COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1967/100

CAPE HORN AREA GEOPHYSICAL SURVEY,

QUEENSTOWN, TASMANIA 1966

by

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017204

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ILLUSTRATIONS

Note. This Record supersedes Record No. 1966/95.

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SUMMARY

Early in 1966 a geophysical survey was conducted in the Cape Horn area of the Mount Lyell field, Queenstown, Tasmania. Electrical and electromagnetic methods were used in the search for sulphide orebodies.

The geophysical results suggest a continuous zone of weakly disseminated mineralisation, which follows the contact of the Lyell Schists and Owen Conglomerate and extends for about 1000 feet into the schists from the contact. The main geophysical anomalies are probably due to local concentrations of mineralisation in the form of lenses within this zone. It is not possible to estimate the copper content of the mineralisation.

The few drilling results available are not sufficient to determine the economic potential of the area. Six drill holes are recommended as a preliminary test of the main geophysical findings.

1. INTRODUCTION

The Cape Horn area lies on the north-west flank of Mount Lyell about two and a half miles north-north-east of Queenstown, Tasmania. Sulphide mineralisation was revealed in the area in early workings of the Queen Lyell adit, the North Crown Lyell, workings, and the Anaconda tunnel. Apparently this mineralisation is restricted to the schists in the vicinity of the contact between the Lyell Schists and the Owen Conglomerate. Field mapping and early geophysical work (Blazey, 1933-35; Douglas, 1935-38) indicated possible extensions of the mineralisation along the contact.

Early in 1966, the Bureau of Mineral Resources conducted a geophysical survey of the Cape Horn area with the aim of delineating the zones of mineralisation more accurately and investigating the possibility of additional mineralisation at greater depths. The methods used were electromagnetic, induced polarisation, and self-potential. The area is bounded by the Corridor area and the Comstock mines and extends about 1000 feet into the Lyell Schists (which are part of the Mount Read Volcanics) from the schist/conglomerate contact (Plates 1 and 2). The ruggedness of the area is due to differential weathering, which has produced, particularly in the conglomerate, steep cliffs and the pinnacle (Cape Horn) from which the area has derived its name.

The survey was commenced on the 14th January by B.B. Farrow and E.C.E. Sedmik (geophysicists) with N. Ashmore (geophysical assistant) and one field-hand. Surveyors, track cutters, and two additional field-hands were supplied by the Mount Lyell Mining and Railway Company. The author joined the survey on 11th February when E.C.E. Sedmik returned to headquarters. The survey was completed on 1st April 1966.

Poor access, which was limited to a vehicular track and one foot track (Plate 2), together with rugged terrain, greatly hindered all phases of the survey operations.

The author wishes to thank the staff of Mount Lyell M. & R. Co., especially the Chief Geologist, R. Elms, for their co-operation during the course of the survey.

2. GEOLOGY

This summary, which deals primarily with the Cape Horn area, is condensed largely from the most recent accounts of the geology of the Mount Lyell field by Wade and Solomon (1958) and Solomon and Elms (1965).

The regional geological map (Plate 1) indicates the complexity of geology in the area. The geological succession of the field is indicated in the legend of Plate 1, but only the Mount Read Volcanics and the Owen Conglomerate Series crop out in the Cape Horn area. This map is basically the same as regional maps included in previous BMR Records of the area (e.g., Williams, 1966) but the lithological terms and boundaries have been modified to comply with recent geological interpretation by the Mount Lyell M. & R. Co. Thus, most of the Dundas Group and metamorphic rocks are now included in the Mount Read Volcanics.

In the Mount Lyell area, the Cambrian Mount Read Volcanics exhibit a well defined schistosity, which extends some way from their contact with the Owen Conglomerate (Ordovician). For this reason, they are often referred to, locally, as the Lyell Schists. In the Cape Horn area, the Mount Read Volcanics are represented by quartz schists, which are, in places, chloritised and sericitised. The Owen Conglomerate Series is composed mainly of sandstone, shale, and conglomerate.

The contact of the Lyell Schists and the Owen Conglomerate in the Cape Horn area appears to be controlled largely by the north-trending Lyell Shear and the WNW-trending North Lyell Fault (Plate 1). There was some movement along the Lyell Shear during the Jukesian movement at the close of deposition of the Mount Read Volcanics. However, the major movements of the Lyell Shear and the formation of the North Lyell Fault and other major faults took place during the Tabberabberan Orogeny (Middle Devonian). The mineralisation of the Mount Lyell field also occurred during this orogeny. The mineralisation is essentially sulphidic, with a predominance of pyrite; the most important economic minerals being bornite and chalcopyrite, which occur in varied amounts throughout the area.

Little is known of the detailed geology of the Cape Horn area although pyrite and chalcopyrite are known to occur in some outcrops of schist. The geological sections of Plate 6 show only the attitude of the schist/conglomerate contact and some outcrops of pyrite. The surface position of the contact is shown in Plates 2 to 5.

In this area it is not possible to predict the type of mineralisation from nearby workings because of the diversity of mineralisation in the Mount Lyell field. The Comstock mine near the north-eastern boundary of the area (Plate 1) revealed four en-echelon lenses of disseminated chalcopyrite with bornite, pyrite, and associated gangue material. This type of mineralisation is fairly typical of the Mount Lyell field. However, the North Lyell orebody, which is south-east of Cape Horn, is essentially high-grade bornite.

The details of shafts and drives are shown in Plate 2 and include workings at Queen Lyell, North Crown Lyell, and the Anaconda tunnel, but few details of mineralisation are available. The available assay values of copper and pyrite are shown in Plate 4.

In 1898, two distinct orebodies, one 20 feet wide and one 7 feet wide, were intersected at North Crown Lyell (Mines Department, 1898-99). It is possible that this mineralisation is bornitic because good bornite has been recognised in the North Crown Lyell workings (R. Elms, pers. comm.). In 1901, a small amount of high-grade ore was intersected in the lower of two cross-cuts that totalled 1219 feet (Mines Department, 1901a). The Mines Department Progress Report of 1906 states that a drive had been extended north and south along the contact for 1000 feet without meeting anything payable. This account describes the schist/conglomerate contact at the 1300-ft level, but does not indicate whether unpayable minerals, such as pyrite, are present. Three drill holes put down by the Mount Lyell M. & R. Co. (Plate 2) indicate the presence of pyrite, but copper values are low.

Even less is known of the Queen Lyell workings, but it may be surmised that the workings were stopped near the conglomerate contact.

In the south of the area, the Mines Department (1901b) records that "The Anaconda tunnel, over 600 feet, has cut the so-called contact wall, and the face shows schist with copper and iron pyrites".

It is evident from these records that further mineralisation in the area may be mainly pyrite, chalcopyrite, bornite, or some combination of these. The mineralisation is close to the contact which appears to dip towards the schists. No other information concerning mineralisation or structure is available.

3. PREVIOUS GEOPHYSICAL SURVEYS

The earliest surveys in the Cape Horn and adjoining areas were conducted for the Mount Lyell M. & R. Co. by Blazey (1933-35) and Douglas (1935-38). These results were later reviewed by Richardson (1949 a & b) and further geophysical work was done in 1948 and 1949 by Webb (1958). In 1956, the BMR surveyed the Corridor area (Rowston, 1957) and in 1957, the Comstock area (Rowston, 1957) and in 1957, the Comstock area (Rowston, 1959). A series of geophysical tests was also carried out in the Corridor area by private companies (Boniwell & McKenzie, 1961).

The surveys by Blazey and Douglas covered the schist/ conglomerate contact from Comstock to Glen Lyell (Plate 1). Douglas covered the area from Comstock to the Royal Tharsis, as well as the Glen Lyell area. Blazey worked mainly in the area between the North Crown Lyell workings and the site of the present West Lyell open cut. The work of Douglas is of more interest to the present survey.

Douglas employed the equipotential line method as described by Webb (1958). In the Cape Horn area he outlined zones B, C, and 25 to 29 as anomalous areas (Plate 2). Because of terrain effects and the poor resolution of the method, a rigorous interpretation could not be applied, particularly when out-of-phase field components were involved. As a result, the presence of anomalous zones was recognised, but the boundaries of these zones were poorly defined. Richardson (1949 a & b) reinterpreted the results of these surveys and recommended drilling targets for zones A (Corridor area) and B. To investigate zone B he suggested a hole collared at 2700S/6300W, depressed 40° in a direction 3° west of the 1966 Cape Horn traverse azimuth, which would have tested the anomalous zone indicated by the 1966 survey. As far as is known, these holes were not drilled. Equipotential anomalies were recorded over most of the mineralised zones at Mount Lyell, West Lyell, Razorback, and North Lyell and, for this reason, the Mount Lyell M. & R. Co. considered the equipotential anomalies in the Cape Horn area to be of interest.

In 1956, the BMR conducted a Turam and S-P survey in the Corridor area (Rowston, 1957). Some geochemical sampling was also done. The Corridor area adjoins the Cape Horn area near traverse 3000S (Plate 2). The most interesting anomalies detected during the 1956 survey were denoted 17/56, 31/56, Indication Zone A, and 16/56.

Anomalies 17/56 and Indication Zone A were considered to be related to Douglas's zones A and B (Indication Zone A is also known as the Footprint Anomaly). Anomaly 31/56 lies between Indication Zones A and B, and, although it was not outlined by Douglas, it is easily reconciled with the equipotential results. These anomalies, which were considered to be caused by sulphide mineralisation, are near old workings, but drilling results to date have been inconclusive. Detailed drilling of anomaly 16/56 revealed good sulphide mineralisation. The results of this drilling and some other geophysical tests were subsequently published as a geophysical case history (Boniwell & McKenzie, 1961).

The Comstock area, which is north-east of Cape Horn, was surveyed by the BMR with the Turam method in 1957 (Rowston, 1959). The main anomaly coincided with the mineralisation of the Comstock mines. Of the remaining results, anomaly 27/57 is of interest to the 1966 survey. This anomaly coincides with part of Douglas's zone 27, but was not outlined completely Rowston. Drill hole DDH 30 (Plate 2), which was drilled to investigate the eastern part of this anomalous zone, revealed sulphide mineralisation with low copper values of about 0.5% (Rowston, 1959, page 14). No further exploration was recommended by Rowston.

An airborne scintillometer survey was made in the general area by the BMR in 1955 (BMR, 1955) and an airborne magnetic survey by Rio Tinto in 1957. The successful drilling of anomaly 16/56 prompted the Mount Lyell M. & R. Co. to arrange a series of geophysical tests over the mineralised zone, which is now known as the Corridor Orebody. Tests using gravity and vertical loop electromagnetic methods were made by Rio Tinto in 1958 and 1959. McPhar Geophysics Ltd under contract to Lyell - E.Z. Explorations carried out AFMAG and induced polarisation tests in 1959. The results of all these surveys were collected and described by Boniwell and McKenzie (1961). Briefly, the AFMAG and airborne methods gave no useful information; the gravity results were inconclusive because of regional and terrain effects; the remaining methods confirmed the findings of the 1956 survey. The induced polarisation method was the only one that gave additional valuable information. A test traverse over the Tasman and Crown Lyell Extended mine (Williams, 1966) also revealed an IP anomaly that coincided with known mineralisation. This traverse and the one in the Corridor area are of special interest because they indicate the type of IP anomaly to be expected from typical Mount Lyell mineralisation.

4. METHODS AND EQUIPMENT

Geophysical methods used on the survey were electromagnetic, induced polarisation (IP), and self-potential (S-P). These methods and their applicability have been described in an earlier Record (Williams, 1966). Only differences in equipment and method are discussed in this Record.

The electromagnetic method

The ABEM Turam 2S compensator-amplifier was used to measure amplitude ratios and phase changes of the vertical electromagnetic field. The primary field was produced by a 220/660-c/s generator connected in series with a long grounded cable. Depth estimates of current concentration were derived from calculated real and imaginary components (Williams, 1966).

The induced polarisation method

A variable frequency unit designed by McPhar Geophysics Ltd was used for the 1966 survey. Transmitting frequencies of 5.0 and 0.3 c/s were employed with the dipole-dipole electrode configuration. The results are presented in the conventional form of a two-dimensional plot, but the results must not be considered a vertical section of the earth's electrical properties. Some model tests conducted by Adler (Madden & Cantwell, 1963), for example, demonstrated that a shallow body can give an IP effect which, if the two-dimensional plots were considered as valid sections, could be interpreted as due to a deep source.

The self-potential method

S-P readings were taken with a BMR type RL807-B S-P meter and a Sharpe ground voltmeter type VP6. Until recently, interpretation of S-P results has been largely qualitative (Daly, 1962). However, Roy (1963) has indicated that depth estimates to S-P sources can be derived. The method involves the application of downwards continuation theory to surface results to give maximum depths to source. This method has been applied to some of the 1966 results.

5. FIELD WORK AND RESULTS

Plate 2 shows the geophysical grid, which is an extension of the 1957 Comstock grid (Rowston, 1959). The position of the Corridor grid (Rowston, 1959) is also indicated. The geophysical grid generally has a traverse spacing of 200 feet, but because of surveying difficulties, traverse 3600W was offset 100 feet from its planned location. Stations were pegged at 50-ft intervals along the traverses. The geophysical results are presented as contours (Plates 3 to 5) and selected profiles (Plate 6). All co-ordinates relate to the 1966 BMR Cape Horn grid unless specified otherwise.

Electromagnetic

The traverses surveyed with the Turam method are shown in Plates 4 and 5. Readings were taken at 50-ft intervals along these traverses. Coil spacing was 100 feet. Frequencies of 220 and 660 c/s were used on all traverses. Only the results measured at the higher frequency are presented because the results at the lower frequency do not give additional information concerning the location of anomalies. The results are presented as contours of amplitude ratios (Plate 4), contours of phase differences (Plate 5), and selected profiles (Plate 6).

Traverses 2400W to 6000W were surveyed with a grounded primary cable along 00S. Selection of this cable position was guided by the position of the 1957 Comstock grounded cable, which was also along 00S.

Traverses 00S to 3000S were surveyed with a grounded primary cable along 7500W. The position of this cable differed from those used in the Corridor area (Rowston,1957).

The results from different cables have been combined in the one contour map. This is considered justified because of the agreement of results in the area of overlap.

<u>Primary cable along 00S</u>. The main feature of the results is the anomaly defined by the high ratios and negative phase differences, which can be traced as a fairly continuous feature, although with variations in intensity, from traverse 2400W to 6000W. The anomaly is located over the schists and about 200 feet north of the schist/conglomerate contact. It was not recorded completely on traverse 6000W, which did not extend far enough south.

On traverse 2400W a strong phase reading (-10°) is accompanied by a weak ratio (1.07) at 1325S. The anomaly then increases to a maximum strength at 3000W/1200S with ratio of 1.16 and phase difference of -10.5°. It weakens towards 3400W, where it is just recognisable. Between 3600W and 4200W it is again prominent with maximum ratio of 1.09 and phase difference of -7.5° at 4000W/1150S. Between traverses 4400W and 5000W the anomaly is recognisable, but quite weak. It is well defined between traverses 5200W and 6000W, reaching maximum strength at 5600W/1200S where the ratio is 1.19 and the phase difference is -13.5°.

A small anomaly, which may be a separate one parallel to the main anomaly, extends from 4600W to 5000W with a maximum at 5000W/700S (ratio 1.05, phase -5.5°).

During the 1957 Comstock survey (Rowston, 1959) traverses 2400W to 2800W were surveyed with the Turam method using frequencies of 440 and 880 c/s. The results of the two surveys are in good agreement.

<u>Primary cable along 7500W</u>. Two anomalies were recorded on traverse 3000S, one centred at 6400W, the other at 5800W. They can be traced to 1600S, where they appear to join. The anomalies show high ratios and large negative phase differences. The Turam profiles on traverses 3000S and 1600S are shown in Plate 6. Between these two traverses the amplitudes are almost constant but the widths vary considerably.

As shown in Plate 2, the southern part of the Cape Horn area (traverses 2400S to 3000S) overlaps the Corridor area surveyed in 1956 (Rowston, 1957). The differences in positions of the anomalies (Plates 2, 4, and 5) may be due to the different positions of the primary cables in the two surveys.

Induced Polarisation

Plates 4 and 5 indicate the traverses surveyed with the IP method and positions of the principal IP anomalies. The most interesting results are presented in the form of two-dimensional plots in Plate 6. Progress of the field work was very slow because of the rugged terrain and the method was confined mainly to places that gave interesting Turam results. On some of the traverses, the steep terrain prevented satisfactory coverage of the schist/conglomerate contact. The dipole length used was 200 feet but this was reduced to 150 feet on traverses 4400W to 6000W in an attempt to obtain more detailed information. In discussion of the results, the terms deep and shallow used to describe the anomalies refer only to the position of the anomalous values in the two dimensional plots.

On traverses 2800W to 6000W the average value of apparent resistivity was about 400 ohm-metres but increased to about 1000 ohm-metres near the conglomerate. The background frequency effects ranged from about 6 to 8%. IP anomalies were considered to exist when the resistivities and frequency effects differed appreciably from these values, e.g. on traverse 5600W, where apparent resistivities decreased to 49 ohm-metres and frequency effects increased to 16½%. In all such cases, metal factor anomalies were obtained. No attempt was made to classify the anomalies on the basis of the metal factors as in the Comstock survey (Williams, 1966), because over the whole survey area there were considerable variations in the background resistivities and frequency effects.

IP anomalies were recorded on traverses 2800W to 5800W, except on traverse 3200W, where the readings may not have been continued far enough towards the contact. Steep terrain hampered work on traverses 4600W to 5200W and prevented complete coverage of the anomaly on traverse 5800W.

The IP results on traverses 1600S and 1800S differ from those on traverses 2800W to 6000W in that the background frequency effects are low (2-3%) in comparison. On both 1600S and 1800S, the anomaly is strongest between 6000W and 6200W but is weak compared with other IP anomalies in the survey area.

The results on traverses 2800S and 3000S differ in character from those in the remainder of the Cape Horn area. In places high frequency effects occur with high resistivities, usually adjacent to zones of low frequency effects and low resistivities. The high metal factors are more dependent on the low resistivities, so a straightforward classification of the anomalies is impracticable.

The anomalies on traverses 2800S and 3000S are similar. The frequency effects on traverse 3000S (Plate 6) are strongest between 6100W and 5800W and increase in depth towards 5800W. A prominent resistivity 'low' extends west of 6000W. The resultant metal factor anomaly is strongest between 6000W and 6200W. Small metal factor anomalies near 5600W and 6500W were not outlined completely. On traverse 2800W a strong frequency effect anomaly between 6300W and 6100W deepens towards 6000W. The main metal factor anomaly lies between 6300W and 6100W. A small metal factor anomaly is evident at 5800W.

Self-potential

The traverses surveyed by the S-P method and the contoured results are shown in Plate 3. Readings were taken every 50 feet along these traverses. All readings on traverses 2200S to 3000S were related to 3000S/7450W, which was assumed to have zero potential; the zero datum for traverses 5000W to 6000W was 6000W/00S. As the two data were not connected, the contoured values of these two groups of traverses are unrelated. However, since these bases were selected in electrically undisturbed areas, it is likely that they have nearly the same value.

The S-P results are characterised by a gradient giving a general decrease in potentials approaching Mount Lyell. Superimposed on this are smaller anomalies, some of which can be traced from traverse to traverse, whereas others appear to be random. These features are illustrated by the profiles on traverses 5600W and 3000S (Plate 6).

Traverses 5400W to 5800W show a small anomaly striking south-west with maximum of 150 millivolts at 5600W/1200S. East of 5400W the readings are very irregular and continuation of the anomaly is uncertain.

A strong anomaly recorded on traverse 3000S at 1300W has an amplitude exceeding 400 millivolts. This extends to 2800S but is not present on traverse 2600S.

A strong narrow anomaly exceeding 300 millivolts was recorded at 6000W/2800S. It was not covered by traverse 3000S in 1966, but is evident in Plate 6 in the projected profile from the Corridor survey (Rowston, 1957). It continues to 2600S and apparently terminates near 6050W on traverse 2400S.

6. DISCUSSION OF RESULTS

The whole of the Cape Horn grid was surveyed with the Turam method and the Turam results formed the basis for the initial interpretation. The more interesting Turam anomalies were investigated with the IP method.

All the Turam anomalies indicate steeply dipping conductors. Although the anomalies are continuous over considerable distances, the conductors are not necessarily continuous as a Turam anomaly extends beyond the end of a conductor.

The strongest part of the anomaly between traverses 2400W and 3400W is at 3000W/1200S, where the calculated depth to current concentration is 200 feet. There are slight differences in results measured at 220 and 660 c/s, which could be caused by a body of limited extent or a body in which the conductivity changes with depth (Parasnis, 1962).

The Turam results on traverses 3200W and 3400W do not appear to be very significant and suggest only a weak conductor possibly due to sparsely disseminated sulphides, or an edge effect of a zone of mineralisation at 3000W.

Between traverses 3600W and 4200W the Turam results indicate that the conductor is of limited extent and at shallow depth. The anomaly is strongest on traverse 4000W at 1145S, where calculated depth to current concentration is 170 feet.

Between traverses 4400W and 5000W the Turam anomaly is weak and resembles the anomaly on traverses 3200W and 3400W. It is probably due to weak mineralisation.

The samll anomaly at 5000W/700S suggests a conductor of limited extent. Between traverses 5200W and 6000W, the strongest part of the Turam anomaly is at 5600W/1200S, where the calculated depth to the current concentration is 200 feet. It appears that the source is deeper on traverses 5400W and 5800W than on 5600W.

If it is assumed that the main mineralisation in the anomalous zone is near the schist/conglomerate contact, it should be possible to estimate the dip of the contact from its surface position and the positions of the conductors interpreted from the Turam results, but because of the scree-covered slopes the position of the contact is not known very accurately and only an approximate estimate of the contact dip is possible. Between 2800W and 6000W, the contact appears to dip steeply to the north.

The Turam ratio and phase contours show that the anomalous zone continues with a south-east strike through the area covered by traverses 1400S to 3000S, although in these traverses the anomalies are broader and suggest deeper sources. The anomaly centred at 5800W/3000S appears to be due to a deep conductor. The current concentration is estimated to be at a depth of 360 feet 5750W. This conductor probably extends to traverse 2600S without any appreciable change in depth, but, from traverse 2600S to traverse 1800S, it is probably nearer to the surface as the anomaly has narrowed considerably on traverse 1800S, and the calculated depth to current concentration at 6050W is about 175 feet.

The anomaly on traverse 3000S near 6400W seems due to a conductor dipping steeply to the north-west as indicated by the slight difference in position of the maximum ratio and phase values. It is estimated that current concentration is at a depth of 420 feet at 6250W. The conductor causing this anomaly apparently continues to traverse 2800S, and may be continuous with the conductor causing the anomaly on traverse 1800S at 6250W. However, a decrease in conductivity is suggested between 2600S and 2000S by the weakening of the anomaly. The current concentration appears shallower (about 175 feet) at traverse 1800S.

The Turam results on traverse 1600S (Plate 6) are difficult to interpret. The anomaly may be due to one steeply dipping conductor, in which case the calculated depth to current concentration is about 250 to 300 feet below 6100W. However, the trend of the anomalies from traverse 3000S to 1800S suggests that this anomaly may be due to two steeply dipping conductors in close proximity. The axes of the current concentrations of these conductors would be near 6200W and 6050W with depths between 150 and 200 feet.

The Turam anomalies observed in the Cape Horn area could be caused by several different types of conductor: a series of en-echelon sulphide lenses; a continuous sulphide zone that varies in strength; a zone of mineralised solutions; or mineralised solutions with patches of sulphide mineralisation.

The IP survey revealed some anomalies coinciding with Turam anomalies. In general, high background frequency effects were observed. There are insufficient observations to determine frequency effect background over the conglomerate, but from previous work, e.g. at Comstock (Williams, 1966). this is known to be normally low, reflecting the absence of mineralisation. The generally high frequency effects observed over the schists is best explained by assuming low-grade pyrite dissemination, which in fact is evident in many schist outcrops in the area.

The IP anomaly on traverses 2800W and 3000W suggests a small metallic conductor between 1000S and 1200S at a depth of about 200 feet.

On traverses 3400W and 3600W there are two weak anomalies, one near 1200S and the other between 600S and 800S. As only one broad anomaly was recorded on traverse 3800W between 600S and 1100S it would appear that the conductors causing these anomalies may meet between traverses 3600W and 3800W. The anomaly continues from traverse 3800W to traverse 4000W, where it is characteristic of a shallow source similar to the one suggested on traverse 3000W. It then weakens considerably but can be traced to traverse 5600W, where it again is stronger and characteristic of a shallow conductor between 1000S and 1200S. Sulphide mineralisation is the most likely explanation of these IP anomalies. As previously stated, the high frequency effect background suggests that the schists generally have a small sulphide content, and it is reasonable to suppose that the amount of sulphide will vary and, in places, may be concentrated in the form of pockets or lenses. This would explain the variations in strength of the IP anomalies.

The IP anomaly on traverses 1600S and 1800S is different from the other anomalies in the Cape Horn area because of the low frequency effect background. The anomaly shows weak IP effects similar to the background on traverses 2800W to 6000W and may mark the transition between barren and slightly mineralised schist.

The IP anomalies on traverses 2800S and 3000S appear to be due to deep sources (relative to those causing the anomalies between 2800W and 6000W). The anomalies are difficult to interpret because the maximum frequency effects do not coincide with the lowest resistivity values. It is possible that the frequency effects are due to disseminated mineralisation and the resistivity 'lows' to more massive mineralisation or to shear zones. The nature of the sources is therefore doubtful. They could be shear zones and disseminated sulphides or massive conductors with disseminated haloes.

The regional gradient in the S-P results is considered to be a topographical effect, as has been observed in previous S-P surveys in the Mount Lyell area. The more localised anomalies superimposed on the regional gradient are probably due to oxidation processes related to sulphide mineralisation.

The S-P anomaly at 5600W/1200S indicates a fairly shallow source. The weakening of the anomaly towards traverses 5800W and 5400W could be due to increased depth of the source or change in oxidising conditions. Both these possibilities are satisfied by a conductor such as a sulphide lens; e.g., the increase in depth towards traverse 5800W and 5400W may be due to the geometry of the lens; the change in oxidising conditions may be due either to change in degree of mineralisation or change in the position of the water table.

The S-P anomaly at 6300W/3000S is the widest and strongest S-P anomaly recorded at Cape Horn. The downwards continuation method indicates a depth of about 300 feet to source. A similar depth is estimated for the source of the anomaly at 6000W/2800S. Both anomalies are considered to be due to sulphide mineralisation.

In general there is a good agreement between the Turam, IP, and S-P results. The general trend of the anomalies from the three methods is approximately parallel to the schist/conglomerate contact. On traverses 2400W to 6000W, except for the very weak IP anomaly at 3400W/1200S, the IP anomalies either coincide with, or are slightly north of, the Turam anomalies.

A slight displacement of IP and Turam anomalies has been observed over dipping orebodies in other areas, e.g. at Zeehan (Williams, 1965). A displacement may also be caused by topography, as may be illustrated by reference to the two-dimensional plots of Plate 6. If these plots were inclined at the angle of average slope of the traverse, the positions of the IP values would be moved 'uphill' towards the axes of the Turam anomalies. The Turam and IP anomalies appear to be due to a common source and the most likely explanation is zones of more concentrated sulphide mineralisation in the schists.

The same explanation is also applicable to the S-P anomalies, which agree in position with the Turam and IP anomalies between 5000W and 6000W. The highest concentrations would appear to be on traverses 3000W, 4000W, and 5600W, where the strongest anomalies with both Turam and IP methods were recorded.

On traverses 1600S to 3000S, the agreement between the Turam and IP results is not so good as in the rest of the survey area. However, the Turam anomalies coincide with S-P anomalies on traverses 2400S to 3000S and are considered to be caused by sulphide mineralisation. The Turam results suggest two separate zones of mineralisation which continue to traverse 1800S and possibly merge at about traverse 1600S. The IP anomalies on these two traverses indicate weaker mineralisation, and it is possible that the Turam anomalies here are in part caused by mineralised solutions in shear zones.

7. COMPARISON OF RESULTS WITH PREVIOUS INVESTIGATIONS

As the 1966 Cape Horn grid overlapped the 1956 Corridor grid and the 1957 Comstock grid, comparison of the 1966 results with the electromagnetic and IP results of these areas is possible. This comparison is useful in interpreting the 1966 results because some of the anomalies recorded in the adjoining area are representative of the type of anomaly to be expected from Mount Lyell mineralisation. However, comparison with the earlier equipotential work is of little value because the electromagnetic and IP methods give more detailed information than the equipotential method.

The electromagnetic survey by Rowston (1959) covered part of the anomalous zone on traverses 2400W to 3000W. Drill hole DDH 30 situated near traverse 2800W (Plate 2) was drilled to test Rowston's anomaly 27/57. It intersected pyrite and copper values (about 0.5%). The hole reached 269 feet and mineralisation ceased at 263 feet. The fairly shallow body indicated is consistent with the 1966 results, but on the basis of these results stronger mineralisation could be expected on traverse 3000W.

The similarity of the geophysical results on traverses 3000W, 4000W, and 5600W suggest that they are due to similar causes. Drill hole DDH 30 indicates that the most probable cause is sulphide mineralisation. It is interesting to note that drill holes DDH 472, 474, and 475 (Plate 2) give much lower assay and pyrite values and are in an area of very weak geophysical anomalies near traverse 5000W. This suggests that, if the anomalies at 5600W and 4000W are due to sulphide mineralisation, this mineralisation should be stronger than the mineralisation encountered in these holes.

Anomaly 17/56 shown in Plate 2 was observed during the Turam survey of the Corridor area (Rowston, 1957) with primary cable along 6150W. The anomaly is actually much broader than indicated in Plate 2, which shows only the highest contour of the ratio values. It probably corresponds to the anomaly through 3000S/5750W of the present survey, the difference in location being accounted for by the different primary cable positions used in the two surveys. Anomaly 31/56 was observed with a primary cable along 5500W. Although the maximum of the anomaly is at 1250W, the current concentration is below 6150W, because of the steep terrain. The corresponding anomaly of the 1966 survey has a maximum near 6400W (on traverse 3000S) and an estimated current concentration at about 6250W. The difference between the two interpretations is to be expected because the primary cables were on opposite sides of the conductor. The Turam anomaly over a steeply dipping conductor occurs near the side of the conductor closest to the primary cable, and comparison of the results of the two surveys indicates that the width of the conductor is about 100 feet.

The Turam anomalies on traverse 3000S are not so strong as the anomaly 16/56 recorded over the Corridor orebody. This may be partly due to their position relative to the primary cable and is not necessarily related to the degree of mineralisation. An IP traverse read over anomaly 16/56 (Bonewill & McKenzie, 1961) gave results very similar to those obtained on 3000S in the Cape Horn survey.

The Turam results of the Corridor survey support the idea that the Turam anomalies on traverse 3000S of the Cape Horn survey are due to two different conductors. The assays from the Anaconda tunnel (Plate 4) indicate good pyrite values between 5800W and 6000W on traverse 2600S, and the anomaly at 5750W/3000S is probably due to an extension of this mineralisation, which appears to continue further to the North Lyell Consols mine. The Turam anomaly at 6250W appears to be related to the extension of the mineralisation of the Western Tharsis.

8. CONCLUSIONS AND RECOMMENDATIONS

The survey of the Cape Horn area has revealed a series of geophysical anomalies that are considered to indicate sulphide mineralisation. The results suggest that, between the Corridor and Comstock areas, weak disseminated mineralisation extends for at least 1000 feet into the schists from the schist/conglomerate contact. In places the mineralisation is concentrated into zones, probably of lenticular form.

Generally, throughout the Mount Lyell field, it has been possible to correlate geophysical anomalies with sulphide mineralisation but the copper content of the sulphides cannot be predicted from the geophysical data and must be determined by test drilling. On the basis of the geophysical survey, six drill holes have been selected to investigate the most interesting geophysical results. These are listed below. Further testing would depend on the results from these holes.

Drill hole number	Position of target	Depth to target (feet)	Location of collar	Depression of hole	Direction of hole along traverse	Minimum length of hole (feet)
1	3000S/ 5750W	360	3000S/ 6100W	45°	East	550
2	3000S/ 6250W	420	3000S/ 6570W	45°	East	550
3	1600S/ 6150W	250	1600S/ 6335W	45°	East	400
4	5600W/ 1200S	150	5650W/ 1150S	60°	45° east of south	250
5	4000W/ 1100S	150	4000W/ 1000S	60°	South	250
6	3000W/ 1200S	200	3000W/ 1100S	60°	South	300

The drill sites are shown in plan in Plates 2, 4, and 5, and in section in Plate 6, together with the relevant geophysical and topographic profiles. All the drill holes except No. 2 should be continued until the conglomerate is reached. The drill sites have been selected to test all possible explanations of the geophysical results.

Drill holes Nos. 1 and 2 are designed to test the geophysical anomalies on traverse 3000S. If No. 1 intersects favourable mineralisation, No. 2 could be extended to investigate for possible extension of the mineralisation to greater depths. Drill hole No. 3 is intended to test the strong Turam anomaly on traverse 1600S and to show whether the anomaly is due to one deep source or two shallow sources. Drill holes Nos. 4, 5, and 6 on traverses 5600W, 4000W, and 3000W respectively are intended to test the anomalous zone on the northern part of the area, at places where the geophysical results suggest highest concentrations of mineralisation.

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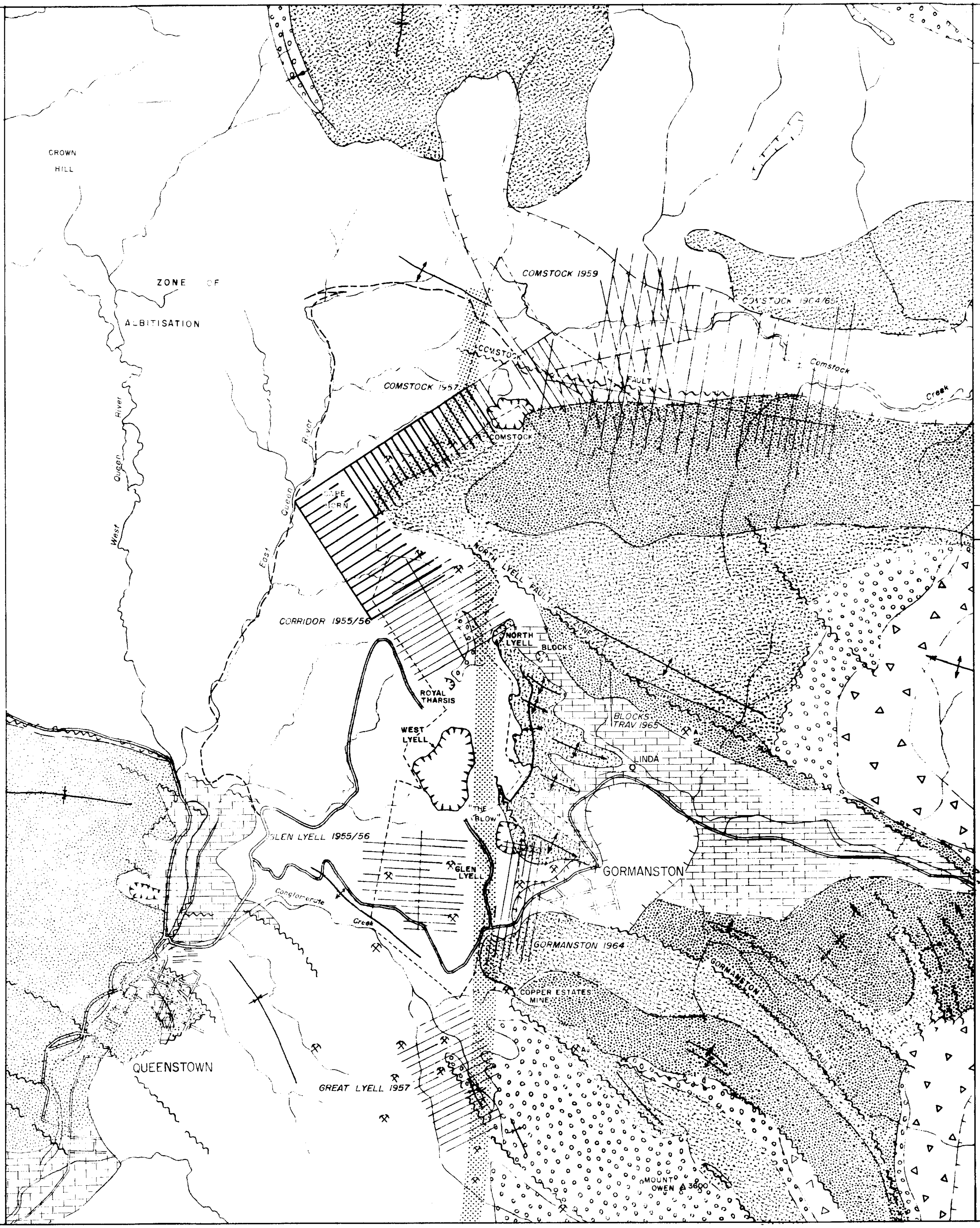
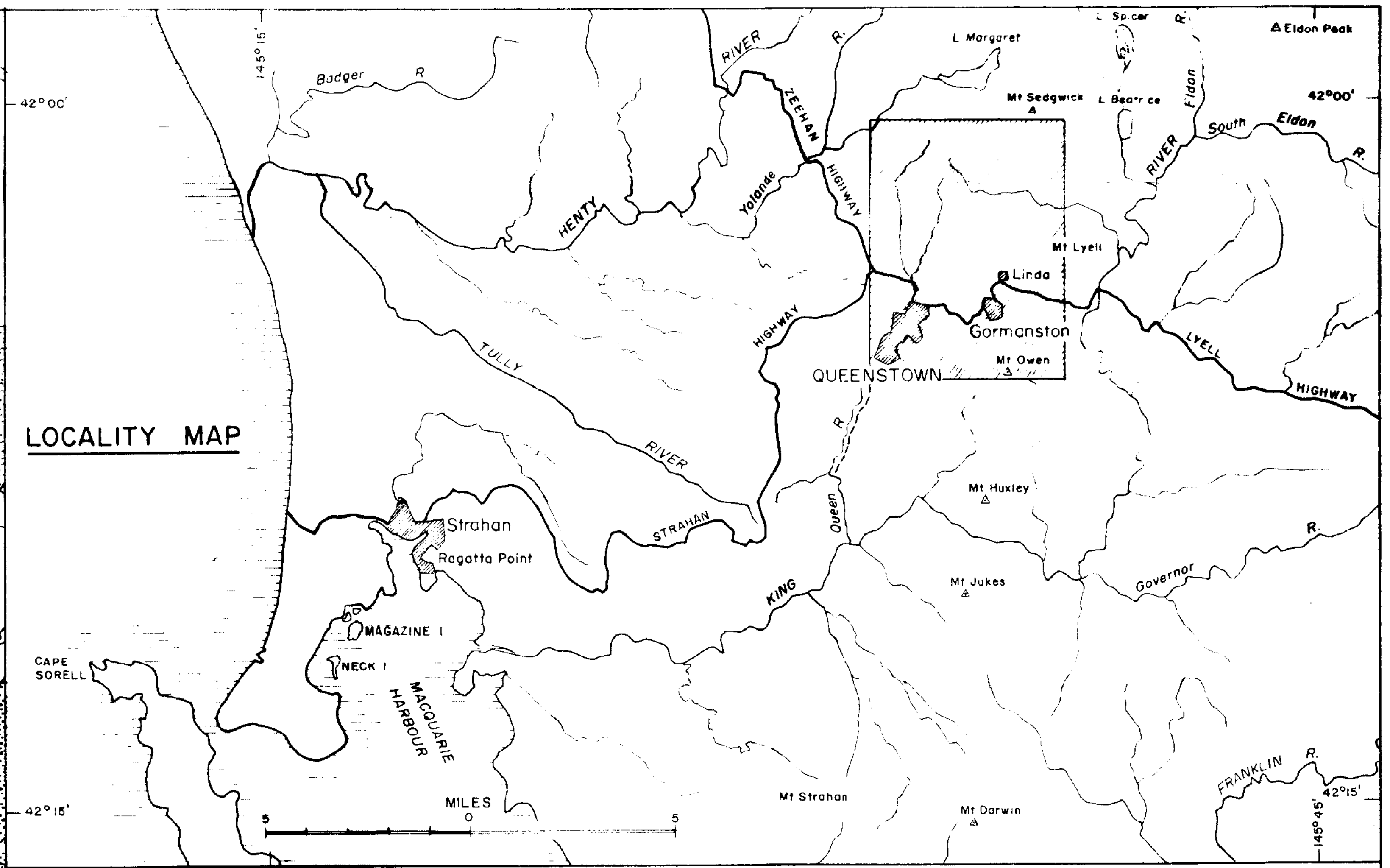
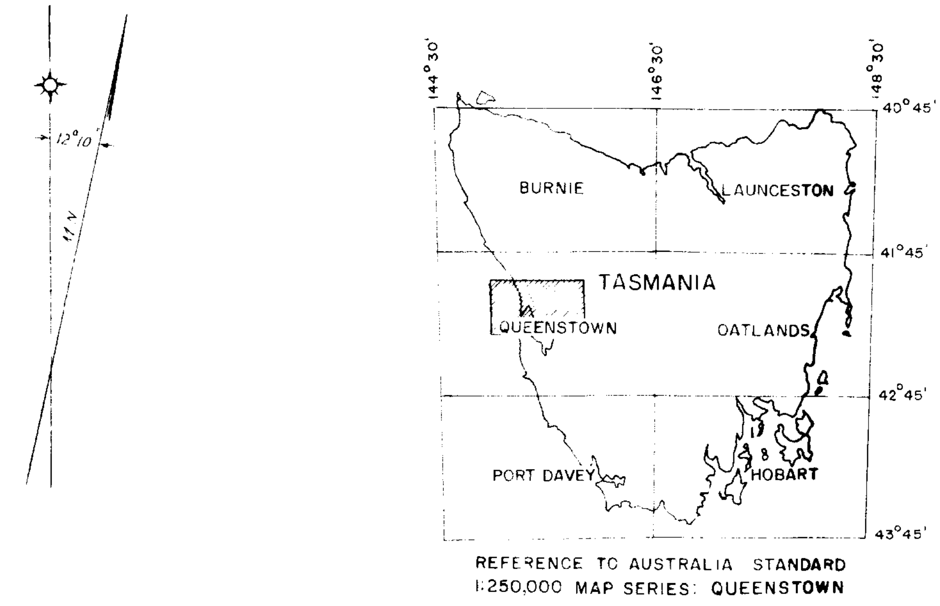
LEGEND

- Pleistocene Moraine } Pleistocene
- Eldon Group } L.Devonian to Silurian
- Gordon Limestone
- Upper Owen Conglomerate
- Middle Owen Conglomerate } Ordovician
- Lower Owen Conglomerate
- Jukes Conglomerate
- Mount Read Volcanics (including Lyell Schists) } Cambrian
- Observed geological boundary
- Approximate " "
- Observed fault
- Approximate "
- Approximate position of Lyell Shear
- Syncline (with plunge)
- Anticline
- Mine for copper
- Au Unless marked gold
- Quarry
- Trigonometric station
- Main road
- Vehicular track
- River or creek
- Outline of geophysical survey areas prior to 1949
- BMR geophysical surveys 1949-1965
- Rio Tinto geophysical survey 1959
- BMR geophysical survey 1966







CAPE HORN AREA
QUEENSTOWN, TASMANIA, 1966
LOCALITY AND REGIONAL GEOLOGICAL MAP

MILES

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

TO ACCOMPANY RECORD No 1967/100

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. K55/B7-129


PLATE 2
CAPE HORN
CAPE HORN AREA
TOPOGRAPHY, GEOPHYSICAL GRID, AND EXPLORATION DETAILS
LEGEND
Geophysical traverse surveyed by B.M.R. in 1966
Geophysical traverse surveyed by B.M.R. in 1955/1956
Outline of geophysical area surveyed prior to 1948
Topographic contours
Quarries etc.
Mine buildings etc.
Road
Track
Costean
Creek
Geological boundary
Shaft
Adit
Existing drillhole
Recommended drillhole
Centre of calculated current concentration (from Turam results)
Position of geophysical anomaly
Position of geophysical anomaly, Blazey and Douglas.
SCALE IN FEET
CONTOUR INTERVAL 50FT
Mine Grid
Magnetic North
TO ACCOMPANY RECORD No 1967/100
Geophysical Branch, Bureau of Mineral Resoures, Geology and Geophysics.
K55/B7-147

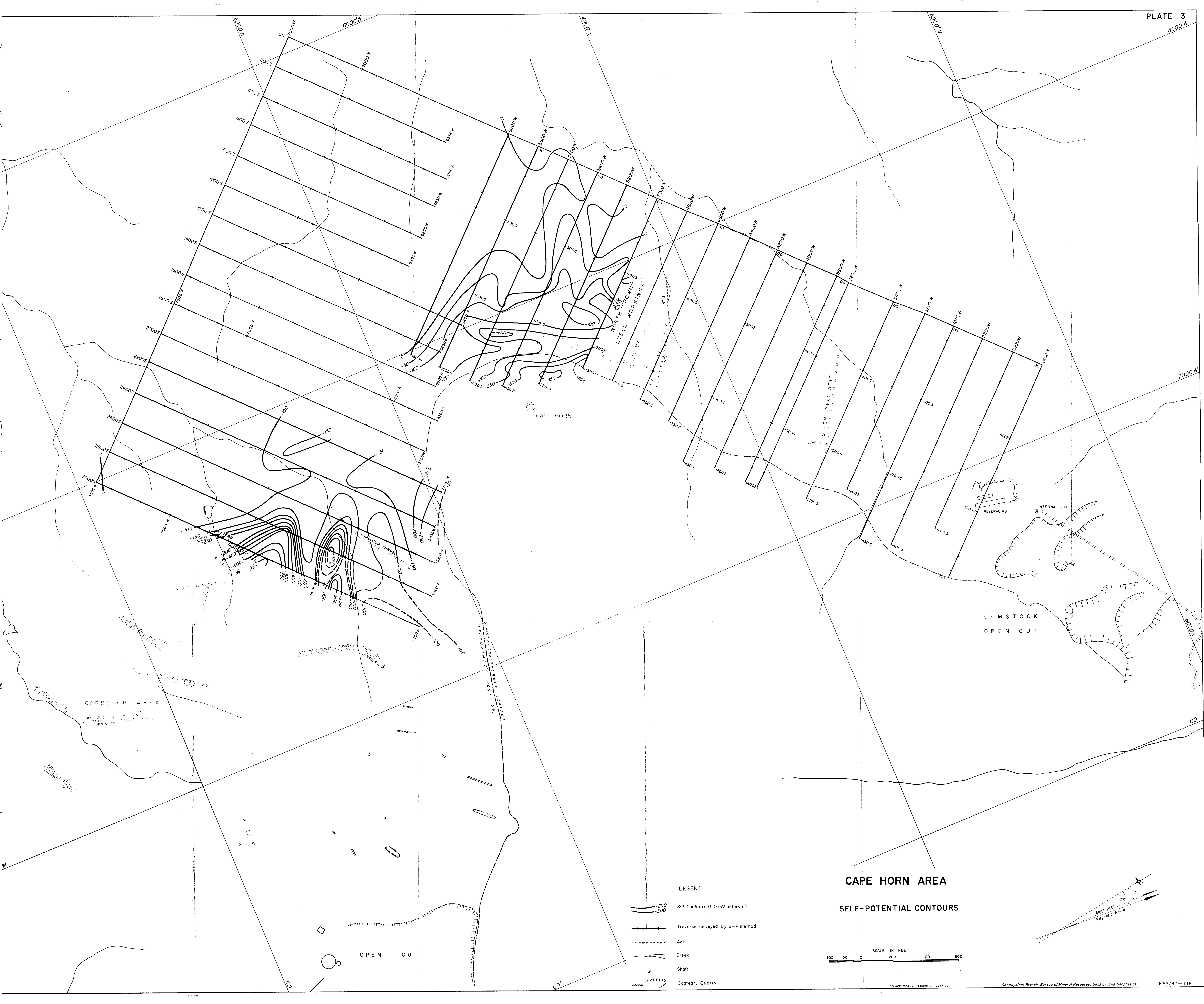
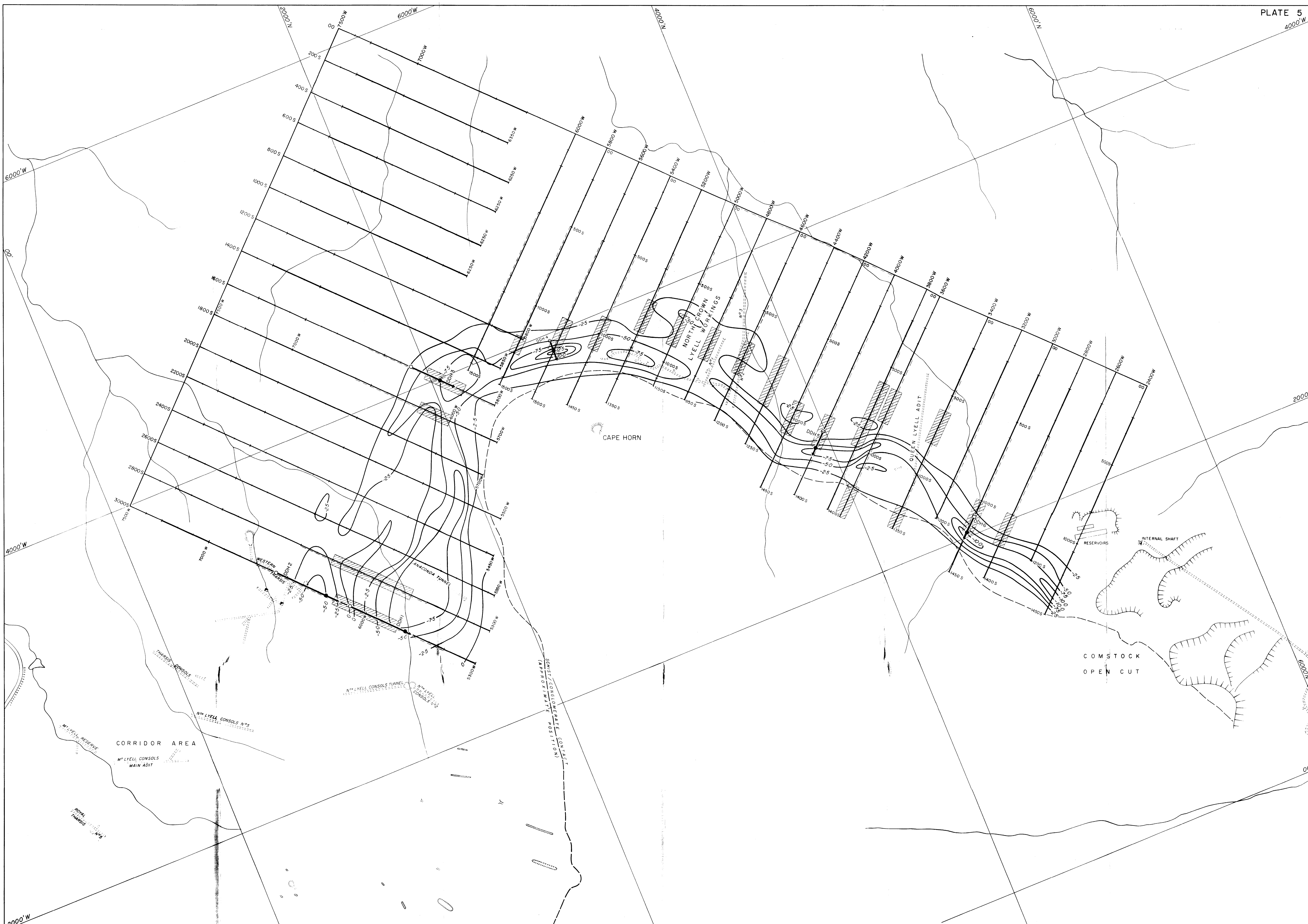


PLATE 3
CAPE HORN
NORTH CROWN
LYELL WORKINGS
QUEEN LYELL ADIT
ANACONDA TUNNEL
RESERVOIRS
INTERNAL SHAFT
COMSTOCK
OPEN CUT
CORRIDOR AREA
OPEN CUT
LEGEND
S-P Contours (5.0 mV interval)
Traverse surveyed by S-P method
Adit
Creek
Shaft
Costean, Quarry
CAPE HORN AREA
SELF-POTENTIAL CONTOURS
SCALE IN FEET
200 100 0 200 400 600
Mine Grid
Magnetic North
TO ACCOMPANY RECORD No 1967/100
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
K55/B7-148

PLATE 5



CAPE HORN AREA

I P ANOMALIES, TURAM PHASE CONTOURS, AND RECOMMENDED DIAMOND-DRILL HOLES

TO ACCOMPANY RECORD No 1967/100

Geophysical Branch, Bureau of Mineral Resoures, Geology and Geophysics. K55/B7-150

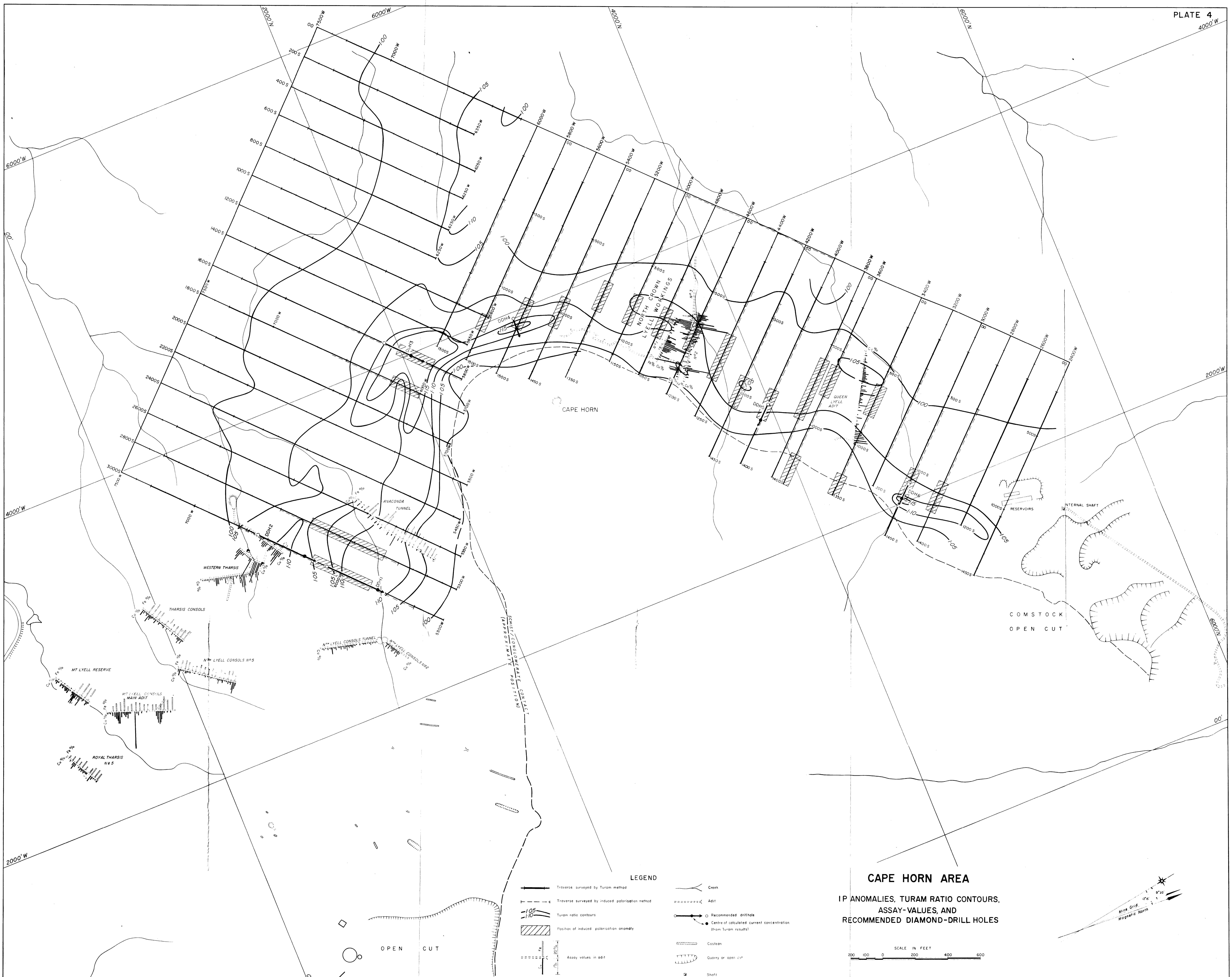


PLATE 4
CAPE HORN AREA
IP ANOMALIES, TURAM RATIO CONTOURS, ASSAY-VALUES, AND RECOMMENDED DIAMOND-DRILL HOLES
LEGEND
Traverse surveyed by Turam method
Traverse surveyed by induced polarisation method
Turam ratio contours
Position of induced polarisation anomaly
Assay values in adit
Creek
Adit
Recommended drillhole
Centre of calculated current concentration (from Turam results)
Costean
Quarry or open cut
Shaft
SCALE IN FEET
200 100 0 200 400 600
TO ACCOMPANY RECORD No 1967/100
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
K55/B7-149-1
CAPE HORN
NORTH CROWN LYELL WORKINGS
QUEEN LYELL ADIT
ANACONDA TUNNEL
WESTERN THARSIS
THARSIS CONSOLS
MT LYELL RESERVE
ROYAL THARSIS No 5
COMSTOCK OPEN CUT
RESERVOIRS
INTERNAL SHAFT
OPEN CUT
SCHIST/CONGLOMERATE CONTACT (APPROXIMATE POSITION)

SELECTED GEOPHYSICAL RESULTS, GEOLOGICAL SECTIONS, AND DRILLING RECOMMENDATIONS

TO ACCOMPANY RECORD Nº 1967/100

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

K55/B7-146