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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1960 No. 111

CYPRESS CREEK AND MOORES VALLEY GEOPHYSICAL SURVEY, TASMANIA 1959

by

D.L. Rowston

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ABSTRACT

The metalliferous surveys described were made by the Bureau of Mineral Resources for Lyell-E.Z. Explorations in early 1959. Lyell-E.Z. Explorations were engaged in prospecting the south-western corner of Tasmania for base metals, and requested aid in a ground follow-up of selected airborne geophysical anomalies.

Surveys were made at Cypress Creek (to investigate Airborne Electromagnetic Anomalies No. 20/6 and 20/4) and Moores Valley (selected on geological evidence). Electromagnetic, magnetic, and self-potential methods were employed in both localities.

Strong indications were obtained by the electromagnetic and self-potential methods at Cypress Creek. The indications outlined two anomalous zones which correlate with graphitic-pyritic shale of the Cambrian "Dundas Group" (shale, chert, greywacke, and basic lava). Assays of samples of the graphitic-pyritic shale showed no copper or any other economic minerals and therefore no recommendations are made for further testing.

As expected, the electromagnetic methods were unsuccessful in delineating either the Lyell Shear or postulated cross-faults, beneath a considerable thickness of Tertiary sediments at Moores Valley.

1. INTRODUCTION

A geophysical survey employing electrical and magnetic methods was conducted by the Bureau of Mineral Resources in south-western Tasmania from January to March 1959. The survey was requested through the Tasmania Department of Mines by Lyell-E.Z. Explorations (L.E.E.) who were searching for mineral deposits in the area south of Queenstown.

The results of airborne electromagnetic (A.E.M.) and magnetic surveys performed for L.E.E. during 1956-1958 by Adastra-Hunting Geophysics Pty.Ltd., disclosed several anomalies that warranted ground investigation. The Bureau was asked to assist in this phase of the exploration, and carried out geophysical surveys over the A.E.M. anomalies known as 20/6 and 20/4 at Cypress Creek, and over parts of Moores Valley, an area selected for investigation on geological grounds.

The areas investigated are located some 50 miles from Queenstown in the uninhabited country south of Macquarie Harbour (Plate 1). To facilitate field operations L.E.E. established a base camp at Birch Inlet on the south-western extremity of Macquarie Harbour, about 4 hours by boat from Strahan. Personnel and supplies were transported from this base to the operation sites by Bell G2 helicopter. There were no roads and few rough foot tracks in the area. Communication was maintained by a portable radio network controlled from Queenstown.

The Bureau party comprised D.L. Rowston (party leader), R. Goodchild (geophysicist), and two university vacation students. Additional field hands were provided by L.E.E. which also organised all camping facilities.

2. GEOLOGY

Lyell-E.Z. Explorations has been engaged in a geological investigation of the area south of Queenstown for several years. A relevant portion of their map of the regional geology of the prospecting area, compiled from airphoto interpretation and ground survey, is reproduced as Plate 1 of this Record.

The rocks are the same as those found elsewhere on the west coast of Tasmania; namely the pre-Cambrian Dundas, Junee, and Eldon Groups, overlain in places by Permian and Tertiary-Recent sediments. Serpentinite and granite probably of Cambrian age have also been mapped.

The major fold and fault structures have a predominant north-south trend, but there are also well-developed tectonic features exhibiting strikes which range from south to east. It has been suggested that the Tertiary lacustrine sediments which form the narrow belt south from Macquarie Harbour were deposited in a rift valley. The eastern boundary of the rift valley is recognised as the continuation of the Lyell Shear and is for this reason important in the search for mineral deposits. Of particular interest is the Moores Valley locality where the Tertiary sediments conceal what is apparently a major distortion of the Lyell Shear; it is considered to be similar to the Linda Disturbance at Mt. Lyell. The Tertiary sediments have an estimated thickness of up to 400 ft at Moores Valley.

At Cypress Creek the rocks belong to the Cambrian Dundas Group and comprise interbedded chert and black shale within a broader sequence of shale, greywacke, tuff, and basic lava. Predominantly the beds dip steeply to the west and have a general strike of 160 degrees. The sediments are on the west limb of an overturned anticline. Strike faulting is prominent and has resulted in some brecciation of the chert bands, and the formation of thin graphitic films within the black shale. Pyrite occurs in finely disseminated form throughout the shale, and as occasional blebs in the chert. The mineralisation is believed to be syngenetic (Scott, 1959).

3. PREVIOUS GEOPHYSICAL EXPLORATION

A large part of the prospecting area was flown for L.E.E. by Adastra-Hunting Geophysics Pty.Ltd., in 1957-58. Airborne electromagnetic and magnetic techniques were used. Many of the anomalies recorded could be eliminated on geological grounds. Other anomalies, indicating a high conductivity and situated in a favourable environment, were selected for a ground geological and geophysical follow-up.

The airborne results provide much information of a regional nature concerning the distribution of particular rock types and the positions of formation boundaries.

The A.E.M. contours (Adastra Sheet 20) are comparatively featureless over the Dundas Group beds, except for one distinctive anomaly. This anomaly (20/6) appears in the contours as a long, narrow anomaly which extends with a general southerly strike for over two miles. The high ratios of the dual-frequency phase components indicate a highly conducting body. A very weak anomaly (20/4) was recorded about half a mile north of 20/6.

The Tertiary sediments are clearly defined by a group of broad anomalies of relatively low intensity. The anomalies, which in general occur near the margins of the sediments, are considered to be due to conducting clay beds.

The results of the airborne magnetometer survey show that A.E.M. anomaly 20/6 is situated in a magnetically disturbed area. This area, which is sharply outlined by the contours of total magnetic intensity, forms a north-south belt up to 3½ miles wide extending from the Wanderer River to south of Cypress Creek. Within it are many magnetic "highs" (up to 800 gammas) which may be linked to form several narrow north-south zones. It is considered that these anomaly zones are probably due to basic lavas in the Dundas Group beds. The ground survey area at Cypress Creek coincides approximately with a magnetic "low".

Lyell-E.Z. Explorations conducted its own geophysical reconnaissance and also engaged private contractors to carry out gravity, "AFMAG", and Induced Polarisation surveys concurrently with the Bureau investigations.

4. GEOPHYSICAL PROBLEMS AND METHODS

The geophysical problems of Cypress Creek and Moores Valley differed greatly.

The clear-cut A.E.M. anomaly at Cypress Creek suggested that normal ground electromagnetic and self-potential methods could be used successfully, and this was found to be so. There were no problems presented by highly conductive overburden or poor electrical ground contacts.

On the other hand, Moores Valley was not a favourable area for application of these methods because of the presence of a considerable thickness of Tertiary sediments, in which broad horizontal layers of conducting clay were likely to occur. The magnetic method was used in an endeavour to locate the contact between Owen Conglomerate and Dundas sediments along the Lyell Shear. In some places the Dundas beds exhibit a higher magnetic susceptibility than the Owen Conglomerates.

Observations of the vertical component of the earth's magnetic field were made using a Watts Vertical Magnetic Variometer (No. 85998). Local variations may be caused by a particular rock type or formation or, as in the case of the copper ore at Mt. Lyell, by accessory magnetite.

The self-potential method is applicable to the search for sulphide bodies undergoing active oxidation. Such bodies generate electro-chemical potentials which may be measured at the ground surface. The sulphide body is indicated by a negative centre or minimum. Graphitic or carbonaceous rocks and pronounced topographic features can also give similar anomalies however, and the method alone is therefore not a conclusive indicator of sulphide mineralisation. Potential measurements were made with a B.M.R.-pattern S-P. meter (Type C, No. 1).

Two electromagnetic techniques, "Slingram" and "Turam", were employed during the survey. The physical principles of the methods are described in the standard texts, such as those by Heiland (1946) or Jakosky (1952), and in previous reports on geophysical surveys in the Mt. Lyell area.

Both techniques may detect conductive bodies beneath the surface. Common conductors include sulphide bodies, graphitic-pyritic beds, and shear zones. The depth at which a conductor may be located depends in a complex way on the size, disposition, and conductivity of the body and on the overburden conductivity, the frequency, and the instrument configuration.

The Slingram equipment measures the real and imaginary vertical components of secondary electromagnetic fields which originate from any conducting bodies located between the transmitting and search coils. Terrain corrections must usually be applied to the real component. The depth penetration of the primary field is limited to about three quarters of the coil separation (normally between 100 and 200 ft) and is therefore adequate for the Cypress Creek environment.

The Turam equipment has the advantage of greater depth penetration, and rarely requires height corrections. The primary field coil is not portable however, and a more accurately surveyed grid is required. An audio-frequency electromagnetic field is established over the area by a motor-generator connected in series with a long insulated cable earthed at each end. This primary field induces secondary currents in any conducting bodies nearby. The vertical component of the resultant field is measured at the ground surface and expressed as the intensity ratio and phase difference between two coils. These coils are separated by a constant horizontal distance, and are moved to successive stations along traverses at right angles to the cable line. Calculated primary field effects are subtracted from measured values of the total field. A conductor is indicated by a phase minimum and an intensity ratio maximum.

The frequencies used in both techniques are in the low audio range; 500 and 1500 c/s for Slingram, and 440 and 880 c/s for Turam.

5. CYPRESS CREEK SURVEY

(A) Operations

The Cypress Creek A.E.M. anomalies, 20/6 and 20/4, are located in Dundas sediments some 20 miles south of Birch Inlet. The country is difficult of access. The topography consists of low ridges and valleys. The ridges are covered with tall myrtle and sassafras timbers in contrast to the somewhat swampy valleys with their dense growth of Bauera, horizontal scrub, and Manuka vegetation.

The camp was located north-west of the A.E.M. anomalies, and on the only potable water supply; it was established by L.E.E. prior to the arrival of the geophysical party. Surveying of the geophysical grid was done by chain and compass; the baseline was laid approximately on a north-south magnetic bearing and the traverses were cut at right angles to it at about 400-ft intervals. The baseline was surveyed to 8800S and although some errors in distance were revealed, the original traverse numbering has been retained.

The grid from 8800S to 12000S was only roughly surveyed, and shows only approximate positions. Thirty two traverses, varying in length from 800 to 1800 ft, were cut and pegged at 50-ft intervals. The area investigated by the geophysical survey was about two miles long, from Traverse 1600S to 12000S, and on the average, one quarter of a mile wide (Plate 2).

Slingram, self-potential (S-P.), and magnetic methods were used at Cypress Creek (20/6); 29 traverses were surveyed with the Slingram equipment, 31 with the S-P. meter, and 23 with the magnetic variometer.

A reconnaissance survey was also carried out over A.E.M. anomaly 20/4 situated about half a mile north of 20/6. A baseline from 00 to 3200N was surveyed on a magnetic bearing of 350 degrees. Five traverses were cut at 400-ft intervals from 1600 to 3200N and extending from 400W to 400E of the baseline. All traverses were surveyed by the Slingram method, and one by the magnetic method.

Gravity and AFMAG surveys were made over selected sections of Anomaly 20/6 by private contractors employed by Lyell-E.Z. Explorations.

(B) Results and Interpretation

The results of the geophysical ground survey are shown on Plates 2, 3, and 4 as Slingram imaginary-component contours, self-potential contours, and magnetic contours. Plate 5 gives an example of typical profiles from which the contours were compiled; it shows also a Slingram real-component profile corrected for height, and the corresponding vector diagram.

(i) Slingram Method

A frequency of 1500 c/s and a constant coil separation of 150 ft were used during the Slingram observations. The transmitting coil was always situated to the west and the readings plotted for the centre point of the array. Topographic levels were obtained only on a few traverses; as the Slingram real-component measurements must be corrected for height, they are not suitable for presentation, and are omitted from this report. The imaginary-component contours and S-P. contours however provide sufficient information for reconnaissance.

Several strong electromagnetic anomalies, as shown in the imaginary-component contours on Plate 2, were measured in the area. In general the anomalies are lenticular and elongated roughly north-south in agreement with the strike of the Dundas Group beds. The anomalies form two sharply defined zones, A and B.

Anomaly Zone A extends from Traverse 1600S to Traverse 12,000S, and beyond these limits, as a long narrow feature which correlates with the A.E.M. anomaly 20/6. The zone varies from 200 to 800 ft in width and is composed of a number of narrow conductors separated by non-conducting strata. Although the conductivity varies along the length of the zone, the persistence of the feature suggests that it is caused by a particular stratigraphic layer in the Dundas beds. Geological mapping in the grid area by Scott (1959) revealed interbedded chert and graphitic-pyritic shale which correlate with the conductors indicated by the geophysical results. Strike faulting is also in evidence, and the conductivity variations could therefore arise from disruptions in the continuity of the beds.

Anomaly Zone B is situated east of Zone A and has the same general strike. Zone B commences abruptly on Traverse 4800S and ends at Traverse 10,200S. The conductivity is more constant over the length of the zone and although its area is smaller than that of Zone A, its conductivity is somewhat higher. This is demonstrated by the vector diagram of Traverse 6800S (Plate 5) in which the real and imaginary components of the vertical field are plotted for each observation point. The slope of the closed curves on the vector diagram is a measure of relative conductivity; increasing slope indicates a high conductivity.

The Slingram results in general show no asymmetry that can be definitely ascribed to the dip of the conductors. The dip is therefore assumed to be near-vertical, and this assumption agrees with the steep westerly dips observed by the geologists.

A portion of Traverse 3800S was trenched to expose fresh rock; the geological section showed that the carbonaceous shales coincide with the electromagnetic anomalies. On assay the shales were found to contain finely disseminated syngenetic pyrite with $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent sulphur and about 1 to 2 per cent total carbon.

(ii) Self-potential Method

The contours of the surface distribution of naturally-occurring earth potentials (self-potentials) shown on Plate 3 are markedly similar to those of the electromagnetic results.

The self-potential anomalies occur as a series of elongated features which may be combined to form two anomaly zones. These correspond closely with the Slingram Zones A and B.

Some of the potentials measured exceeded minus 500 millivolts; negative centres greater than 300 millivolts constitute strong indications.

It has been found that many self-potential anomalies are associated with graphitic-pyritic shale, and the anomalies at Cypress Creek are attributed to this source.

The contours indicate that the anomalies arise from shallow and near-vertical bodies. Here again the anomalous zones appear to be due to what were originally continuous stratigraphic horizons in the Dundas sediments, but which were subsequently disrupted by movement along the strike.

Anomaly A appears to persist strongly beyond the limits of the grid; Anomaly B is a weaker, parallel indication located between Traverses 4600S and 12,000S.

(iii) Magnetic Method

The results of the ground magnetic survey are shown in the form of contours on Plate 4. They confirm the airborne results to a reasonable degree; the A.E.M. anomaly 20/6 occurs in an area of magnetic "low" within a broader disturbed zone.

There are no magnetic anomalies coincident with the electromagnetic or S-P. anomalies but two local magnetic "highs" occur on the margins of the zones.

On Traverses 1600S and 2000S along the western margin of Anomaly A, variations up to 1900 gammas were observed. The other anomaly attained 450 gammas and is centred at 650W on Traverse 9600S. No rock outcrops occur in these localities, and consequently no samples were obtained for susceptibility determinations. The cause of the anomalies is unknown but is probably basic lava. The increases in the magnetic values on the eastern extremeties of Traverses 6400S to 8000S coincide with the airborne "high" over one of the main north-south magnetic features.

No special significance, with regard to possible mineralisation, is attached to the magnetic anomalies.

The gridded area was not completely surveyed by the magnetic method because of the limited time the helicopter was available to transport the party and its supplies.

(C) Conclusions

The geophysical ground investigation of the A.E.M. Anomaly 20/6 revealed strong electromagnetic and self-potential anomalies. No useful results were obtained from the magnetic observations.

The electromagnetic and self-potential results defined two Anomaly Zones, A and B. These two zones correlate with the graphitic-pyritic shale which exhibits a high relative conductivity; this shale is also the apparent source of the self-potential anomalies. The shale is interbedded with non-conducting chert.

The persistence of the anomaly zones indicates that the anomalies are associated with a particular bed in the Dundas Group sediments, and the breaks in continuity indicate possible post-depositional movement. From the en echelon occurrence of the individual anomalies comprising the zones, this movement appears to be nearly parallel to the strike of the beds.

Assays of representative samples of the graphitic rocks collected and analysed by L.E.E. show that although the shales contain pyrite, copper is absent. The sulphides are therefore considered to be of no economic significance, and no recommendations are made for further testing of the geophysical anomalies.

The weak A.E.M. anomaly 20/4 was not detected by ground survey.

6. MOORES VALLEY SURVEY

(A) Results

Moores Valley is about 48 miles south of Queenstown (Plate 1) between the Wanderer and Colin Rivers and just east of their junction. The Owen Conglomerates and Dundas Group beds (which crop out north and south of Moores Valley) are overlain by Tertiary lacustrine sediments. These Macquarie beds have been estimated by Scott to be up to 400 ft thick. The contact of the Owen and Dundas sediments is postulated as the Lyell Shear, and its location beneath the Tertiary layer is important, particularly as some major flexture or displacement is indicated by the geological mapping. Such distortions of the Shear have, elsewhere, been favourable environments for copper mineralisation. Two transverse faults, the Colin and the Hazell, have been suggested, to account for the apparent displacement of the Shear at Moores Valley.

The geophysical surveys were carried out by the Bureau and private companies to try to locate the Shear beneath the Tertiary sediments. As the Dundas Group rocks are known in some places to have a higher magnetic susceptibility than the Owen Conglomerates or Lyell Schists, it was decided to use the magnetic method to locate the Shear.

The survey area lies mainly to the west of an extensive peneplain, and is sharply dissected by drainage towards the Wanderer River. An open vegetation prevails, although most of the swampy flats and streams are densely covered by light trees and scrub.

A grid, primarily pegged for the AFMAG and Induced Polarisation surveys by McPhar Ltd. of Canada, was used for the Bureau work. The traverses were nominally 400 ft apart at right angles to the baseline, whose bearing was 208 degrees magnetic. Most of them extended from 2000 ft east to 2000 ft west of the baseline.

Electromagnetic and self-potential methods were tested concurrently with the magnetic survey, but the field operations had to be restricted because of interference with the Canadian equipments.

Eighteen traverses, totalling 13 miles, were read at 100 and 200-ft intervals with the Watts Variometer. The results are shown as magnetic vertical force contours in Plate 6. Two additional northerly traverses to the east of the baseline were surveyed to test over the suspected Hazell Fault.

From the results of two test traverses by L.E.E., and from the airborne total intensity contours, it was known that only small magnetic anomalies could be expected; considerable care was taken therefore with diurnal and temperature corrections. The accuracy of the survey results is about ± 5 gammas.

The local magnetic anomalies in the gridded area ranged from minus 10 to plus 50 gammas, with a preponderence in the range 0 to 30 gammas. Such changes, which occur over many hundreds of feet, are too small to be considered significant. The results show a general increase in the vertical component towards the western ends of the traverses. A very poorly defined magnetic "low" occurs along the baseline from Traverse 12 to Traverse 48; it then diverges west to 1200W on Traverse 76. No definite conclusions can be drawn from these results, and the two northerly traverses show no evidence of the Hazell Fault.

Two traverses were tested with the self-potential method. The small fluctuations measured were closely related to the topography, a common phenomenon in western Tasmania, and the method was abandoned.

A portion of the grid area was investigated by the Turam electromagnetic method. The primary field was established by means of an earthed cable parallel to the baseline at 600W. Traverses 12 to 60, from 350W to 1600E, were read at 50-ft intervals, with a frequency of 440 c/s and 100-ft separation between the search coils.

The only anomaly of any significance was obtained on Traverse 12 between 300E and 350W where the phase difference reached a minimum of minus 5 degrees and averaged minus 4 degrees. The sudden change from 0 to minus 5 degrees in the phase difference at 300E indicates a shallow horizontal conducting sheet. The extent of the conductor to the south and west could not be investigated with the existing layout, and further electromagnetic work was curtailed because of interference with the Canadian Induced Polarisation equipment.

(B) Conclusions

The geophysical methods employed by the Bureau at Moores Valley gave no results that can be used to determine the location of the Lyell Shear or of any mineralisation beneath the Tertiary sediments.

The Turam electromagnetic method indicated a possible horizontal sheet conductor on the western end of Traverse 12 but the anomaly could not be fully outlined, for reasons already given.

No recommendations are made for further exploration of the Moores Valley area by magnetic or self-potential methods. Electromagnetic prospecting by the Turam technique has not been fully exploited but the results of the test area are not indicative of successful operation.

7. ACKNOWLEDGEMENTS

The author expresses his appreciation to the Lyell-E.Z. Explorations staff for their co-operation and willing assistance during the surveys.

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JAKOSKY, J., 1952 EXPLORATION GEOPHYSICS. Trija, Los Angeles.

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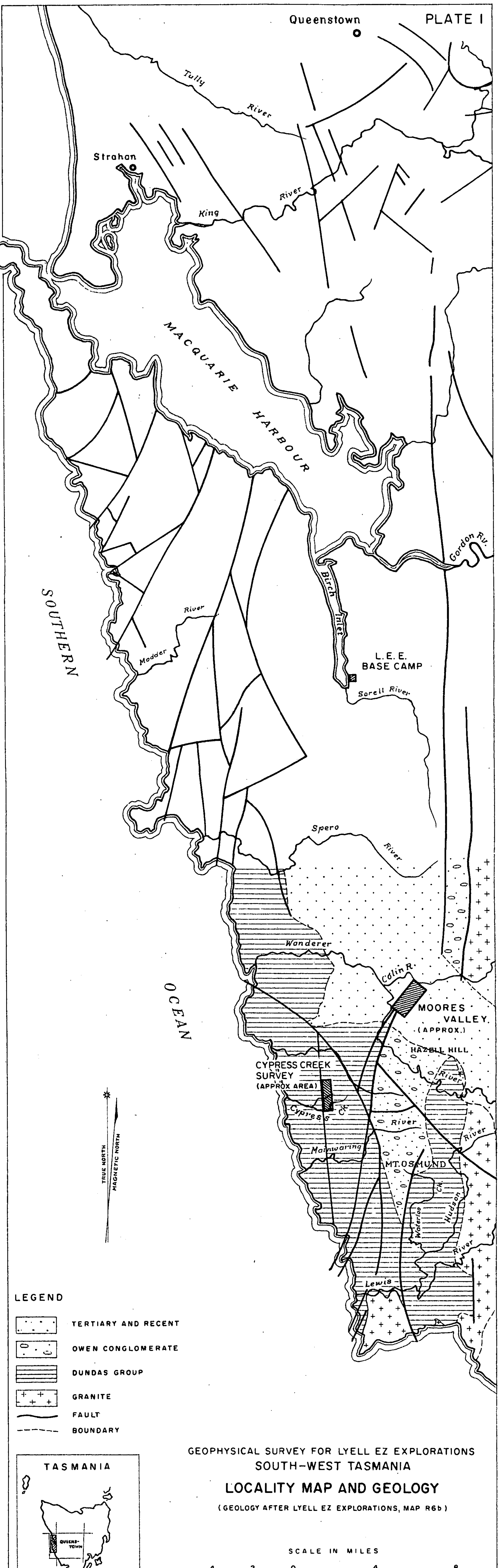

GEOPHYSICAL SURVEY FOR LYELL EZ EXPLORATIONS

SOUTH-WEST TASMANIA

LOCALITY MAP AND GEOLOGY

(GEOLOGY AFTER LYELL EZ EXPLORATIONS, MAP R6b)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 367-5

To Accompany Records 1960, No.111

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 367-2

To Accompany Records 1960, No.111

PLATE 3

CYPRESS CREEK

SELF - POTENTIAL CONTOURS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 367 – 3

To Accompany Records 1960, No. 111

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. G 367 - 4

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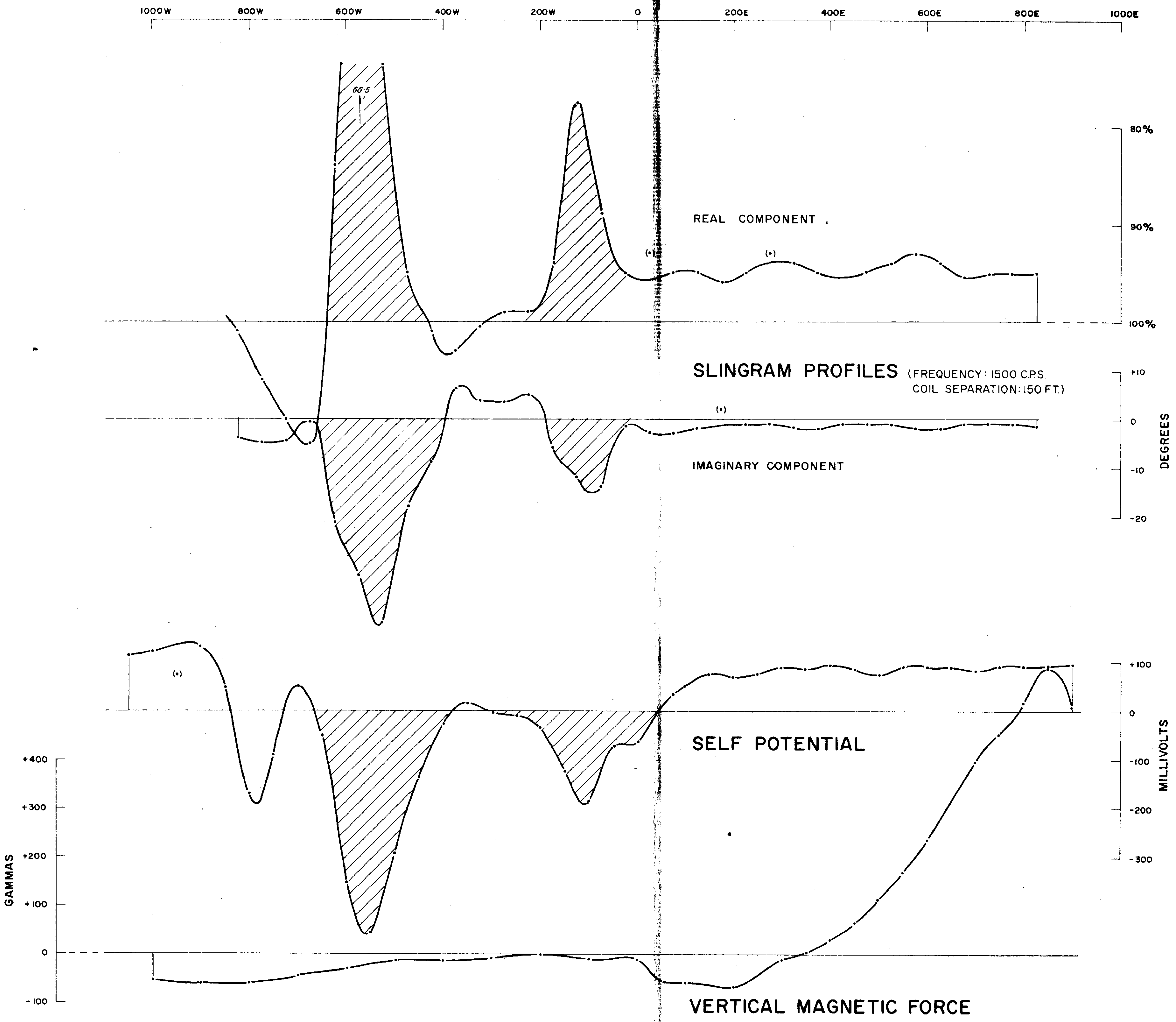
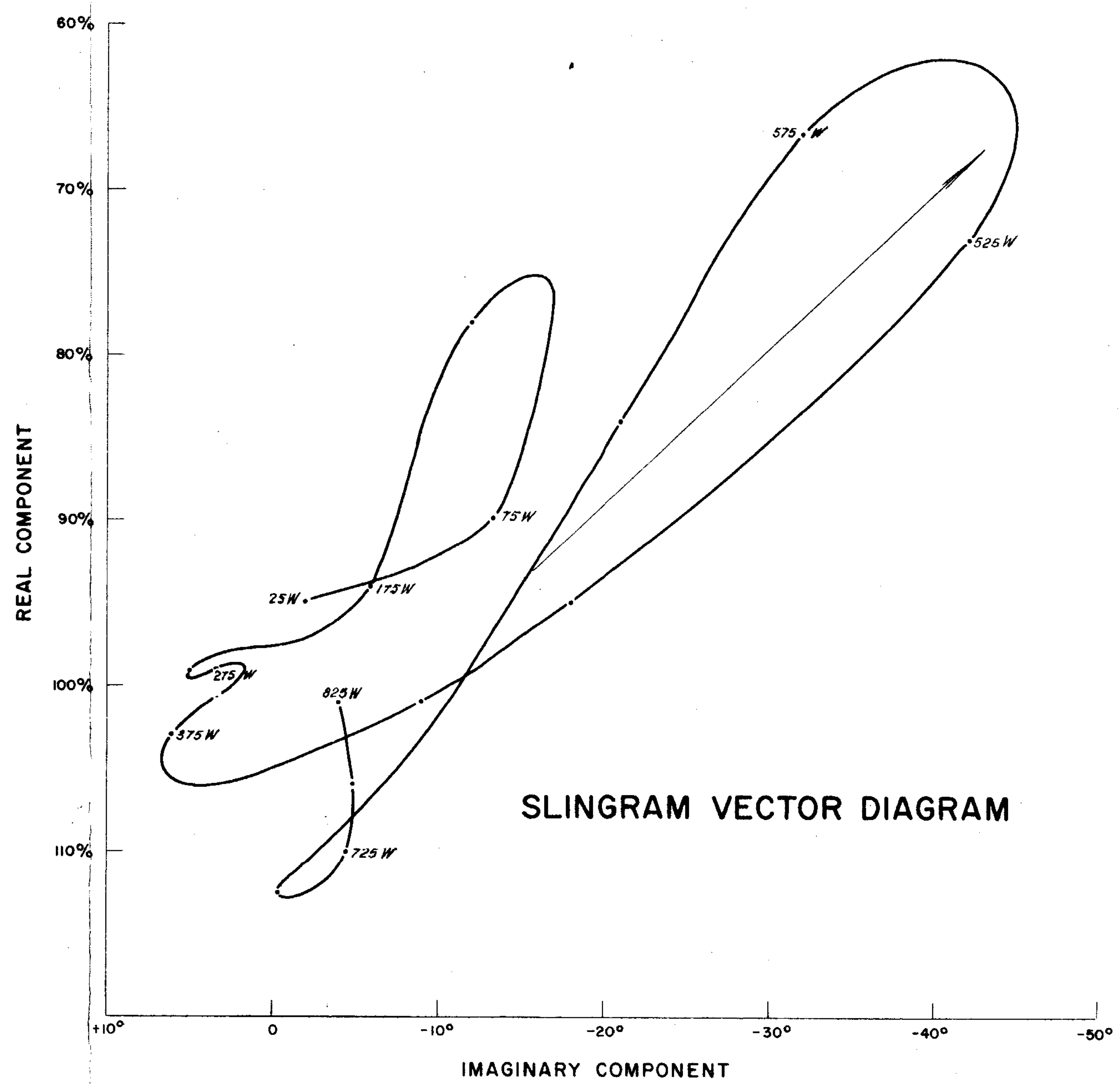
CYPRESS CREEK, TAS

PLATE 5





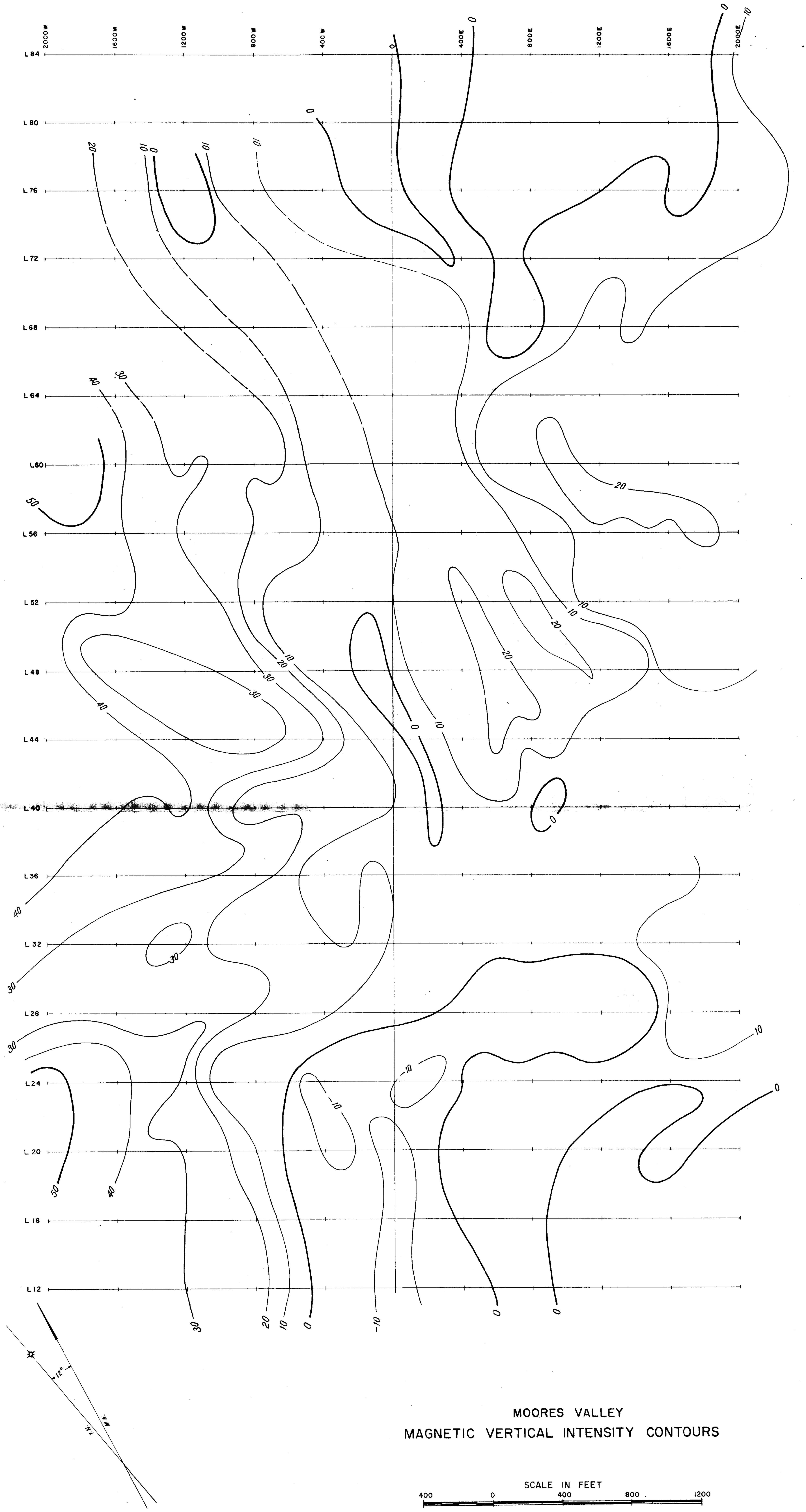
CYPRESS CREEK, TRAVERSE 6800 S

TYPICAL GEOPHYSICAL PROFILES

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G367-1

To Accompany Records 1960, No. 111

CYPRESS CK, S-W TAS.



MOORES VALLEY

MAGNETIC VERTICAL INTENSITY CONTOURS

SCALE IN FEET

400 0 400 800 1200

CONTOUR INTERVAL 10 GAMMAS

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics G 367-6

To accompany Records 1960, No 111