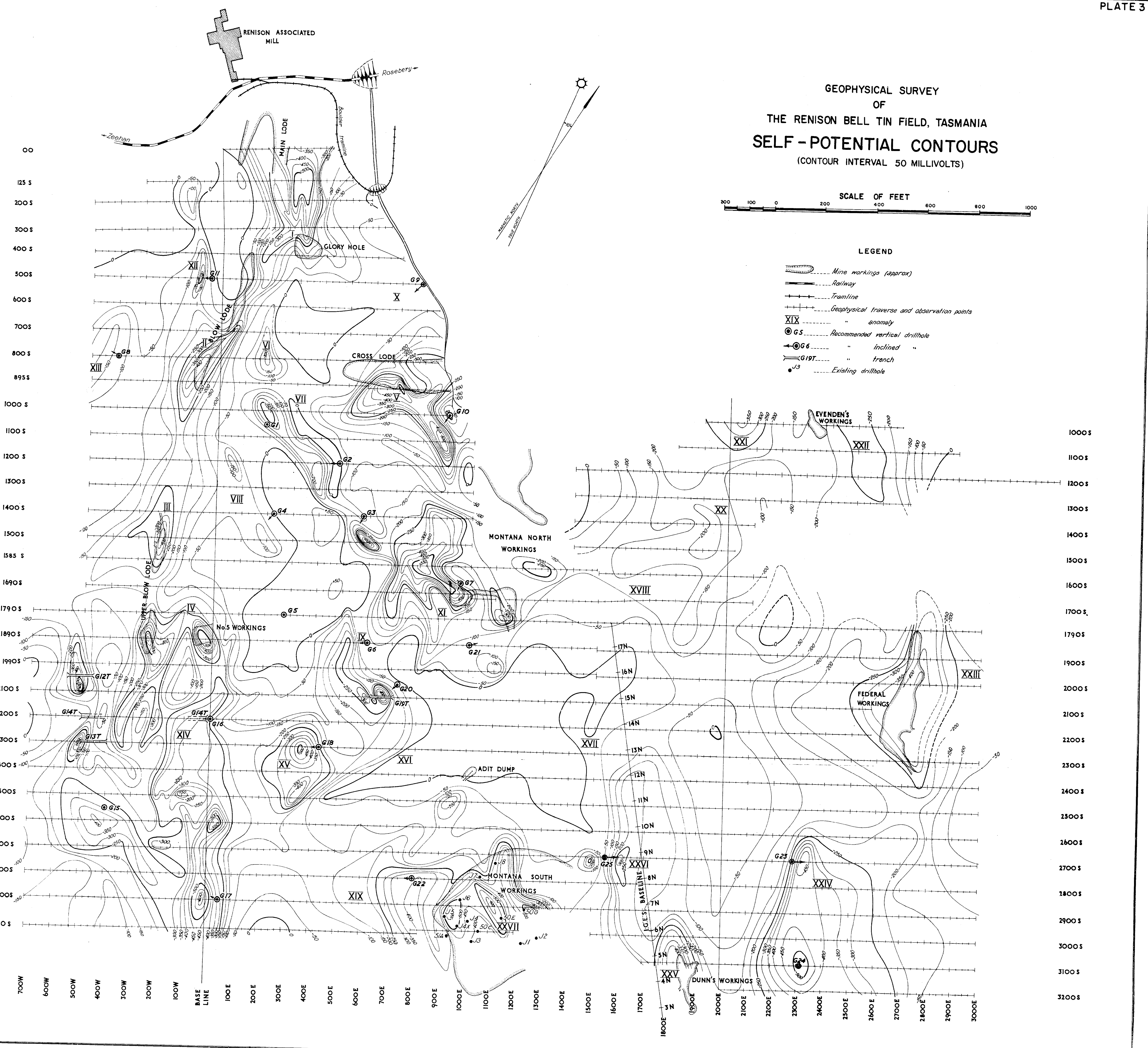
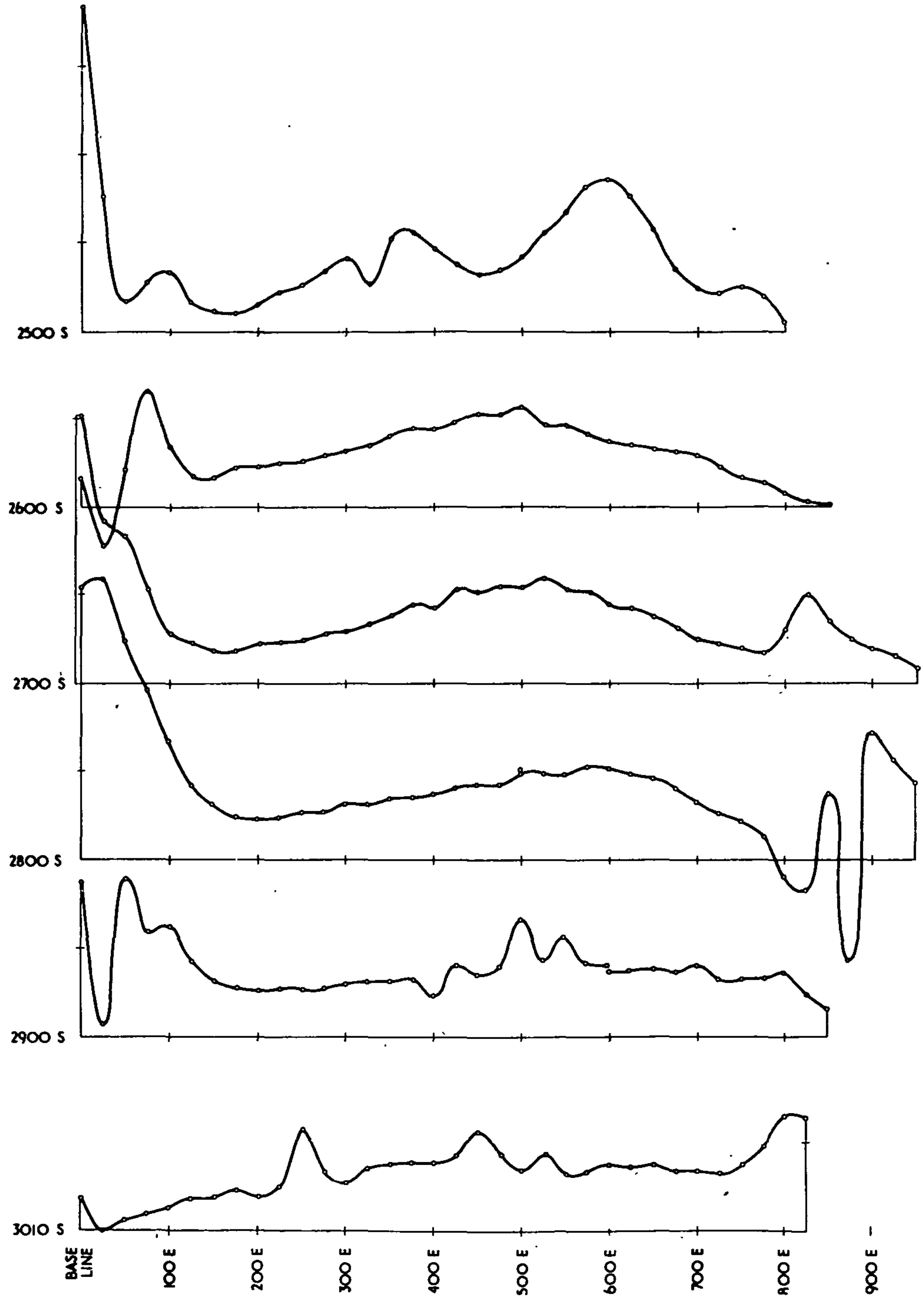

GEOPHYSICAL SURVEY
OF
THE RENISON BELL TIN FIELD, TASMANIA
SELF-POTENTIAL CONTOURS
(CONTOUR INTERVAL 50 MILLIVOLTS)
SCALE OF FEET
200 100 0 200 400 600 800 1000
LEGEND
Mine workings (approx)
Railway
Tramline
Geophysical traverse and observation points
XIX anomaly
G5 Recommended vertical drillhole
G6 Inclined
G19T trench
J3 Existing drillhole
RENISON ASSOCIATED MILL
Rosebery
Zeehan
Boulder tramline
MAIN LODE
GLORY HOLE
BLOW LODE
CROSS LODE
MONTANA NORTH WORKINGS
UPPER BLOW LODE
No.5 WORKINGS
ADIT DUMP
MONTANA SOUTH WORKINGS
EVENDEN'S WORKINGS
FEDERAL WORKINGS
DUNN'S WORKINGS
I.G.E.S. BASELINE
BASE LINE

PLATE 4



R. Philip Loh
GEOPHYSICIST

SCALES

HORIZONTAL 100 0 100 200 300 400 FEET

VERTICAL 1000 0 1000 2000 3000 4000 GAMMAS

GEOPHYSICAL SURVEY AT RENISON BELL TIN FIELD, TASMANIA

MAGNETIC VERTICAL FORCE PROFILES

MONTANA SECTION

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