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COMSTOCK AREA
GEOPHYSICAL SURVEY, QUEENSTOWN

TASMANIA 1965

by

J.P. WILLIAMS

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CONTENTS

		Page
	SUMMARY	
1.	INTRODUCTION	1
2.	GEOLOGY	1
3.	METHODS AND EQUIPMENT	3
4.	FIELD WORK AND RESULTS	5
5.	INTERPRETATION	7
6.	CONCLUSIONS AND RECOMMENDATIONS	10
7.	REFERENCES	12

ILLUSTRATIONS

Plate 1.	Locality map showing geology.	(Drawing No. K55/B7-120)
Plate 2.	Topography and survey plan	(K55/B7-122)
Plate 3.	Comparison of geophysical and geological sections, traverse 1200W.	(K55/B7-115)
Plate 4.	Selected geophysical profiles, inferred geology, and drilling recommendations	(K55/B7-121)
Plate 5.	I.P. anomalies and Turam ratio contours (grounded cable along 800S)	(K55/B7-117)
Plate 6.	I.P. anomalies and Turam ratio contours (grounded cable along 1800N)	(K55/B7-119)
Plate 7.	I.P. anomalies and Turam phase contours (grounded cable along 800S)	(K55/B7-118)
Plate 8.	I.P. anomalies and Turam phase contours (grounded cable along 1800N)	(K55/B7-116)

NOTE. This Record supersedes Record No. 1965/151.

SUMMARY

Geophysical work carried out in the Comstock Valley in early 1965 for the Mount Lyell Mining and Railway Company completed the survey initiated in 1964. The aim of the survey was to investigate the possible occurrence of sulphide mineralisation similar to that already known in the Mount Lyell field using electromagnetic, magnetic, and electrical methods.

Anomalies were recorded with both electromagnetic (Turam) and induced polarisation methods. The Turam results indicate a conducting zone extending across the area in a position geologically favourable for mineralisation. Strong to medium induced polarisation effects were recorded over the greater part of the conducting zone. The geophysical results compare favourably with those over known orebodies in the Mount Lyell field. It is considered that the anomalous zone is due mainly to mineralisation, although in places shear zones may contribute to the higher conductivity.

Another Turam anomaly of small extent, accompanied by a weak induced polarisation anomaly may be due to weak sulphide mineralisation or possibly to lead-zinc mineralisation similar to that in the Tasman galena lode.

Four drill holes are recommended as a preliminary test of the geophysical results.

1. INTRODUCTION

The Comstock mines are situated on the northern flank of Mount Lyell about three miles north-east of Queenstown, Tasmania, (Plate 1). The old workings are near the head of the Comstock Valley, which is bordered by Mount Sedgwick to the north and Mount Lyell to the south. The valley is drained by the Comstock Creek, which flows eastward into the King River. A road along the old Comstock tram track provides access to the area (Plates 1 and 2).

The Lyell Comstock mine contains four en echelon, disseminated, pyrite-chalcopyrite orebodies. These have been mined sporadically for copper from 1901 until 1944 when prevailing economic conditions caused a cessation of operations. The Tasman and Crown Lyell mine extended (hereafter referred to as the Tasman mine) is a small galena-sphalerite lode about eight hundred feet east of the main workings.

The earliest geophysical surveys of the area were conducted by E.L.Blazey and G.Douglas between 1934 and 1938 (Richardson, 1949). The equipotential-line method was employed on the survey, which covered a small area north of the mines. The Bureau of Mineral Resources (BMR) conducted a similar survey in 1948-1949 (Webb, 1958) and covered all the area in the vicinity of the mines. A second survey was carried out by the BMR in 1957 (Rowston, 1959) using the more modern Turam (electromagnetic) method. The survey again covered the mine area, and the earlier findings were outlined in more detail. The private company Rio Tinto (1959) conducted a similar survey north-east of Rowston's work in 1958-1959. The positions of all these areas are shown in Plate 2. These surveys outlined mineralisation of the Lyell Comstock and Tasman mines, but did not indicate any new prospects.

At the request of the Mount Lyell Mining and Railway Company, supported by the Tasmanian Mines Department, a geophysical survey of the Comstock Valley was commenced in 1964 (Williams, 1965) and completed during the period January to April 1965. Most of the work was carried out in the 1965 season. The surveyed area is shown in Plates 1 and 2. It was selected to investigate the eastern part of the valley, which appeared a favourable prospect for further sulphide orebodies. The methods used were electromagnetic, induced polarisation, self-potential, and magnetic.

The progress of the survey was hampered by bad weather and the rugged terrain, which are typical of the west coast of Tasmania. The geophysical party consisted of geophysicists J. P. Williams (party leader), R. H. Andrews, and A. Howland-Rose (for part of survey), and four field-hands. Two of the field-hands were provided by the Mount Lyell Mining and Railway Company. The geophysical grid was surveyed and pegged by the Mount Lyell M. & R. Co., which also assisted the progress of the survey by bulldozing access tracks.

Permission of the Mount Lyell M. & R. Co. to use the inferred geological sections is gratefully acknowledged. The author also wishes to thank the staff of Mount Lyell M. & R. Co., especially the Chief Geologist, R. Elms, for their co-operation.

2. GEOLOGY

The most recent accounts of the geology of the area are given by Wade and Solomon (1958) and by Solomon and Elms (1965). This summary is drawn largely from these two sources.

The Comstock Valley is a classic example of a U-shaped glaciated valley. It is bordered to the north and south by the slopes of Mounts Sedgwick and Lyell, which are composed of the weather-resistant Owen Conglomerate Series. The western part of the valley is rugged owing to recent erosion of glacial deposits, but in the east the glacials have been reduced to the level of a swamp.

The geological succession is indicated in the regional geological map of Plate 1. Since this map was compiled, the geology of Mount Lyell has undergone revision and the Dundas Group, with the exception of the Jukes Conglomerate, is now referred to as the Mount Read Volcanics. The use of the term Mount Read Volcanics in this report follows the geological description of Solomon and Elms (1965). A detailed geological map of Comstock is not available because of the lack of outcrop. The inferred geological sections of Plate 4 were supplied by the Mount Lyell M. & R. Co. as a guide to the possible structure of the area. Owing to lack of outcrop, they are not claimed to be accurate. Their main purpose is to demonstrate the complicated folding and faulting which produce such anomalies as older schist on top of conglomerate.

The oldest rocks that crop out in the Comstock area are the Lyell schists. These are mainly the Cambrian Mount Read Volcanics which have undergone chloritisation and albitization during the Devonian period. They have been described variously as altered volcanics, greywackes, porphyries, and, most recently, as altered keratophyres and pyroclastics (Solomon & Elms, 1965). Near the Lyell Comstock open cut the schistosity has a north-easterly trend, but gradually swings to the east over the Tasman mine as it follows the conglomerate contact.

Deposition of the Owen Conglomerate Series commenced in the late Cambrian or early Ordovician. The series consists of conglomerate, shales, and sandstones and forms the main outcrop in the Comstock area. The series contains some haematite, which may be secondary, and in places appears to be altered to schists so that the schist-conglomerate contact is not necessarily a stratigraphic one.

The Gordon Limestone is also Ordovician. It does not crop out at Comstock, but may overlie the conglomerate in the east (see inferred geological section of traverse 5600E, Plate 4.) The Crotty Quartzite of the Eldon Group (Silurian) crops out to the north-east of the area. It would overlie the Gordon Limestone, if this is present, but otherwise the Owen Conglomerate.

The main Cainozoic deposits are tills and varved shales, which resulted from the Pleistocene glaciation. Maximum thickness of these sediments is probably about 200 feet (authors observation).

Lower Palaeozoic tectonic movements caused folding of the Lyell schists and the early movements along the Lyell Shear. These movements continued during the Tabberabberan Orogeny. The folding and upthrusting of the Owen Conglomerate Series were accomplished in this period. The Sedgwick and Comstock Faults, prominent structural features of the area, are also related to this orogeny.

The mineralisation of the Mount Lyell field took place in the closing phases of the Tabberabberan Orogeny. The orebodies are largely in the Mount Read Volcanics. They are adjacent to the conglomerate and at the intersection of the Lyell Shear zone and the major east-west structures of the field. The Comstock orebodies are at the intersection of the Lyell Shear and the Comstock Fault.

The four Comstock orebodies are en echelon and pitch to the south-west. The ore is disseminated chalcopyrite with bornite, pyrite, and minor amounts of associated minerals. The mineralisation is typical of the disseminated orebodies of the Mount Lyell field.

5

The Tasman mine lies to the east of the Lyell Comstock open cut and has two orebodies (Plate 3). The northern body is disseminated bornite in schist. The southern body is a small, rich, silver-lead-zinc lode.

The structural features of the area suggest that the Comstock Fault continues east of the Tasman mine under glacial cover. Mineralisation may be related to this fault zone.

The 1964-5 geophysical survey was planned to investigate the possibility of mineralisation along the presumed extension of the Comstock Fault. The geophysical traverses were located at right angles to the regional strike of the sediments because known mineralisation is approximately parallel to this strike. The traverses were extended north across the valley to cover the area about the Sedgwick Fault. No mineralisation has been recorded along this fault, but it is in a structurally favourable position. Although copper clay deposits occur in the Gordon Limestone at Linda, their presence is not suspected in the survey area.

3. METHODS AND EQUIPMENT

Geophysical methods used on the survey were self-potential (S-P), magnetic, electromagnetic (E.M.), and induced polarisation (I.P.).

The self-potential method. This method involves the surface measurement of naturally occurring potentials within the earth. An electrochemical process involving two half-cell reactions, oxidation and reduction, can give rise to large negative self-potentials over sulphide orebodies. It is generally thought that the orebody should be intersected by the watertable to provide the necessary conditions, but this is not always the case (Becker & Telford, 1965). S-P anomalies may also be due to graphite deposits or large topographic features.

A transistorised S-P meter (type RL807B) designed by the BMR was used in the survey. This unit is portable, an important consideration in areas of rough terrain. It also has a high input impedance which is very desirable at Mount Lyell, where the contact resistance of potential electrodes is usually high. This is partly due to the scree slopes and partly to the covering of peat which may be several feet thick in the valley.

The magnetic method. Variations of the vertical magnetic field intensity of the Earth were observed at Comstock with an ABEM vertical variometer. Magnetic anomalies are due to the concentration of magnetic minerals such as pyrrhotite or magnetite. Pyrrhotite has never been recognised at Mount Lyell. Minute quantities of magnetite are present in some orebodies and surrounding sediments. Although correlation is difficult, the resultant anomalies may assist in outlining the general structure of an area (Williams, 1965).

The electromagnetic method. With this method an artificial electric field is induced in the earth, and its behaviour is studied at various points on the Earth's surface. The anomalous fields that arise if electrical conductors are present can be recognised from surface observations. The E.M. method used at Comstock was Turam. The equipment was the ABEM Turam 2S compensator-amplifier.

In the Turam method an alternating electrical field is established in the area by an audio-frequency generator connected in series with a long straight insulated cable grounded at both ends. The distribution of the primary field over the area can be calculated for homogeneous earth. Secondary or eddy currents will be induced in any electrical conductor present. The fields due to these currents are superimposed on the primary field, and the resultant field can be measured at the surface. The detection apparatus consists of two search coils connected to a compensator-amplifier. The coils are kept a constant distance apart and moved along traverse lines at right angles to the primary cable. The parameters measured are the ratio of the vertical field amplitudes and the difference in phase angles in the two coils. A correction for normal ratio of homogeneous earth is then applied to each measured or field ratio to give the reduced ratio. The phase angle differences do not require corrections. The reduced ratios and phase angle differences are indicative of subsurface conductivity.

Superimposition of the secondary fields on the primary field usually causes an increase of total field amplitude, so reduced ratios greater than 1.0 normally indicate the presence of a conductor. The secondary currents usually cause a phase lag relative to the primary field, so that the presence of conductors is usually indicated by negative phase angle differences.

The depth at which the Turam method can detect subsurface conductors is governed by the frequency of the primary field. Depth of penetration increases with decrease of frequency. Primary field frequencies of 220 c/s and 660 c/s can be employed with the 2S equipment. 220 c/s is a convenient frequency that is low in the audio range, but high enough to avoid effects due to natural earth currents.

The strength of a Turam anomaly depends on distance of the source from the primary cable as well as the nature of the source. Turam observations are usually confined to within 1800 feet of the primary cable as the strength of the primary field decreases with distance from the cable.

The maximum ratio and minimum phase angle difference coincide approximately with the location of the conductor. Under favourable conditions, the depth to the current concentration in the conductor and the degree of conductivity may be estimated from the Turam results. The real and imaginary components of the vertical electromagnetic field vector can be derived from the reduced ratios and phase angle differences. These components are then used to calculate the position of and depth to the current concentration. The degree of conductivity is deduced from the relative amplitudes of the ratio and phase anomalies. At the scale on which the Turam results are plotted in Plates 3 and 4, equal amplitudes indicate a medium conductor; a small ratio and large phase anomaly indicates a poor conductor; and a large ratio and small phase anomaly a good conductor.

<u>The induced polarisation method</u>. The I.P. effect is exhibited by rocks in which the ionic conduction paths are blocked by metallic minerals. If a current is passed through such a rock, an electrochemical force must be overcome to permit passage of the current. The force opposing current flow is believed to be due to polarisation at the metal/solution interfaces and an added voltage called overvoltage is required for passage of the current. If the applied current is switched off, the overvoltage decays in a finite time. Because the overvoltage is also built up over a finite time, it is found that rock impedances decrease with increasing frequency.

With the Geoscience Inc. equipment used at Comstock, measurements were taken in the frequency domain. The apparent resistivity of the ground is measured at two frequencies, and the percentage change is called the frequency effect (F.E.). Hence

$$F.E. = \frac{\rho_{dc} - \rho_{ac}}{\rho_{ac}} \times 100\%$$

7

where ρ_{dc} is the apparent resistivity at the low, or 'd.c.', frequency and ρ_{ac} is the apparent resistivity at the high frequency. The frequency effect increases as the difference between the two transmitting frequencies is increased. Frequencies of 10 c/s and 0.3 c/s were used. 10 c/s is chosen as an upper limit because electromagnetic coupling can be troublesome above this value. 0.3 c/s was the minimum value used in order to avoid interference from natural low frequency earth currents and self-potential effects.

The results are also presented in the form of metal factors (M.F.), where

$$M.F. = \frac{F.E. \times 2000}{\rho_{ac}} \text{ mhos/ft}$$

The metal factor is considered to be related to the content of metallic minerals in the ground.

The observations were made with the dipole - dipole configuration, and the results were plotted in the conventional sectional form. These sections must not be considered as true vertical cross-sections of the earth's electrical properties. They may have no direct relationship to depth.

The I.P. effect is exhibited by electronic conductors such as metallic sulphides, oxides such as magnetite, graphite, and native copper. Under certain conditions, clay deposits can also give I.P. effects. Ionic conductors, such as mineralised water in shear zones, will not produce I.P. effects.

The I.P. anomalies due to sulphide mineralisation are generally characterised by small apparent resistivities, large frequency effects, and consequently, high metal factors. The low resistivities are due to the high electrical conductivities of the sulphides compared to the country rocks.

The form of an I.P. anomaly is influenced by several variables. The most important are :

(1) The size of the source. This has obvious effects on the extent of the anomaly.

(2) The degree of mineralisation. It is found that disseminated mineralisation will give a stronger frequency effect than a massive body. This is due to the increased number of interfaces over which polarisation can take place.

(3) The position and separation of the electrodes relative to the source. This may have an unexpected effect, e.g., if the source is small and lies entirely between two electrodes, it is impossible to determine its position from one set of readings.

4. FIELDWORK AND RESULTS

Plate 2 shows the geophysical grid. It has the same orientation as the mine grid, but the co-ordinates were simplified and the datum was chosen arbitrarily. Traverse 6400 E marks the eastern limit of the lease held by the Mount Lyell M. & R. Co.

Self-potential

Traverses 00 to 2400 E were surveyed at 50-ft intervals from 1400 S to 300 N with the S-P method. Large negative anomalies were recorded on the southern parts of all traverses. These coincided with the steep slopes of Mount Lyell. Effects due to electric trains (Williams, 1965) were recognisable, but avoidable. As poor surface conditions led to inaccurate readings and no significant anomalies were recorded, the use of the method was discontinued.

Magnetic

Test readings were made over E.M. and I.P. anomalies, but no anomalies were recorded and the method was not further applied.

Electromagnetic

The traverses surveyed with the Turam method are shown in Plates 5 to 8. Readings were taken every 50 feet with a coil spacing of 100 feet. Traverses 5000 E to 6200 E were re-surveyed with a coil spacing of 50 feet to give more detailed information for depth calculations. Frequencies of 220 c/s and 660 c/s were used on all traverses. The results using the two frequencies were similar and only those at 660 c/s are presented.

Selection of suitable positions for the primary cable was a problem. After a series of tests, a primary cable at 1200 S was abandoned in favour of one along 800 S, with grounding points at 00 and 7000 E.

The ratio and phase results shown by contours in Plates 5 and 7 were measured with the primary cable at 800 S, except for traverse 00 and 400 E, which were surveyed with the primary cable at 1200 S. The results on traverses 00 and 400 E have been included to complete the contour plans and this appeared to be justified as the results on 800 E from both cables were in good agreement. The contoured ratio and phase results of Plates 6 and 8 were measured with primary cable at 1800 N and grounded at 1000 W and 7200 E.

The Turam results obtained with the two primary cable positions, 800 S and 1800 N, show minor differences where the layouts overlap between 00 and 800 N. The agreement of results was not improved by changing the cable position or grounding points. Because of these differences, the results from the two cables are discussed separately. Turam profiles, with I.P. results and inferred geological sections, along selected traverses are shown in Plate 4.

Primary cable at 800 S (Plates 5 and 7). The main feature is the anomaly extending from 300 S on traverse 6400 E to 800 N on traverse 800 E. The anomaly is narrow and well-defined on traverses 6200 E to 5200 E, but becomes wider west of 5200 E. The highest ratio values occur between 3600 E and 1600 E. West of 1600 E the anomaly weakens rapidly and on traverse 800 E it is only discernible in the phase difference measurements. On the north side of the anomaly from 3600 E to 1600 E, positive phase differences up to $+10^{\circ}$ and low ratios of about 1.0 are present. These features could not be traced west of 1600 E as the distance from the primary cable became too great.

Between 800 N and 200 S on traverse 00 to 1200 E, another Turam anomaly was observed. This is strongest on traverse 800 E (see Plate 4), where ratio values reach 1.13 and phase differences -13°. Low ratios (1 to 0.9) and positive phase differences (to $+5^{\circ}$) occur on the north side of the anomaly.

Primary cable at 1800 N (Plates 6 and 8). The main Turam anomaly already described was not covered completely because the distance from the cable at 1800 N became too great. However, a small anomaly with ratio 1.20 and phase difference -5°, observed on traverse 400 E at 800 N and traverse 00 at 1000 N, may be a continuation of the main anomaly, although its presence on 800 E is doubtful.

A small but well-defined anomaly occurred on traverse 6400 E at 2400 N. It weakens rapidly to the west and its eastern extent is unknown, as the survey was not continued beyond the lease boundary. There are no other significant anomalies in the area. Some variations in ratio and phase values are apparent in the contour maps, but they are not in the form of recognisable anomalies.

Induced polarisation

The method was not used on all traverses but was concentrated mainly on the Turam anomalies. The traverses surveyed are indicated in Plates 5 to 8. A dipole length of 200 feet was used. One traverse, 3200 E, was repeated with 300-ft dipoles but little additional information was obtained. The depth penetration, which is increased by increasing the dipole separation, was limited by the power of the I.P. transmitter. With the maximum transmitted current (2 amps), it was not possible to produce a readable signal at the receiver with dipole separations greater than five times the dipole length, i.e. 1000 feet.

In Plates 5 to 8, the presentation of the I.P. results is intended to show the location of the metal factor anomalies along the traverses and not the extent of the anomaly source.

The strongest I.P. effects were recorded on traverses 4800 E to 6400 E between 00 and 600 S. The highest frequency effects (greater than 20%) and metal factors (greater than 1000) occur on traverse 5600 E. The apparent resistivities decrease gradually from about 60 ohm-metres on traverse 6400 E to about 40 ohm-metres on 4800 E. A weaker I.P. anomaly was observed on traverse 3200 E, with apparent resistivities as low as 45 ohm-metres, frequency effects of the order of 10%, and metal factors of about 400.

An I.P. anomaly extends from 200 E to 00 but becomes progressively weaker towards 00. The apparent resistivities increase from 40 ohm-metres on traverse 2000 E to 100 ohm-metres on traverse 00. The frequency effects are generally low, ranging from 4% to 6%. As a result, the metal factors decrease from about 250 on 2000 E to 80 on 00.

The I.P. anomalies described above are probably continuous but as not all the traverses were surveyed, this cannot be stated definitely.

Another I.P. anomaly was observed from traverses 00 to 800 E between 100 N and 600 N. Resistivities over the anomaly are as high as 150 ohm-metres, but the frequency effects rarely exceed 5%, so that the metal factors are of the order of 150. No I.P. anomaly was recognised over the Turam anomaly on traverse 6400 E at 2400 N.

The I.P. results of the 1964 survey (Williams, 1965) differ slightly from those recorded in 1965. This is to be expected because different transmitting frequencies were used on the earlier survey. In 1964, the frequencies were 3.0 c/s and 0.5 c/s. They were changed to 10.0 c/s and 0.3 c/s in 1965 to avoid the effects of the electric trains and natural low frequency earth currents.

Traverse 1200 W was surveyed to test the I.P. method over the Tasman mine, where information was available from the workings and from drilling. The results are shown in Plate 3, together with the geological section and Turam profiles derived from an earlier BMR survey (Rowston, 1959). A well-defined I.P. anomaly was recorded, with resistivities of about 60 ohm-metres, frequency effects of the order of 15%, and metal factors between 500 and 600. North and south of the anomaly, resistivities increased to about 800 ohm-metres and frequency effects decreased to about 2%.

5. INTERPRETATION

Some possible sources of geophysical anomalies can be eliminated when a combination of methods is employed, if the methods are chosen to measure different properties of the earth. At Comstock, properties related to electronic and ionic conduction were measured. Turam anomalies are generally due to sulphide mineralisation, magnetite, graphite, or mineralised water in shear zones. I.P. anomalies are generally due to sulphide mineralisation, magnetite, graphite, or, in some circumstances, clay deposits.

No graphite is known to occur at Mount Lyell. If magnetic anomalies are absent, the most likely cause of coinciding Turam and I.P. anomalies, at Mount Lyell, is sulphide mineralisation. Shear zones would have to contain mineralisation other than mineralised water to give I.P. anomalies.

The main Turam anomaly extends from 300 S on traverse 6400 E to 1000 N on traverse 00. Between traverses 6400 E and 4800 E the Turam anomaly indicates a conductor dipping steeply to the north. Traverse 5600 E (Plate 4) is representative of these results. The conductivity of the source is indicated as medium by the ratio values. The estimated depth to the current concentration increases from 180 feet on traverse 5600 E to 265 feet on traverse 4800 E. This increase in depth is evidenced by the broadening of the anomaly on traverse 4800 E (Plate 4). West of 4800 E the Turam ratio values increase to a maximum on traverse 3200 E suggesting an increase in the conductivity. The anomaly weakens rapidly west of traverse 2000 E and is barely discernible on traverse 800 E. The conductivity decreased slightly west of traverse 2000 E but remains higher than the conductivity of the eastern section.

Between traverses 4800 E and 800 E, the Turam profiles show marked asymmetry, suggesting that the conductor dips at a more shallow angle than between traverses 4800 E and 6400 E. Irregularities on the profiles suggest that more than one body is present or that the conductor is irregular in shape. The estimated depth to the current concentration increases from 265 feet on traverse 4800 E to 400 feet on traverse 1200 E and is 340 feet on traverse 3200 E. Because of the irregular form of the profiles, these depths are less reliable than those further east.

Although the I.P. method was not used on all the traverses, the results shown in Plates 5 and 7 indicate that the I.P. anomaly is probably continuous through the area from 6400 E to 00. On most of the traverses surveyed it coincides closely with the main Turam anomaly. It is strongest on traverse 5600 E. Towards traverse 4800 E the I.P. anomaly decreases in strength and the depth to the anomaly source appears to increase. The increase in depth may account for the weakening of the I.P. effects. The I.P. anomaly on traverse 3200 E is weaker than on traverse 4800 E and the depth to source appears to have increased appreciably. The apparent resistivities on traverse 3200 E are lower than those on 4800 E suggesting an increase in conductivity towards 3200 E. The anomaly weakens from 2000 E to 800 E, but the source remains deep. If this I.P. anomaly is due to sulphide mineralisation, the weakening of the anomaly to the west may be due either to an increase in depth to mineralisation or weaker mineralisation.

The Turam and I.P. anomalies have certain features in common. Between traverses 6400 E and 4800 E both Turam results and apparent resistivities suggest medium conductivity for the anomaly sources. Depth to the conducting zones apparently causing the anomalies increases to the west. Both anomalies weaken markedly on traverse 6400 E. This general agreement suggests that the Turam and I.P. anomalies may have a common origin between traverses 6400 E and 4800 E. The most likely cause of these anomalies is sulphide mineralisation.

Between 4800 E and 00, the I.P. anomaly again coincides in position with the Turam anomaly. Both methods suggest that the depths to the respective sources increase to the west. An increase in conductivity towards traverse 3200 E is evident in the Turam and apparent resistivity results. Both the Turam and I.P. anomalies weaken between traverses 2000 E and 800 E and are barely discernible on 400 E and 00. It is possible that the Turam anomaly is due to more than one conductor. These conductors may be sulphide mineralisation or mineralised solutions. The presence of a shear zone carrying mineralised solutions could explain why the Turam anomaly becomes stronger and the conductivity increases west of traverse 4800 E. This type of conductor would not produce I.P. effects. The decrease in the I.P. anomaly suggests that the mineralisation becomes weaker west of 4800 E.

In considering the possible causes of these anomalies, it is useful to compare them with those obtained elsewhere in the Mount Lyell field.

In the Corridor area (Rowston 1957; Boniwell & McKenzie, 1961), coinciding Turam and I.P. anomalies satisfactorily outlined the position of the sulphide orebody, which lies in the schist adjacent to the conglomerate contact. A similar geological environment is expected in the Comstock Valley. The Turam anomaly indicated a zone of medium conductivity. The I.P. results were characterised by low resistivities, high frequency effects, and high metal factors.

On traverse 1200 W over the Tasman mine (Plate 3), two Turam anomalies coincide with the Tasman (galena) lode and the northern (bornite) orebody, and are considered to be due to them. The northern body is shown to be the better conductor by the higher ratio values. The I.P. anomaly appears to be due to the northern body but the orebodies may be too close to be resolved by this method. The bornite body would be expected to give a stronger I.P. anomaly as it is more disseminated and larger than the galena lode. It appears that the galena lode is a weak electrical conductor and produces very weak or possibly no I.P. effects.

Comparison with the Comstock results shows that between traverses 6200 E and 2000 E, the Turam results are similar to those in the Corridor area and on traverse 1200 W, although in the latter areas the anomalies are more regular and appear related to better defined sources. The I.P. results between traverses 6400 E and 4800 E are at least as strong as those on traverse 1200 W over the known mineralisation of the Tasman mine. The I.P. anomaly on traverse 3200 E is weaker than that on traverse 1200 W but this may be due to a greater depth of the source. It can be said that between traverses 6400 E and 4800 E, the geophysical results are typical of those recorded over known mineralisation in the Mount Lyell field, and that from traverse 4800 E to about traverse 2000 E, the results are still encouraging.

The Turam anomaly extending from traverse 00 to traverse 1200 E between 200 S and 800 N is characteristic of a shallow dipping body. It appears to have a conductivity less than the bornite body on traverse 1200W. Depth to calculated current concentration is about 200 feet. The I.P. anomaly in this part of the area is weak and barely recognisable above the background effects. The Turam results may be due to weak mineralisation or a shear zone. The small displacement of the I.P. anomaly north of the Turam anomaly on traverse 800 E suggests that the sources may be dissimilar. On traverse 800 E it is difficult to distinguish two separate I.P. anomalies - one related to the main Turam anomaly and the other related to the area under discussion. If the I.P. results are due to the background effects of the schists, the Turam results are probably due to mineralised water in a shear zone that may be the extension of the Comstock Fault. It is also possible that the weak I.P. results may be due to mineralisation similar to that of the galena lode in traverse 1200 W. However, the conductivity of the galena lode appears much lower than that of this anomaly source.

The Turam anomaly at 6400 E/2400 W indicates a steeply dipping body of medium conductivity. As no I.P. effects were observed over it, the source of the anomaly is more likely to be a shear zone with mineralised water rather than mineralisation.

The remainder of the area surveyed in 1965 does not appear interesting. Irregularities in the Turam results seem to be due to the local conditions at Comstock. The conglomerates, schists, and glacials would give rise to inhomogeneous fields if their conductivities differ.

Distortions of the field would be emphasised by grounding the cable in different materials. The primary cable at 1200 S was grounded in conglomerate. The primary cable at 800 S was grounded in glacial detritus near conglomerate. The primary cable at 1800 N was grounded in a swamp, probably above glacial material. The extension of the I.P. work to the north did not reveal any conductors undetected by the Turam method.

South of the main Turam and I.P. anomalies, the apparent resistivities rise to about 1000 ohm-metres. This is probably due to the presence of the Owen Conglomerate Series. The resistivity rise to the north is not so great. The inferred geological sections suggest the presence of conglomerate. If the conglomerate is some depth below the surface, the resistivity would be less than where the conglomerate crops out.

The failure of the S-P method at Comstock is fairly typical of the Mount Lyell field (Rowston, 1959) and may be due to an unfavourable position of the water table. The masking effects of topography and poor surface conditions undoubtedly contributed to the failure of the method. It is not considered that the absence of S-P anomalies in any way rules out the possibility of mineralisation in the area.

The lack of magnetic anomalies eliminates pyrrhotite and magnetite as possible sources of I.P. and Turam anomalies. This lack of magnetic anomalies is consistent with the findings of the 1957 survey (Rowston, 1959).

The Rio Tinto electromagnetic survey of 1958-1959 covered part of the 1965 area (Plate 2). The results obtained were similar to those obtained in 1965 with the grounded cable at 1800 N. The main Turam anomaly observed in 1965 became prominent only when observed with the cable at 800 S. This is probably due to the fact that the conducting zones dip to the north and the Turam anomalies are more prominent when the grounded cable is on the footwall side of the conducting zone.

6. CONCLUSIONS AND RECOMMENDATIONS

The 1965 geophysical results at Comstock compare favourably with results over known mineralisation in the Mount Lyell area. In the Corridor area and at the Tasman mine, coinciding Turam and I.P. anomalies appear to be due to sulphide mineralisation. In general it would appear that the anomalies at Comstock are at least partly due to mineralisation similar to that found in these two areas. The lead-zinc mineralisation at the Tasman mine is characterised by low ratio values of the Turam anomaly and a very weak I.P. anomaly, but these results do not give sufficient basis for recognising mineralisation.

The most important Turam and I.P. anomalies located in 1965 extend from 300 S on traverse 6400 E to 1000 N on traverse 00. The Turam anomaly is continuous over this area, and the I.P. anomaly is probably continuous too. The anomaly zone is approximately parallel to the regional strike of the area. The rise of apparent resistivities to the south indicates that the conglomerate/schist contact is close to the conductive zone. This anomalous zone is in a favourable position because mineralisation at Mount Lyell normally lies near the conglomerate/schist contact. At least part of this anomalous zone appears to be due to mineralisation.

Between traverses 6400E and 4800 E, the agreement of the Turam and I.P. anomalies indicates that they are due to the same conductive zone. The Turam results further suggest that the conductor is steeply dipping. Both methods indicate an increase of depth to the west. The most likely cause of these anomalies is sulphide mineralisation in the form of a disseminated body.

Four drill holes, listed in Table 1 are recommended as a preliminary test of the geophysical results.

13

TABLE 1

Recommended drill holes

Drillhole numbers	Location of drillsite (B.M.R. Grid co-ords)	Angle of depression	Depth of hole (feet)	Approx length of hole (feet)	Position of geoph. target.
1	5600E/190S	60°	180	350	5600E/275S
2	4800E/100S	60°	265	350	4800E/240S
3	3200E/360N	45°	340	450	3200E/100N
4	800E/050N	90°	210	250	800E/050N

Note. All holes bear south along traverse.

Drill hole No. 1 is located on traverse 5600 E because the I.P. effects on this traverse are the strongest in the area. The weakening of the I.P. anomaly towards traverse 4800 E may be due to increased depth, bedause the Turam results do not change. Drill hole No. 2 is located on traverse 4800 E to determine whether the changing characteristics of the anomalies are due to increased depth or degree of mineralisation.

Between traverses 4800 E and 800 E, the Turam and I.P. anomalies have a different character, suggesting the possibility of one or more orebodies, probably accompanied by a shear zone. Drill hole No. 3 was selected to test these possibilities and to determine whether the weakening of the I.P. anomaly is due to increased depth or poor mineralisation. Further drilling in the western part of main anomalous zone would depend on the amount of mineralisation encountered in this drill hole.

The Turam anomaly between traverses 00 and 1200 E from 200 S to 800 N is well defined but accompanied by only very weak I.P. effects. However, it is considered to warrant testing because it could possibly be due to lead-zinc mineralisation similar to that of the Tasman galena lode. Drill hole No. 4, located on traverse 800 E where the Turam anomaly is strongest, is recommended for this purpose.

The targets for these drill holes are based mainly on location of the current concentrations, calculated from real and imaginary components of the electromagnetic field. The targets as shown in Plate 4 are intended to indicate the most favourable zone for intersection of mineralisation and are not related to shape or concentration of mineralisation.

It appears that a combination of Turam and I.P. work can be successful in outlining sulphide mineralisation at Mount Lyell. This is definitely the case in the Corridor area and at the Tasman mine. However, care must be taken in disregarding Turam anomalies not accompanied by I.P. anomalies if the presence of lead-zinc mineralisation is suspected. The position of the primary cable for Turam work must be carefully selected and may have to be shifted to give optimum results. These facts should be borne in mind if further geophysical work is carried out at Mount Lyell.

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LEGEND

SEDIMENTARY ROCKS

	QUATERNARY	Q	Talus, alluvium, etc.
	QUATERNARY	Qp	Moraine with varved clays
	PERMIAN	Pt	Tillite of Mt Sedgwick
ELDON GROUP	SILURIAN	Sc / s	Crotty Quartzite:– grey, medium to coarse-grained, locally split by shales
JUNEE GROUP	ORDOVICIAN	Og	Gordon Limestone, dark blue-grey, argillaceous
JUNEE GROUP	ORDOVICIAN	Oo / Oou	Upper Owen Conglomerate
JUNEE GROUP	ORDOVICIAN	Oo / Oom	Middle Owen Conglomerate
JUNEE GROUP	ORDOVICIAN	Oo / Ool	Lower Owen Conglomerate
DUNDAS GROUP	CAMBRIAN	€ / c	Greywacke Conglomerate
DUNDAS GROUP	CAMBRIAN	€ / s	Miners Slate:– finely banded siltstones
DUNDAS GROUP	CAMBRIAN	€ / €jc	Jukes Conglomerate very coarse greywacke conglomerate

METAMORPHIC ROCKS

(ex Dundas Group)

qp	Quartz feldspar porphyry

IGNEOUS ROCKS

lam	Lamprophyre (kersantite?) dykes (post-Permian)
dl	Dolerite of Mt Sedgwick (post-Permian)

GEOLOGICAL BOUNDARIES

- Observed
- Approximate
- Doubtful

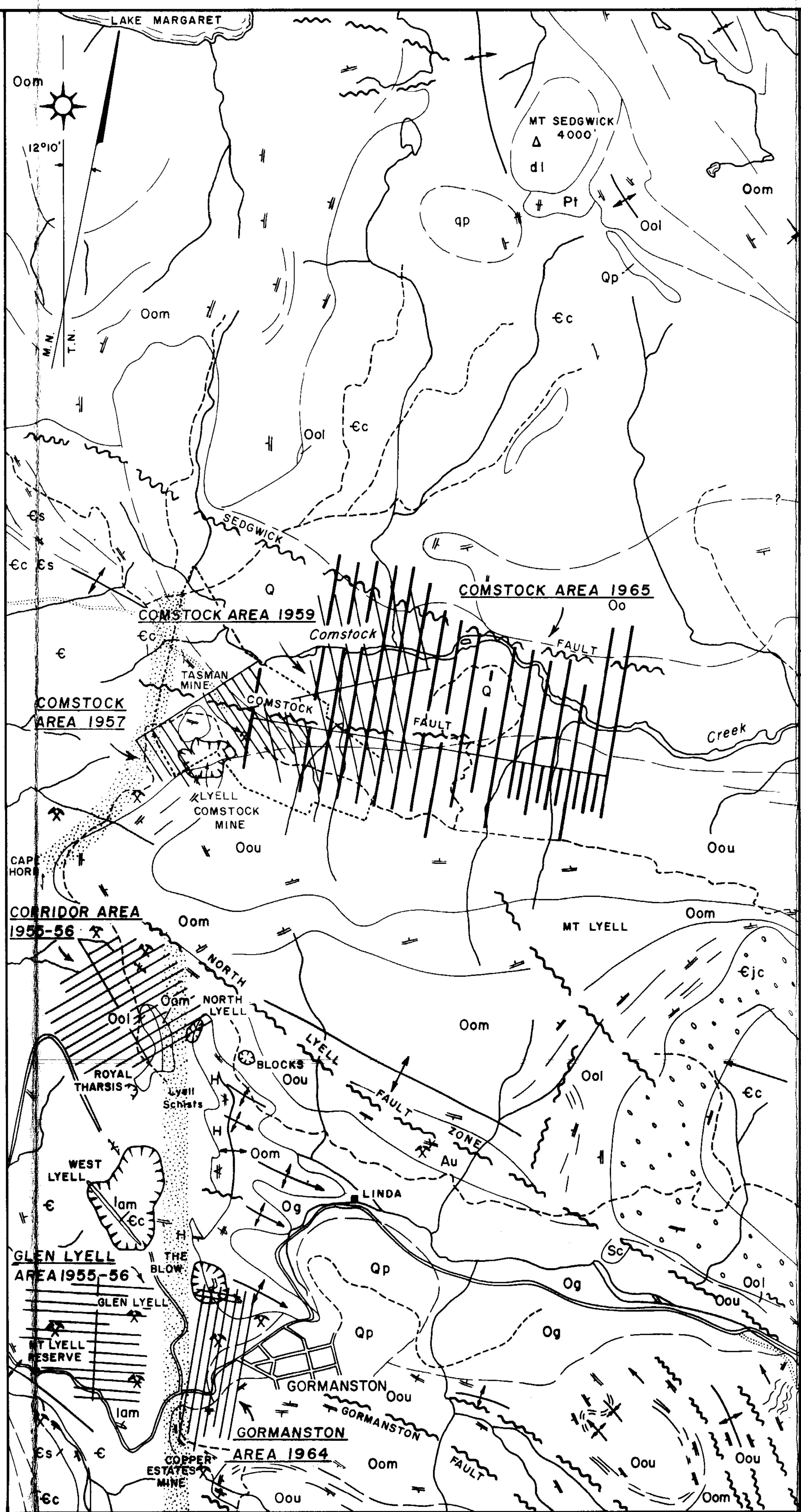
FAULTS

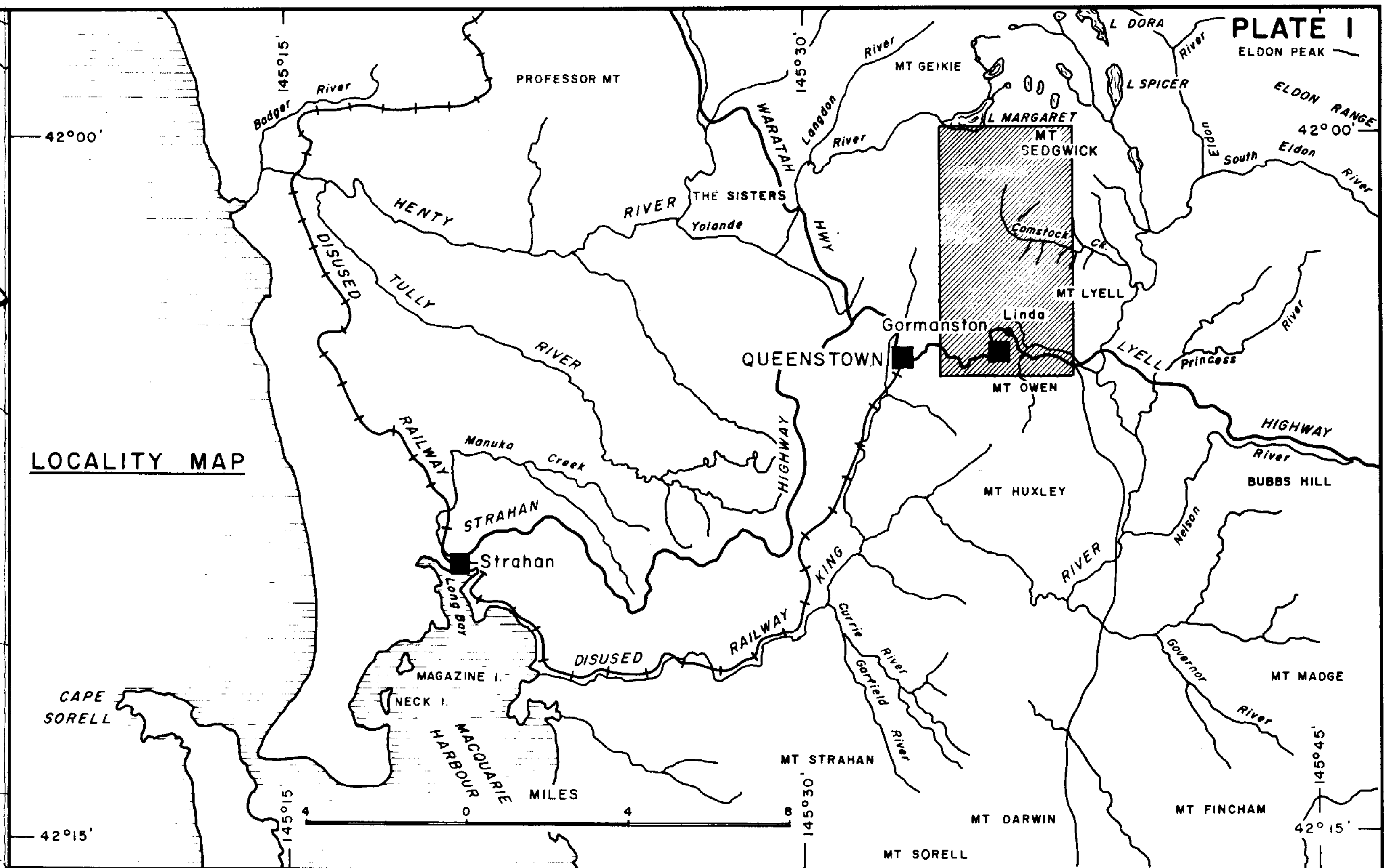
- Observed
- Approximate
- Approximate position of the Lyell Shear

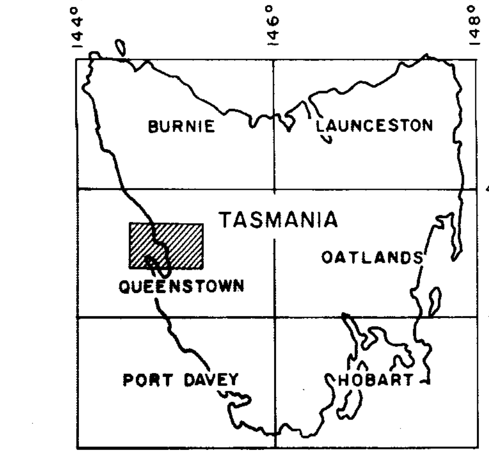
BEDDING

- Strike and Dip
- Vertical
- Horizontal
- Overturned
- Pitch
- Schistosity
- Cleavage
- Syncline
- Anticline

- Main Road
- Vehicular Track
- Foot Track
- River or Creek
- Δ Triangulation Station
- Quarry
- Mine for Copper
- Au Unless Marked — Gold
- H Haematite
- Geophysical traverses of previous surveys
- Geophysical traverses 1965
- Outline of area covered by equipotential survey in 1934-38 by Blazey & Douglas (Richardson, 1949) and in 1948 by Webb (1958)







REFERENCE TO AUSTRALIA STANDARD
1:250,000 MAP SERIES: QUEENSTOWN

GEOPHYSICAL SURVEY AT MT LYELL, QUEENSTOWN, TASMANIA, 1965

LOCALITY AND GEOLOGICAL MAP

MILES 0 1 2

AFTER MT LYELL M and R CO LTD, QUEENSTOWN AREA GEOLOGICAL MAP

TO ACCOMPANY RECORD No. 1966/103

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

K 55/B 7-120

PLATE 2

LEGEND

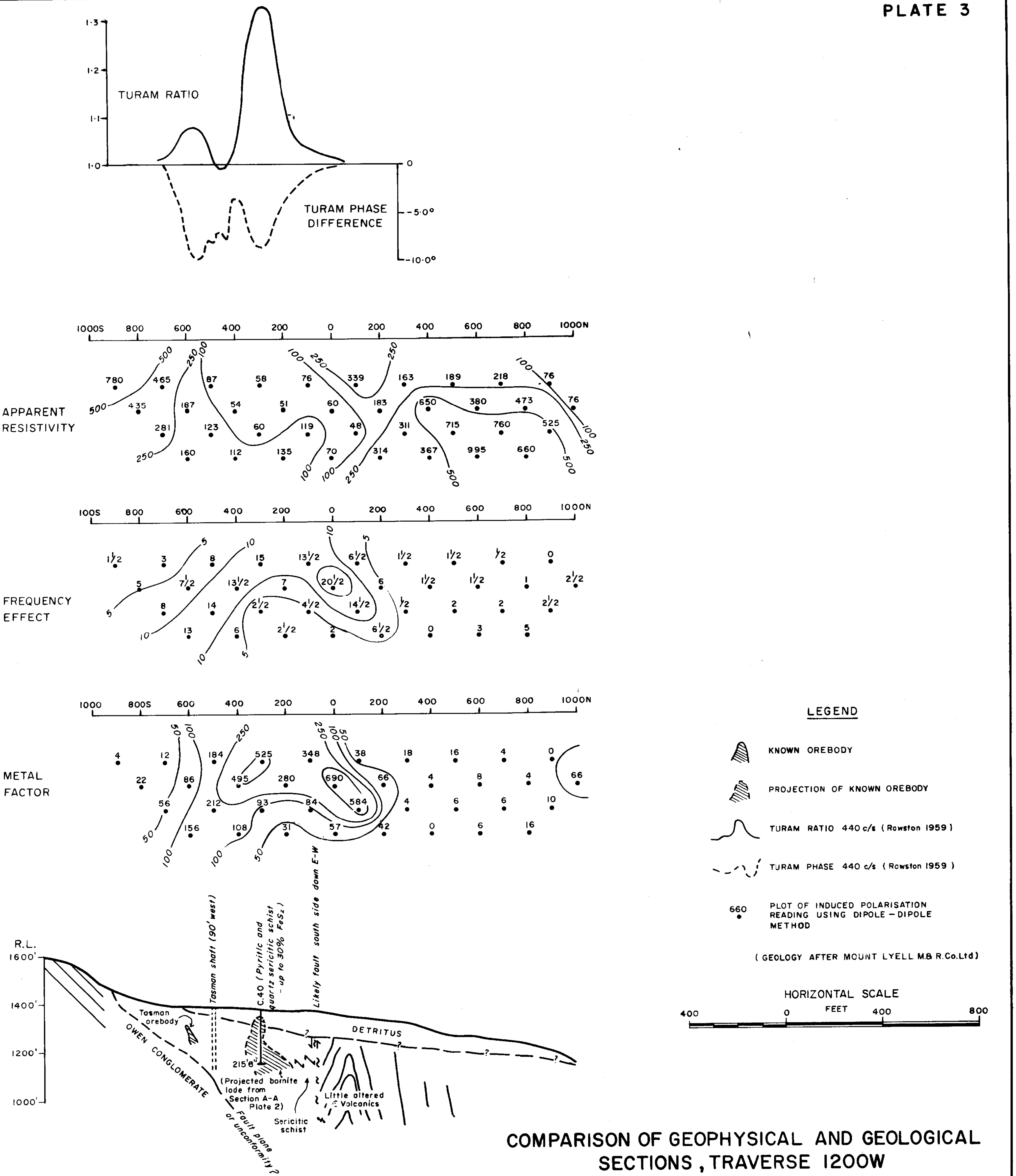
- DDH 2, 60° — Recommended diamond-drill hole with angle of depression
- 1300 — Topographic contours
- Road
- Track
- Geophysical traverse surveyed by BMR in 1964 (Williams, 1965) and 1965
- Traverse surveyed by E.M. method by BMR in 1957 (Rowston, 1959)
- Traverse surveyed by E.M. method (RIO TINTO 1958)
- Outline of area covered by equipotential surveys in 1934-38 by Blazey & Douglas (Richardson, 1949) and in 1948 by Webb (1958)

COMSTOCK AREA
TOPOGRAPHY AND SURVEY TRAVERSE PLAN

TO ACCOMPANY RECORD No. 1966/103

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

K55/B7-122



COMPARISON OF GEOPHYSICAL AND GEOLOGICAL SECTIONS, TRAVERSE 1200W

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics
TO ACCOMPANY RECORD No. 1966/103

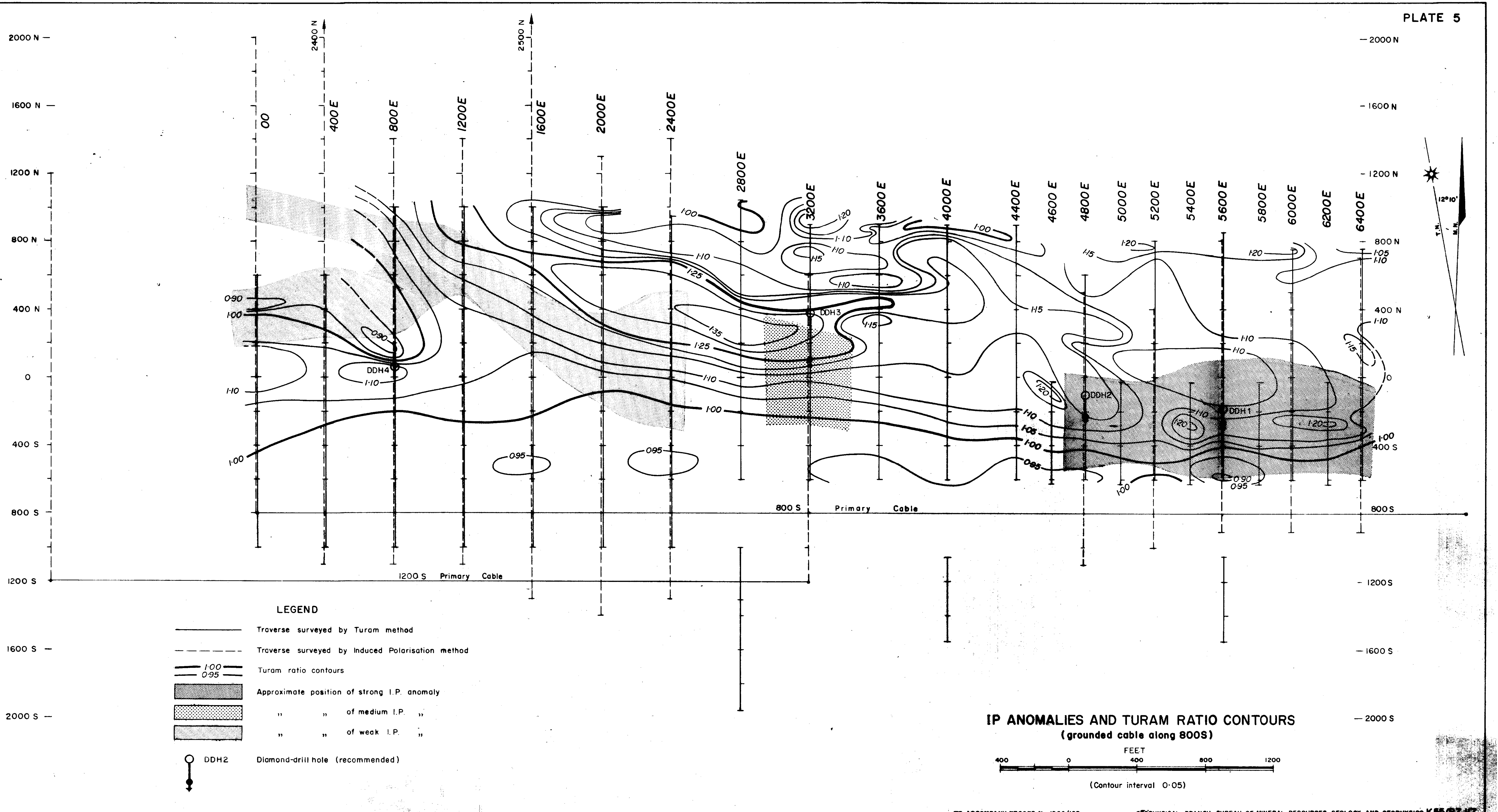
K55/B7-115

COMSTOCK, TASMANIA, 1965

PLATE 4

SELECTED GEOPHYSICAL PROFILES, INFERRED GEOLOGICAL SECTIONS, AND DRILLING RECOMMENDATIONS

TO ACCOMPANY RECORD No. 1966/103 — Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics — K55/B7-121



IP ANOMALIES AND TURAM RATIO CONTOURS

(grounded cable along 800S)

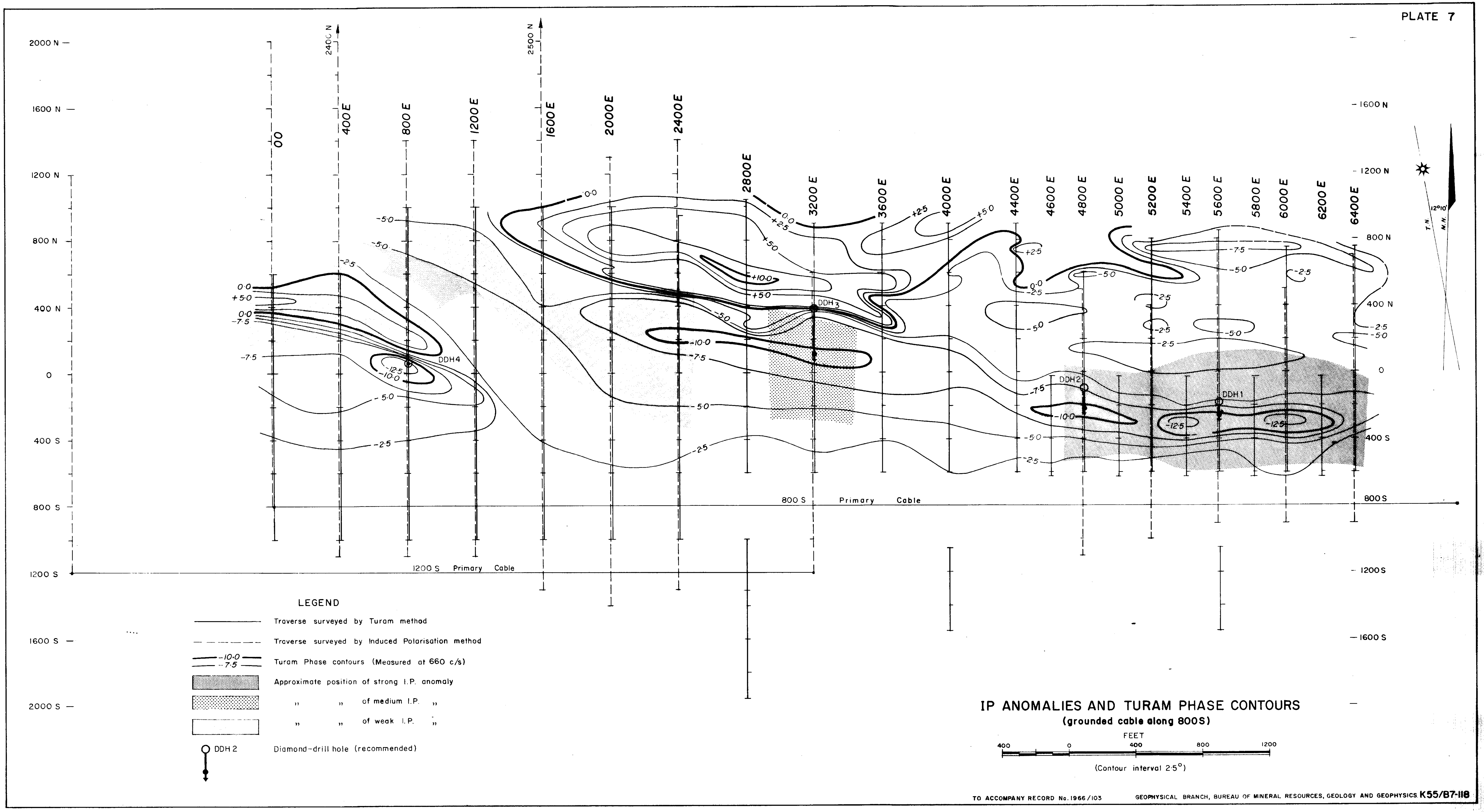
COMSTOCK AREA, 1965. TAS.

PLATE 6

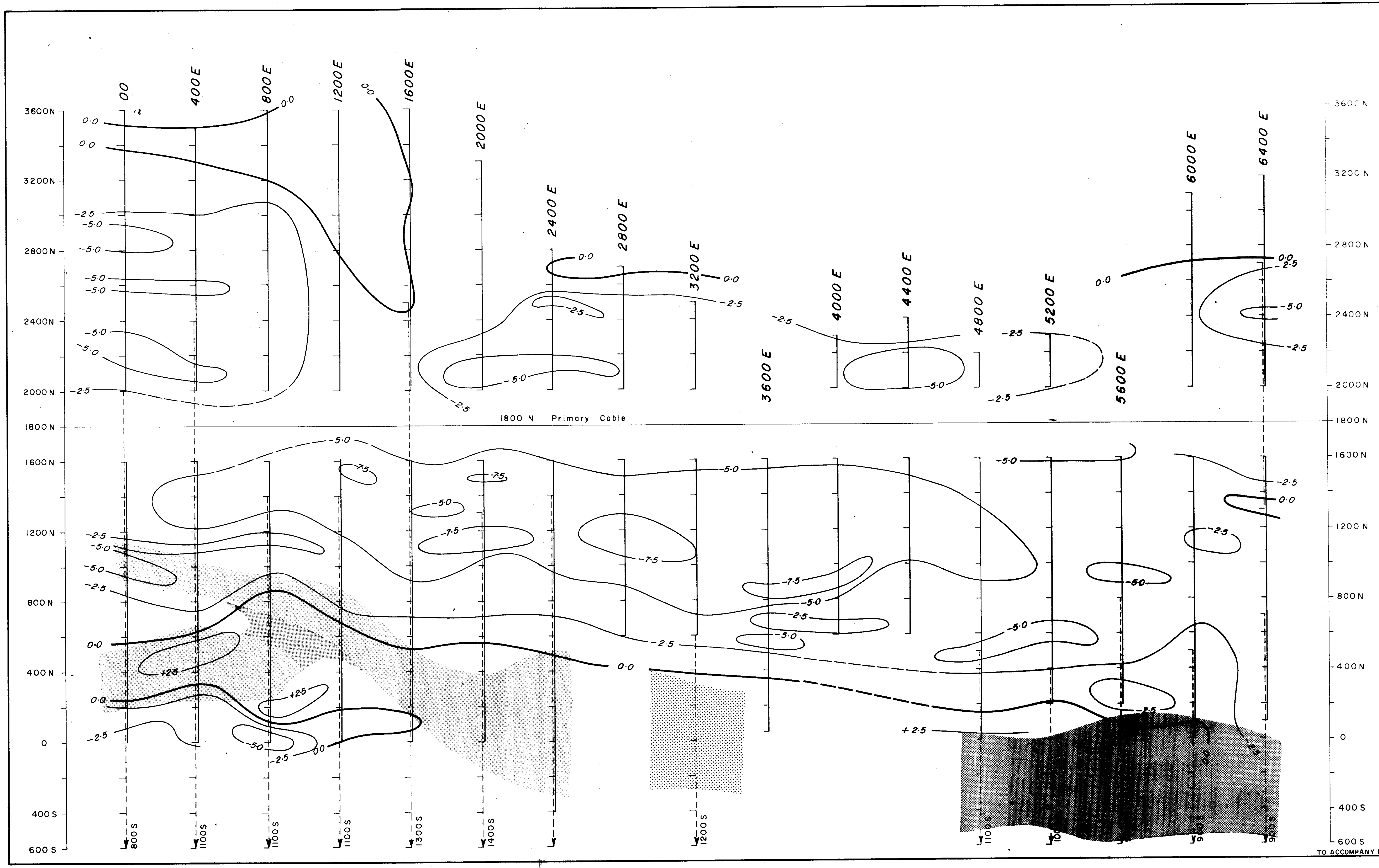
IP ANOMALIES AND TURAM RATIO CONTOURS
(grounded cable along 1800N)

TO ACCOMPANY RECORD No. 1966/103

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics



COMSTOCK AREA, 1965. TAS.



LEGEND

Traverse surveyed by **Turam method**

Traverse surveyed by **Induced Polarisation method**

Turam phase contours **(Measured at 660 c/s)**

Approximate position of strong I P anomaly

Approximate position of medium I P anomaly

Approximate position of weak I P anomaly

IP ANOMALIES AND TURAM PHASE CONTOURS

(grounded cable along 1800N)

400 0 400 800 1200

(Contour interval 2.5°)

TO ACCOMPANY RECORD No.1966/103

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

K55/B7-116