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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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RINGAROOMA DEEP LEADS SEISMIC REFRACTION SURVEY, TASMANIA 1957

by

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ABSTRACT

A seismic refraction survey was made by the Bureau of Mineral Resources in the Ringarooma district over four traverses chosen by Rio Tinto Australian Exploration Pty Ltd to test for the presence of buried channels in the bedrock, which may contain deep leads carrying cassiterite in economic amounts. The results gave no reliable indications of the presence of such channels, and it appears that geophysical methods are not likely to provide useful indications in this area.

The only possibility of using geophysical methods effectively to assist in prospecting the Ringarooma deep lead would be to make surveys as far to the south as possible.

1. INTRODUCTION

The Ringarooma district, in north-eastern Tasmania (see Plate 1), was at one time an important tin-producing area, but now mining activity is comparatively small. Rio Tinto Australian Exploration Pty Ltd recently completed a geological examination of the alluvial tin prospects of the area under S.P.L. 323, and as a result nominated several small areas as being worthy of further investigation (Rattigan, 1957). In September 1957 the company asked for the Bureau's aid in locating, by geophysical methods, the course of the old Ringarooma lead or its tributaries, which are buried under Tertiary sediments between the Boobyalla and Little Boobyalla Rivers. The request was supported by the Department of Mines, Tasmania, and the Bureau agreed to make a brief test survey using the seismic refraction method.

The survey was made between 18th November and 17th December 1957 over an area (known as Area A) selected by the company. During the survey period the field party was based at Derby, a small agricultural and mining centre about 60 miles by road north-east of Launceston.

Area A is situated around the confluence of the Boobyalla and Little Boobyalla Rivers, about 13 miles north of Derby(Plate 1) and only about four miles from the coast.It is a relatively flat, alluvial tract, covered with sparse vegetation. Numerous swampy patches and creeks prevented access to some parts of the traverses in wet weather.

An airborne magnetometer survey made by Adastra Hunting Geophysics Pty Ltd failed to show any significant magnetic anomalies that could be attributed to deep leads.

The geophysical party consisted of two geophysicists, D.L. Rowston (party leader from 21st November to 3rd December) and E. Sedmik, and one field assistant. J. Horvath took over as party leader on 4th December. J. Rattigan, resident geologist for the company, acted as liaison officer during the survey. The company also provided three field assistants, a vehicle, explosives, etc., to assist in the survey.

2. GEOLOGY

The most comprehensive report on the geology of the district is by Nye (1925). The area discussed by him does not include the area of the survey, but is so close to it that geological conditions may be expected to be similar. A geological map of the area based on mapping by geologists of Rio Tinto Australian Exploration Pty Ltd is shown on Plate 1.

The country rocks of the Ringarooma Valley consists of slate, mudstone, and sandstone, probably of Silurian age, which have been intruded over large areas by Devonian granite. Valleys are filled with Tertiary drift and Quarternary sediments. Between Derby and Herrick, the Ringarooma Valley has been filled by basalt flows which cover the drift and sediments to a depth of 200 ft or more. North of Herrick, the basalt has been eroded and remains only as local remnants. There are good reasons for supposing that the basalt flows have diverted the Ringarooma River from its original course. It now flows to the east of Mount Cameron, whereas it seems likely that its original course from Derby was northerly, somewhat in the direction of the present course of the Boobyalla River.

The granite is extensively mineralised with cassiterite which occurs in greisen veins, and as disseminations in altered granite. Some mining has been done on primary veins, and eluvial and alluvial deposits derived from weathering of the granite have been extensively mined. These deposits have been followed along old valleys to a depth of over 150 ft near Derby, and in the deeper ground have proved extremely rich. However, mining has been interrupted at Derby owing to the presence of the basalt. The combined depth of drift and basalt here is about 400 ft which is too great for hydraulic sluicing. North of the basalt, mining has been confined to a few shallow head leads close to outcrops of granite, but the deeper ground has not been investigated. If the original course of the Ringarooma River can be traced north of the basalt, it may be a channel of considerable size, containing a large amount of cassiterite. Important tributary leads may also be present.

Although the combined depth of basalt and drift was too great for economic mining at Derby, there is a considerable fall in ground level to the north, and it is quite possible that the lower reaches of the old river bed will be within range of mining. However, the area chosen for the survey by the Company is only about four miles from the sea and it is many miles north of the last point at which the main lead has been investigated. The choice may be criticised on two grounds:-

(1) The area chosen is presumably close to the mouth of the old river, so that no well-defined channel may be present in the bedrock.

(2) The amount of cassiterite in the lead may be expected to decrease with increasing distance from the source rocks. It is possible that, even if a defined channel in the bedrock exists in this area, its cassiterite content may be much less than that in the upper reaches, unless the lead has been fed by tributaries lower down the stream.

3. GEOPHYSICAL METHOD

Under the geological conditions existing at Ringarooma, the geophysical problem is the locating of depressions or river channels in bedrock covered by up to several hundred feet of unconsolidated Tertiary sediments. As an appreciable velocity contrast could be expected between bedrock and the overlying sediments, the seismic refraction method was selected as being the most suitable.

Although a concentration of heavy magnetic minerals can also be present in alluvial stanniferous deposits, the magnetic method was not used because of the negative results obtained in the recent airborne magnetometer survey over the area by Adastra Hunting Geophysics Pty. Ltd.

The theory of the seismic refraction method, and in particular the 'Reciprocal Method', is described in standard textbooks on geophysical prospecting. The application of the methods to the location of deep leads is described in detail by Urquhart (1956).

It is sufficient here to say that, if velocity contrasts between adjacent stratigraphic layers are high and considerable detail in a refractor boundary is required, the Reciprocal Method is most suitable. This method was employed at Ringarooma.

4. FIELD OPERATIONS

Initially, three traverses, A, B, and C, were pegged and levelled by a licensed surveyor employed by Rio Tinto Australian Exploration Pty Ltd. A branch of Traverse B to the north-east was called B'. The traverses are shown on Plate 1. An arbitrary level datum, a bench mark on a tree offset 27.44 ft on a bearing 284° 56' from the point 975 on Traverse B', was assumed to have an R.L. of 300 ft.

A 12-channel "Century" portable refraction seismograph and "Century" geophones were used for the survey. The shot-holes, of an average depth of 6 ft, were drilled by a "Proline" rotary drill mounted on a Landrover. Charges of Nobel 60 gelignite, ranging from 1/3 lb to 20 lb were exploded by electric detonators No. 6.

Continuous refraction profiles were obtained by using the Reciprocal Method from which estimates of the depth to bedrock were made. Each spread, comprising eleven geophones at 50 ft intervals, was 500 ft long. The 12th channel of the equipment was used for the reciprocal geophone, which, at the most distant shots, consisted of two geophones in parallel. Five charges, one at the centre of the spread, two at 50 ft and two at 750 ft from each end of the spread, were shot over every 500 ft. Weathering spreads were shot every 1000 ft of traverse with, generally, a geophone interval of 10 ft.

5. RESULTS

The geological conditions may be represented from the seismic point of view by two layers, the upper one consisting of loosely compacted Tertiary and Quarternary sediments with a low velocity, and the lower one of granite or Silurian sediments, with a high velocity. The conditions were thus favourable for the use of the Reciprocal Method. The results are consistent with the presence of the following layers:

(1) A surface layer, with a velocity of about 5000 ft/sec (V_1).

(2) A basement refractor with a velocity of 15,000 to 20,000 ft/sec (V_2).

The boundary of the lower refractor was sharply defined, except at one or two places on Traverse C where it appeared that a third layer of intermediate velocity was present. On some weathering spreads a very low velocity of less than 1400 ft/sec was observed. This is attributed to the top soil layer. The velocity V_1 is attributed to the Tertiary and Quarternary sediments, the velocity V_2 = 15,000 ft/sec to the basement sediments, and the velocity V_2 = 20,000 ft/sec to the granite.

The depth to the basement refractor beneath each geophone point may be calculated using the vertical travel times and the velocity V_1. Two uncertainties are involved in this process.

(1) The travel time to be used in this calculation is the vertical travel time, which is obtained from the observed travel time by correcting for shot-hole depth, for departure of wave paths from the vertical, and for the effect of the weathering layer.

(2) There is reasonable evidence that the value of the velocity V_1 calculated from the records is not the value that must be used in the calculation of depth to basement.

With regard to the first difficulty the correction for shot-hole depth is easily made. The departure of wave paths from the vertical depends on the ratio V_1/V_2, which is roughly 1/4 at Ringarooma. Urquhart (1956) shows that, in these circumstances, neglect of this correction introduces an error of about 2 per cent in calculated depths. The effect of weathering is more difficult to allow for. The results of the weathering spreads, and examination of cuttings from shot-holes, show that the composition of the weathered layer varies considerably along the traverses, so that accurate correction at every point would require a continuous weathering profile. In an endeavour to remove this uncertainty where possible, a method of reduction suggested by Pakiser and Black (1957) was used. Delays of arrival time duplicated in parts of the travel-time curves associated with each of the layers may be attributed to the weathered zone, and corrected accordingly. These corrections are generally of minor importance, but in at least two instances (Traverse B, 550-1500, and Traverse C, 3000-3500), they affect the results radically, in that what appeared as local depressions in bedrock after the first reduction were removed by application of this correction.

With regard to the second uncertainty, no results of boring with which the results would be correlated were available, nor was there any possibility of obtaining a direct measurement of vertical velocity by shooting in a bore-hole. However, results of similar surveys near the Endurance mine, at South Mt Cameron, suggest that the measured value of the velocity V_1 should be used with caution (Keunecke, 1957). Although South Mt Cameron is some distance from the site of the present survey, geological conditions are generally similar. At the Endurance mine, a seismic profile was observed over an area in which the bedrock profile was known from boring. The value of the velocity V_1 calculated from the records was about 5000 ft/sec, which is approximately the same as that observed at Ringarooma. However, the use of this velocity led to a calculated bedrock profile much deeper than that proved by boring. To reconcile the seismic results with the boring records, it was necessary to assume a value for V_1 of about 3000 ft/sec. A value approximately the same was obtained by a direct determination of vertical velocity, obtained by shooting at the bottom of a shaft. There is no means of checking whether or not a similar situation occurs at Ringarooma, but it must be supposed possible. The interpretation of results must remain uncertain to this extent, pending checking by boring.

Such discrepancies have been observed previously. Domzalski (1956) discusses the question and suggests that they are due to the presence of low-velocity layers overlain by layers of higher velocity. It is readily conceivable that such a succession of layers could exist in the Ringarooma area.

The results are shown on Plates 2 and 3, as profiles of basement along the traverses. Two profiles are shown on each traverse, one calculated using a value of 3100 ft/sec for V_1, and the other using values of V_1 derived from the records. It is considered that the true profile lies somewhere between the two of these; but it is impossible to interpret the results more precisely without further information obtained by boring, or by a direct determination of vertical velocity.

6. INTERPRETATION AND CONCLUSIONS

The most obvious feature of the results is that the calculated profiles of unweathered bedrock are generally flat; they show no evidence of steep slopes or well-marked depressions except for some narrow ones that appear most clearly on Traverses B' and C.

In assessing the possible importance of such indications, the following points must be borne in mind, which apply to all surveys of this type.

(a) the result of a successful survey is a profile of unweathered bedrock. However, the valuable minerals sought will be concentrated in channels in the unweathered surface of the bedrock. The results of the survey are likely to be of economic value, only if there is reason to expect that the deeper portions of the unweathered bedrock coincide in position with the deeper portions of the weathered bedrock. If the profile of unweathered bedrock shows a channel, not very wide, with well-defined banks this assumption is reasonable. However, if the main channel is very wide, it is quite possible that the valuable minerals occur in relatively narrow channels, on the weathered bedrock surface, which are not indicated at all on the unweathered surface. Examples of such channels were frequently encountered during deep lead mining in Victoria.

(b) the accuracy of the calculated profile of unweathered bedrock depends critically on the accuracy of the correction for the weathered layer near the surface. If the composition of the weathered layer is uniform, this accuracy is easily obtained. However, if the composition of the weathered layer is not uniform, it is difficult to be sure that enough information has been obtained from weathering spreads to enable complete correction to be applied. In such circumstances, apparent depressions in the bedrock must be regarded with suspicion, particularly if they are narrow.

(c) it cannot be assumed that the bedrock will weather to a uniform depth, even over a restricted area. Several instances are known of bedrock apparently of uniform composition, in which weathering has proceeded to an exceptionally great depth in a small area. No explanation for such freaks of weathering can be supported by definite proofs, but there is no doubt that they do occur.

The effect would be that the profile of unweathered bedrock would show a well-defined depression, whereas the weathered bedrock surface would be flat. Such a condition would not be detected by geophysical surveying; however, if a depression in the bedrock occurs on each of several neighbouring traverses sufficiently close together for correlation of the various depressions to appear reasonable, the possibility that a true channel exists is greatly strengthened.

In summary, the type of indication most likely to warrant testing is a depression in the bedrock with well-defined and fairly steep sides neither too wide nor too narrow, and appearing in corresponding positions on each of several adjacent traverses, provided that sufficient information is available to enable reliable correction for the weathered layer to be made. From this point of view the indications obtained in the present survey are unsatisfactory in every respect. The apparent depressions are narrow, their sides are not well defined, and the traverses are too far apart to allow correlation between them. Also, the results strongly suggest that the constitution of the weathered layer is not uniform. If this is so, the information available is quite inadequate to allow reliable corrections to be made.

It is considered, therefore, that no testing of the results is warranted. The only conclusion that can be drawn is that geophysical surveys are not likely to give useful results in this area. If it is desired to use geophysical methods to assess the economic possibilities of the Ringarooma lead, the only possibility of obtaining useful results is to start surveys as far to the south as possible, where any channel that may exist would be more likely to be well defined.

7. ACKNOWLEDGEMENTS

It is desired to acknowledge the ready assistance and cooperation of Rio Tinto Australian Exploration Pty Ltd and especially that of the Resident Geologist, J. Rattigan.

Thanks are due also to the manager of the Endurance Tin Mine, South Mt Cameron, for his co-operation in placing the mine facilities at the disposal of the party.

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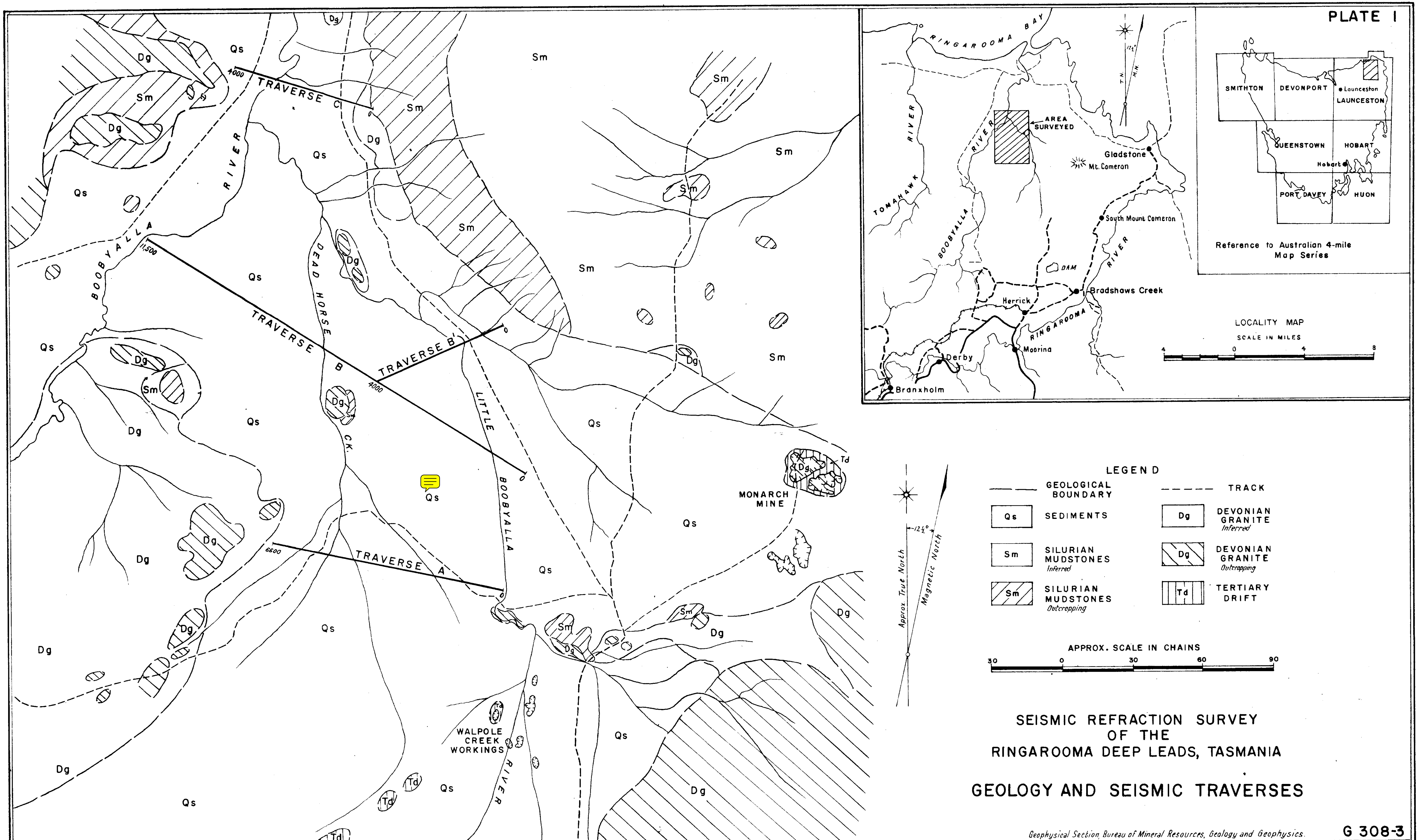

To accompany Record No 1961-151

PLATE 2

LEGEND

SURFACE ELEVATION

SOLID BEDROCK COMPUTED WITH v_1 = 3,100 FT/SEC

SOLID BEDROCK COMPUTED WITH v_1 = 5,000 FT/SEC (APPROX)

SEISMIC REFRACTION SURVEY OF
THE RINGAROOMA DEEP LEADS, TASMANIA

SEISMIC PROFILES
TRAVERSES A AND B

SCALES

HORIZONTAL 200 0 200 400 600 FEET

VERTICAL 100 0 100 200 300 FEET

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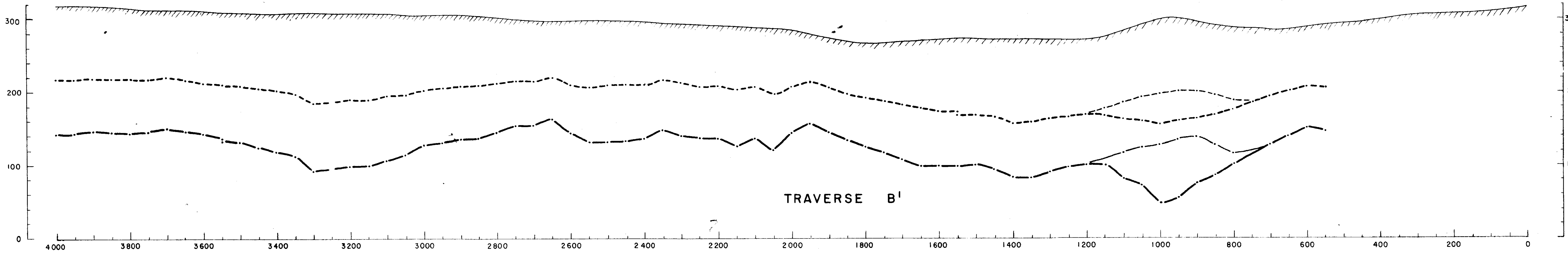
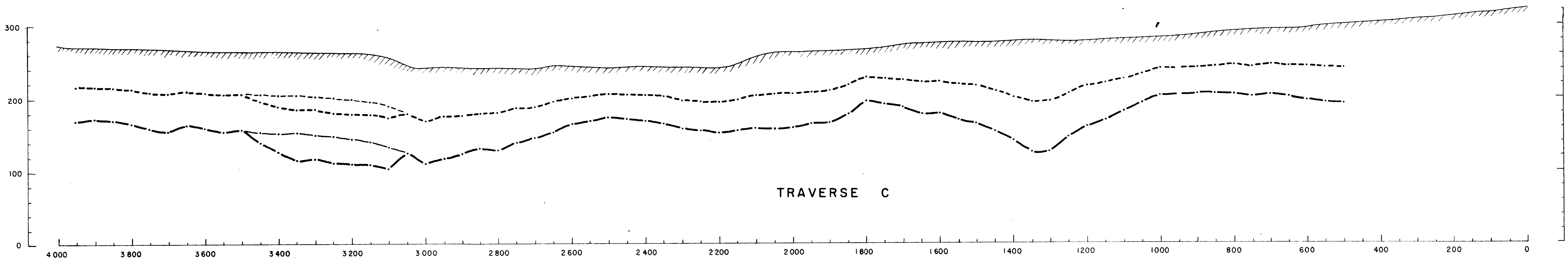
PLATE 3





SEISMIC REFRACTION SURVEY OF THE RINGAROOMA DEEP LEADS, TASMANIA

SEISMIC PROFILES. TRAVERSES B' AND C

LEGEND

- SURFACE ELEVATION
- SOLID BEDROCK COMPUTED WITH v_1=3,100 FT./SEC.
- SOLID BEDROCK COMPUTED WITH v_1=5,000 FT./SEC. (APPROX)

SCALES

HORIZONTAL	200	0	200	400	600 FEET
VERTICAL	100	0	100	200	300 FEET

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