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RECORD No. 1966/163

ZEEHAN GEOPHYSICAL SURVEYS, TASMANIA 1947 - 1948

by

W.J. LANGRON

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FOREWORD

The surveys described in this Record were made in 1947 and 1948 and, although a draft report was written shortly after the surveys were completed, for various reasons it was not issued. However, the results of the surveys were made available to the lease holder.

The report is now issued, with minor alterations, in order to place the findings of the survey permanently on record.

CONTENTS

ILLUSTRATIONS

SUMMARY

Geophysical surveys were made by the Bureau of Mineral Resources in the Oceana, Silver King/Silver Bell, Town Limestone, and Austral areas of the Zeehan silver-lead mining field, on behalf of Zeehan Explorations. The purpose of the surveys was to detect and, if possible, to delineate bodies of massive galena, which are known to exist in parts of the field. The gravity method was adopted, as this was considered to be the most likely method of detecting the dense galena in the less-dense country rock. Tests were also made using the magnetic, self-potential, electromagnetic, and potential ratio methods.

In the Oceana area, several gravity anomalies were found, which are associated with known mineralisation. Testing of these showed that they are due mainly to the presence of siderite. Testing of other local anomalies in the Oceana area failed to reveal any associated mineralisation.

Several minor anomalies, which may be due to mineralisation, were found in the other areas, but, as far as is known, no testing of these has been carried out.

1. INTRODUCTION

Early in 1947 the Bureau of Mineral Resources (BMR) received an application from Zeehan Explorations for a geophysical survey to be made in the Zeehan (Tasmania) silver-lead mining field. At that time the company was investigating occurrences of galena in limestone in the Zeehan area and some diamond-drilling had been completed for that purpose. Considerable difficulties had been experienced in these drilling operations owing to the presence of soft 'pug' and caverns in the limestone. The areas being prospected are largely covered by recent glacial deposits and consequently little useful guidance for drilling could be obtained from geological surveys.

In presenting the case for a geophysical survey, the company drew attention to the proved existence, in the Oceana area, of a vein of solid galena 14 feet wide at a vertical depth of 380 feet, and enquired concerning the possibility of using gravity meters to detect deposits of that nature. Several other limestone areas in the Zeehan field were to be closely examined and, if satisfactory results were obtained by the use of gravity methods in the Oceana area, there would be scope for the use of gravity methods in the other areas. Attention was also drawn to the Silver King/Silver Bell area (which is not a limestone area), where the company was engaged in prospecting by drilling.

The problem was examined from a theoretical viewpoint and it was shown that bodies of massive galena of the type known to exist in the Oceana area would, if they occurred at sufficiently shallow depth, produce measurable gravity anomalies. It also seemed likely that other methods might be applicable and the BMR agreed to carry out geophysical surveys in the Oceana and other areas.

The necessary pegging of traverses was done by the company. Field work extended from 2nd July to 12th December 1947 and from 20th January to 5th May 1948. The author was engaged on the survey for the entire period. J.E. Webb (geophysicist) was present for a large proportion of the time and L.A. Richardson paid two supervisory visits to the party. M.G. Allen and J. Colville (university undergraduates) and W. Foskett (Broken Hill South Ltd) joined the party for varying periods during 1948.

The location of the areas surveyed by geophysical methods is shown in Plate 1.

2. GEOPHYSICAL METHODS

Gravity method

A Heiland gravity meter No. 53 was used in the Oceana, Silver King, and Town Limestone areas. In the early work at Oceana a small barometric correction was included in the reductions because of a leak in the compensator drum of the gravity meter; repairs to the drum were carried out subsequently. The standard drift, free air, Bouguer, and latitude corrections were applied to the field readings. A slight variation in calibration factor occurred during the course of the work but generally the makers factor of 0.089 milligals per scale division was used in the reductions. An assumed rock density of 2.5 g/cm^3 was included in the Bouguer correction factor applied in all areas.

The gravity meter had to be carried by hand over rough tracks from the roads to the areas surveyed and along the traverses.

As a result, the instrument received numerous small shocks, which adversely affected its performance. Furthermore, weather conditions were at most times extremely bad owing to heavy rain and high wind. It is difficult to specify a figure, as a measure of precision for the results, that would apply to the whole survey, but a study of the misclosures in the Oceana and Town Limestone areas shows that the average misclosure is of the order of 0.05 milligal.

Magnetic method

The instrument used during the survey was a Watts Vertical Force Variometer with a sensitivity of 29.1 gammas per scale division. Variations in the vertical component of the Earth's magnetic field were measured and the presence of local anomalies established. The magnetic method was used in the Oceana and Silver King areas and along some selected traverses in the Town Limestone area.

Electrical methods

Electromagnetic, potential ratio, self-potential, and equipotential methods of survey were used in the Oceana area. Potential ratio tests were made over part of the Silver King/Silver Bell area and in the Austral area. Resistivity surveys were made in the Austral area and some tests were made with this method on an outcropping lode formation in the Town Limestone area. Self-potential surveys were also made in the Town Limestone area.

3. DESCRIPTION OF AREAS AND RESULTS OF SURVEYS

Oceana area

Description of the area. The Oceana area, situated approximately three miles south of Zeehan, is surrounded by prominent hills a few hundred feet high, which contain sandstone and conglomerate beds. The area of low relief inside the cordon of hills forms the Oceana area of interest and is believed to consist essentially of limestone, covered in part by glacial deposits and swamp. At the northern end of the valley, the limestone is bounded by a major fault, which has probably played a prominent part in the mineralisation that exists nearby.

Information regarding the known mineralisation is available from old mining records and from the results of diamond-drilling operations carried out by Zeehan Explorations.

The information from mine records is not very complete, but reveals that galena ore of good grade was mined at the 40-ft and 80-ft levels. The position of the workings is shown in Plate 2.

The diamond-drilling carried out by Zeehan Explorations revealed wide mineralisation in DDH Nos. 1 and 2 at the positions shown in Plate 2. DDH No. 1 intersected a zone of mineralisation 40 feet wide at a vertical depth of 100 feet. The zone was very low in silver and lead content and contained a high percentage of ferruginous material. The mineralised zone intersected by DDH No. 2 was about 14 feet wide at a depth of 380 feet, and consisted of high-grade galena ore. DDH No. 3 intersected a band of very low-grade mineralisation a few feet wide at a depth of 180 feet.

Density determinations made on drill cores from DDH Nos. 1 and 2 gave the following results:

Limestone	2.7 g/cm^3
Mineralised portion;	
DDH No. 1	3.3 g/cm^3
DDH No. 2	5.2 g/cm^3

Gravity survey. The survey was commenced with traverses over the area of known mineralisation and later was extended to cover almost the whole of the valley. The survey was extended a few hundred feet to the west without difficulty, but because of the steep terrain, extension in other directions was impracticable.

The gravity results, corrected for free air and Bouguer effects are shown as profiles in Plate 3. Features of the results include:

(1) A regional trend, in the form of a decrease in gravity values, from the central part of the area to traverse 10N.

(2) A decrease in gravity values at the eastern end of most traverses.

(3) Local gravity maxima.

The first two of these features are probably topographical effects due to the hills that adjoin the area along its northern and eastern limits. No attempt has been made to calculate these effects as no accurate contour plans were available. Terrain corrections were calculated for a few stations in the central part of the area but were found to be negligible.

The local gravity maxima are the features of main interest in the results because they could be due to mineralised bodies of density greater than that of the limestone. This supposition is supported by the fact that anomalies of this kind occur where mineralisation is known to exist.

To show the essential features of these anomalies it is necessary to remove the regional and topographic effects from the results. As a first attempt to do this, the profiles were taken separately and a 'normal' profile drawn by inspection, as shown in Plate 3. The local anomalies were measured from these 'normal' profiles along each traverse, and the results obtained were used to prepare the gravity contour lines shown in Plate 2. This treatment is considered to be satisfactory as a first step in delineating the form and distribution of the local anomalies. It is possible that some of these anomalies are due to variations in the thickness of the glacial material that covers part of the area; however, little information is available concerning the nature of such variations.

The outstanding features in the contour pattern are the central anomaly and the northern anomaly. Mineralisation is known to exist at a few places along the axes of both anomalies and it is considered likely that the distribution of these anomalies is directly related to the distribution of the principal mineralisation occurrences in those parts of the area.

An analysis of the anomalies was made by the method outlined by Hedstrom (1940), using a graticule prepared by W.D. Keating of the BMR. This analysis indicated that, if mineralised bodies are responsible for the anomalies, such bodies would be found at relatively shallow depth and would have substantial widths. Recommendations were made for testing the central anomaly at a vertical depth of 100 feet at positions 1, 2, and 3 as shown in Plate 2.

This information was supplied to the company on 13th September 1948, and test drilling was subsequently carried out. The results, together with the results of other test drilling, are described in Section 4 of this report.

The form of the anomaly centred at position 5 is such that if it were due to a mineralised body, the body would be spherical or plug-like in shape. Recommendations were made to the company that the site of this anomaly and of the ones numbered 6 to 11 should be examined geologically, with the aid of costeaning if necessary, for signs of mineralisation. If mineralisation were found, it was considered that deeper testing would be warranted.

Magnetic survey. The area between traverses 9N and 3S was surveyed magnetically, using a Watts Vertical Force Variometer. The results are shown in the form of profiles and contours in Plate 5.

On traverses 9N, 8N, 7N, and 6N, an anomaly of low intensity, but with good definition, was found, and is probably related to the mineralisation intersected in DDH No. 1. The position of the anomaly agrees closely with that of the northern gravity anomaly. The mineralisation referred to above contains an appreciable amount of ferruginous material, and tests made on the drill core showed that the material is slightly magnetic. Specimens of mineralised drill core from DDH Nos. 1 and 2 were submitted to CSIRO for mineragraphic examination. The results are given in CSIRO Mineragraphic Report No. 390. It appears likely that the slight magnetisation detected in the material from DDH No. 1 is due to iron carbonate.

The anomaly centred at 3W on traverses 2N, 1N, and 00 is probably related to the known mineralisation that is assumed to be responsible for the gravity anomaly there. However, whereas the gravity anomaly persists to traverse 3S, no magnetic anomaly is present in corresponding positions on traverses 1S, 2S, or 3S. It is not clear whether the anomaly at 1S/6E is due to an extension of the feature responsible for the anomalies referred to above or to a separate feature. A survey along traverse ½S would help to clarify the position.

The anomalies on traverses 4N and 3N at 6E are prominent features of the results, but it is possible that they are due to a buried pump column in the old main shaft nearby. No corresponding gravity anomalies are present.

Self-potential survey. This survey extended from traverse 10N to traverse 3S. The results are shown in the form of profiles in Plate 6.

The profiles are very irregular, owing largely to shallow-seated effects. The negative centre at 00/4W is almost certainly due to the mineralisation known to exist there. The site is near a gossan outcrop, which is well exposed in Fox's open cut. As no other anomalies are present along the line of this known mineralisation, it is probable that, in the region of Fox's open cut, the pyrite content of the mineralisation is greater than elsewhere, because this mineral is commonly found to contribute more to the self-potential effect than do other minerals.

There is no negative centre associated with the known mineralisation at the northern occurrence or elsewhere in the area surveyed. There are certain semi-regional features that may be related to geological conditions, but their interpretation in terms of geology is very uncertain.

Equipotential survey. Plate 7 shows the distribution of a.c. equipotential (E.P.) lines in the central part of the area. The electrodes for the E.P. layout were at 15N/16W and 20S/16W. A weak indication was obtained from the known mineralisation of the central zone. This indication suggests that the body responsible extends from traverse 2N to traverse 00 and possibly to traverse 1½S. An anomaly of smaller dimensions and rather indefinite form indicates the presence of a conductive zone extending from 3S/6E to 4S/7E. The pronounced swing in the E.P. lines near traverse 4N is probably the normal behaviour of E.P. lines as one electrode is approached.

Electromagnetic survey. The area between 9N and 4S was surveyed by this method, with the primary cable along the 16W line. Real and imaginary vertical and horizontal components were measured. No anomalies were found that could be attributed to mineralisation, known or unknown.

Potential ratio survey. This method was used on all traverses, the near electrode being at 18W on various traverse lines. Electrode spacing was 50 feet. The results are shown in Plate 8 in the form of potential gradient profiles. As the known mineralisation does not produce definite anomalies, it is apparent that the results are of little use as an aid to the search for new occurrences. Certain features, such as the broad trough (i.e. the zone of relatively low resistivity) on traverses 7N, 6N, 5N, and 4N, and the relatively high gradients at the eastern end of traverses 11S, 12S, and 13S, may be related to geological conditions.

Silver King/Silver Bell area

Description of the area. The Silver King mine, near Zeehan railway station, was one of the earliest producers in the Zeehan field. Plate 9 shows the Silver King area, some of the mine workings, and the geophysical grid. The mineralisation occurs in a steeply-dipping fracture zone, the enclosing rocks being shales and sandstones. The fracture containing the main lode has been proved by mine workings to be continuous over a length of 750 feet. It is believed that its limits are determined by cross-faults, but no workings exist at the position of these faults to substantiate this belief. The main lode has been worked at the 105-ft, 175-ft and 245-ft levels. The lode material is siliceous and contains galena with subordinate sphalerite. Detailed records giving dimensions of the orebodies mined are not available, but the portions of the lode that have been stoped are apparently those carrying the concentrations of galena. The stopes are up to 300 feet in length and it appears likely that the average width of the rich ore mined was less than 2 feet. It is known, however, that the mineralisation in the lode channel is up to 20 feet wide in certain parts. The west crosscut at the 105-ft level intersected three lodes (Nos. 2, 3, and 4), the positions of which are shown in Plate 9. No. 2 lode is 3 feet wide and contains much sphalerite, No. 3 lode is 7 feet wide, and No. 4 lode is 2 feet 6 inches wide.

At the Silver Bell mine, the most important orebody (that worked by Fahey) was stoped over a length of 500 feet and contained bunches of galena 14 feet wide. Mining commenced on a gossan outcrop, which was replaced at a depth of 30 feet by solid galena, 4 feet wide. This lode continued downwards, with diminishing grade, for a further 60 feet. The southern end of the lode is terminated by a cross-fault. Plate 12 shows the position of the principal shafts and of Fahey's lode.

Gravity survey. The gravity results are shown in the form of profiles in Plate 10. The area surveyed included the Silver King centre and extended 500 feet to the north and 1500 feet to the south of the

Silver King shaft, but because of streams and swamps, parts of certain traverses were not surveyed. The South King and Silver Bell centres were not surveyed by the gravity method. Traverse 11N was extended to 40W to cover the vicinity of the lodes intersected in the west cross-cut from the Silver King shaft.

The anomaly of about 0.15 milligals centred at 15N/1E could possibly be due to an orebody. As no corresponding anomalies occur on the adjoining traverses, the length of any such body would probably be less than 100 feet. Traverses 1N and 1S show increasing gravity between 8W and 2W and this could also be due to the presence of an orebody. Because of swampy ground, gravity readings could not be obtained along traverse 00 or the eastern part of traverse 1S. The gravity picture is therefore incomplete, but the results suggest that a more detailed survey, at a time when ground conditions are favourable, might worth-while in this part of the area. On traverse 11N, no gravity anomalies were obtained from the lodes intersected in the west cross-cut at the 105-ft level.

Magnetic survey. Magnetic vertical force profiles along traverses 16N and 6N are shown in Plate 11. The numerous and irregular disturbances are undoubtedly due to iron debris and houses, but in most other parts the magnetic values are particularly uniform. The only feature believed to be of interest is the weak anomaly at 7N/8E and 6N/10E. The anomaly is not very well defined and additional work would be needed for clarification. It is possible that the anomaly is due to a slightly magnetic body at 6N/10E striking towards 7N/8E.

Self-potential survey. Measurements were made along traverse 15N from 11E to 14W and along traverse 11N from 00 to 40W. The results are shown in Plate 11. The profiles are very irregular and no well-defined anomalies are present. The negative values at 3E and 4E on traverse 15N could possibly represent a negative centre of small magnitude, but this is of interest only because it lies on or near the continuation of the line of strike of the Silver King lode channel. The possible existence of mineralisation at 15N/1E, where a small gravity anomaly exists, was not confirmed. The lodes intersected in the 105-ft level west crosscut produced no self-potential anomalies along traverse 11N.

Potential ratio survey. This method was used on the Silver Bell area only, where seven traverses were surveyed between 23S and 35S. The results obtained are shown in Plate 13 in the form of profiles of potential gradient. It is considered that the only feature of possible interest in the results is the slight difference between the average magnitude of the gradients over certain parts of the area. This difference is best shown on traverse 31S, and a possible interpretation of this feature is that the rocks along this traverse from 8E to 20E are more resistive than those from 8E to 20W. Extending this interpretation to the other traverses, corresponding points are obtained where the difference in potential gradient is most marked; the position of many of these points is very doubtful. The line formed by joining the points is shown in Plate 12.

Town Limestone area

Description of the area. The Town Limestone area, the position of which is shown in Plate 1, is fairly flat and soil-covered. Further to the north, the limestone country becomes swampy. A prominent sandstone ridge lies to the east of the limestone, and Argent Flat, an area of slates and sandstone, lies to the west.

Minor occurrences of mineralisation have been found at several places in the area and exploration to a depth of 80 feet has taken place in the Despatch shaft. The position of the geophysical traverses is shown in Plate 14. Prior to the geophysical survey, exploration by the company included several diamond-drill holes and costeans, but no important mineralisation had been found. The diamond-drilling conditions were bad and core recovery was poor.

Gravity survey. The results of the gravity survey are shown as profiles in Plate 15. The principal feature of the results is the strong regional increase in gravity towards the south-west. This persists over the whole of the area surveyed and for a distance of 3300 feet on traverse 6N, which was extended to the south-west across Argent Flat. This feature is no doubt due to some geological condition of major proportions, such as the distribution of denser rock material at depth, and a gravity survey of a large part of the Zeehan field would be needed to determine the nature of this trend. It is possible that the results of such a survey would be of value in connection with the mineralisation distribution on a regional scale.

Anomalies that would be produced by orebodies of the Oceana type would, if present, be superimposed on the regional effect. It is clear from Plate 15, that no such anomalies exist. Some small anomalies are present, such as the one centred at 15N/37W; this anomaly could be due to a shallow-seated orebody of small dimensions.

Self-potential survey. Some tests were made on a few traverses, but the work was not very extensive and the results are of little interest.

Resistivity survey. Some tests were made along a traverse that crossed a mineralised zone exposed by costeans near the Grand Hotel. This zone, approximately 8 feet wide, occurs at the junction of sandstone and tuff, and contains scattered masses of solid galena and much iron oxide down to the exposed depth of 6 feet. The tests consisted of standard four-electrode (Wenner) determinations of resistivity, using electrode separations of 5 feet, 10 feet, 20 feet and 30 feet, at intervals of 25 feet along the traverse. No anomaly was obtained that could be related to the mineralised zone. The resistivity of both the sandstones and tuffs was found to be of the order of 10,000 ohm-cm.

Austral area

Description of the area. Plate 16 shows the area surveyed and the position of the workings, and also includes the principal geophysical results. The flux quarries contain iron oxide deposits of irregular form. The mine workings further south operated on silver-lead occurrences distributed irregularly throughout a 'black pug' formation of substantial width. The company's geologists believe that this formation might contain enough lead and silver to be of interest as a low-grade mining proposition and attempts were made to determine the boundaries of the mineralisation. Because of poor ground conditions, diamond-drilling near the flux quarries, from both sides, failed to prove the boundaries. The area was therefore proposed for geophysical investigation. As an additional means of exploration, the company later completed several long costeans across the area and assays were made along these. The results of these assays have been made available to the BMR. The 'black pug' formation is believed to occur in limestone near the contact between limestone and quartzite, which occurs adjacent to the workings on the south-western side. The limestone forms an area of low relief and mostly swampy ground on the north-eastern side of the roadway, and the quartzite forms a prominent area of high ground.

Resistivity survey. Resistivity tests, using a constant electrode separation of 25 feet, were made along traverses 5 and 6. The results (Plate 16) show that the resistivity values over the limestone on traverse 5 are fairly constant at about 20,000 ohm-cm. The higher resistivity values west of 13W are probably due to quartzite in situ or quartzite detritus. The limestone/quartzite contact on traverse 5 may be placed at about 14W, on the basis of these results, or further west if there is a substantial thickness of quartzite detritus present on the sloping ground in this vicinity. The contact is not so well defined on traverse 6. On the evidence obtained from the resistivity tests along traverses 5 and 6, it was considered that it might be possible to locate the position of the limestone/quartzite contact by electrical survey, but it was thought unlikely that the boundaries of the 'black pug' could be determined. As the next step in the investigation, it was decided to survey the area by the potential ratio method.

At a later stage in the survey, some detailed resistivity measurements were made along trench 10A; the results of these are included in Plate 16. The principal feature of these results is a zone of relatively low resistivity, about 10 feet wide, centred at 50W. The centre of the zone is 76 feet from the edge of the road. The assay plan for this costean shows good lead values between 86 and 96 feet from the edge of the road. Negligible lead values were obtained from the zone of low resistivity.

Potential ratio survey. All traverses were surveyed by this method, using 50-ft electrode spacing. The potential gradient profiles are shown in Plate 16.

The troughs on these profiles are due to zones of relatively low resistivity. On the plan of the area, the axes of the troughs form two lines, one extending from traverse 5 to traverse 15 and passing through the mine workings, and the other extending from traverse 1 to traverse 6 and passing through the flux quarry area. Examination of the assay plan for the costeans fails to reveal a consistent relationship between the position of these lines and the high lead assays. It is possible, nevertheless, that the relationship is better at depths greater than those of the costeans, and if so, these potential ratio results may be a useful guide for further exploration.

It is considered that the trough centred at 15E on traverse 3 should be tested for mineralisation. If favourable results are obtained there, additional potential ratio surveys would be justified.

4. TESTING OF SURVEY RESULTS

In accordance with the recommendations submitted to the company on 13th September 1948, the central gravity anomaly on the Oceana area was tested by drilling, at the anomaly centres 1, 2, and 3 (Plate 2). Holes were drilled from the east side and intersected each anomaly zone at a vertical depth of about 100 feet. Favourable results were obtained at anomaly centres 1 and 2 but not at centre 3. The density values and assay results of the drill cores are tabulated below.

DDH No. 27 (anomaly centre 1)

Collar at 1N/28 feet west (geophysical co-ordinates). Hole depressed 53 degrees in direction 217° (magnetic).

Sample depth (ft)	Pb (%)	Density (g/cm^3)	
87- 90	1.2	3.8	
90- 93	5.7	3.8	
93- 96	4.5	3.5	
96- 99	15.2	4.0	
99-102	3.6	3.7	
102-104	5.3	3.7	Ave. density
104-110	2.6	3.9	= 3.7
110-113	6.2	3.7	Hor. width
113-115	1.2	3.3	= 32 ft
115-118	18.0	4.0	
118-120	9.4	3.7	
120-123	3.6	3.6	
123-126	1.7	3.6	
126-129	4.6	3.7	
129-134	4.8	3.7	
134-139	2.7	3.8	
139-141	11.4	3.8	
141-145	9.3	3.9	

DDH No. 28 (anomaly centre 2)

Collar at 00/23 feet west (geophysical co-ordinates). Hole depressed 53 degrees in direction 217° (magnetic).

Sample depth (ft)	Pb (%)	Density (g/cm^3)	
41- 50½	-	2.5	
50½- 52½	31.0	4.5)	Ave. density = 3.6
52½- 58½	not assayed	3.6)	Hor. width = 11 ft
58½- 69	not assayed	3.5)	
69 - 83	-	2.6	
83 - 87	6.3	3.6)	
87 - 91	2.0	3.5)	
91 - 94	0.9	3.5)	
94 -102	1.7	3.6)	Ave. density = 3.6
102-109	Nil	3.2)	Hor. width = 25 ft
109-112½	25.8	4.2)	
112½-117	9.1	3.8)	
117-120	35.4	4.2)	
120-123	6.2	3.3)	
125	not assayed	3.4)	
130	not assayed	3.0)	

DDH No. 29 (anomaly centre 3)

Collar at 1S/4 feet west (geophysical co-ordinates). Hole depressed 53 degress in direction 217° (magnetic).

Sample depth (ft)	Density (g/cm^3)	
15	2.1	
50	2.8	
80	2.6	
110	2.7	
115	2.7	Ave. density = 2.7
120	2.8	
135	2.6	
145	2.7	
160	2.8	
165	2.7	
180	2.8	
195	2.7	
225	2.7	
240	2.8	

The sections in Plate 4 show the drilling results in relation to the gravity profiles.

Comparison of the densities and lead assay values shows that in practically all instances the amount of galena present is not sufficient to account for the high density values, assuming that the remainder of the mineralised formation is limestone of density 2.7 g/cm^3. This was pointed out to the company and check assays were made on certain samples from DDH Nos. 27 and 28. As the second set of assay results was substantially the same as the earlier ones, the investigations were taken further by the company, and iron, lime, and manganese determinations were made on four samples from DDH 27, with the following results:

Sample depth (ft)	%Pb	%Zn	%Fe	%Mn	%Cao	%CO_2	Density (g/cm^3)
87- 90	1.2	0.2	30.5	9.9	0.9	40.7	3.8
123-126	1.7	0.2	31.8	8.9	0.5		3.6
134-139	2.7	0.2	31.0	8.3	2.1		3.8
141-145	9.3	1.6	29.7	8.3	0.7		3.9

These results led to the conclusion that the high density of the material was due largely to the presence of siderite (density 3.83 to 3.88 g/cm^3) and rhodocrosite (density 3.45 to 3.60 g/cm^3).

The discovery is important from the geophysical aspect because it means that the gravity anomalies at Oceana are related more to the distribution of the carbonates mentioned than to galena, which is much less abundant. However, as the carbonates are often associated with galena, and are a feature of mineralisation zones at Zeehan, it is likely that their discovery will aid the search for galena.

It is clear from the above results that dense bodies of substantial width are present at shallow depth at anomaly centres 1 and 2 but not at the position drilled at centre 3.

At the time the recommendation was made for testing, it was realised that the drill hole proposed for the testing of anomaly centre 3 would be close to the assumed position of the old DDH No. 3, which intersected only a small amount of low-grade ore. However, it had been suggested by company personnel that the old DDH No. 3 might have been deflected, and it was therefore decided to recommend testing at anomaly centre 3 similar to that recommended at centres 1 and 2. When the results of DDH No. 29 became available, a closer examination was made of the measured gravity profile along traverse 1S. Attention was paid to the slight evidence suggesting that the body responsible for the anomaly has a westerly dip; this led to a recommendation for drilling from the west side to test at a vertical depth of 80 feet. This was accepted by the company and DDH No. 46 was drilled from the position 78 feet south/161 feet west (geophysical co-ordinates) in the direction 37° (magnetic) and depressed at 54°. The topography was not convenient for drilling on traverse 1S. The results from this drill hole are given below:

Sample depth (ft)		Pb (%)	Ag (oz)	Zn (%)
0 - 81	Hard grey limestone	-	-	-
81 - 82	Low grade ore	2.6	0.3	0.1
82 - 83	Low grade ore	0.6	0.3	0.1
83 - 85	Calcitic Limestone	4.8	1.6	0.1
85 - 88	Calcitic Limestone	Nil	0.8	Nil
88 - 92	Calcitic Limestone	Nil	Nil	Nil
92 - 96	Calcitic Limestone	Nil	Nil	Nil
96 - 98	Calcitic Limestone	Nil	Nil	Nil
98 - 99	Dense grey rock No reaction to HCl	4.7	0.8	0.2
99½ - 101	Dense grey rock No reaction to HCl	0.9	Nil	0.1
101 - 157	Hard grey limestone			

Density values of cores from this drill hole were not determined. However, it is clear that the drill has intersected a mineralised zone between 81 and 101 feet and it is possible that dense material, containing siderite, extends beyond these limits.

Analysis of the gravity profile along traverse 1S suggests that the dense body responsible for the anomaly might be of limited depth extent. It was, therefore, recommended that another hole should be drilled from the same site as DDH No. 46 to test at greater depth. Accordingly, DDH No. 47 was drilled at the position 78 feet south/163 feet west (geophysical co-ordinates) in the direction 37° (magnetic) and depressed at 74°. The results from this drill hole are given below:

Sample depth (ft)		Pb (%)	Ag (oz)	Zn (%)
0 - 167	Limestone			
167- 172	Grey Ls. High Density	0.6	0.4	0.3
172-173½	Grey Ls. High Density	5.9	1.4	Nil
173½-175	Grey Ls. High Density	0.4	Nil	Nil
175-177	Grey Ls. High Density	1.4	0.5	0.6
177-180	Grey Ls. High Density	Nil	Nil	Nil
180-182	Grey Ls. High Density	3.2	0.4	Nil
182-185	Grey Ls. High Density	2.1	0.4	Nil
185-232	Hard grey siliceous Ls.			

These results suggest that the dense body in this position has a true width of 5 feet as compared with 12 feet in DDH No. 46.

It will be seen from Plate 4 that the mineralised body intersected in DDH No. 47, which is 20 feet to the north of the section line, was not intersected in DDH Nos. 3 and 29, which are on the section line. This suggests that, within the spacing of 20 feet, the bottom of the mineralised body has risen to a point above DDH No. 29 or has ended completely within that 20 feet. The latter seems unlikely in view of the geophysical evidence available.

A further recommendation was made to test along traverse 2S at a vertical depth of 75 feet below the position of the anomaly axis; it is understood that a hole was drilled in this position, but no results are available.

In accordance with recommendations made to the company, a costean was placed across anomaly centre 5, but showed no evidence of mineralisation. The company subsequently tested this anomaly by drilling DDH No. 44 at 1½S/54 feet east (geophysical co-ordinates) in the direction 37° (magnetic) and depressed at 51° (Plate 4). Between 68 feet and 69½ feet, two six-inch seams of rich galena ore were found, but no dense body was revealed. Density measurements were made of samples from this drill hole.

The company then drilled DDH No. 45 at 153 feet south/20 feet east (geophysical co-ordinates) in the direction 37° (magnetic) and depressed at 50° (Plate 4). Drilling was stopped at 241 feet, to which depth no mineralisation had been found; it was pointed out to the company that if no dense body were found at a depth of 100 feet, there was no reason, on geophysical grounds, for testing at a greater depth. Density measurements on samples from DDH No. 45 revealed that a zone of porous rock of density about 1.7 g/cm^3 is present between 29 feet and 90 feet. It is possible that this material has contributed towards the low gravity values between the central anomaly and anomaly centre No. 5. These low values might serve to accentuate the anomaly at centre 5 on one side, and the terrain effects might accentuate it on the other side. In the same way, the southern part of the central anomaly would also be accentuated. The position of this porous rock is shown in Plate 4.

Recommendations were submitted for testing the northern anomaly at centre 4 and an attempt was made to drill from the north side. This failed, because of bad ground, and another attempt was made to drill from the south side, but this also failed.

As stated earlier, a general recommendation was made for preliminary shallow testing of the local anomalies 6 to 11 by costeans, pits, or shallow boring. Because of manpower difficulties, the company was unable to arrange for such work and decided to test the anomalies by drilling. This was carried out at depths ranging from 75 feet to 100 feet but no mineralised bodies were found. It is probable, therefore, that these anomalies are due to variations in the thickness of glacial deposits or other geological irregularities, and in some cases partly to terrain effects.

5. CONCLUSIONS

In the geophysical surveys at Zeehan, attention was concentrated on the use of the gravity method. The problem, namely the detection of relatively small, dense bodies in limestone, was one which needed the utmost accuracy in the field measurements, because only small anomalies were expected. Operating conditions were poor, owing to the severe climate and the need for man-handling the gravity meter into the areas and along the traverses. In the Oceana area, the gravity meter had to be carried by hand for distances of up to three-quarters of a mile from the nearest road.

The principal scene of operations was the Oceana area, where well-defined gravity anomalies were found to be associated with known centres of mineralisation. Testing of the central anomaly revealed the existence of dense bodies responsible for the anomaly at centres 1 and 2 and near to centre 3. Testing was also carried out at the southern end of this anomaly but no results were available at the time of writing this report. Testing of the northern anomaly failed because of unsuitable drilling conditions. It is likely that the configuration of the central and northern anomalies will provide useful evidence concerning the distribution of the upper parts of the mineralised bodies in this region, and should be a useful guide for future exploration.

All other local anomalies were tested by drilling, but no mineralised bodies were revealed and, as far as is known, no other dense bodies were found that could account for the anomalies. It is therefore considered that these anomalies are probably due to such features as variations in thickness of overburden, terrain effects, or geological discontinuities within the limestone.

The investigation of the mineralised zones showed that the anomalies measured are due largely to the presence of siderite, and as this is a common constituent of mineralised zones in the Zeehan area, it can be expected to play an important part in any future gravity survey.

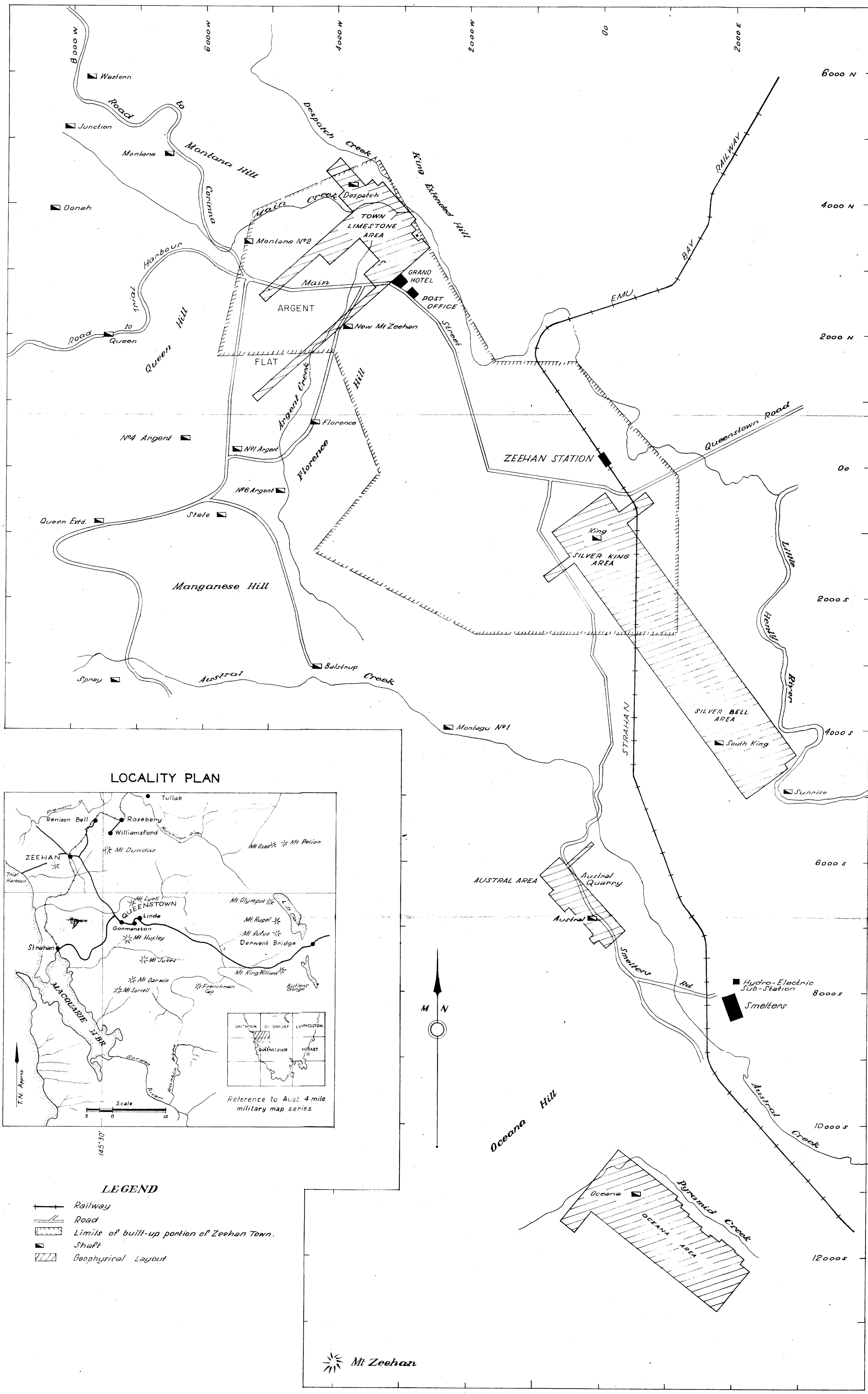
The gravity surveys in the Silver King and Town Limestone areas revealed no anomalies of interest.

The electrical surveys at Oceana failed to give distinct indications over the known mineralisation and elsewhere. This suggests that the galena distribution within the mineralised bodies is spasmodic and does not form continuous conductors of substantial length. Siderite is not a good electrical conductor. The electrical surveys elsewhere were more in the nature of tests and the results were not very promising. However, there appears to be scope for the use of electrical methods in other areas at Zeehan, particularly in the areas of strong relief, which are not suitable for the type of gravity survey necessary.

Up to the time of writing, there is no evidence of the existence of magnetic minerals such as pyrrhotite and magnetite in association with the mineralised bodies at Zeehan. It is likely, however, that some of the iron carbonates are slightly magnetic and it is possible, therefore, that the magnetic method may be of use in tracing the mineralised zones.

6. REFERENCE

HEDSTROM, H. 1940 A new gravimeter for ore prospecting. Trans.Amer. Inst.Min.Metall Engrs. 138, pp 235-257.



GEOPHYSICAL SURVEY AT ZEEHAN, TASMANIA

LOCALITY PLAN

SHOWING

GEOPHYSICAL SURVEYS

TO ACCOMPANY RECORD No. 1966/163

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics.

K55/B7-130

PLATE 2

Legend

Gravity Anomalies
- 0·0 to 0·1 m'gal
- 0·1 " 0·2 "
- 0·2 " 0·3 "
- 0·3 " 0·4 "
- 0·4 " 0·5 "
- ◎ Sites recommended for testing.

Magnetic Anomalies
- Axis of Anomaly

SCALE 0 100 200 300 Feet

Bureau of Mineral Resources, Geology and Geophysics

ZEEHAN GEOPHYSICAL SURVEY

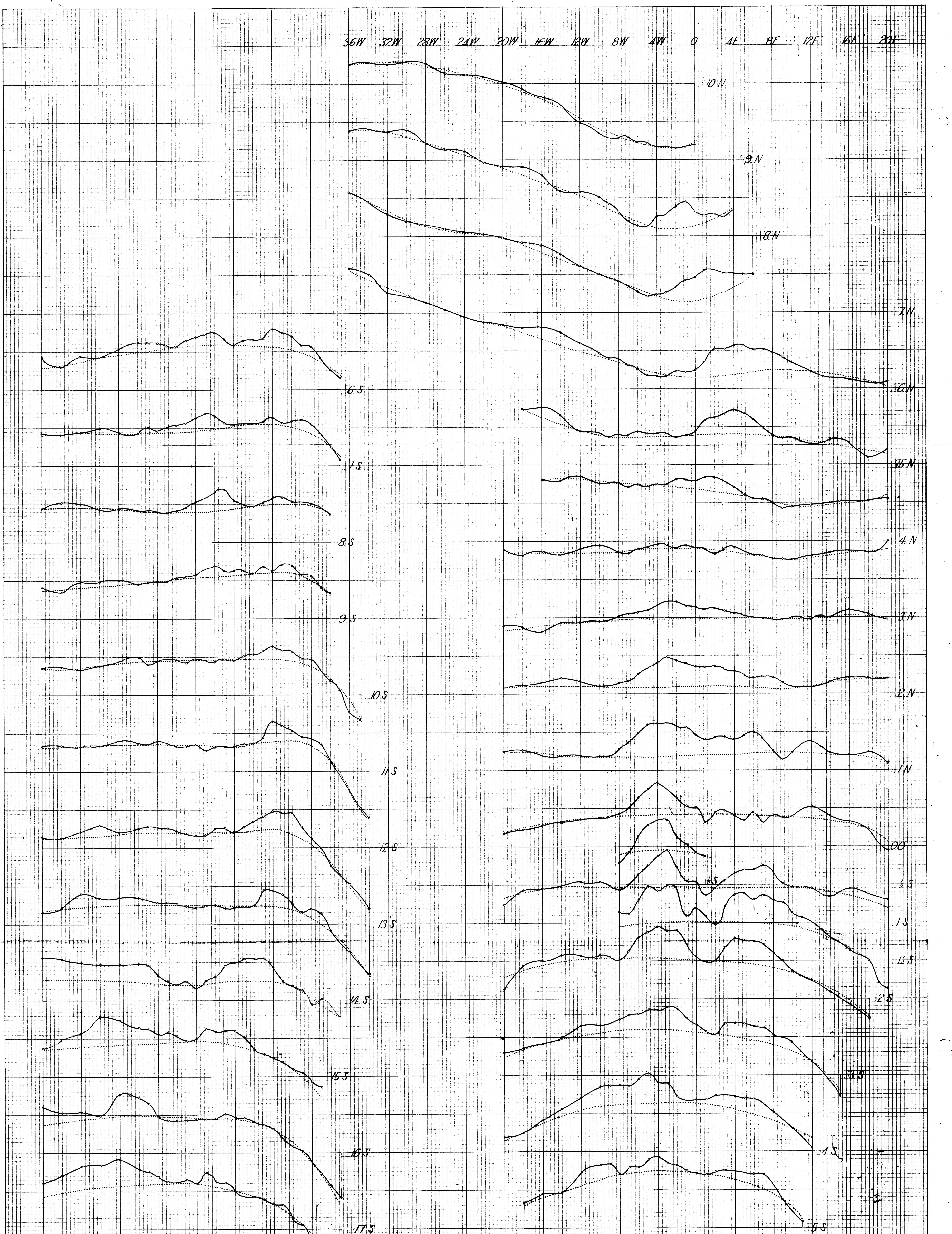
OCEANA AREA

Plan of area showing Gravity and Magnetic survey results

TO ACCOMPANY RECORD No 1966/163

K55/B7-131

PLATE 3.



GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES GEOLOGY & GEOPHYSICS.

LEGEND

Gravity profiles, as measured & corrected for Free Air, Bouger & Latitude effects

Arbitrarily determined "normal profiles" (See report for explanation)

Scales
HORIZ. 0 100 200 300 FEET
VERT. 0 0.5 1.0 1.5 M'GAL.

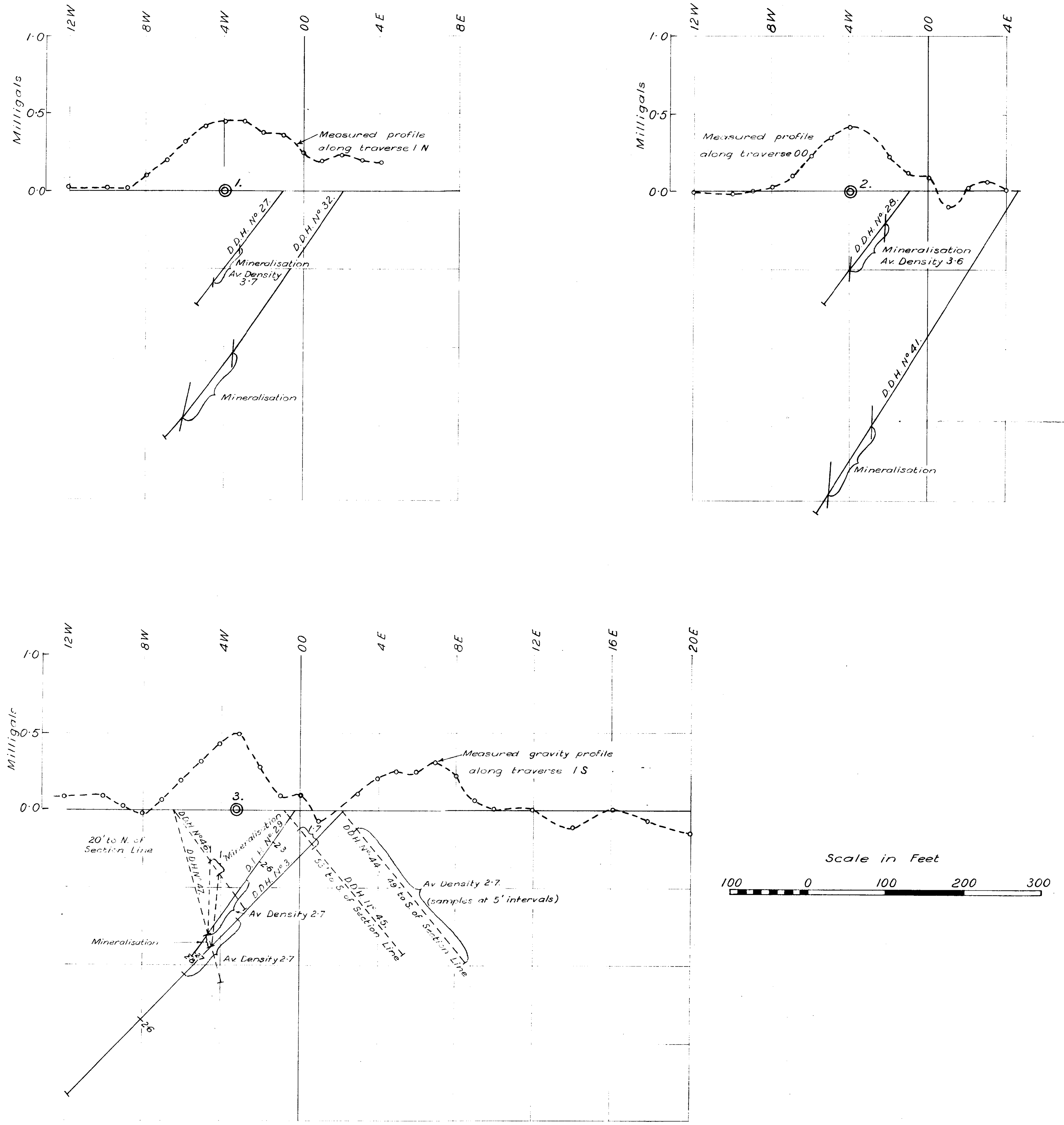
ZEEHAN GEOPHYSICAL SURVEY

OCEANA AREA

GRAVITY PROFILES

TO ACCOMPANY RECORD No. 1966/168

K55/B7-132



GEOPHYSICAL SURVEY AT ZEEHAN, TAS.

OCEANA AREA

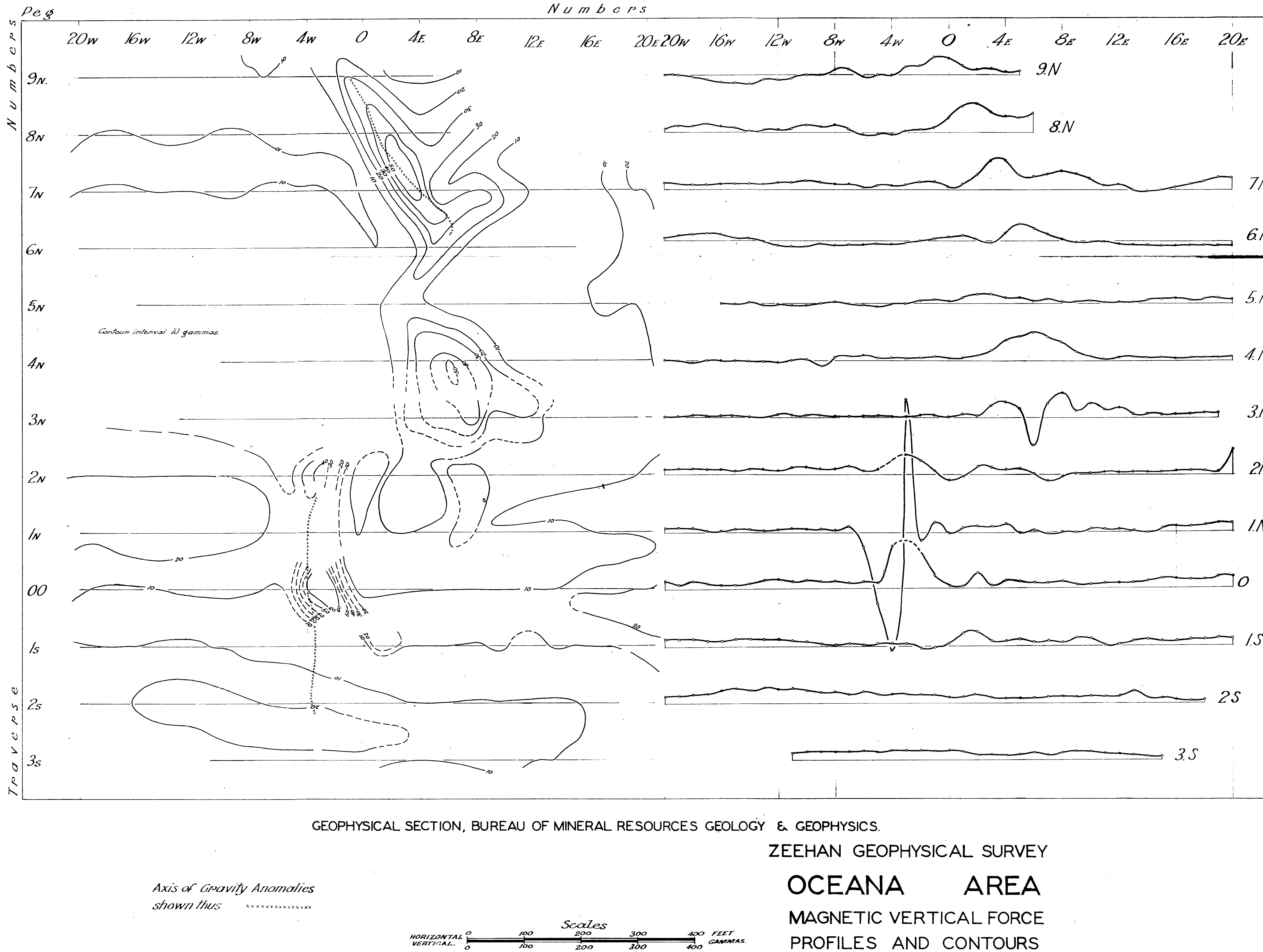
SECTIONS SHOWING

DIAMOND DRILLING RESULTS OF ANOMALY CENTRES 1, 2 & 3 IN RELATION TO MEASURED GRAVITY PROFILES.

TO ACCOMPANY RECORD No. 1966/163

K55/B7-133

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



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ZEEHAN GEOPHYSICAL SURVEY

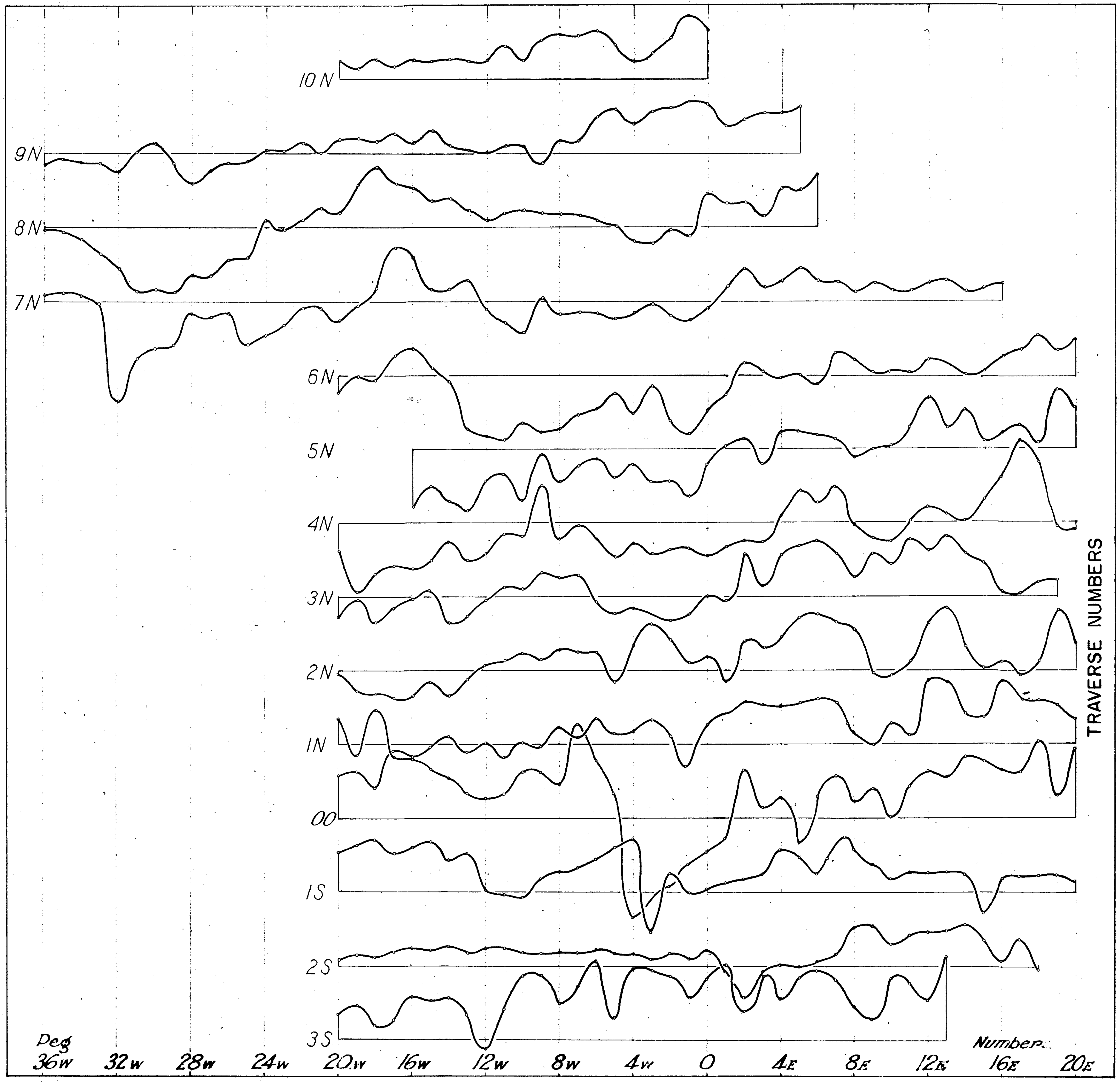
OCEANA AREA

MAGNETIC VERTICAL FORCE PROFILES AND CONTOURS

TO ACCOMPANY RECORD No 1966/163

K55/B7-134

PLATE 6



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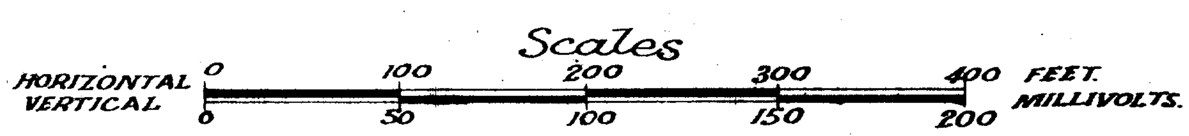
ZEEHAN GEOPHYSICAL SURVEY

OCEANA AREA

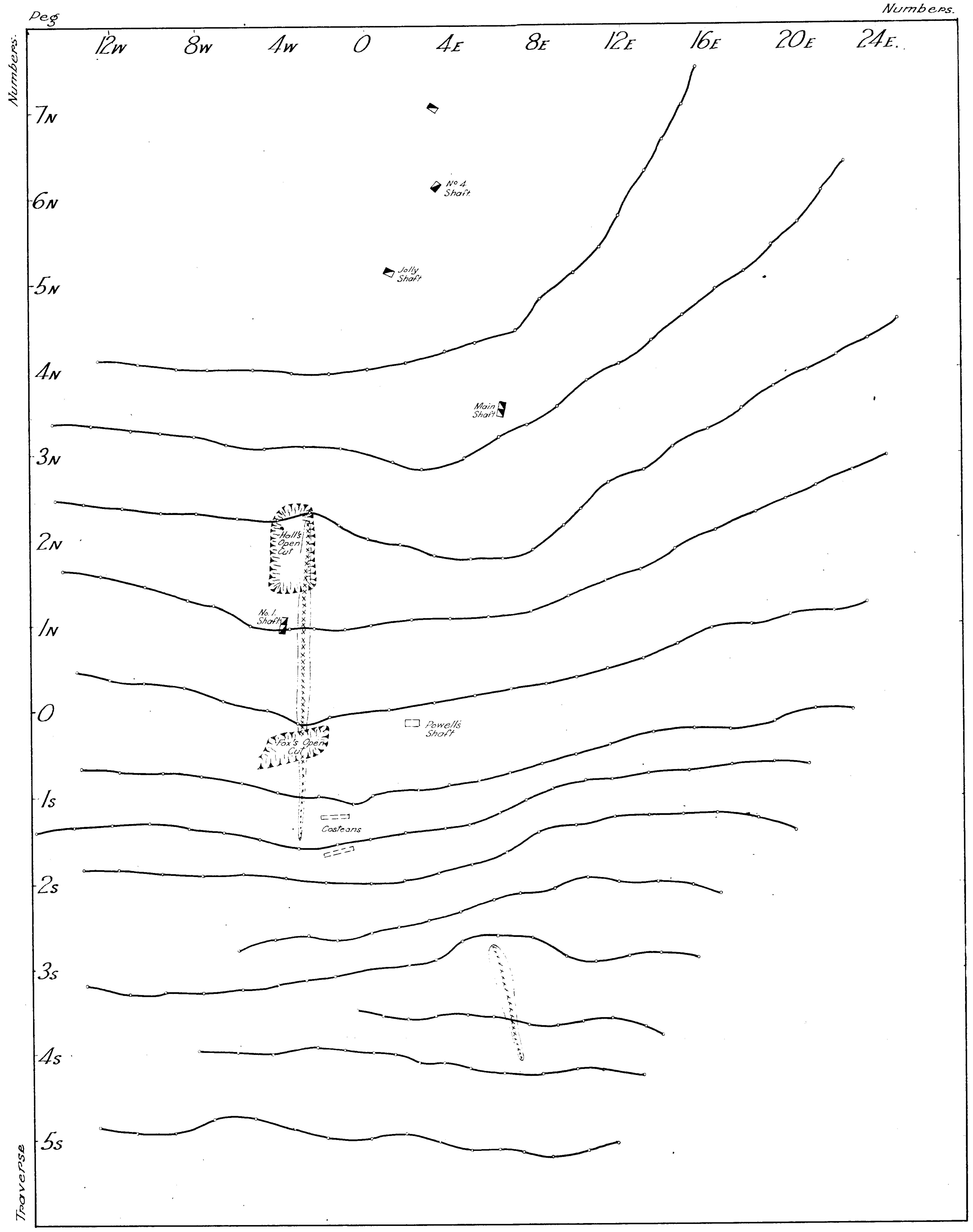
SELF POTENTIAL PROFILES



TO ACCOMPANY RECORD No. 1966/163

K55/B7-135

BINDING MARGIN



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ZEEHAN GEOPHYSICAL SURVEY

OCEANA AREA

RESULTS OF A.C. EQUIPOTENTIAL LINE SURVEY

LEGEND

Equipotential Lines
Conductive Zones
Electrodes at:-
15N/16W and 20S/16W

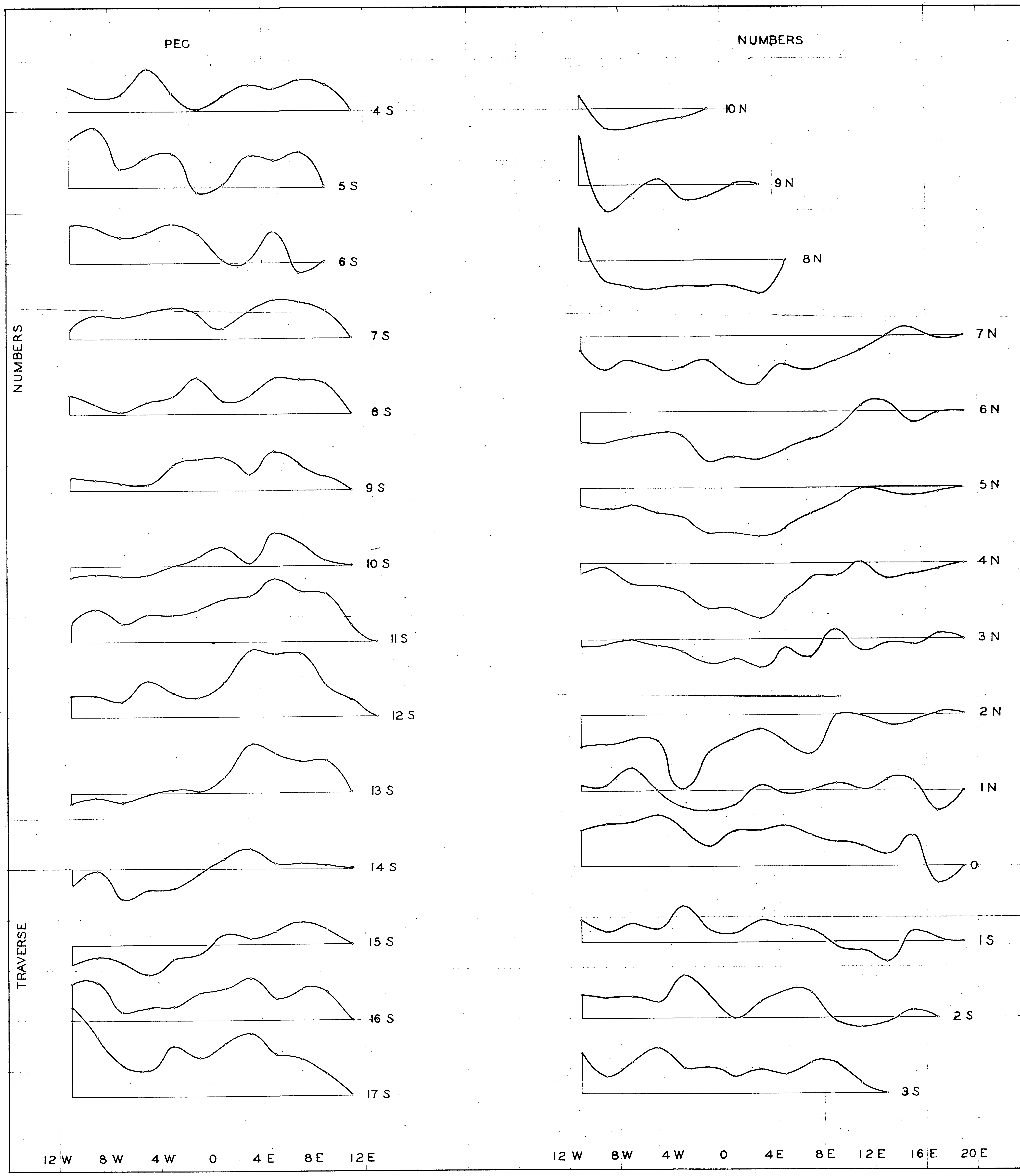
SCALE
0 100 200
FEET

TO ACCOMPANY RECORD No. 1966/163

K55/B7-136

PLATE 7

PLATE 8



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ZEEHAN GEOPHYSICAL SURVEY

OCEANA AREA

RELATIVE POTENTIAL GRADIENT PROFILES (LOGARITHMS), FOR 50FT ELECTRODE INTERVALS.

Gradient at Most Easterly Interval on each Traverse Assumed to be Unity.

Scales

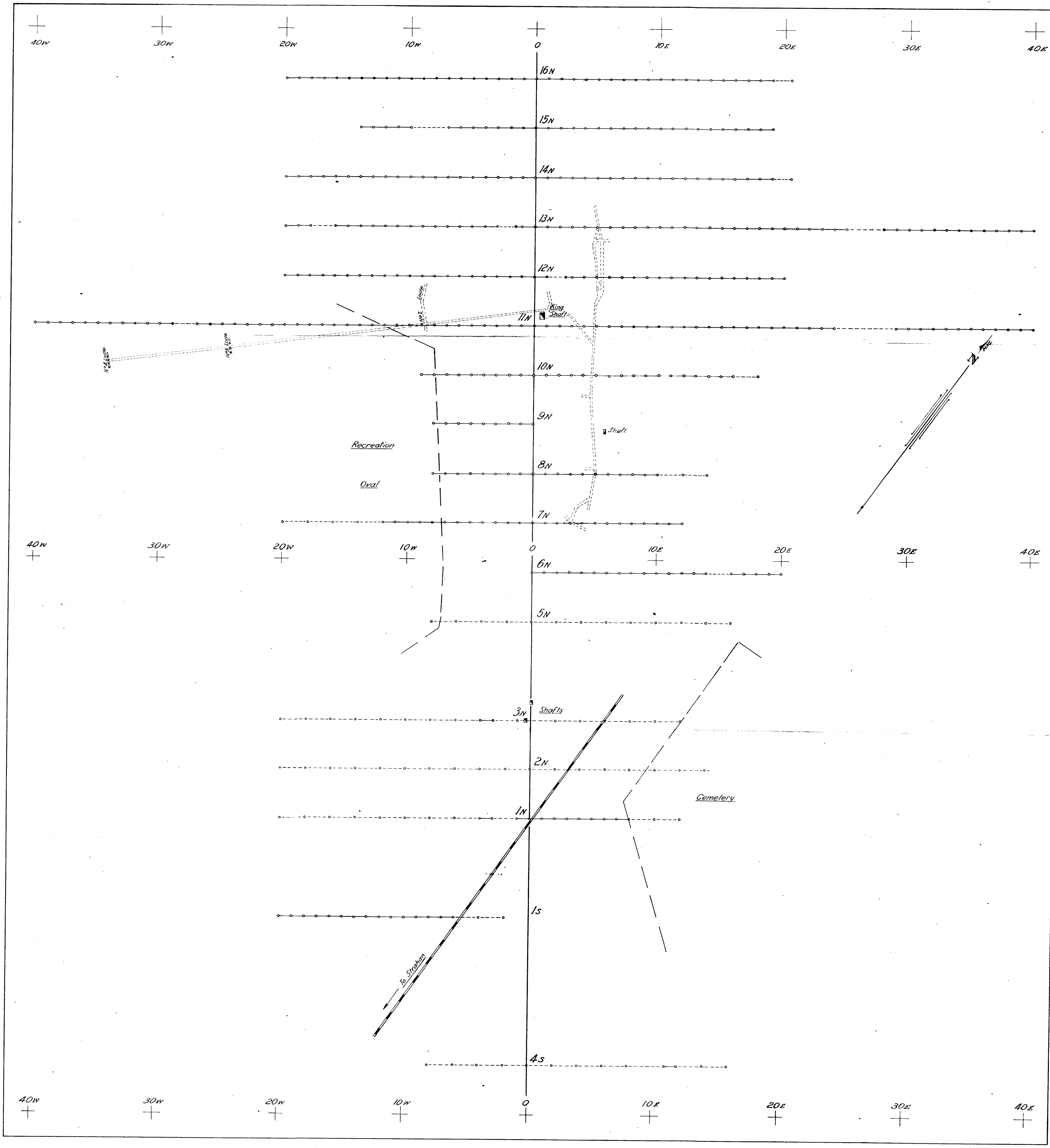
HORIZONTAL 0 100 200 300 400 FEET

VERTICAL 0 ·5 1 1·5 2 LOG UNITS

TO ACCOMPANY RECORD No. 1966/163

K55/B7-137

PLATE 9



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ZEEHAN GEOPHYSICAL SURVEY

SILVER KING AREA

Scale:

0 100 200 300 400 FEET

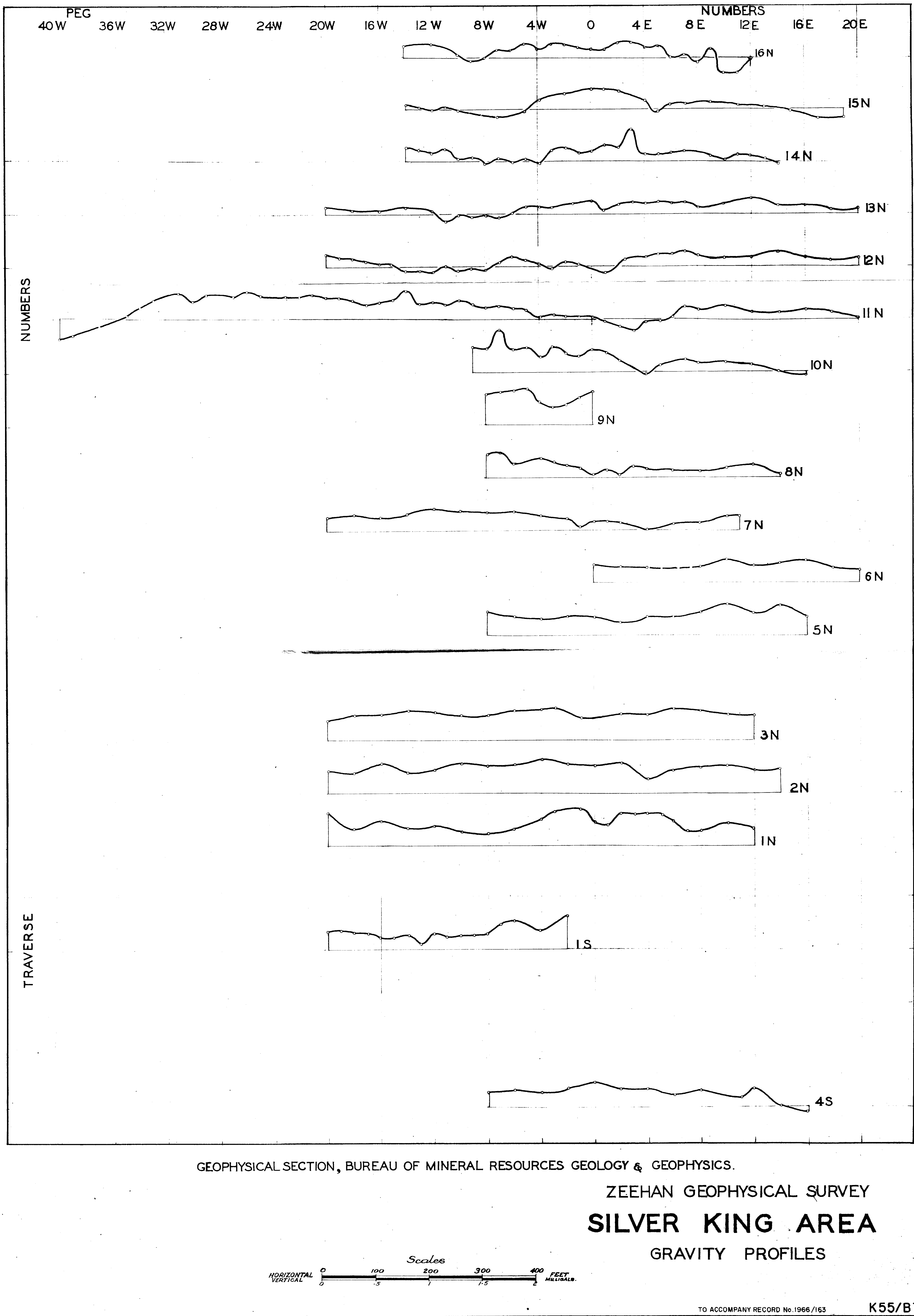
0 1 2 3

Position of No. 1 (105') level shown thus

LOCATION OF TRAVERSES

TO ACCOMPANY RECORD No. 1966/163

K55/B7-138



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ZEEHAN GEOPHYSICAL SURVEY

SILVER KING AREA

GRAVITY PROFILES

TO ACCOMPANY RECORD No. 1966/163

K55/B7-139

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Scales

HORIZONTAL 0 100 200 300 400 500 600 FEET.
VERTICAL 0 100 200 300 400 500 600 GAMMAS

ZEEHAN GEOPHYSICAL SURVEY

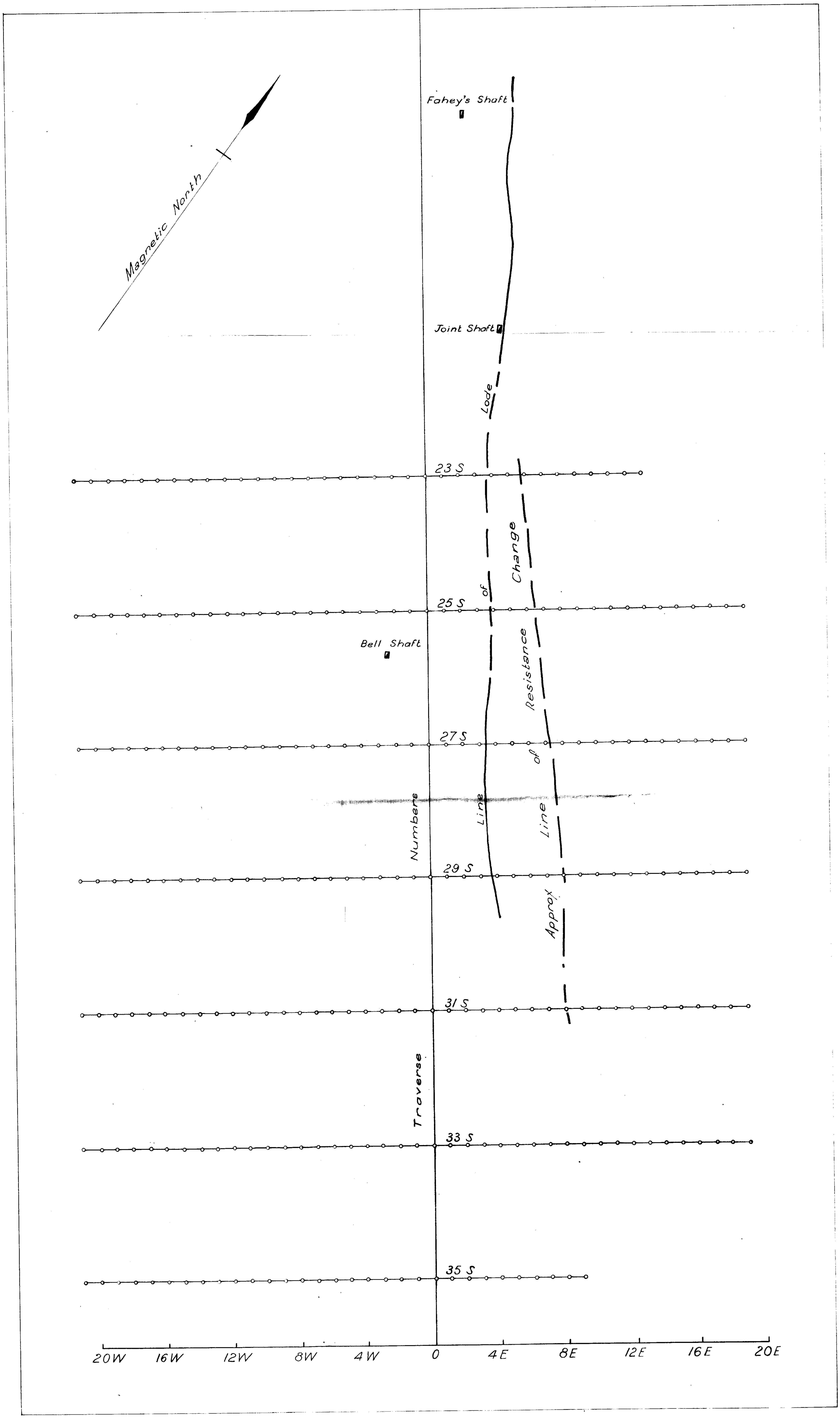
SILVER KING AREA

MAGNETIC VERTICAL FORCE PROFILES AND SELF - POTENTIAL PROFILES

TO ACCOMPANY RECORD No. 1966/163

K55/B7-140

PLATE 12



GEOPHYSICAL SURVEY AT ZEEHAN, TAS.

SILVER BELL AREA

LOCATION OF TRAVERSES

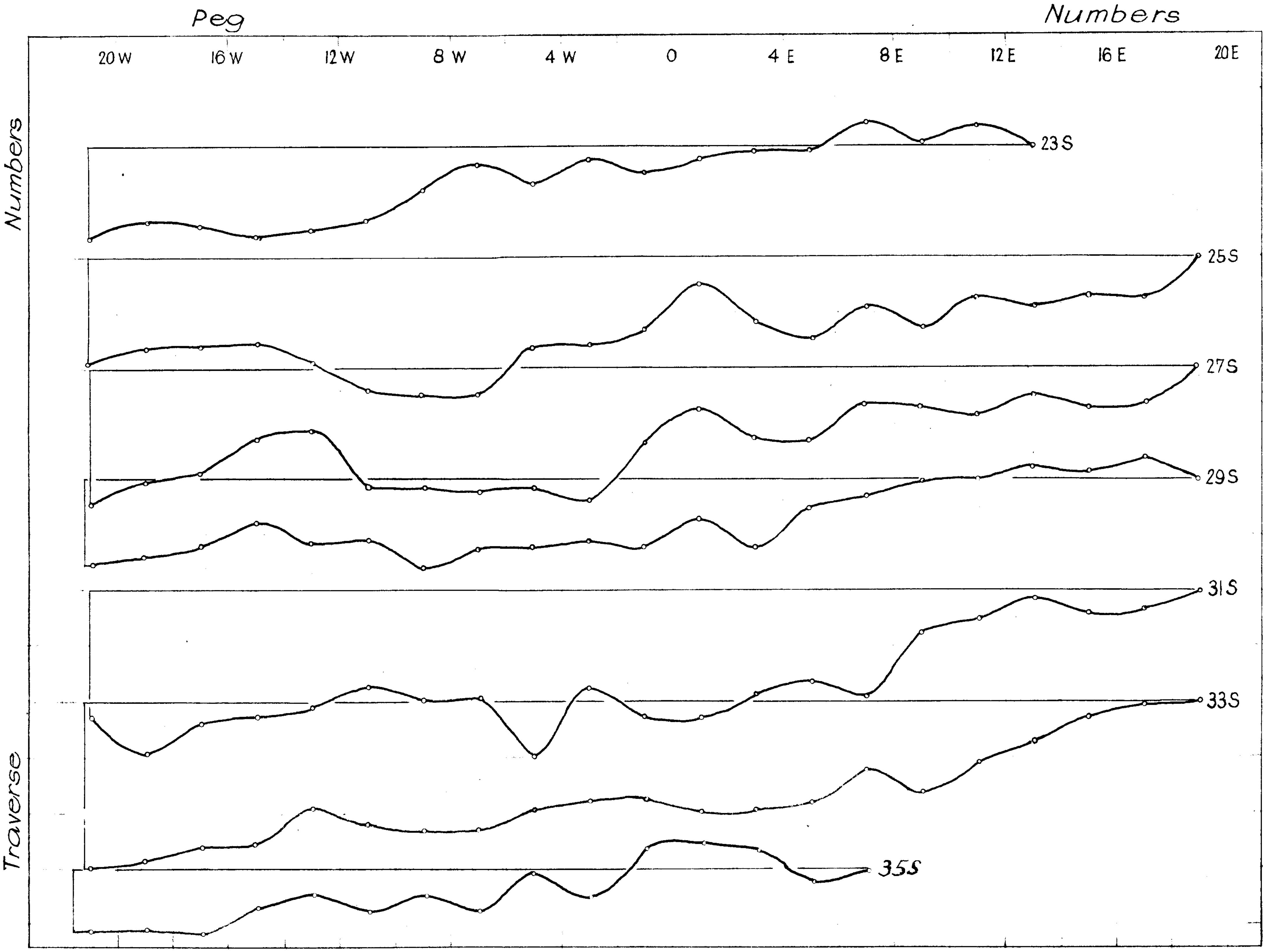
AND MINE WORKINGS

Scale in Feet
400 0 400 800

TO ACCOMPANY RECORD No. 1966/163

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. K55/B7-141

PLATE 13



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Gradient at most Easterly Interval on each traverse assumed to be unity.

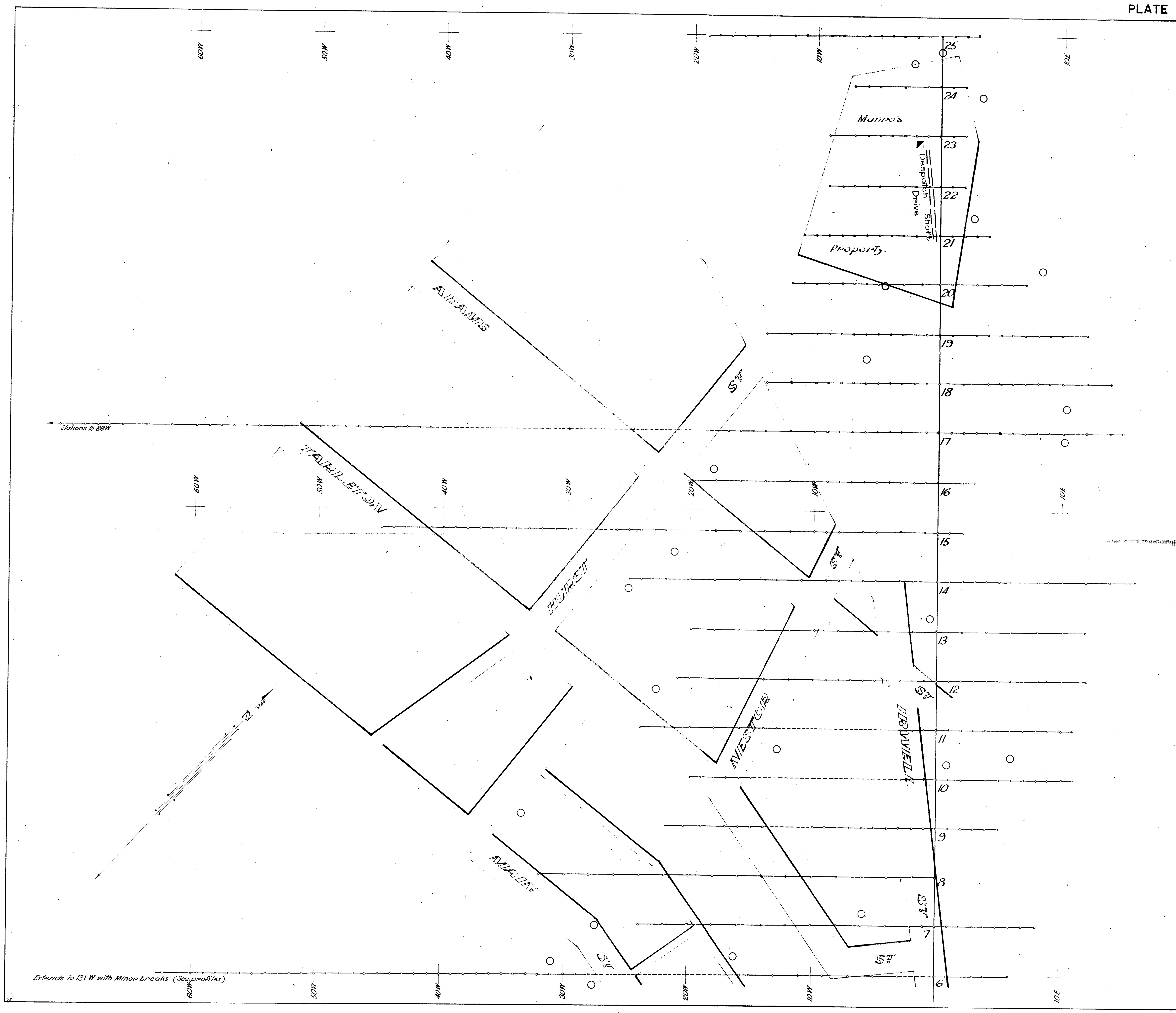
ZEEHAN GEOPHYSICAL SURVEY

SILVER BELL AREA

RELATIVE POTENTIAL GRADIENT PROFILES (LOGARITHMS) FOR 50 FT ELECTRODE INTERVAL

TO ACCOMPANY RECORD No. 1966/163

K55/B7-142



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ZEEHAN GEOPHYSICAL SURVEY

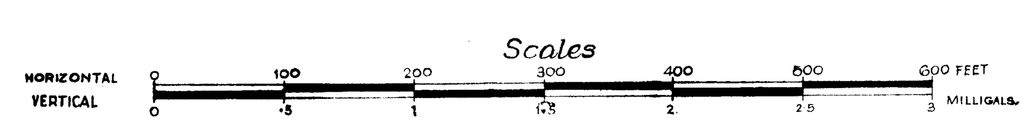
TOWN LIMESTONE AREA

LOCATION OF TRAVERSES

Position of mineralisation traces & occurrences shown thus:- ○

Scale
0 100 200 300 400 FEET.

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES GEOLOGY & GEOPHYSICS.



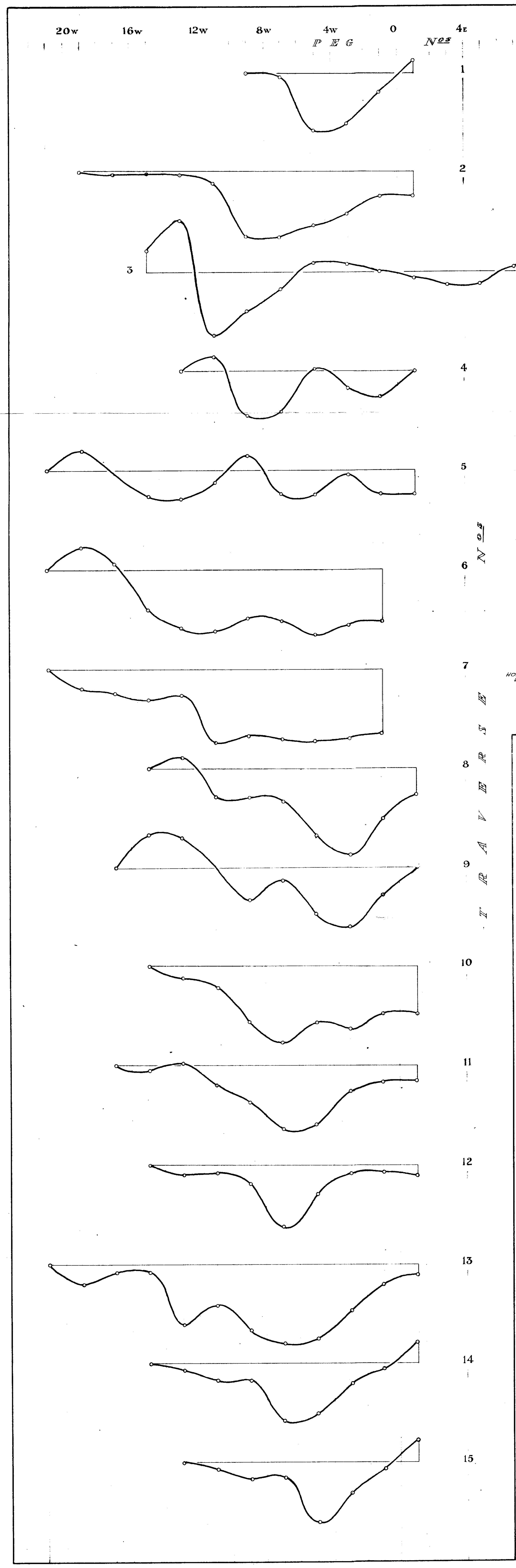
ZEEHAN GEOPHYSICAL SURVEY

TOWN LIMESTONE AREA.

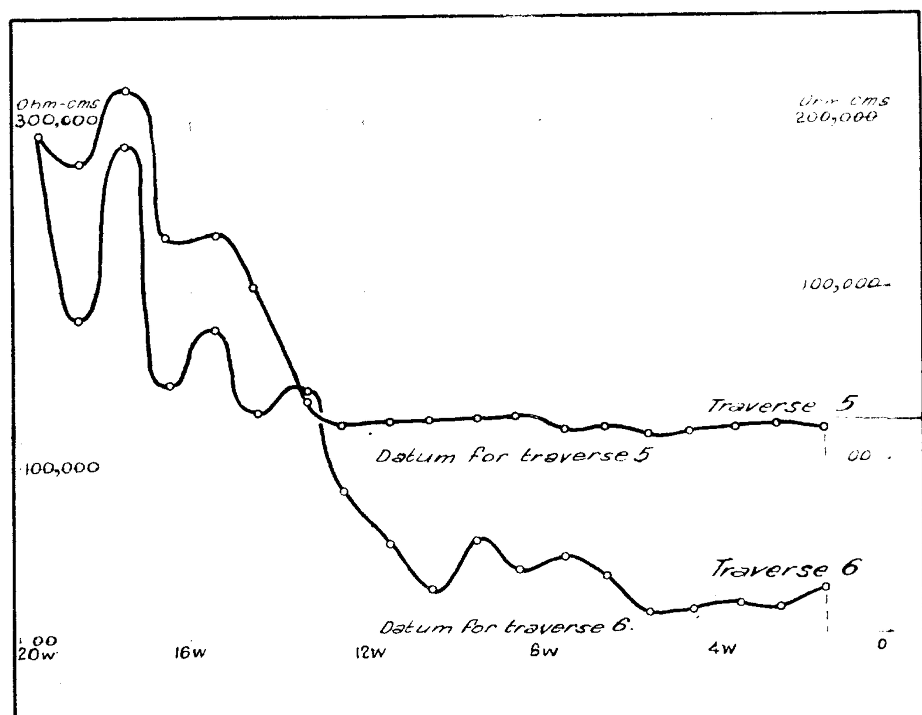
GRAVITY PROFILES

TO ACCOMPANY RECORD No. ~~1966/~~163

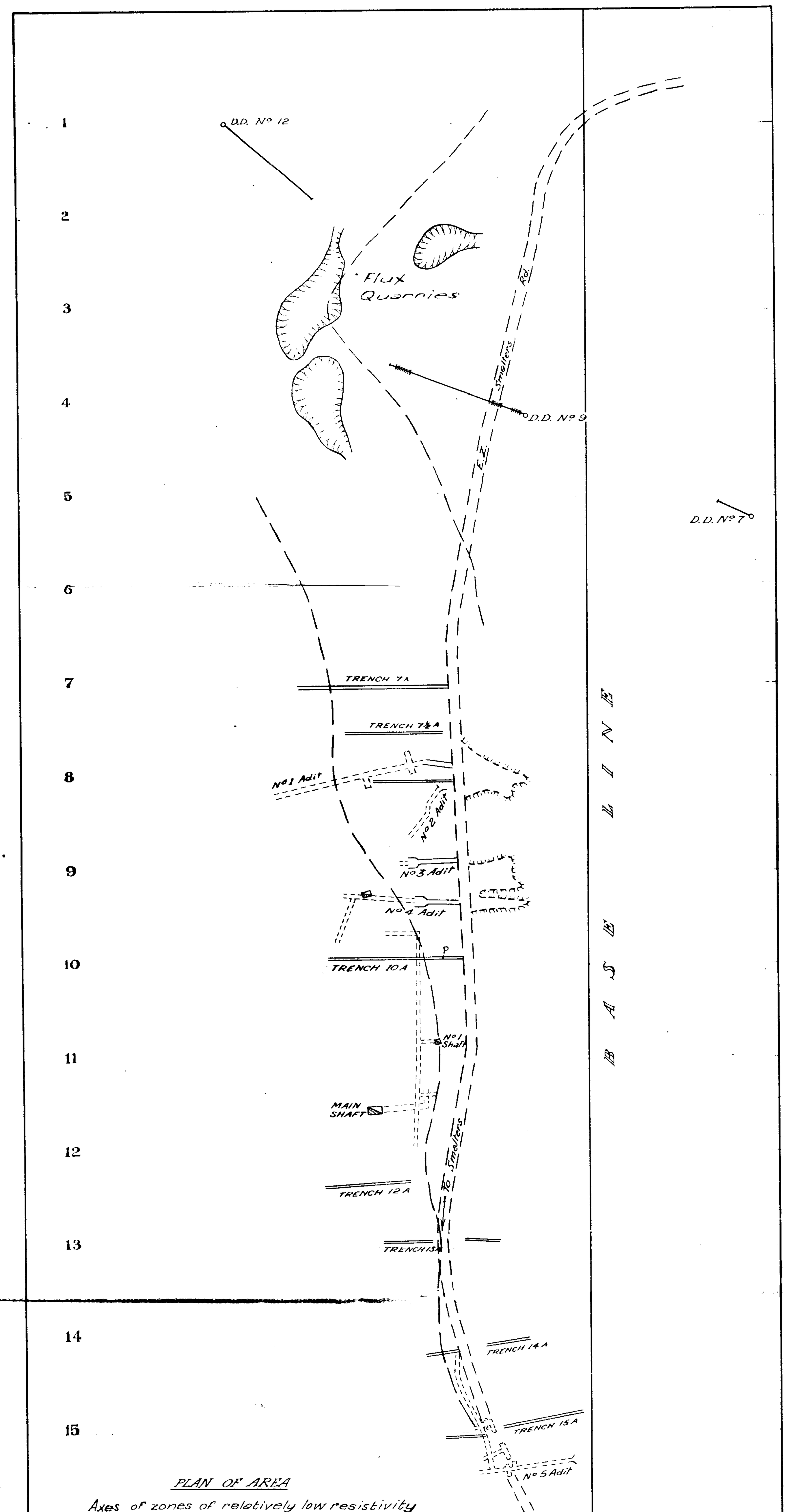
K55/B7-144



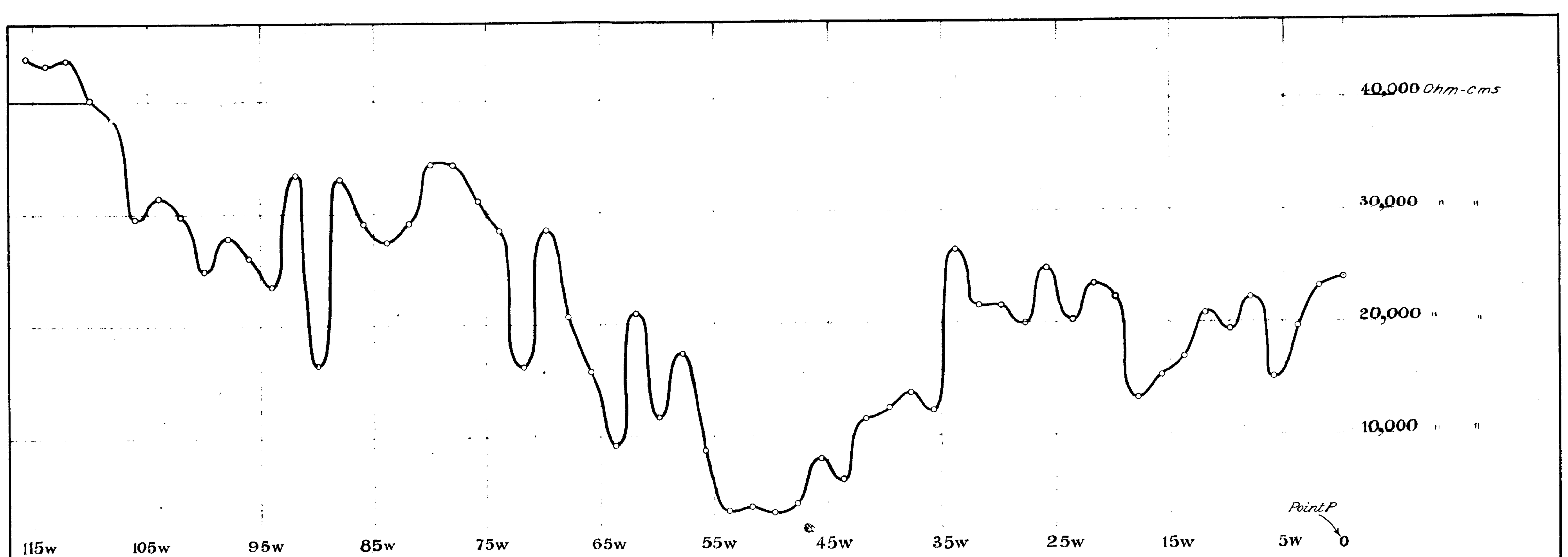
RELATIVE POTENTIAL GRADIENT PROFILES (LOGARITHMS)
(50 ft. Electrode separation used)
Gradient of most Westerly interval on each traverse (except 3) assumed to be unity.
Scale
HORIZONTAL 0 100 200 300 400 FEET
VERTICAL 0 ·5 1 1·5 2 LOG UNITS



RESISTIVITY TESTS
Using a Constant Electrode Separation of 25 ft.
HORIZONTAL SCALE
0 100 200 300 FEET



PLAN OF AREA
Axes of zones of relatively low resistivity as indicated by Potential Ratio method, Shown thus
0 100 200 300 Feet



RESISTIVITY TESTS
Along Trench 10A
Constant Electrode Separation of 2 ft.

HORIZONTAL SCALE
0 10 20 30 FEET

Note: Point P is 26 ft. W of E.Z. Road.

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ZEEHAN GEOPHYSICAL SURVEY

AUSTRAL AREA

LAYOUT PLAN, RESISTIVITY RESULTS AND
RELATIVE POTENTIAL GRADIENT PROFILES (LOGS.)

TO ACCOMPANY RECORD No. 1966/163 K55/B7-145