56/153

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES,

GEOLOGY AND GEOPHYSICS

RECORDS 1956, No. 153

GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS, NEW SOUTH WALES

by

K. H. TATE

COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1956, No. 153

GEOPHYSICAL TEST SURVEY OF
TORRINGTON WOLFRAM DEPOSITS,
NEW SOUTH WALES

by

K. H. TATE

CONTENTS.

ILLUSTRATIONS.

ABSTRACT.

At the application of the New South Wales Department of Mines, brief surveys were made by the Bureau of Mineral Resources over selected mines in the Torrington area, to test the applicability of geophysical methods in prospecting for tin-wolfram lodes of the type generally worked in that area. The mines chosen for the tests were the Butler Mine, the Bismuth Mine and the Fielder's Hill Mine. Visits of inspection were paid to other mines in the district, and a single magnetic traverse was run over the Currawong Mine.

The magnetic and potential drop ratio methods were used for the tests. Although minor geophysical indications of possible geological significance were obtained in some instances, the results, in general, indicate that the geophysical methods used are not likely to be of service in prospecting for deposits of this type.

1. INTRODUCTION.

Torrington, in the New England district of New South Wales, is about 17 miles west of Deepwater, which is 450 miles by rail north of Sydney. Until the end of World War I the district, often referred to as the Mole Tableland, was a significant producer of wolfram, as well as being the chief producer of lode tin ore in New South Wales. The wolfram lodes were worked mainly by open cut and gave recoveries of from 0.25 to 1.0 per cent. WO_3, with tailings up to 0.25 per cent. WO_3. A little wolfram was won during World War II, and since then operations have continued sporadically in the form of lode mining and treatment of tailing dumps.

The Mole Tableland is a plateau with an elevation of 3,600 to 3,700 ft., isolated peaks rising to 4,000 feet. Most of the area is flat and well timbered, but there are also some rugged, deeply dissected areas. One good road from Torrington to Bonshaw skirts the area, but otherwise, access to the now almost idle mines is by rough, unfenced vehicle tracks.

After enquiries regarding the suitability of geophysical methods for locating wolfram lodes in the district, arrangements were made between the Bureau of Mineral Resources and the Department of Mines, N.S.W., for the Bureau to make tests at selected known mines.

Dr. Horvath, a senior geophysicist of the Bureau, visited the area in August, 1953, and again, with the author, in September, 1953. He recommended the use of the potential drop ratio method and the magnetic method and it was decided to make test surveys employing these two methods at the Butler, Bismuth and Fielder's Hill Mines (see Plate 1).

The tests were made in October, 1953, by a field party consisting of the author (party leader) and M. J. O'Connor. The necessary grid surveying and pegging were done by P. O'Reilly, Surveyor, Department of the Interior.

2. GEOLOGY.

The Torrington area has been described in detail by T. W. E. David (1887), E. C. Andrews (1904-07), J. E. Carne (1911b) and C. St.J. Mulholland (1953). The following is a brief summary of such aspects of the geology as are likely to affect the application of geophysical methods and the interpretation of results.

The area consists of an acid, porphyritic, biotite granite of early Mesozoic or late Permian age, in which there is an isolated roof pendant of lower Marine (Permian) sedimentary rocks, about 10 square miles in extent. The pendant lies north-west of Torrington (Plate 1) and consists of flat-lying micaceous mudstones, with some sandstone and conglomerate beds. It is at a slightly lower elevation than the surrounding granite country.

The granite includes fine-grained phases, and is cut by numerous aplite dykes. It is one of the later of the related series of New England Granites. The product of the weathering of the granite is a sandy drift. The tin and tungsten deposits originated in the closing stages of the cooling and differentiation of the granitic magma.

The location of the ore bodies was probably controlled chiefly by the major joint pattern in the granite and overlying sedimentary rocks. A strong system of near-vertical major joints trends N.45°E. in the granite. Some less well-defined joints branch from the main series at angles of 15°, generally on the north-west side, and dip into the main fractures at 10° to 15°. A second, but weaker, set of vertical joints trends N.45°W. Horizontal jointing is common, but appears to post-date the unroofing of the granite. In the sediments, both of the main series of fractures are well developed. Other lines of weakness, mineralised in places, are the junctions of the granite and the sediments, and the almost horizontal bedding planes in the sediments.

The wolfram deposits fall into two groups: (1) narrow siliceous veins with some cassiterite, occurring wholly within the granite, and (2) the more important group, comprising "blows", sills and dykes of greisenised rocks, which are associated with the sediments, and contain bismuth and abundant fluorite and topaz.

"It is inferred that the intrusion of the granite magma was accompanied by the sinking of a large block of the covering sediments into it. Late emanations and siliceous differentiates penetrated into the joints and fissures of the foundered rock along its junction with the granite, and in places into bedding planes, and now appear as quartzose rock (quartzite), pegmatite and greisen." (Mulholland, 1953, p.949).

The wolfram "blows" follow the major vertical joints, forming dykes which range in width from a few inches to 20 ft. In places they occur as sill-like bodies up to 100 ft. thick, extending laterally for hundreds of feet, as at Fielder's Hill. Within these masses, "bungs" of wolfram weighing several hundredweights have been found.

3. CHOICE OF METHODS.

In order that an ore deposit be detectable by geophysical methods it is necessary that it be distinguished from the surrounding rocks by some physical property, such as density, electrical conductivity, content of magnetic material, etc. From the general geological description given previously, it is apparent that the deposits in question are not likely to be favourable in this regard. Evidence presented later in the report suggests that the ore rocks are generally a little denser than the granite. This fact indicates that the gravity method might give useful results where very large rock masses are concerned. However, the usefulness of the gravity method could not be tested, as no gravity meter was available. The deposits are generally associated with zones of silicification or greisenisation, suggesting that ore bodies could have a higher resistivity than country rock, though the country rock itself would be expected to have a high resistivity also. None of the ore bodies contains sufficient sulphide minerals to produce self-potential anomalies or offer any prospects for the application of inductive methods. As regards magnetic properties, there is no obvious reason to expect the lode material to be either more, or less, magnetic than the country rock, though the magnetic method is so economical and rapid in use that tests using it are always warranted.

It would be expected that the most useful prospecting tool would be an electrical method capable of detecting zones of very high resistivity in a country rock which is generally highly resistive. For this reason, the potential drop ratio method was chosen. In this method an A.C. potential supplied by a motor generator is applied to the ground through a single electrode, the other ground contact being placed at a great distance. The potential distribution around the electrode is measured by laying out traverses, and measuring the potential differences between points equally spaced along the traverses. The ratios of these potential drops are compared with those calculated assuming an earth of uniform conductivity. This method is considered to be the most suitable one for detecting the presence of poor conductors.

A small amount of magnetic work, using a Schmidt type vertical balance, was carried out. As some of the ore bodies are reported to contain monazite which is radioactive, due to its thorium content, the possibility of using portable Geiger counters to trace ore bodies was also investigated.

4. THE BUTLER MINE.

(a) Introduction.

This mine was considered to be typical of those containing the fissure vein type of lode of the district, and is probably the largest of this type. It is about five miles by rough road south-west of Torrington. It has been worked intermittently since 1881, at first for tin and later for wolfram. Operations at the mine ceased before the completion of the test survey, because of the uncertainty of the market for wolfram.

(b) Geology.

Wilkinson (1883), quoted by Carne (1911a, p.124) reported a vein of varying width, extending for a quarter of a mile, and yielding tin and a little wolfram. David (1887) described the deposit at a slightly later stage of development. He reported a lode striking 26° to 32° north of east, and dipping north-west at 72° to 85°. A shoot with a north-east pitch was observed near the surface. Carne (1911a) described the Butler Lode as strong and well defined, between true walls, and ranging in width from a few inches to 20 feet. The lowest level was then 314 ft. from the surface. The enclosing rock is the typical acid granite of the district. Vugs in the lode channel afforded evidence of intermittent movement and progressive filling, large slabs of country rock falling vertically in the cavities.

Mulholland (1953) describes a wide zone of banded silicified rock, apparently a zone of shearing trending N.60°E., subsequently silicified. The major system of fractures, striking N.45°E., impinges on this silicified zone and turns along it for some considerable distance. The ore shoots are usually found in these fractures, the silicified zone being almost barren. Chlorite is a very important constituent of the lodestuff. Cassiterite and wolfram occur, with smaller amounts of galena, monazite, chalcopyrite, arsenopyrite and molybdenite.

(c) Selection of Geophysical Methods.

There is no problem in locating the main lode at Butler's Mine because, as noted by David (1887), it can be traced on the surface, except in a few places where it is hidden under a cover of alluvium. Because the mineralisation occurs in shoots within an otherwise barren formation however, any geophysical method which would give information on the occurrence and pitch of the ore shoots would be useful. When planning the survey it was considered likely that if the chloritic lode formation contained magnetite, the ore shoots could be located by observing the associated magnetic anomalies. Because electrical methods can locate veins of quartz as poor conductors or ore minerals as good conductors, it was thought that the intersection of the shear zone and the veins striking N.45°E. might be located by using the potential drop ratio method to map the course of the siliceous veins.

(d) Results.

(i) Magnetic method.

Three traverses over the known lode were surveyed with a vertical force variometer (Plate 2). The vertical magnetic force profiles obtained along these traverses are shown on Plate 3. The readings obtained in the area of known mineralisation were considerably affected by old pipes, tanks, etc. However, it can be seen on profiles 00 and 140E that, after allowing for the anomalies due to such material, there is no significant residual anomaly.

(ii) Potential Drop Ratio method.

Two traverses were surveyed using this method and the results are shown on Plate 4 in the form of potential ratio profiles, derived potential gradient and phase variation curves. Apart from some minor variations in the potential ratio curves, there is a definite feature on each profile at about 300S, which coincides with the line of lode. On traverse 00 the potential ratio curve shows two pronounced maxima separated by a minimum at this point. There is a strong minimum on the potential gradient curve, which indicates the presence of a good conductor, and there is a corresponding feature on the phase variation curve. Similar features are seen on the profiles for traverse 140E. The line joining the indications on these two traverses corresponds to the strike and position of the main lode. This indicates that the vein shows up as a poor conductor on the foot-wall side, accompanied by a better conductor than the acid granite on the hanging-wall side. The profiles, however, do not show the presence of the branching Lockwood's vein.

Several technical difficulties were encountered in this part of the survey. In setting up a current electrode, it was found that contact resistances were so high that it was necessary to use an array of twelve steel spikes. Furthermore, contacts were difficult to obtain with the movable (rapier) potential electrodes because the soil was usually thin and the ground conductivity very low. However, it should be possible to complete a survey successfully by making the observations during, or just after, a period of wet weather.

(iii) Radiometric method.

The occurrence of monazite in the Butler Mine has been noted, but there is no information as to whether it is a uniform constituent of the ore or not. Some doubt exists as to the thorium content of New England monazite. Carne (1911b) quotes assays of samples from various localities showing thorium contents generally about 0.6 per cent., and exceeding 2.0 per cent. only in rare cases. On the other hand, tests performed by the Bureau on samples of dredge tailings from Stannum show that the monazite from this area has a thorium content of about 6 per cent.

Using an Austronic Ratemeter (Type PRM 200), a reading of 2½ times background was observed over a distance of about 20 feet at the 350 feet level where the Lockwood tin vein intersects the main lode (Plate 2). However, a dump of monazite concentrates in the mill caused no appreciable increase in the count rate.

(e) Conclusions.

The potential drop ratio method was successful in that definite indications were obtained coinciding with the line of lode. However, it is slow, and the geological interpretation of results is difficult because the method is very sensitive and small changes of conductivity influence the potential distribution.

Considering the doubts as to the distribution of monazite in the ore, the thorium content of the monazite and the very limited depth penetration obtained in radiometric testing, it is unlikely that radiometric tests would be of practical service in locating ore shoots.

5. THE BISMUTH MINE.

(a) Introduction.

This mine is one of the best known in the Mole Tableland and is situated about six miles, by rough track, north-west of Torrington (Plate 1). It was the first mine opened up by the Torrington Ore Company, which subsequently worked the Fielder's Hill and Wolfram Hill Mines.

(b) Geology.

The Bismuth Mine has been thoroughly studied by Andrews (1905, 1907), who saw the mine when it was opened up and also at a later stage when he was able to examine it at depth (see cross-section, Plate 5).

The mineralised rock is a highly siliceous formation and consists of quartz, topaz, and fluorite, with wolfram and native bismuth as the chief ore minerals. At the Bismuth Mine, the ore rock occurs at the contact of granite and sediments. The original outcrop (Plate 5) trended north-west, and from subsequent mining developments, it appears that it was a narrow, dyke-like body, dipping south-west for at least 300 feet.

The specific gravity of the mineralised rock is about 2.8 to 2.9, and although its electrical properties have not been measured, the resistivity is probably high. On the hanging-wall side of the lode, the sedimentary mass has a fairly sharp boundary which is readily seen in the northern end of the open-cut. The foot-wall side is characterised by greisen and pegmatitised sediments. On Andrews' old plan (Plate 5) the nearest granite outcrop is to the north-west. Unfortunately, the granite outcrop was not plotted during this short test survey. The sediments have been altered for some distance from the granite/sediment contact. The section of the area from south-west to north-east is therefore undisturbed sediments, indurated (or silicified) sediments, a highly siliceous narrow vein of ore rock dipping at about 30° south-west, high siliceous greisen, and then probably altered sediments and undisturbed sediments.

(c) Selection of Geophysical Methods.

With the exception of monazite, which is mentioned as an accessory mineral (Andrews, 1904), there appears to be no mineral constituent of the mineralised rock at the Bismuth Mine which could be located directly by geophysical methods. By an indirect approach, electrical methods offer the best possibility of locating the highly resistive ore rock within sediments - and possibly within the parent granite rock.

(d) Results.

(i) Magnetic method.

Traverses 00 and 100W were surveyed with a vertical force variometer, and the resulting profiles are shown on Plate 6. It appears likely that the portion of profile 100W between 300S and 150S represents a small negative anomaly of not more than 20 gammas. Because this part of the profile has a smoother outline than the remaining portion, it may correspond to the mass of greisen between the sediments. A corresponding, but smaller, negative anomaly appears on profile 00.

(ii) Potential Drop Ratio method.

Traverses 00, 100W and 206W were surveyed by this method, with a current electrode at the point 00/700S. Profiles showing the measured successive potential ratios along each traverse, and the derived potential gradients and phase variations are shown on Plate 7. The logarithm of the potential gradient is plotted and this curve shows clearly the changes in electrical conditions along each traverse. The increasing resistivity between 500S and 400S on traverse 206W could correspond to a zone of silicification of the sediments, and the decreasing resistivity between 400S and 300S could correspond to the sediment/greisen contact. The continuous high resistivity from 250S to 00 could correspond to the highly resistive greisen. A similar correlation with the geology can be made from the potential gradient curve for traverse 00. The intermediate traverse, 100W, shows the same features until the point corresponding to the sediment/greisen contact is reached at 275S. From this point, difficulty in making measurements was experienced at a number of points and the north-eastern part of the profile is therefore omitted.

It is clear from the results of the present test survey that further geophysical work in the area would enable the sediment/greisen contact and the contact aureole to be located fairly accurately. The application of the return survey technique would also provide greater depth resolution.

(iii) Radiometric method.

It was not possible to make a radiometric survey of the deposit because the portable ratemeter was temporarily unserviceable. However, for the reasons given in the discussion of the results of the survey at the Butler Mine, it does not appear that this method of survey would be of practical use.

(e) Conclusions.

The potential drop ratio technique, or similar electrical work, is the most useful geophysical method for this locality because of the differences in electrical resistivity between the geological formations. The method should be of value in delineating the contact aureole of intrusions and in locating the sedimentary/granite (or greisen) contact where the position of the contact is in doubt.

6. FIELDER'S HILL MINE.

(a) Introduction.

This mine was originally operated by the Torrington Ore Company and later by the Broken Hill Block 14 Company. The large quarry is about seven miles, by rough track, north-west of Torrington (Plate 1). Only one day was spent in examining the area.

(b) Geology.

The quarry is probably the largest in the district, and a large quantity of ore has been won. The section and plan (Plate 8) of Mulholland (1953) show the body to be a large sill-like mass of quartzose ore rock or greisen which is overlain by claystone sediments, and underlain by coarse acid granite. It is presumed that in drawing the section, Mulholland has made use of the information obtained by diamond drilling carried out by the Broken Hill Block 14 Company. Carne (1911) described an ore rock/sedimentary rock contact in the quarry floor which showed clearly the intrusive nature of the ore rock. The wolfram is irregularly distributed throughout the quartzose rock, and sometimes occurs as rich "bungs".

(c) Selection of Geophysical Methods.

Because of the high resistivity of such a siliceous rock, its vertical boundaries with the sediments should be sharply definable by the potential drop ratio method. The Fielder's Hill deposit has its major development horizontally and the use of the potential drop ratio method is therefore limited. The great size of the body makes it suitable for investigation by the gravity method, provided there is sufficient density contrast between the formations. The survey party was not equipped with a gravimeter, but rock specimens were collected for specific gravity determinations, the results of which are given in the appendix.

(d) Results.

(i) Potential drop ratio method.

Only one traverse, crossing the area from north-west to south-east, was surveyed (Plate 8). The current electrode was set up at the point 00, and observations were made from 150W to 675W. Reference to the plan on Plate 8 shows that the traverse crosses a vertical boundary at 200W, and a shallow dipping boundary at 375W. No correlation can be made between the geology and the electrical profiles (Plate 9), although the latter show several features. Bearing in mind the success of the method at the Bismuth Mine, the inability to correlate results is difficult to understand, particularly in the case of the vertical boundary. Use of the return survey technique is advisable, as well as a change in the position of the current electrode.

(ii) Gravity method.

The specific gravity of specimens of the mineralised rock was found to be about 2.8. The average specific gravity of the sediments was difficult to determine, but it is not likely to be greater than 2.5. The specific gravity of the main granite mass can be taken as 2.63 (Andrews, 1907). These figures give sufficient density contrast between any two of the formations to warrant a test survey with a gravity meter, the results of which would be of considerable interest.

(e) Conclusions.

The results of the survey of the short test traverse made it doubtful whether the potential drop ratio method would be of value in the investigation of the Fielder's Hill type of deposit. The gravity method of survey might yield more useful information.

7. OTHER MINES SURVEYED.

(a) Currawong.

This property is being developed by Premier Tungsten Consolidated, and by courtesy of the staff of the mill which was being erected at the time, the writer was able to take magnetic measurements along a traverse at right angles to the long open cut (Plate 10). The country is undulating and sparsely timbered and surveying conditions are good. From Plate 1, it appears that this property is part of the former Wolfram Hill Workings and that the open cut, which trends about 45° magnetic, is that marked "Bismuth End". The vertical magnetic force profile on Plate 10 shows fairly constant magnetic intensity and indicates that the magnetic method does not show the ore body.

(b) Cow Flat Mine.

A short visit was made to this property which, at the time of the survey, was owned by Mr. R. Tobin, but no tests were made. A wolfram-bearing lode, trending north-east, has been worked by a 40-foot-wide open cut at the junction of a decomposed granite and sediments. "Trails" of rounded boulders carrying wolfram can be seen close to the lode on the downhill side. The country is very suitable for surveying, as it carries only light scrub and has a slight, regular slope. Carne(1911b, p.90) states that ilmenite is reported to have cut out the wolfram at the Cow Flat Mine. This may be significant for possible magnetic surveying of the deposit.

(c) Highland Home Mine, Scrubby Gully.

This mine is about 1½ miles south-west of Wolfram Hill, on a lease owned by Mr. T. Bollinger. The property was examined but no tests were made. It appears to be a lode deposit of the Butler type, and quartz, chlorite and some sulphide minerals are associated with the wolfram. Reports of the New South Wales Mines Department reveal that Elliotts and Australian Drugs Ltd. worked the mine, presumably for bismuth. Tributers were operating in 1932, and in 1934 a Mr. J. Dawson raised forty tons of ore which yielded 1.75 tons of wolfram-bismuth concentrates.

(d) Cobalt Mines.

A short visit was made to this area, but no tests were made. Carne (1911b) records that the mineral occurs in quartz veins which are sometimes very persistent, and range in width from 3 inches to 25 feet. It is possible that, where covered by alluvium, these veins could be traced by the potential drop ratio method.

8. CONCLUSIONS.

The tests carried out in the Torrington district have shown that geophysical methods are not likely to be of great service in prospecting for the typical wolfram lodes of the district. The potential drop ratio method gave encouraging indications in some areas. The results of magnetic tests were negative. Density measurements indicate that a gravity survey might be of service at the Fielder's Hill Mine.

9. REFERENCES.

Andrews, E.C., 1904 - Geology of New England, Rec.Geol.Surv., N.S.W., 7(4), 281-300.

" 1905 - New England Geology, Rec.Geol.Surv., N.S.W., 8(2), 108-152.

" 1907 - New England Geology, Rec.Geol.Surv., N.S.W., 8(3), 196-251.

Carne, J.E., 1911a - The Tin Mining Industry and the Distribution of Tin Ores in N.S.W., Dept. of Mines, Min.Res. No. 14.

" 1911b - The Tungsten Mining Industry in N.S.W., Dept. of Mines, N.S.W., Min.Res.No. 15.

David, T.W.E., 1887 - Geology of the Vegetable Creek Tin Mining Field, Dept. Mines, N.S.W.

Mulholland, C.St.J., 1953 - Torrington Tin and Wolfram Deposits 5th Emp.Min. & Met. Congress, Aust. and New Zeal., 1, 944-949.

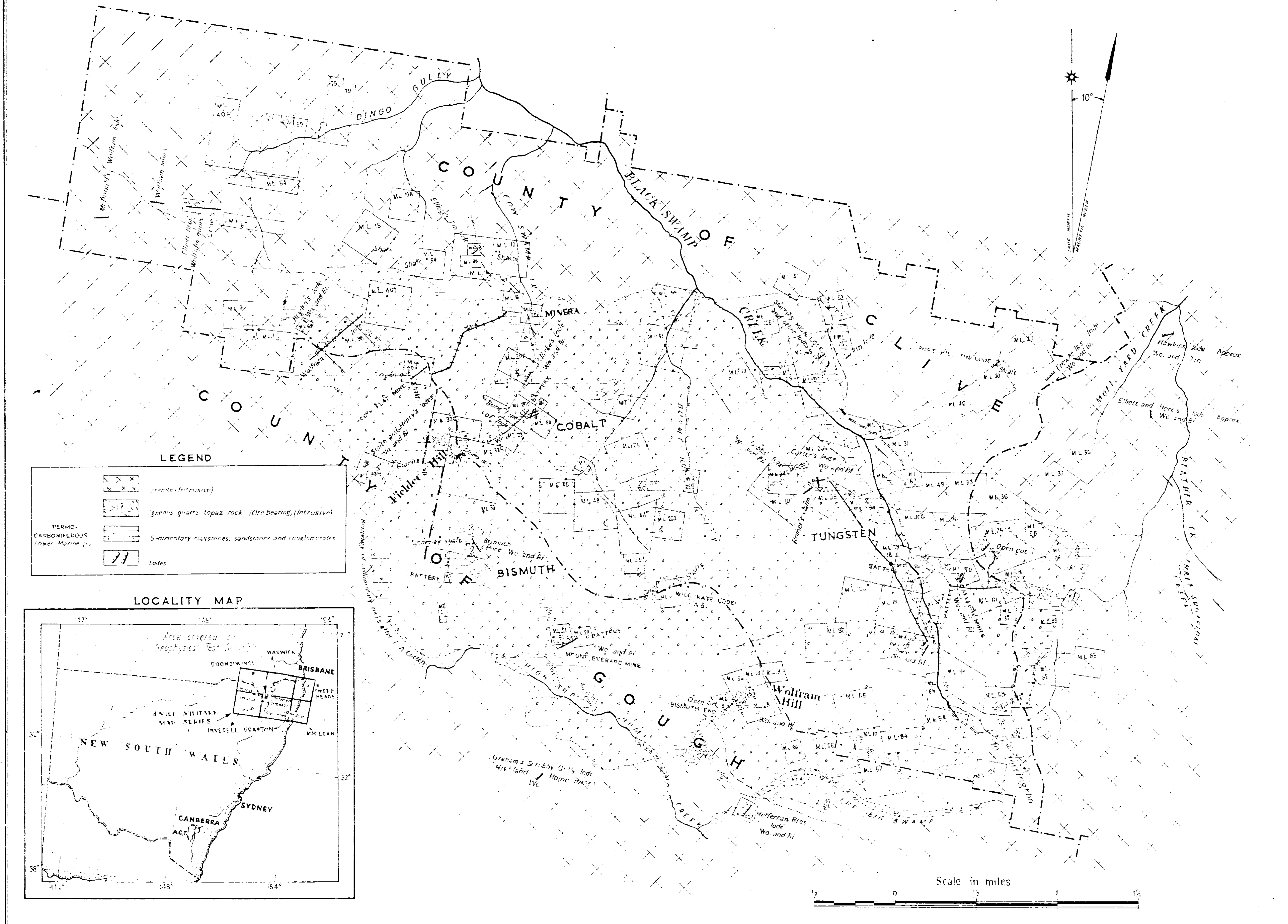
APPENDIX.

TABLE OF ROCK DENSITIES.

Specimen Type	Locality	Density	Remarks
Mineralised rock (with little fluorite)	Fielder's Hill	2.83	In situ
Mineralised rock	" "	2.81	" "
Mineralised rock	Currawong	2.90	Specimen took up water.
Aplite	Bismuth	2.62	From dump
Silicified sediments	"	2.87	" "
" "	"	2.79	From dump, specimen veined by aplite.
Granite	Cow Flat	2.80	From dump, partly weathered; large development of biotite.

Note: Numerous recorded assays of the acid granite of the Torrington district give a density value of 2.63.

PLATE 1



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS. N.S.W.

SURFACE FEATURES AND GEOLOGICAL BOUNDARIES

AFTER CARNE (1911)

LEASES SHOWN AS AT 1911

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G180-1

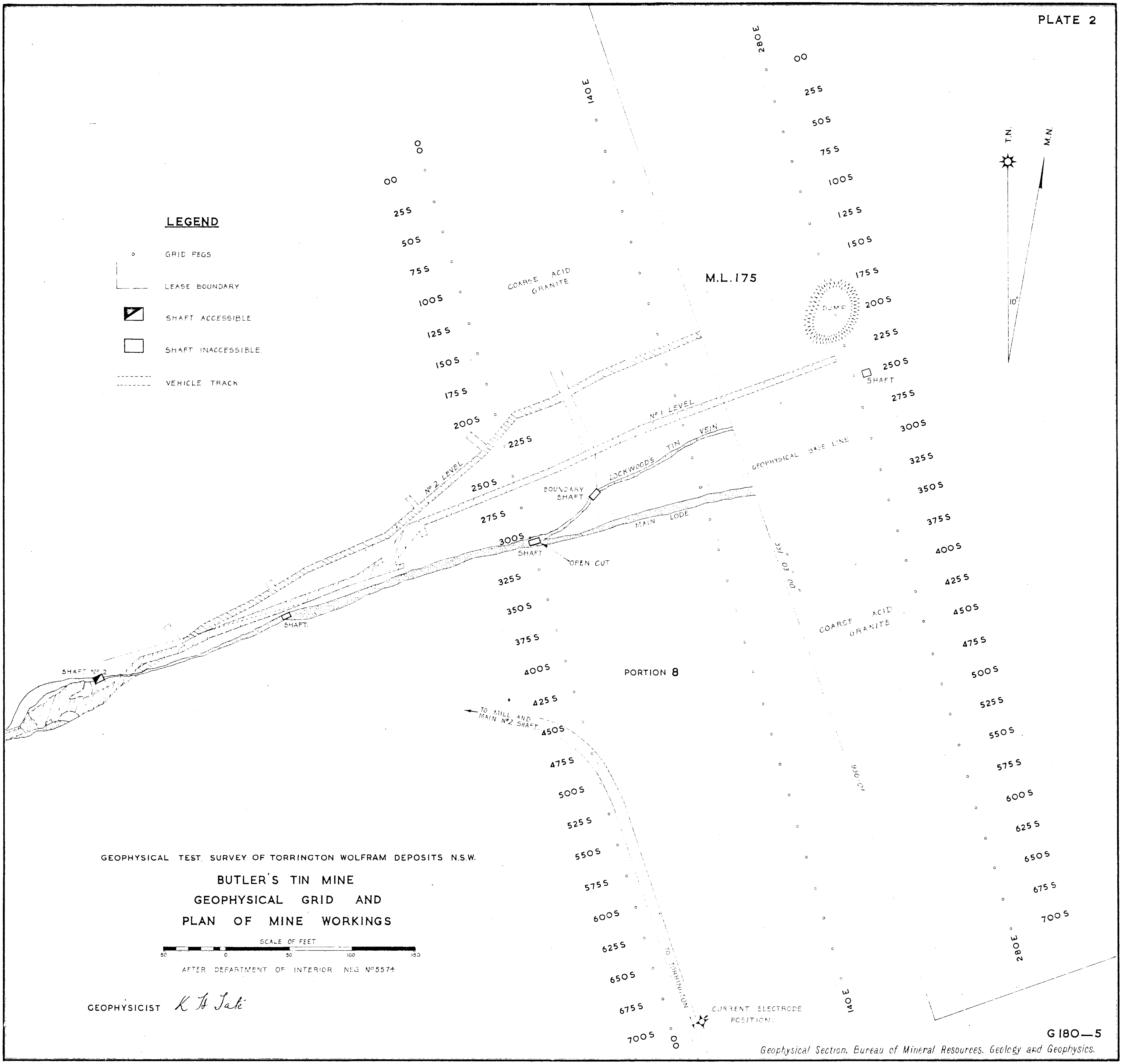
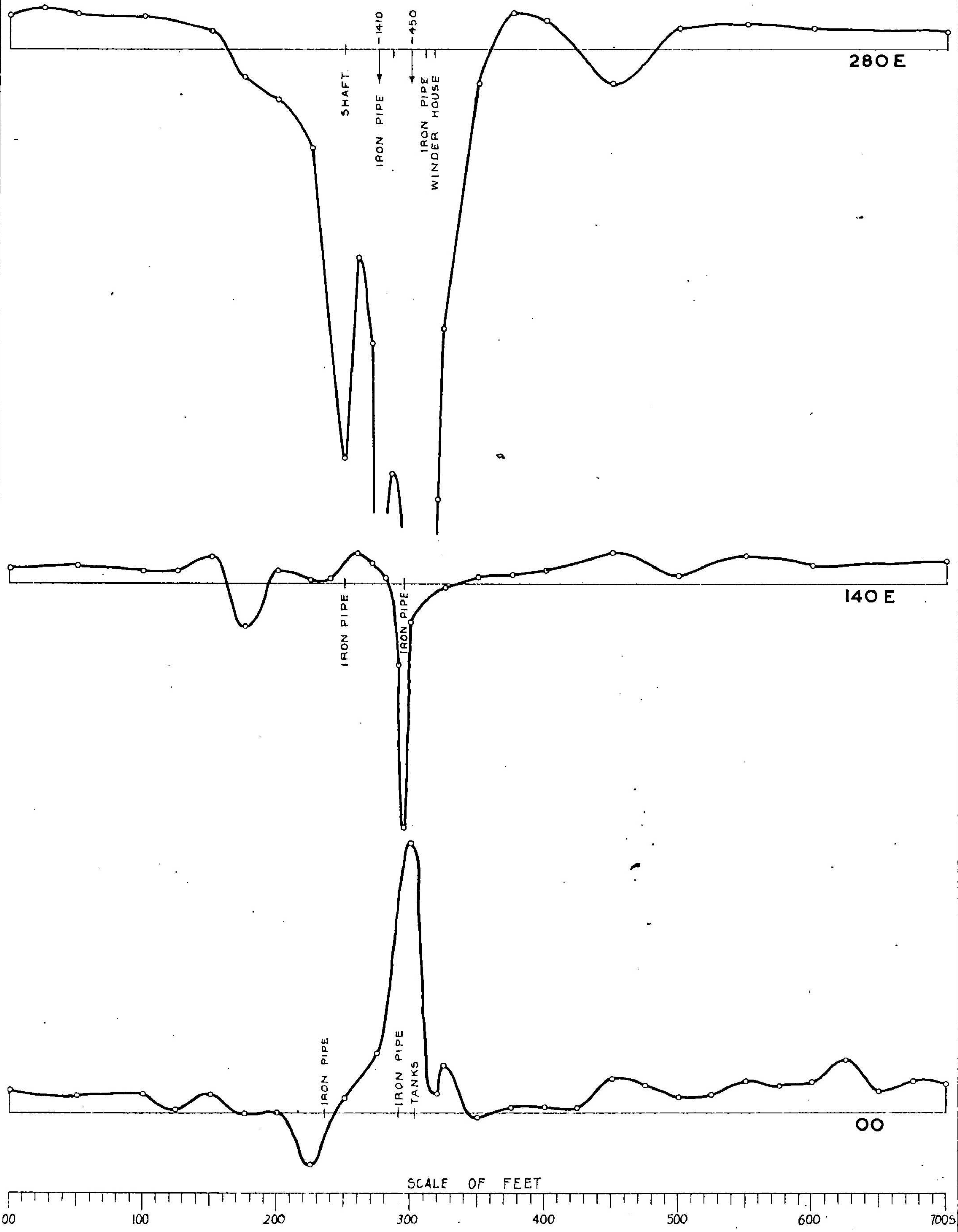


PLATE 2
LEGEND
GRID PEGS
LEASE BOUNDARY
SHAFT ACCESSIBLE
SHAFT INACCESSIBLE
VEHICLE TRACK
T.N.
M.N.
10°
M.L. 175
PORTION 8
COARSE ACID GRANITE
DUMP
SHAFT
No 1 LEVEL
No 2 LEVEL
LOCKWOOD'S TIN VEIN
GEOPHYSICAL BASE LINE
BOUNDARY SHAFT
MAIN LODE
OPEN CUT
SHAFT No 2
TO MILL AND MAIN No 2 SHAFT
TO TORRINGTON
CURRENT ELECTRODE POSITION
140 E
280 E
GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.
BUTLER'S TIN MINE
GEOPHYSICAL GRID AND
PLAN OF MINE WORKINGS
SCALE OF FEET
50 0 50 100 150
AFTER DEPARTMENT OF INTERIOR NEG No 5574
GEOPHYSICIST K H Tate
G 180—5
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics.

PLATE 3



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.

BUTLER'S TIN MINE
VERTICAL MAGNETIC FORCE PROFILES

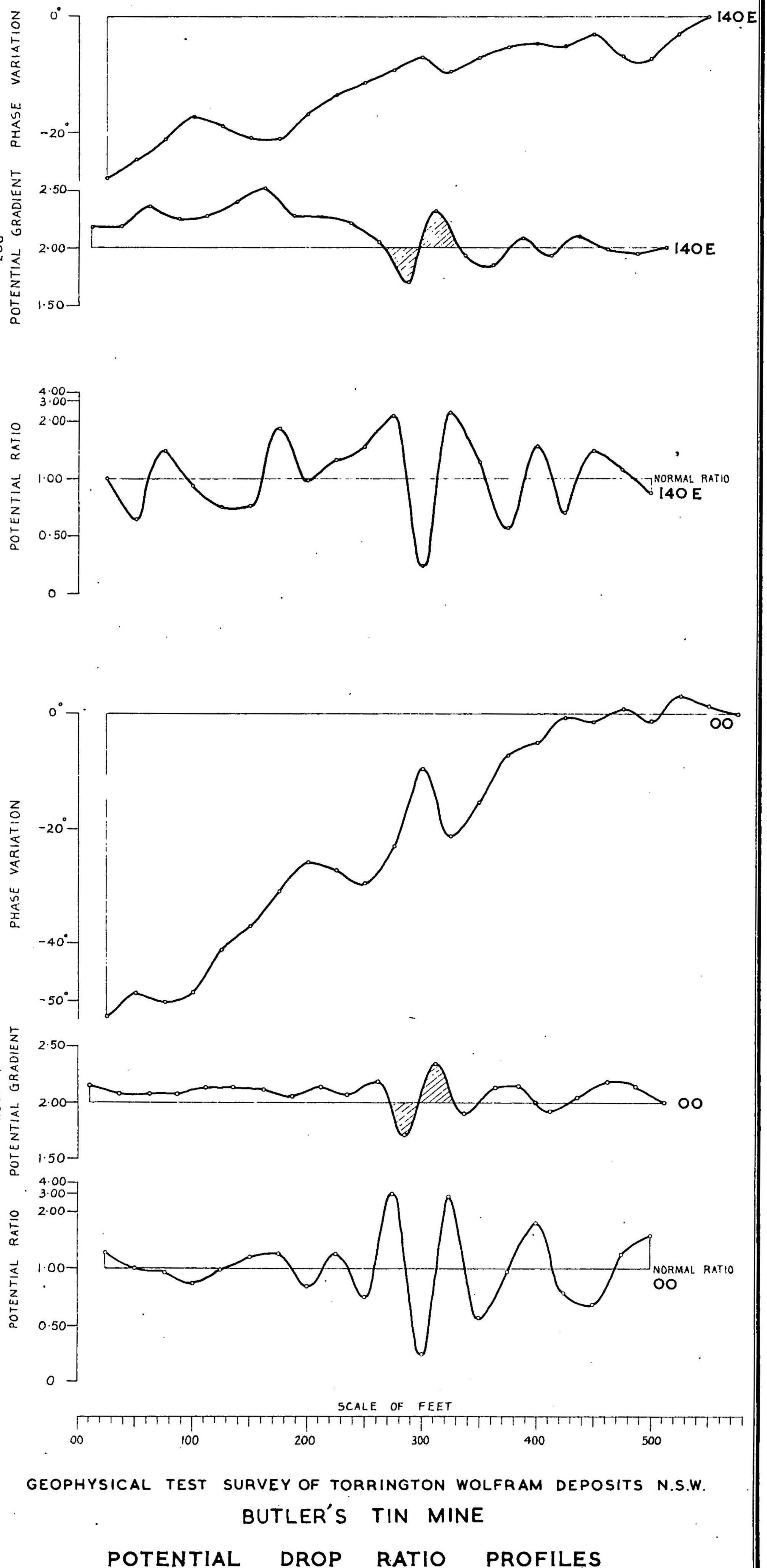
SCALE OF GAMMAS

100 0 100 200

GEOPHYSICIST *K H Tate* G 180—6

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

PLATE 4



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.

BUTLER'S TIN MINE

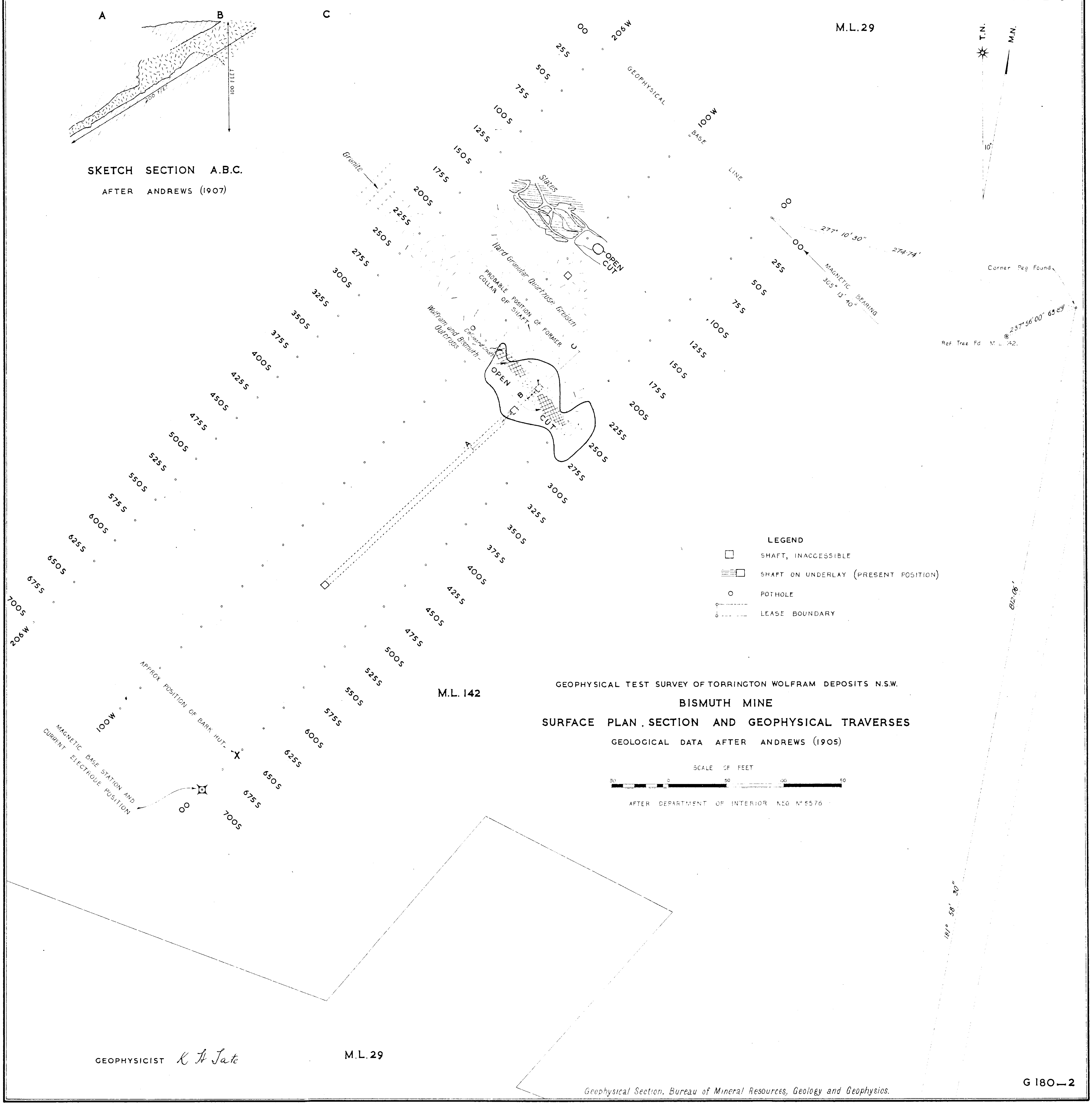
POTENTIAL DROP RATIO PROFILES

GEOPHYSICIST K H Tate

G 180—7

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

PLATE 5



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.

BISMUTH MINE

SURFACE PLAN. SECTION AND GEOPHYSICAL TRAVERSES

GEOLOGICAL DATA AFTER ANDREWS (1905)

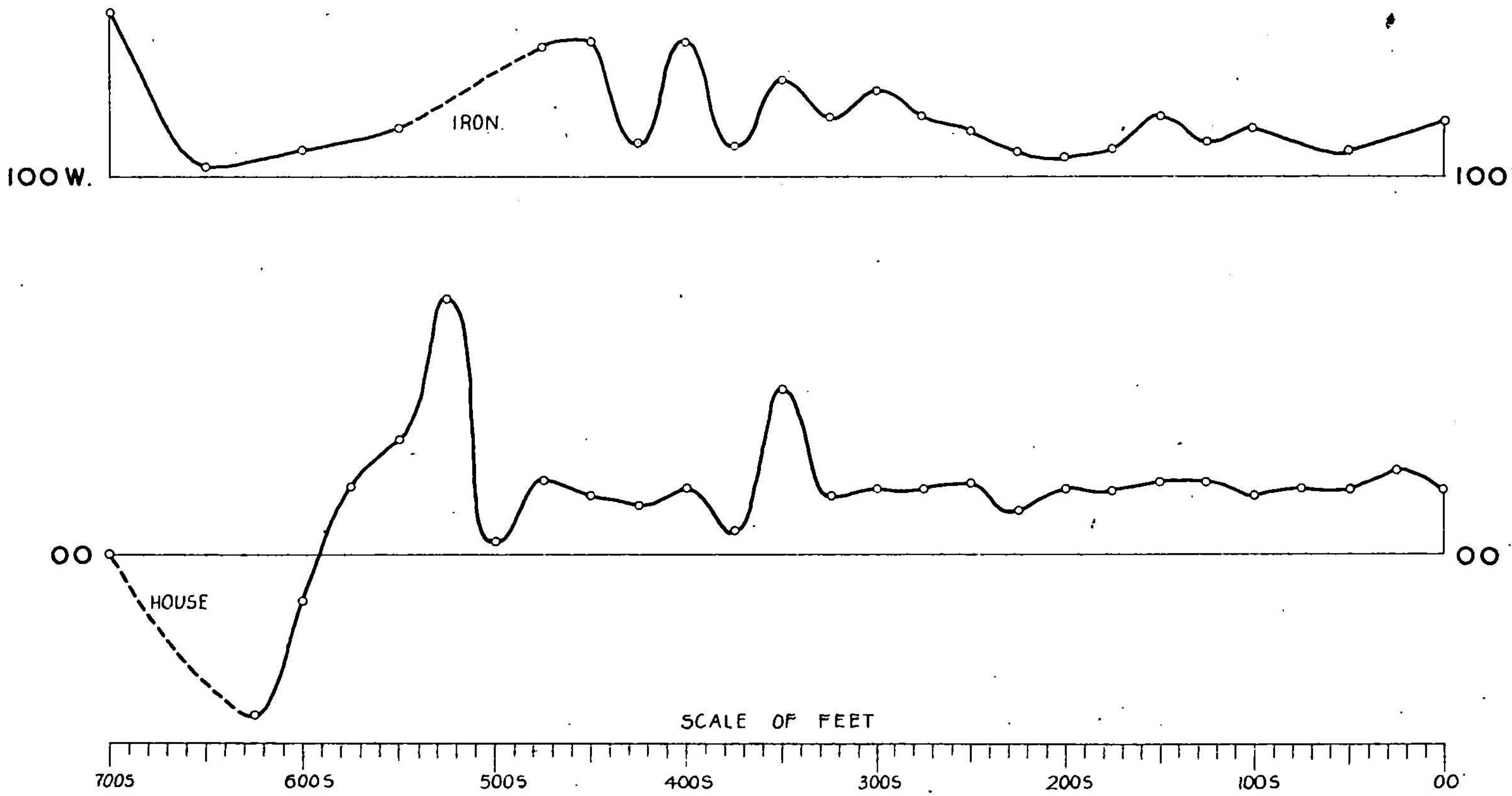
SCALE OF FEET

AFTER DEPARTMENT OF INTERIOR NEG. Nº 5576

G 180—2

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

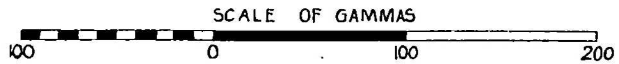
PLATE 6.



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS, N.S.W.

BISMUTH MINE

VERTICAL MAGNETIC FORCE PROFILES



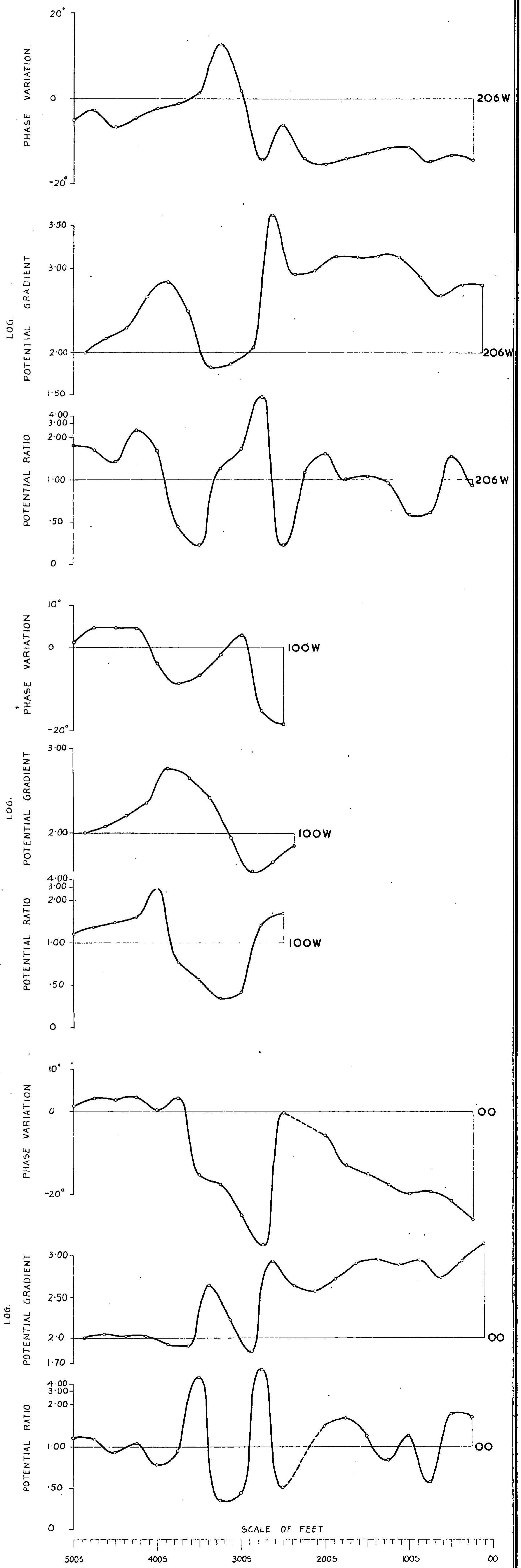
GEOPHYSICIST K. H. Tate

G.180—4

PLATE 6

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

PLATE 7



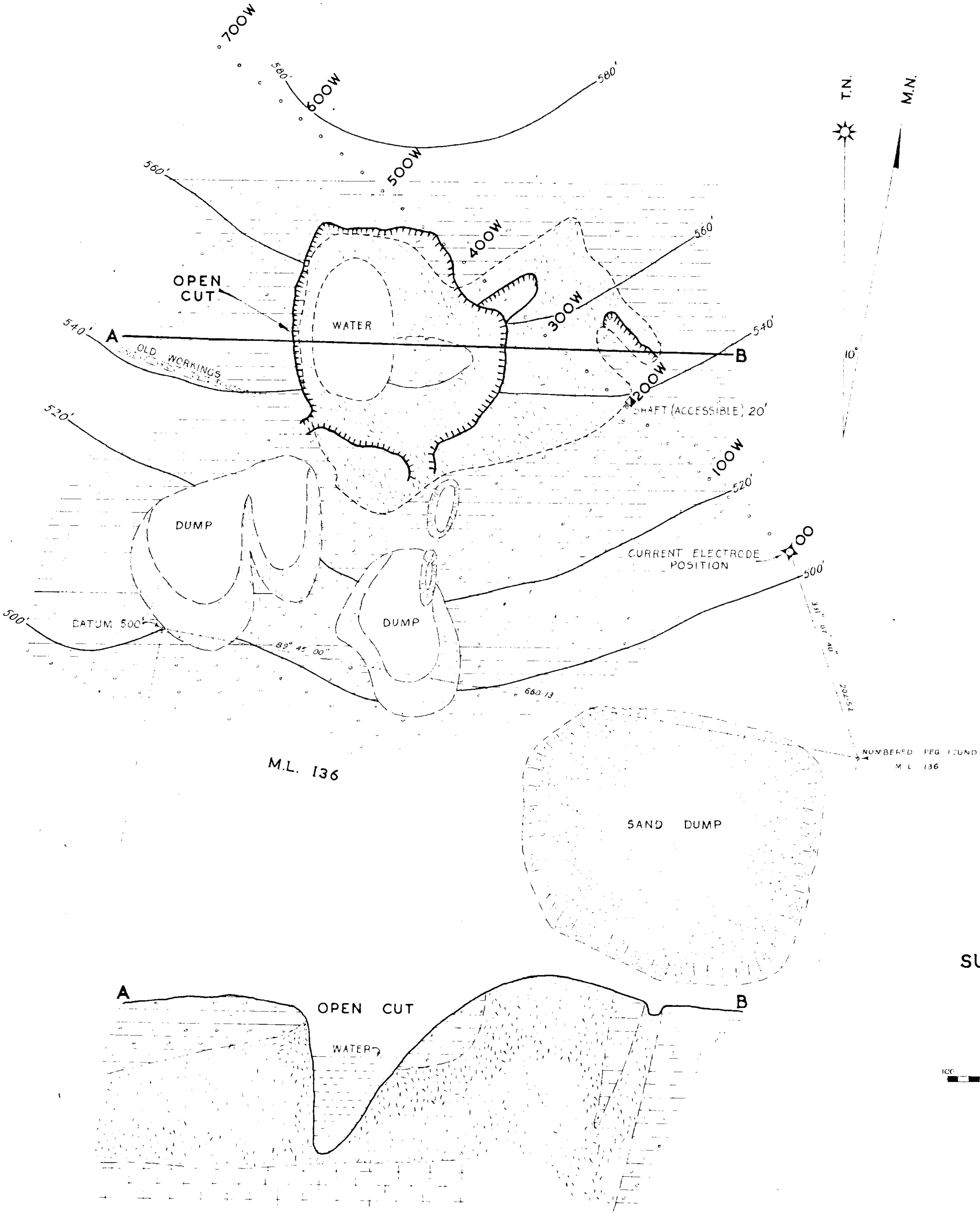
GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS, N.S.W.

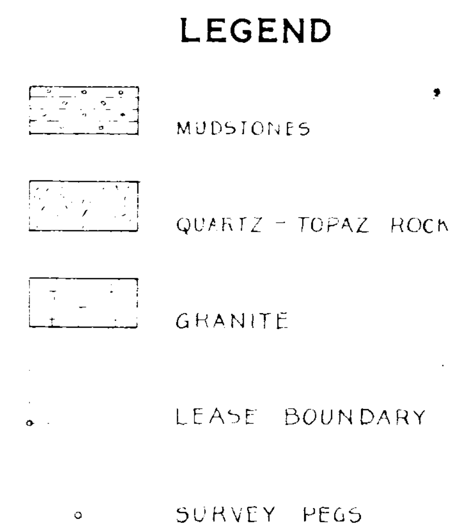
BISMUTH MINE
POTENTIAL DROP RATIO PROFILES

GEOPHYSICIST *K H Tate* G.180—3

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

PLATE 8





GEOPHYSICAL TEST SURVEY OF

TORRINGTON WOLFRAM DEPOSITS, N.S.W.

FIELDER'S HILL MINE

SURFACE PLAN, SECTION AND GEOPHYSICAL TRAVERSE

AFTER MULHOLLAND (1953)

SCALE OF FEET

100 0 100 200 300

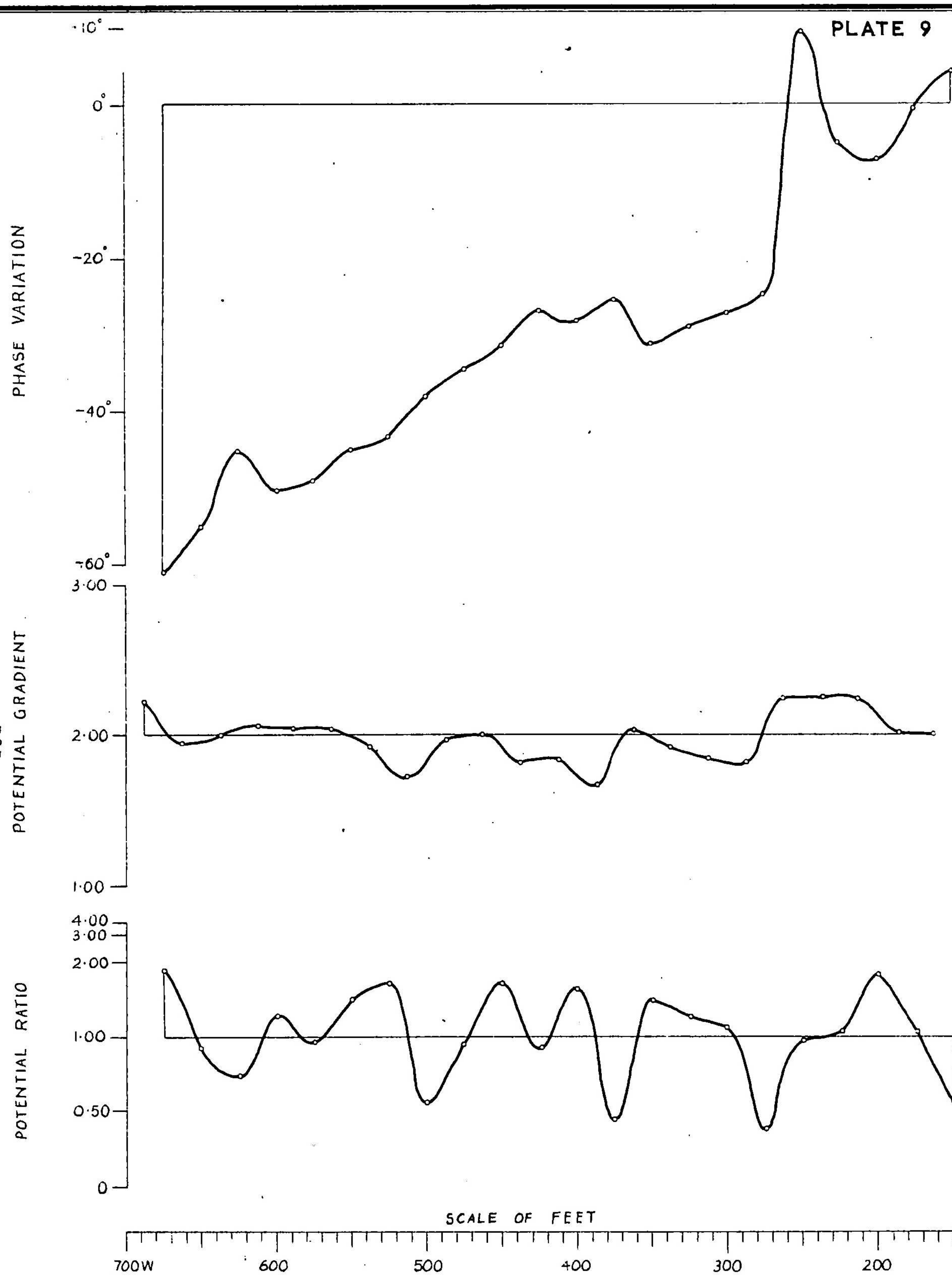
AFTER DEPARTMENT OF INTERIOR NEG. N°5575

K. H. Tate
GEOPHYSICIST

G 180—8

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

PLATE 9



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.

FIELDER'S HILL MINE

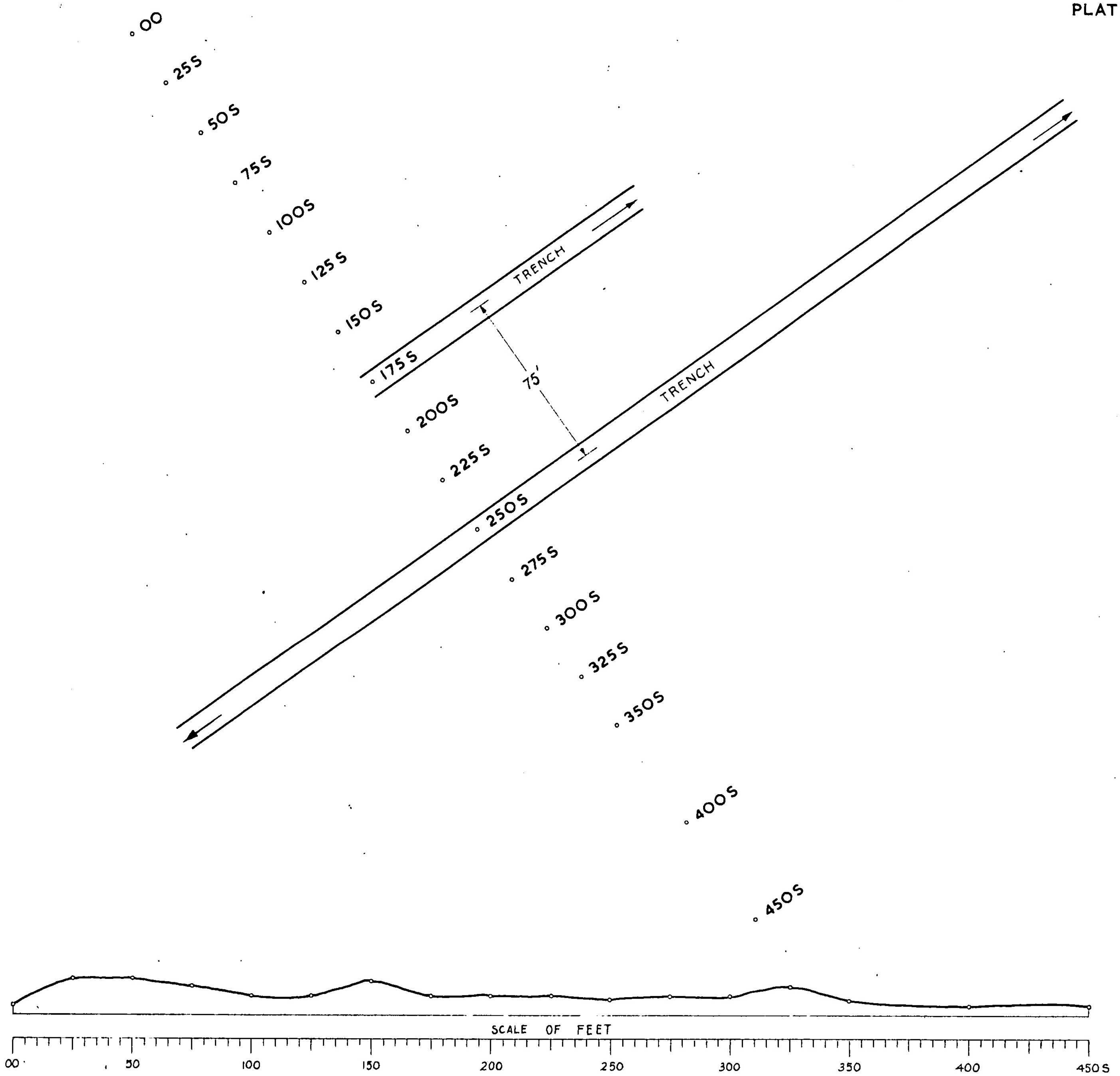
POTENTIAL DROP RATIO PROFILES

K H Tate
GEOPHYSICIST

G 180—9

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

PLATE 10



GEOPHYSICAL TEST SURVEY OF TORRINGTON WOLFRAM DEPOSITS N.S.W.

CURRAWONG

SKETCH PLAN AND

VERTICAL MAGNETIC FORCE PROFILE

SCALE OF GAMMAS

50 0 50 100

K H Tate
GEOPHYSICIST

G 180—10

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