AIRBORNE MAGNETOMETER SURVEY

of

P. and N.G. PERMIT NO. 3152

NORTHWEST TERRITORIES

for

WESTERN DECALTA PETROLEUM LIMITED

CANADIAN AERO SERVICE LIMITED
OTTAWA, ONTARIO

INTRODUCTION

This report concerns an airborne magnetometer survey of P. and N.G. Permit No. 3152, in the Northwest Territories. The aircraft, a Piper Apache, was based at Fort Nelson, B.C. It arrived there on December 4, 1963. After waiting several days for irregular magnetic activity to subside, the survey was completed in two flights on December 9 and 10.

The survey consisted of 17 east-west traverses, one mile apart, and 3 north-south tie lines, six miles apart. All lines were flown at a constant barometric altitude of 1750 feet above sea level. This is about 1000 feet above the average ground elevation in the area. The lowest elevations, between 550 and 600 feet, occur along the Liard River, which flows across the Permit; the highest, over 1000 feet, are reached in the southeast corner of the survey, approaching a large range of hills.

The position of the aircraft was recorded by photographing the ground beneath it with a continuous strip 35mm camera. Fiducial marks were automatically put on all the records so that they could be keyed together.

The total intensity of the earth's magnetic field was continuously recorded by a Gulf Research and Development

Model III Airborne Magnetometer. This instrument has a core of high magnetic permeability, wound with two coils in series opposition, which are used to drive the core cyclically to saturation. If there is no external magnetic field, the output pulses from the two coils are of equal amplitude, but if there is an external field the output pulses do not balance. By means of a compensating coil, the output pulses are continuously balanced, and the current flowing through this compensating coil measures the earth's magnetic field. The measuring element of the magnetometer is automatically aligned in the direction of the earth's field by two similar elements mounted so that all three are mutually perpendicular. These two elements orient the platform by setting themselves to give a zero reading through servo-mechanisms.

A Gulf Research and Development Magnetic Storm Monitor was operated at the base in Fort Nelson to record the fluctuations of the earth's magnetic field. No disturbances large enough to require reflights were observed while the aircraft was surveying. The terrain clearance of the aircraft was continuously recorded with an APN-1 radio altimeter.

COMPILATION PROCEDURES

The flight path of the aircraft was recovered by identifying points on the strip film with corresponding points on the RCAF air photographs of the area (scale roughly 3200 feet to one inch). A one inch to one mile base map was made by photographic enlargement of the published 1:250,000 topographic maps (Sheets 95B and 95G). The points identified were transferred from the photographs to the base map by projector. These points are marked by small circles along the flight lines on the final maps. All the intersections between traverses and tie lines, save those over water, were exactly located by crossing the pairs of 35mm films. These intersections were plotted on the magnetometer records. The measured differences of the magnetic level between these points were analysed and adjusted so that base lines could be established, including a regional correction to remove the effect of the main magnetic field of the earth. This regional correction is an average figure obtained from published maps and tables. Finally, the records were transcribed onto the map locating contour intersections, maxima, minima and other critical points, and the map was contoured with an interval of five gammas.

GEOLOGY

Information on the geology of the area has been obtained from two papers published by the Geological Survey of Canada:

45-22 : Geological reconnaissance along the Lower Liard River by C.O. Hage

59-6 : Fort Liard and La Biche map areas by R.J.W. Douglas and D. K. Norris.

The following brief discussion is intended to show the geologic setting for the geophysical interpretation:

The survey area is at the western edge of the Interior Plains. Exposed bedrock has been mapped as Lower Cretaceous in most of the area, and Devonian along the Liard River in the northeast corner. However, the exposures are limited, for the Liard has a broad flood plain.

The Cordilleran mountain ranges lie close to the area. Indeed the Nahanni Range comes within 8 miles of the western boundary. This range runs south to the Liard River, where it turns to the southwest, and the mountains decrease in size. The Nahanni thrust fault probably persists to the south, beneath the plains, but the mountains lie further west, forming the Liard Range. Thus the Nahanni and Liard Ranges both run north-south, but are arranged en echelon.

Douglas and Norris interpret the bedrock exposures in the neighbourhood of the Permit as suggesting the western flank of a broad basin. A sedimentary section many thousands of feet thick could be expected. However, Hage found a silicified zone containing quartz veins on the Liard River very near the northern boundary of the area. The zone is 58 feet wide and strikes S 20° E. Also we understand that the Shell Liard River No. 1 well was abandoned after penetrating igneous or metamorphic rock at a total depth of 2237 feet. It seems possible that there may be shallow igneous rocks within the survey area, far above the true Precambrian basement surface.

INTERPRETATION THEORY

The magnetic field of the earth is roughly that of a dipole with its axis along the line joining the north and south magnetic poles. This field, acting on magnetic minerals in the crust of the earth induces a secondary field which reflects the distribution of these minerals. The primary field varies slowly from one place to another, but the secondary field varies much more rapidly, since any magnetic field is an inverse function of the distance from the magnetic sources. The airborne magnetometer records these variations in the total magnetic field along continuous profiles. The regional correction removes the greater part of the primary field of the earth, so that the local variations of the secondary field are emphasized.

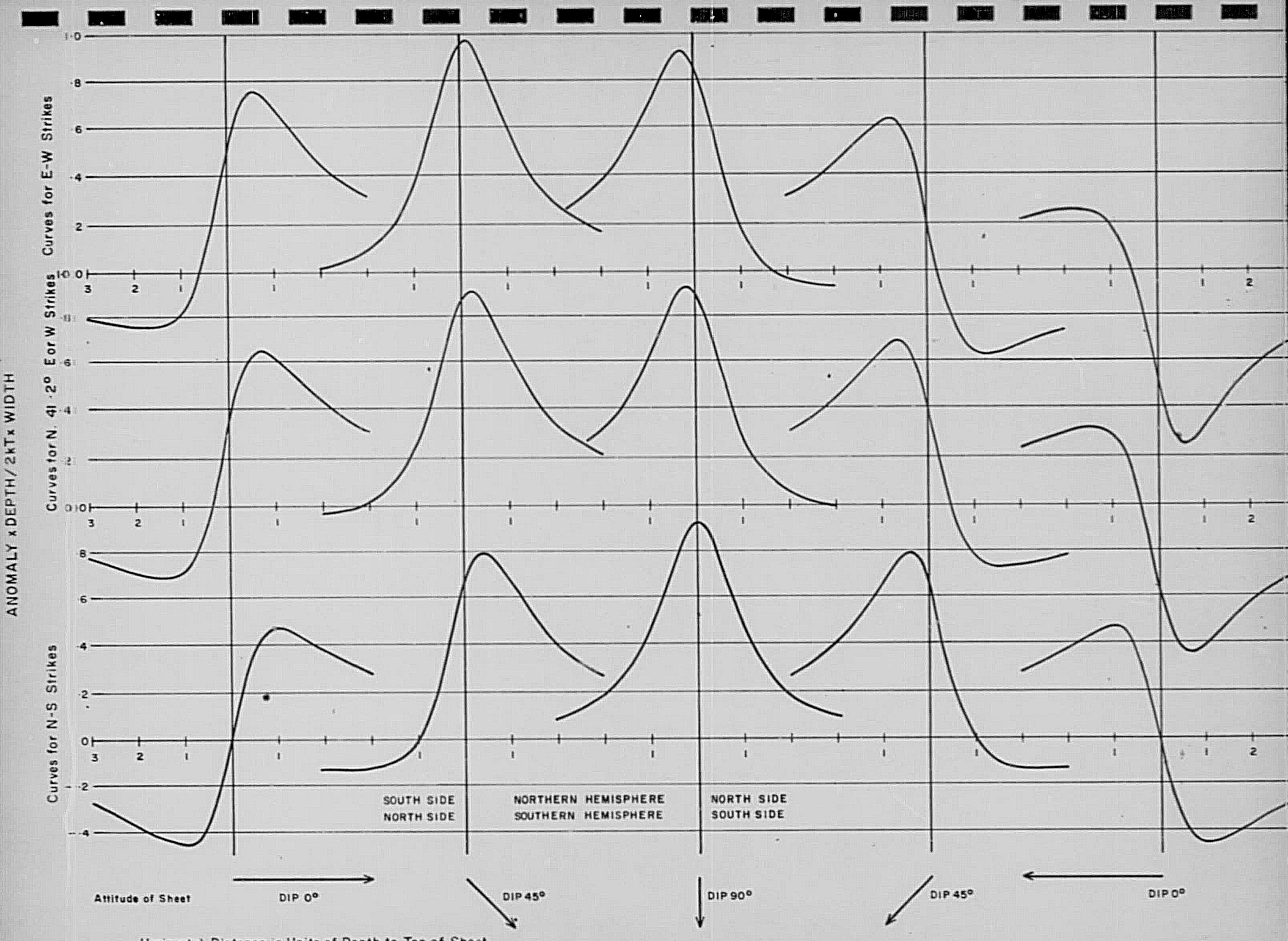
The study of magnetic anomalies and the rocks which cause them shows that the main cause of the anomalies is the varying magnetite content of the rocks. Magnetite is found as an accessory mineral in igneous and metamorphic rocks. Sediments, with the exception of iron formations, are relatively non-magnetic. In addition to this induced magnetic field, the rocks may have acquired remanent magnetism; in other words, they may act as permanent magnets. The two are not necessarily in the same direction, nor of equivalent intensities. An increasing degree of attention is now being devoted to permanent magnetism, particularly in dealing with volcanic and intrusive rocks where it may be strong, and in a direction markedly different from the present magnetic field of the earth.

The magnetometer profiles will normally reflect changes arising from the basement rocks or igneous material above the basement. These rocks will cause anomalies, the strength of which depends on the distance between the rocks and the point of observation, the size and shape of the rock mass, and the magnetite content of the rock.

A diagram has been drawn up to illustrate the way in which the anomaly of the same body in this region will vary as its dip and strike change. This particular body is the thin sheet, of infinite strike length, extending to great depths, and magnetized by induction.

Suitable magnetic features can be used to calculate the depth to the top of the rocks causing them. These depth calculations can be made in different ways. In this interpretation two methods have been used. One is a detailed analysis developed by H.A. Ackerman and the author. (Ackerman and Reford: A method of magnetic interpretation: SEG meeting, Calgary, 1962) The second is based on the work of Vacquier, Steenland, Henderson and Zietz (Geological Society of America Memoir 47, 1951) using uniform slopes on the flanks of magnetic features. Some remarks on the fundamental ideas and applications of these methods may be helpful.

The analytical method is based on the fact that magnetic anomalies caused by long, uniformly magnetized bodies



TOTAL FIELD MAGNETIC ANOMALIES CAUSED BY A THIN SHEET AT INCLINATION 75°

are made up of two components, one symmetrical about a centre point, and the other antisymmetrical. On the diagram of thin sheet anomalies the curve for N-S strike and 90° dip is symmetrical. For the same strike and zero dip, the curve is antisymmetrical. For 45° dip, the curves include both symmetrical and antisymmetrical components.

The profile across a suitable anomaly can be separated into the two components by a folding process. If the folding centre has been correctly chosen, it may be possible to interpret both components to give the location, depth and width of the body. This is done by fitting the component curves to the shapes of theoretical models. The thin sheet is the simplest to use, but by using the horizontal derivative instead of the total intensity, the interface is equally easy to interpret. An interface is defined as a body of rock bounded on top by a horizontal plane surface, and on one side by another surface dipping at any desired angle. Once the location and shape of the model have been interpreted, dip and susceptibility contrast can be calculated assuming that the body is magnetized by induction. The closeness of fit between the model and field curves gives a measure of the expected reliability of the interpretation. Any number of points may be used, and in some cases the complete anomaly curve may be computed from the model to see how closely it matches the original curve.

The weakness of the analytical method is that it may be impossible to match the field curve with a simple theoretical model. Closely spaced, interfering anomalies can be most difficult, and so too are bodies of finite length, width and thickness. However, these weaknesses apply to all current methods of magnetic interpretation. The virtues of this analytical method are balanced by the time required for its application, which can become prohibitive.

Measurement of the horizontal lengths of the uniform gradients along anomaly flanks provides a quick and invaluable complement to the analytical method. It is impossible to predict these lengths on a theoretical basis, but factors to transform them into depths can be found empirically, using basement depths that are known or interpreted by other methods. In the G.S.A. Memoir the straight slope lengths have been measured on anomalies computed from theoretical models.

The danger of the straight slope method is to apply it to anomalies caused by bodies very different from the theoretical models. However, experience has shown that it can be applied in a variety of conditions provided that no great reliance is placed on a single depth figure. Essentially, some sort of averaging process is required. The simplest and most direct is to follow a band of uniform gradient along the flank of a magnetic anomaly, determining its position from one profile after another. If the band has a consistent width, this may be used to estimate the depth to the body causing it. But, before this can be done, the widths of all the neighbouring bands must also be reviewed. Only if the whole group of widths give consistent results can reliable estimates be made. The analytical method is preferable, but it is laborious. The time required for a solution of complex anomalies is so great that it can be used only in selected cases. A combination of the two methods gives the advantages of the speed of one and the accuracy of the other.

Depths determined from magnetic data are not exact figures. It should not be inferred that the body causing a given anomaly has been found as a unique solution, even when observed and computed anomalies have been matched exactly. This is perhaps the simplest solution, but in actual fact an infinite number of other solutions could have the same magnetic effect. These are unlikely to lie much deeper, but could easily be shallower than the simple dyke. Therefore, depth estimates made from magnetic data are often called maximum depths.

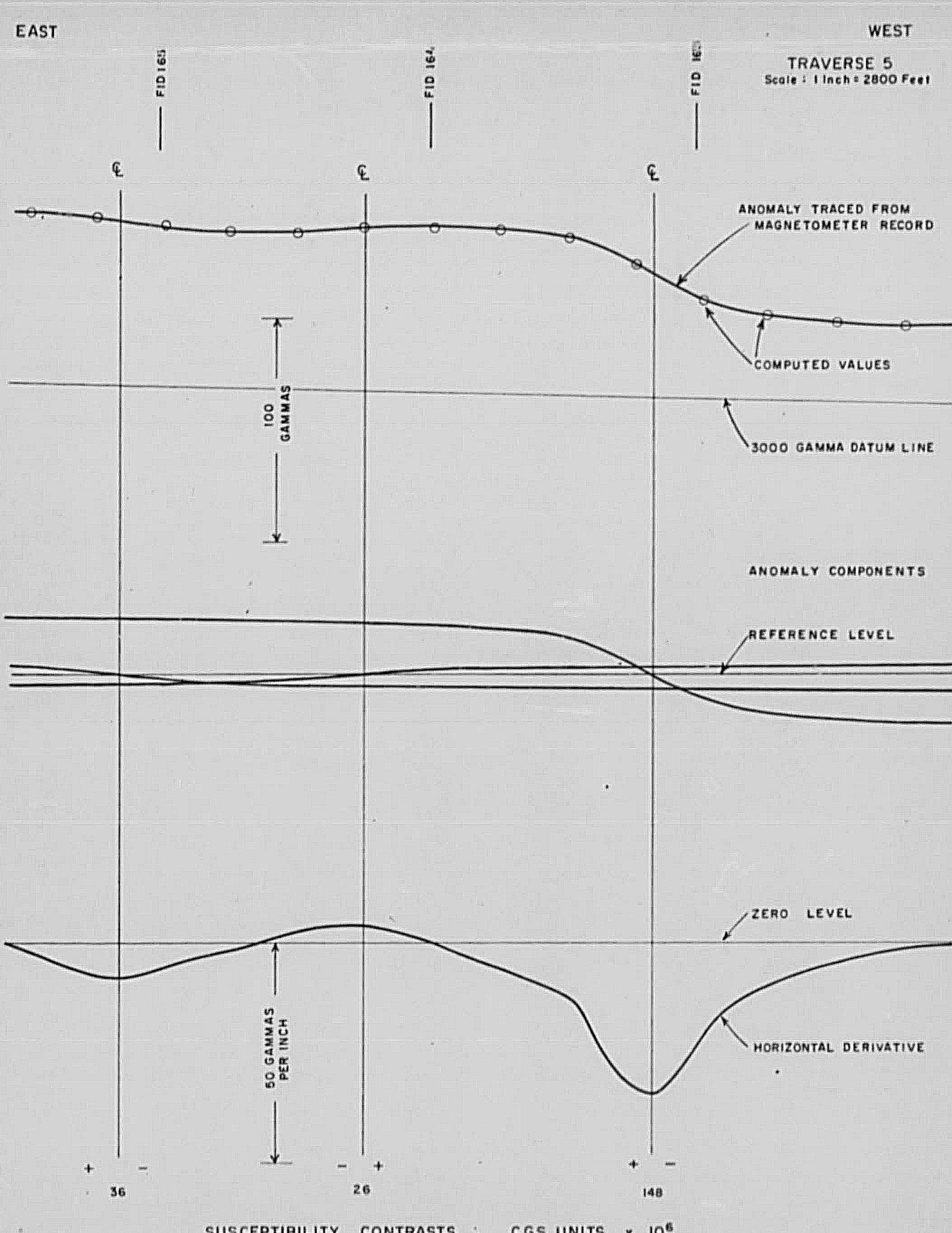
These anomalies caused by changes in composition of the underlying rocks may have amplitudes of 1000 gammas or more. Another type of anomaly, sometimes called a supra-basement feature, may be caused by structural relief on the basement surface. Such anomalies rarely exceed 50 gammas in size, and are usually much smaller.

These two types of feature may form various combinations. For instance, the magnetic effect of structural relief across a fault can be obscured by the larger anomaly caused by a change in rock type across the fault.

INTERPRETATION BACKGROUND

The interpretation given here is based on a detailed review of the magnetometer records and map. All possible uniform gradients have been measured, located on a manuscript, and correlated from line to line. These gradients have been used to locate the flanks of magnetic anomalies, and outline their shapes. Some regularly shaped anomalies were selected for analysis, using graphical horizontal derivatives of the magnetometer records. The resulting depths are shown on the map, and consistently suggested that the straight slope lengths should be multiplied by a factor of 1.3 to transform them into depths. The depth contours shown on the map make use of both analytical and straight slope depth estimates.

Good analytical results were obtained from the eastern end of traverse 5. They are shown on the diagram on page 14, to illustrate the method and a critical limitation. The upper curve is traced from the magnetometer record. From this, the horizontal derivative or gradient was graphically constructed, and is shown at the bottom of the figure. The large derivative minimum fitted well with a symmetrical interface function at the centre line shown, with a depth of 1400 feet below flight level. The weaker maximum and minimum to the left also fitted symmetrical interface functions at the same depth. To check the interpretation, the parameters of these interface functions were used to calculate the total intensity components of each of the three interfaces. These anomaly components are shown in the centre of the sheet.



ANALYSIS YIELDS THREE VERTICAL INTERFACES AT DEPTH 1400 FEET AT ℄S.

ANOMALY ANALYSIS AND RECONSTRUCTION

When the components were added together, with an appropriate shift of the datum level, the computed values were obtained. These fit the original profile within one gamma, an excellent result.

Assuming that the magnetism is all induced, the parameters of the interface functions were used to calculate the dips of the bodies. In this case, all were near the vertical. Then the susceptibility contrasts across the interfaces were calculated. These are shown at the bottom of the figure.

Two qualifications of the results must be noted. The right hand anomaly is quite strong and distinct, so its interpretation should be reasonably exact. The other features are weak and poorly separated from their neighbours. Their parameters, particularly the depths, could be altered by as much as 50% with little change in the anomaly shapes. The depths of these weak features are not reliable, and have been guided more by the depth of the stronger anomaly than anything else.

The second qualification is that this east end of Traverse 5 was not flown in the correct location. It was chosen for analysis because it crosses fewer anomalies than its neighbours, and so is easier to analyse. Also this end was flown reasonably straight, and the bend in the line occurs over an area where the magnetic field is nearly flat. The results should not be affected by the bend.

INTERPRETATION

The complex nature of the magnetic field in this area reflects complexity of geology. We believe that three different sources of magnetic material are represented: Precambrian basement rocks, younger intrusives or volcanics, and small, surficial bodies of magnetic material.

The anomalies interpreted as reflecting intrusives are the most obvious and will be discussed first. The prime examples are anomalies 1, 2, 3, and 4, which form a group across the centre of the area. They are linear features with strikes ranging from north to northeast. Their amplitudes are moderate, all exceeding 20 gammas, with the greatest relief, about 50 gammas, at the north end of anomaly 1. Analysis of these anomalies gave the following results:

Anomaly	Traverse	Side	Depth feet below flight level	Dip	Susceptibility Contrast cgs units x 10^6
1	5	West	1400	90°	148
1	5	East	1400	90°	26
2	7	West	2200	75°W	242
2	7	East	2200	55°E	186
4	13	Both	3600	60°E	106

Neither the dips nor the susceptibilities are very certain figures. However, we believe that the consistently low values for the susceptibilities indicate that the anomalies reflect similar types of rock, probably acidic intrusives. The increased relief at the north end of anomaly 1, about 50 gammas, probably reflects a local segregation within the body. Anomalies 2, 3, and 4 could be joined together into a single, broad feature, and it seems likely that their sources join together at depth. The strikes of all four anomalies suggest a structural relationship with the Nahanni fault system.

Depth contours have been drawn across these features, suggesting a surface dipping to the southwest. This represents the top of the intrusives, not the Precambrian surface. The contours have not been extended across the whole map because depths on either side of this zone are uncertain. The other magnetic features are generally too weak to yield reliable depth estimates, although they suggest a surface at depths roughly corresponding to that shown by the contours.

Anomalies 5 and 6 are linear, narrow features, probably reflecting thin sheets of intrusive material rising to about 200 feet below sea level. Anomaly 7 is similar, but shorter and weaker. 5 and 6 may be connected with anomaly 2 to the southwest, but obviously involve smaller volumes of rock. All three anomalies reach peak values on traverse 1, 12, 9 and 5 gammas respectively, and weaken to the southwest. The quartz vein discovered by Hage is close to these features, but he reported a very different strike, S 20° E.

Apart from these stronger features, the magnetic contours show many local irregularities, which are difficult to interpret, because they are so weak. The stronger anomalies amongst them, which could be traced across the map with some certainty, have been outlined. Weaker, or less certain features, are indicated by dashed lines, and some dubious features are marked by queries.

One of the problems in interpreting these anomalies is the presence of magnetic material near the surface of the ground. Effects of this material are obvious within the area outlined as anomaly 11 in the southeast corner of the survey.

Following the magnetometer record southwards along tie line 3 shows a succession of stronger and sharper features, averaging about 5 gammas relief. Similar anomalies occur on the eastern ends of traverses 15, 16, and 17. Their sharpness indicates a near surface origin, probably ferruginous sedimentary material. They are particularly common in this corner of the survey because here the aircraft flew closest to the ground. The question remains as to whether similar material may cause weak anomalies in the rest of the area. This possibility must be kept in mind when considering most of the anomalies discussed below.

Anomalies 8 and 9, in the northwest corner of the area, are poorly defined, with about 5 and 3 gammas relief respectively. They might reflect rises of the basement surface, but more probably, continuations of the intrusive interpreted from anomaly 4 to the south.

Anomaly 10 outlines some dubious expressions not exceeding 3 gammas.

Anomalies 12 and 13 are more interesting features. They mark irregular trends of about 3 gammas. Anomaly 13 does become stronger to the north, reaching a peak of perhaps 8 gammas on traverse 7. Both are quite sharp, suggesting sources no deeper than 1000 feet below sea level, and probably much shallower. The sources could be exposed at the surface in places. If we are correct in joining the individual expressions from line to line, the length of the features suggests bedrock rather than surficial sources. Their strikes correspond with Hage's quartz vein to the north. Might they be related to it? Anomaly 14 is similar but shorter.

Finally, a word must be said about the magnetic expression of the Precambrian basement rocks. We believe that they cause the broad magnetic features of the area, notably the flanks of the maximum appearing in the northwest corner and the minimum, dominating the southeast corner. The incomplete coverage of these features, together with the obscuring effects of the local anomalies superimposed on them, prevents reliable interpretation.

CONCLUSIONS

The principal result of this survey has been the detection of a group of anomalies, numbers 1 - 4, with quite shallow sources. They have been interpreted as reflecting acidic intrusive rocks. Alternatively, they could indicate metamorphism. It would be difficult to explain their presence without involving material rising from the Precambrian basement. The petroleum prospects of the Permit should be reviewed in this light.

The magnetic interpretation indicates that these bodies came close to the surface of the ground in the northeast corner of the Permit. There is a fair chance that their presence might be reflected by surface features, which could be checked by photo or surface geological studies.

M S Reford

M. S. Reford
Chief Geophysicist, P.Eng.

6 February 1964

APPENDIX : OPERATIONAL INFORMATION

AIRCRAFT :	Piper Apache CF-MTD			
PILOT :	H. Moore			
MAGNETOMETER OPERATOR :	M. Fouquet			
TRAVERSES FLOWN :	Number	17	Mileage	212
TIE LINES FLOWN :	Number	3	Mileage	48
TOTALS :		20		260

SURVEY DATES : Aircraft in Fort Nelson: December 4 - 10, 1963

PRODUCTIVE FLIGHTS : December 9 and 10, 1963

MAGNETOMETER :

- Sensitivity - 600 gammas full scale deflection
- Record Speed - 4 inches per minute
- Fiducial Interval - 25 seconds

AIRBORNE MAGNETOMETER SURVEY

P. & N.G. PERM. No. 3152

NORTHWEST TERRITORIES

WESTERN DECALTA PETROLEUM LTD.

SCALE: ONE INCH TO ONE MILE

19-6-4-19.

NORMAL VARIATION CORRECTION APPLIED

HORIZONTAL CONTROL ...... BASED ON ENLARGEMENT OF 1:250,000 TOPOGRAPHIC MAP, PUBLISHED BY THE DEPARTMENT OF MINES AND TECHNICAL SURVEYS, OTTAWA.

FLIGHT ALTITUDE	1750 FEET BAR
TRAVERSE INTERVAL	1 MILE
CONTROL LINE INTERVAL	6 MILES
CONTOUR INTERVAL	5 GAMMAS
BASE INTENSITY	ARBITRARY

INTERPRETATION LEGEND

-1900 DEPTH ESTIMATES AND CONTOURS (FEET BELOW SEA LEVEL)

3 MAGNETIC ANOMALIES

WEAK MAGNETIC ANOMALIES

? DUBIOUS FEATURES

CANADIAN AERO SERVICE LIMITED, OTTAWA, ONTARIO

FINAL SEISMIC REPORT

on

NAHANNI BUTTE AREA
NORTHWEST TERRITORIES

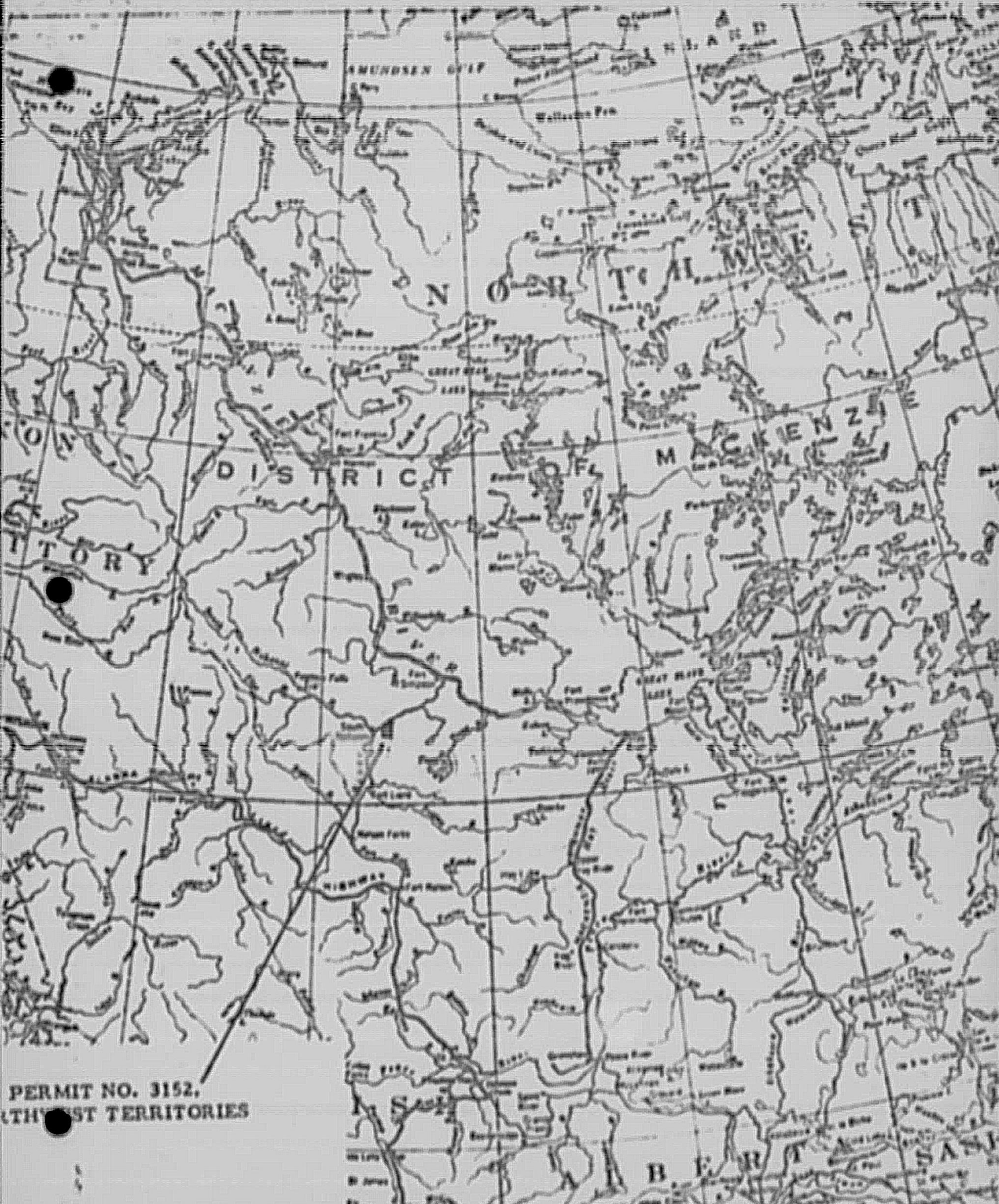
for

WESTERN DECALTA PETROLEUM LIMITED

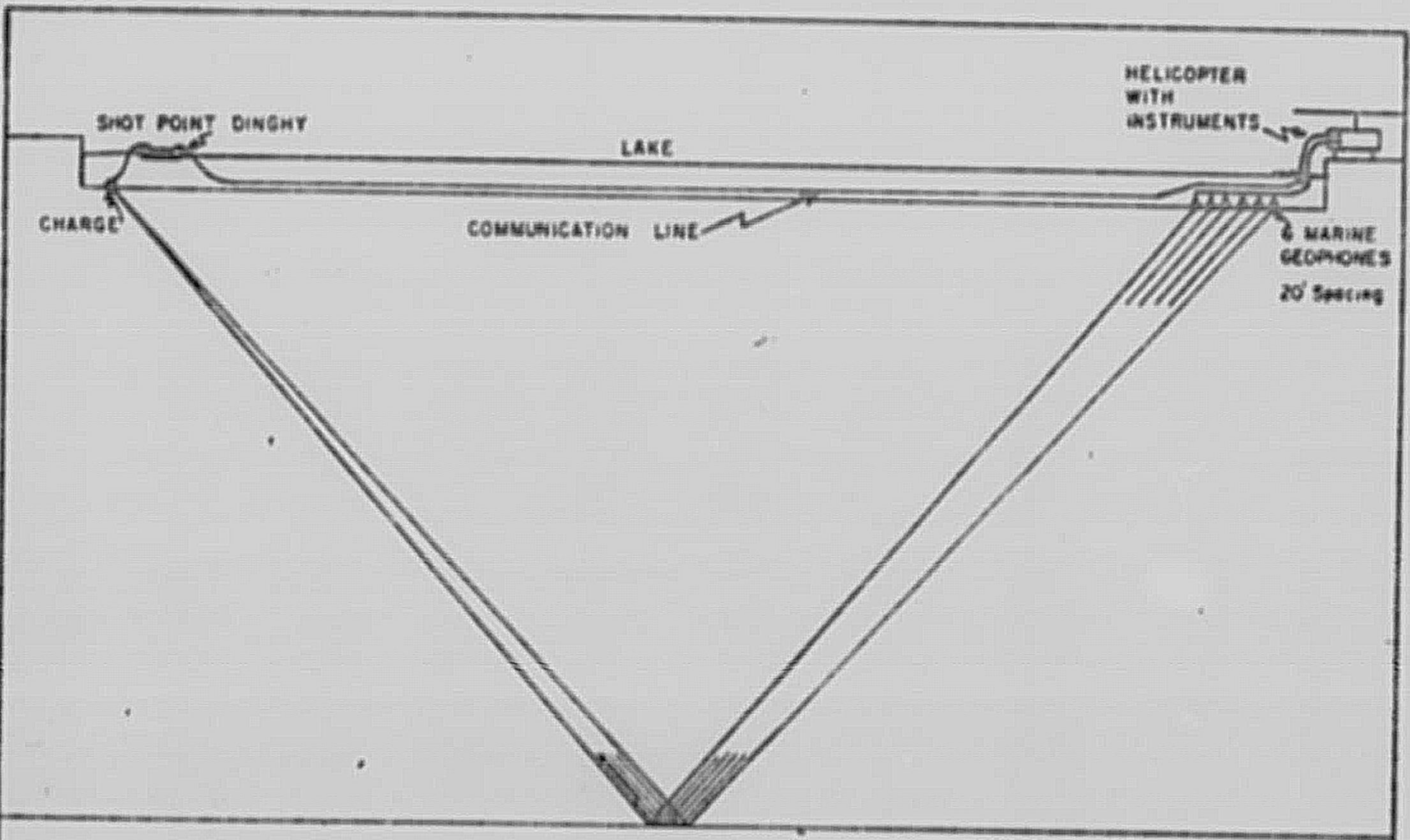
by

VELOCITY SURVEYS LIMITED
October, 1961.

Headquarters:	530A - 6th Avenue S. W., Calgary, Alberta.
Seismologist:	S. A. Mouritsen
Supervisors:	F. C. McConnell P. R. Grier



PERMIT NO. 3152.
RTHWEST TERRITORIES



SCHEMATIC DIAGRAM OF WATER SHOOTING

SEPT 1961

CONTENTS.

FINAL SEISMIC REPORT

NAHANNI BUTTE AREA
NORTHWEST TERRITORIES

PERMIT #3152

INTRODUCTION

This area lies about fourteen miles east of the first major mountain thrust of the Nahanni Range. Inland water shooting was carried out with S.I.E., P-11 portable amplifiers mounted in a "J" Helicopter, using six Electro-Tech. E.V.P.-5 hydrophones over 100 feet and a shot point offset of 1,500 feet.

The correlation shot points fall in sloughs and in the Liard and Blackstone rivers, to give limited control over the permit area.

COMPUTING

The records were obtained at various elevations and through varying near-surface conditions, therefore, a weathering correction was attempted.

We computed the average refraction velocity from the first arrival at the first geophone. The velocity of the refractor was determined from the actual first breaks. This latter velocity averaged 15,000 feet per second. From these velocities, we obtained the cosine and corrected to vertical for the weathering depth. This depth could be influenced by the structure trends in the area, since the spreads are one way only. This refractor was mapped in feet

To avoid air blast on the critical part of the records and to get good data, it is best to use a fairly long offset between the shot point and the spread. The distance used here, 1,500 feet, proved to be a little long owing to the shallowness of the section. A shallower event might be recorded by shortening the spread offset distance. The minimum distance useable is about 500 feet to avoid damage to the geophones.

INTERPRETATION

There are no wells or velocity surveys in the area, and the only geological information is from two wells which are off the area and which show a very steep apparent gradient between them.

The only good reflection in the prospect has been mapped with a minimum structure, since the character of the reflections varies greatly. If the apparent gradient between the wells is valid, then this reflection may be from near the Slave Point horizon. However, if faulting south of the prospect accounts for the steep dip, then this reflection likely originates from near the Precambrian. The lack of a good reflector below the one actually mapped suggests that the mapped reflection is near the Precambrian. This event is mapped in two-way time and is tentatively identified as 'Basement'.

No closures appear, but there is a strong nose in the central part of the permit, with general south-southwest dip. Owing to the lack of control, the interpretation must be qualified. More control is recommended to clarify the reflection identification problem.

CONCLUSIONS

The control was sufficient to partially solve the 'Basement' structure picture.

This method is very economical in providing general information of a reconnaissance nature over an inaccessible prospect.

With additional geological and geophysical thinking provided from this study, we would suggest modifying the approach slightly, mainly by a shorter offset in this particular area.

Respectfully submitted,

VELOCITY SURVEYS LIMITED

S. A. Mouritsen - Seismologist

Approved:

F. G. McConnell, P. Eng.
Supervisor

FINAL REPORT

on

TROUT LAKE AREA
NORTHWEST TERRITORIES

for

WESTERN DECALTA PETROLEUM LIMITED

by

VELOCITY SURVEYS LIMITED
October, 1961.

Headquarters:	530A - 6th Avenue S. W., Calgary, Alberta.
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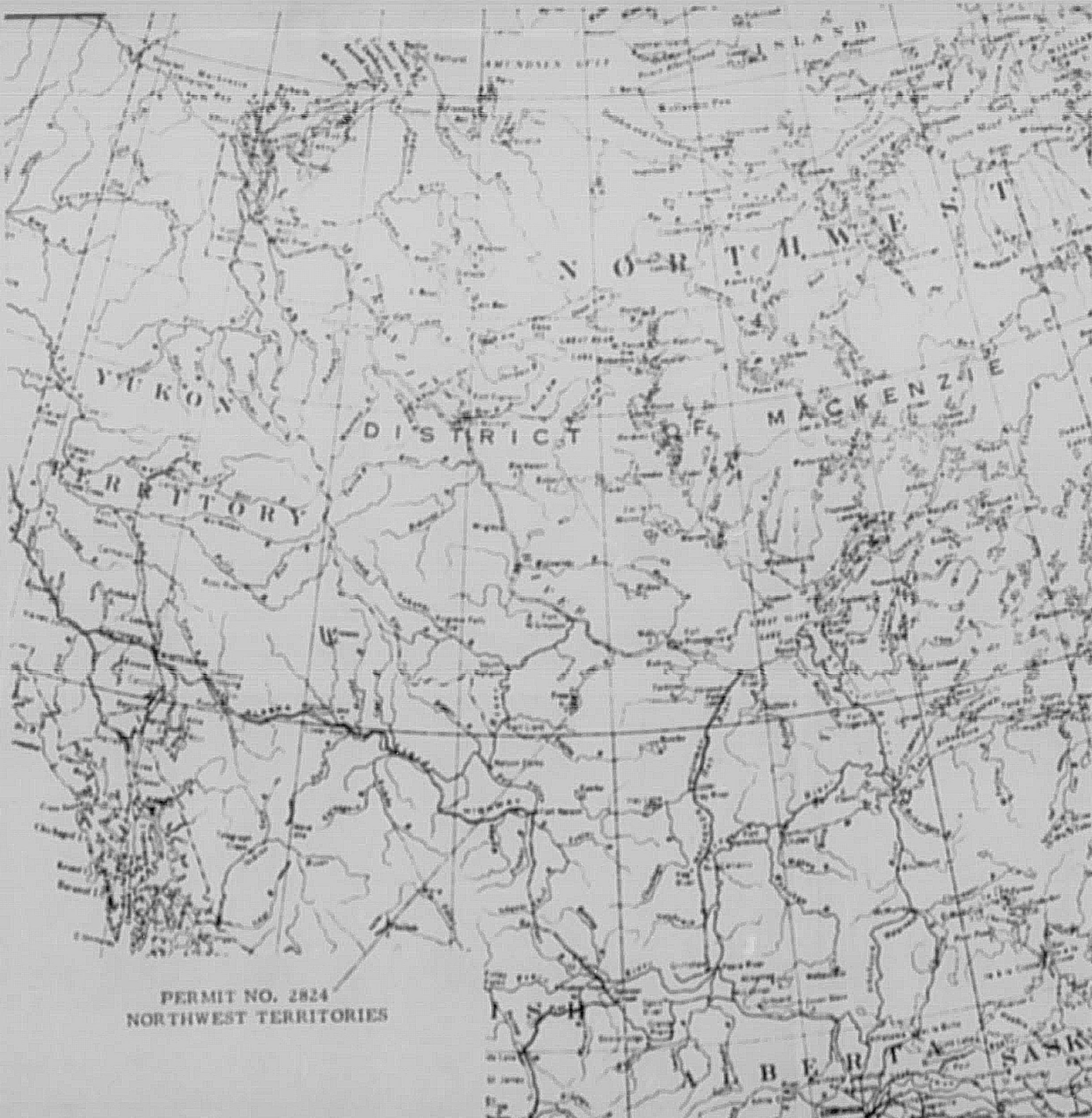
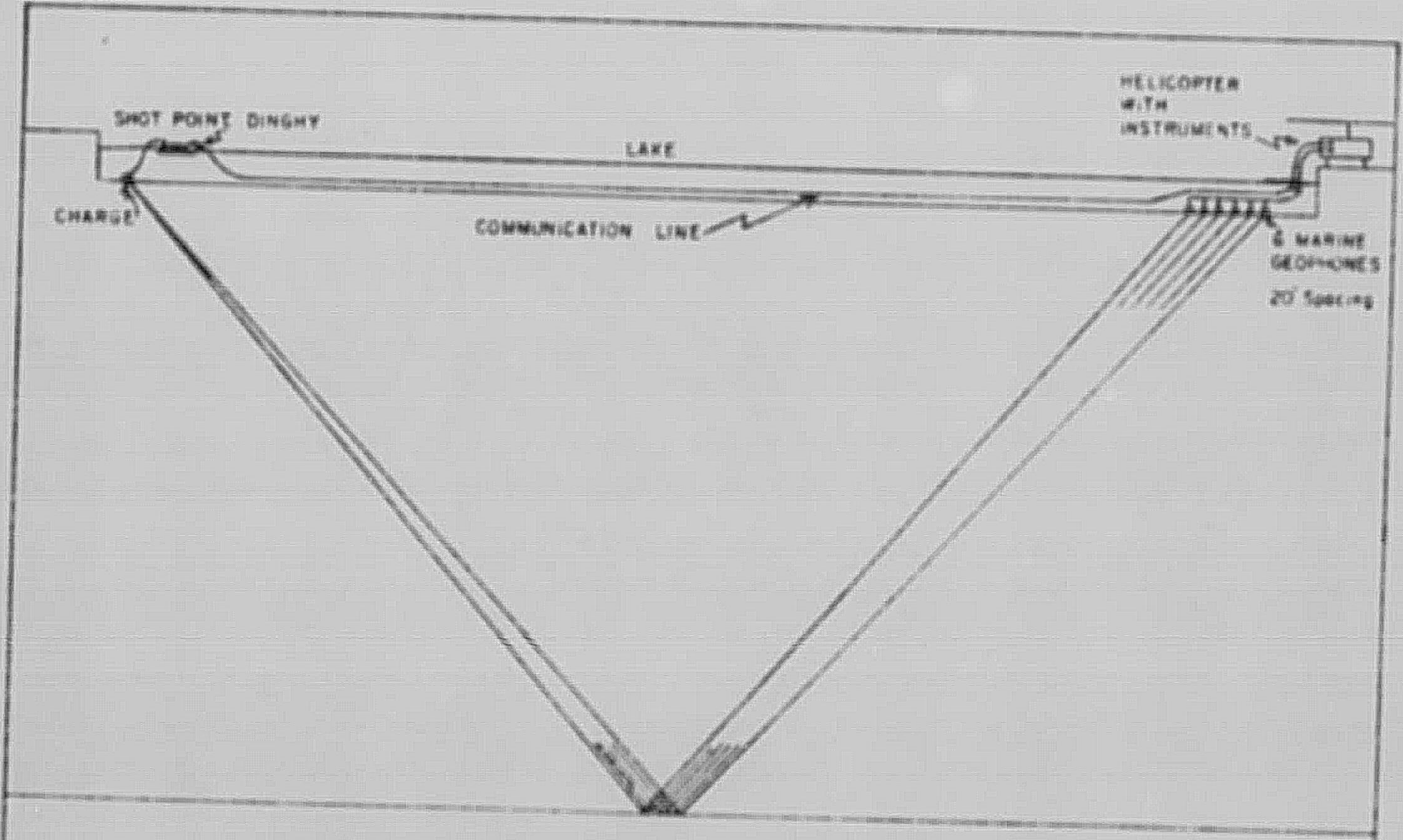


PERMIT NO. 2824
NORTHWEST TERRITORIES



SCHEMATIC DIAGRAM OF WATER SHOOTING

SEPT 1961

CONTENTS

FINAL SEISMIC REPORT

TROUT LAKE AREA

NORTHWEST TERRITORIES

INTRODUCTION

Correlation points were shot in Trout Lake by a portable seismograph crew. Electro-Tech EVP 5 marine geophones were employed throughout and the shots were taken in the water.

Good records were obtained by this method and these records could be correlated. The weathering was assumed to be uniform under the lake and no weathering corrections were made. The records were corrected to a datum of 1,600 feet above sea level by using a correction velocity of 7,000 feet per second.

The control is very limited. Nine locations were shot and some doubt as to the validity of the correlation is inherent due to the great distances between certain shot points. This is not a weakness in the method; it is merely a lack of sufficient control.

INTERPRETATION

The interpretation of the points shot would have been impossible without some sub-surface geological information. The tentative sub-surface geological solution was enhanced by the seismic shooting to give a fairly reasonable solution to the structure problem. The fault striking northwest-southeast is in doubt as to its direction, but appears real from the seismic information.

There are six maps: four structure maps and two isochrons. Two cross-sections have also been made, and the main apparent faults and reflection changes show up clearly on these sections.

The reflections mapped are all Devonian horizons. The "A" reflection is probably the Hay River and the "D" reflection is either on the Slave Point or just below the Slave Point. The structure drawn on the individual maps is much the same for each horizon. This structure may be due to a fold on the up side of a northeast-southwest normal fault or it could be due to Slave Point structure on the up side of this normal fault. The reversal (north dip) of this structure has been drawn from the geological information supplied for the area.

Shot Points 7 and 8 show a peculiar repetition of reflections which could be due to a near surface multiple reflection. However, there is some indication that it could be a repeated section. The shallowest reflection appears repeated and there is a questionable possibility of thrusting in the Devonian above the Hay River shales. More detail is required to determine the cause of this repeated reflection.

From the available information, the interpretation must be considered as the strongest possibility. The points indicate a northeast-southwest trending positive area and this picture is confirmed by the isochron trends. There appears to be approximately twenty milliseconds of isochron thinning associated with the indicated structure trend.

CONCLUSION

The method used to shoot this area would likely be sufficient to solve the structure problems in the area if there were denser shot point concentration over the more difficult portions of the area.

The limited control indicates favourable positive structure in the area.

Respectfully submitted,

VELOCITY SURVEYS LIMITED

S. A. MOURITSEN
Seismologist

Approved:

F. C. McConnell, P. Eng.
Supervisor