SEISMIC SURVEY

GRANDVIEW HILLS

Northwest Territories Canada

for

RICHFIELD OIL CORPORATION
Canadian Division

GEOPHYSICAL SERVICE INTERNATIONAL CORPORATION

CALGARY ALBERTA

A. T. Stewart Party 407

March, 1960

TABLE OF CONTENTS

	Page
ABSTRACT	1
INTRODUCTION	1
PURPOSE	1
GEOLOGY	2
PHYSICAL CONDITIONS	2
FIELD METHODS	3
METHOD OF CALCULATION	4
DISCUSSION OF RESULTS	5
SUMMARY AND CONCLUSIONS	7
ACKNOWLEDGEMENTS	7
GENERAL STATISTICAL DATA	8
KEY PERSONNEL	8
ADDENDUM	9-12

LIST OF ENCLOSURES

Rampart Shale Map
Devonian (Ordovician-Silurian) Map
8000-Foot Map
Rampart Shale to Devonian
(Ordovician-Silurian) Isopach
Bouguer Gravity Map
Elevation Map
Gravity, Elevation Profile Map

ABSTRACT

Three structure maps and one isopach are presented. Interpretation, based upon four-way dip control and spot correlations, reveals anomalous dips northwest of shot point 101 and possibly northeast of shot point 105.

INTRODUCTION

Prospect:	Grandview Hills.
Territory:	Northwest Territories, Canada.
Surveyed for:	Richfield Oil Corporation.
Surveyed by:	Geophysical Service International Corporation, Party 407, A. T. Stewart, Party Chief.
Party Headquarters:	Peter Bawden Rig No. 16.
Dates of Shooting:	February 27 to March 27, 1960.
Detailed Location:	See Plate I.

PURPOSE

The purpose of the survey was to examine record quality and to evaluate subsurface structure by means of spot correlation shooting between the Grandview Hills Well and the Mackenzie River.

GEOLOGY

Dips of formations are generally in a southerly direction. Faulting is to be expected in the area and outcrops of formations along the shores of the Mackenzie River are known to be correlatable to well markers.

The following are geologic markers established at Grandview Hills No. 1 Well.

Devonian

- Imperial Sandstone
- Rampart Shale
- Rampart Limestone
- First Dolomite (Lone Mountain Facies)
- Bear Rock Facies
- Base of Lone Mountain

Ordovician Silurian

- Dolomite

PHYSICAL CONDITIONS

Surface Conditions

Surface topography consists of sparesly timbered hills and small lakes. Shooting was conducted on an access road connecting the well and the Mackenzie River. Additional line for four continuous profiles and the cross-control spreads were cut by a D-7 bulldozer.

Transportation

Equipment, supplies, and the three crew members were flown from Edmonton to the well in a chartered DC-3 and via Pacific Western Airlines. The only vehicle available for the survey was an open pickup truck, supplied by Peter Bawden Drilling Company.

Weather Conditions

With the exception of one day lost due to blizzard conditions, weather was generally clear with morning temperatures ranging from -20 to -45° F.

FIELD METHODS

Surveying

Horizontal and vertical control was obtained by a transit survey tieing Grandview Hills No. 1 Well to a boat marker on the Mackenzie River. An elevation of 1250 feet, an altimeter reading taken at Grandview Lake, was considered the "take-off" elevation, and a magnetic declination of North 40° East was chosen.

A map, based on aerial photos, shows an apparent mistie to the survey of approximately 700 feet in the location of the Mackenzie River bank. As this map will be used for additional work in the area, the survey was adjusted accordingly.

Drilling

A GSI portable auger unit drilled to an average depth of 20 feet through ice, frozen muskeg, gravel and clay. A near-surface layer of gravel and boulder, with a minimum thickness of about ten feet, hampered drilling.

Shooting

Sixty percent high velocity Geogel, and No. 8 Seismo-caps were loaded and shot immediately after drilling to enable loading back for the cross-spread shot. Charge sizes varied from two and one-half to ten pounds per shot.

Recording

Spread and instrumental details: See Plate II. Spread array consisted of 1320 foot, in line split spreads with 24 groups of three seismometers at 55 foot intervals. As reflection frequency ranged from 50 to 60 cycles per second, a 92 to 22 cycles per second pass band with single section "K" filter was used. Satisfactory photography results were obtained when developing equipment was placed in the cab of the transportation unit.

METHODS OF CALCULATION

Depth Chart

A brachistochrone, constructed from the Grandview Hills Well Velocity Survey, was used for converting two-way time to depth.

Weathering Calculations

Record corrections were computed by the up-hole method and travel time corrections through the drift layer were based on velocities determined from refraction plots. A replacement velocity of 9000 feet per second was used to correct to a reference plane of 1000 feet above sea level.

Cross Sections

Only mapping or correlatable reflectors are plotted on the migrated section, which was constructed by converting resolved split dips to an east-west component.

Mapping

Of the three structure and one isopach maps presented, based on outstanding reflection events, character correlations on the shallow horizon are considered to be the most reliable. Maps are drawn to a scale of two inches equal one mile.

DISCUSSION OF RESULTS

Record Quality

Surface elevation appeared to be the main factor governing record quality. Good quality data, with 50 to 60 cycle energy predominant, were obtained on spreads laid out at higher elevations and deteriorated as elevation decreased. Trace information from groups laid out on frozen lakes was not useable. With the exception of the most outstanding event at average reflection time, .300 seconds, high frequency phasing out across the record obscured reflection character to some extent.

Mapping Horizons

Geologic identification of the mapping horizons was made from a study of the records shot near the well. The following tabulation presents pertinent well data:

Geologic Marker	2-Way Time at Well Corrected to 1200' above Sea Level	Approx. Depth at Well below 1200' Reference	Reflection Quality Over Area	Estimated Reflection Occurence
Rampart Shale	.324	1520	Good	95%
Dolomite (Ordovician Silurian)	.528	3420	Fair	90%

The 8000 foot horizon has not been identified as this depth was not reached by the well. An isopach is also presented between the Rampart Shale and the 8000 foot horizon.

Structural Conditions

With the exception of north dip shown on profile 114 on the 8000 foot horizon, the same structural picture is revealed on all three mapping horizons and the isopach. Dips, generally in a southerly direction, increase with depth.

Turnover on continuous correlation profiles 101 to 104 and resolved dips of profiles 101 and 105 have been contoured to show a south plunging nose flanked by a low across the well.

A fault, downthrown to the west in the vicinity of Shotpoint 101, is a possible alternate interpretation.

SUMMARY AND CONCLUSIONS

It is believed that the data obtained is reliable, but it should be considered that interpretation is based on character study of spot correlations. Additional shooting is recommended to investigate anomalous dips, or possible faulting, west of Shot Point 101.

ACKNOWLEDGEMENTS

For assistance and co-operation on the project, the aid of Messrs. D. Grinsfelder, W. Elias, and W. Goodridge, of Richfield Oil Corporation is acknowledged.

Respectfully submitted,

GEOPHYSICAL SERVICE INTERNATIONAL CORPORATION

A. T. Stewart, Party Chief

Approved:

E. E. Sutton, Supervisor

GENERAL STATISTICAL DATA

Number of profiles shot	22
Number of depth shots	39
Total dynamite (pounds	205
Average dynamite per profile (pounds)	5.3
Number of holes drilled	14
Total footage	279
Average depth drilled (feet)	19.9
Range of elevations (feet)	934

KEY PERSONNEL

Party Chief	A. T. Stewart
Observer-Surveyor	C. Campbell
Driller-Shooter	A. Helfrick

ADDENDUM

GRAVITY SURVEY

Surveying:

Forty-five gravity stations were surveyed and tied into the seismic work. The initial gravity interpretation was based on the original shot point location map. This map, after checking, was found to have an error in plotting between Shot Points 109 and 110, and a new gravity map was computed and plotted, and is submitted with this report.

Elevation differences were measured trigonometrically and are probably accurate to within a few tenths of a foot on the short shots using stadia intercepts. Trigonometric elevation differences determined on the long shots should only be accurate to within a few feet, but should be more accurate than altimeter surveying.

It was hoped that the two man metering crew that was flown in after the completion of the seismic work would have time to re-survey the entire line to the river, but they were able to stay in the area only three days instead of the expected six days, and were able to re-survey only a few points in addition to taking the gravimeter observation.

Metering:

Worden Meter No. 17 was used for the survey, and its tilt table dial constant of 0.0828 milligals per scale division was used for computing gravity differences. Drift closures were made every one-and-three-quarters to two-and-one-quarter hours. The recheck accuracy was very good, and only one check exceeded 0.02 milligal.

Computing:

An assumed value of 500 milligals was used for the Observed Gravity at Station 110, and all gravity observations are tied to this point and to this value.

The latitude correction was assumed to be 0.00 at Latitude 67°05', and decreased northward at the rate of 0.0178 milligals per 100 feet. This rate of change was computed for a latitude of 67°05' from latitude correction tables in Geophysical Prospecting for Oil, by L. L. Nettleton, page 142.

There was insufficient elevation turnover to properly estimate the elevation factor. Two profiles were computed over low relief hills on crooked lines, and the average determination of these two elevation factor profiles was 0.065 milligals per foot. An elevation factor of 0.065 milligals per foot would indicate a surface density of 2.3 which would be about right for consolidated materials. The density, however, would be too high for glacial drift, and the elevation factor too low over hills composed of glacial materials. Elevation factors for glacial hills in the Arctic vary from .068 milligals per foot to .081 milligals per foot, depending upon the ice content of the materials.

Interpretation:

Because of possible elevation errors and elevation factor changes, the Bouguer Gravity Map is contoured to only half-milligal intervals. On an altimeter survey, the contour interval is usually one milligal.

The largest anomaly is a 1.4 milligal gravity nose or gravity anticline between Shot Points 107 and 113. Depth computations on the Residual Anomaly Curve indicate depth to center of 1300 feet below the surface on the west side of the feature, and 800 feet below the surface on the east side of the anomaly. On the gravity map, the nose has a sharply dipping, or faulted, western flank, and a more gently dipping eastern flank. The feature apparently strikes north-northwest from Station 128 or 129.

Between Shot Points 105 and 107, the residual gravity profile suggests a possible fault with a depth to center of about 1200 feet. The control is poor, but the feature seems to correlate with seismic structures.

No seismic data are available to check the pronounced gravity fault of 1.2 milligals between gravity stations 144 and 145. The depth to center of this fault is on the order of 800 feet, and the up side is to the east.

A 0.6 milligal gravity fault anomaly, with a depth of origin of 200 feet, is shown on the residual gravity profile between Shot Points 103 and 102. Although the high side of this anomaly correlates in position with a sharp seismic high, the gravity effect is most probably related to the density contrast between pre-glacial topography and glacial drift. If the pre-glacial topography is structurally controlled, the gravity anomaly may be related to the pre-glacial surface expression of a fault.

To relate the gravity structures to seismic structures, the depths to center of the gravity fault-type anomalies were computed, and were plotted in terms of depth below the surface on the gravity-elevation-seismic profiles. Fault throws were estimated assuming a density contrast of 0.4 which would require 200 feet of throw to produce 1.0 milligals. The horizon so obtained falls above the Rampart Shale Horizon, but its general shape corresponds more to the deeper horizons. The gravity depths were computed from the gravity profile, and the profile in turn was obtained from extrapolated gravity contours which may not be too accurate because of insufficient contour control along very crooked lines.

The computed gravity structure horizon is interesting in that it does show the major structures encountered, and indicates a regional dip to the east.

Summary

The objective of the gravity survey was to test the seismic structures to see what size seismic structures would create a gravity anomaly large enough to be seen over the normal noise level of a helicopter gravity survey utilizing altimeters for elevation surveying. Normally, about ninety percent of the elevation errors in a helicopter survey are less than 11 - 14 feet. Under ideal conditions of low relief, and some trigonometric elevation base control, the error level may be as low as 8 - 11 feet for ninety percent of the stations. To determine the error level of the helicopter survey, the elevation errors must be multiplied by the average elevation factor, usually about 0.065 milligals per foot, or 14 x .065 = 0.91 milligal. Consequently, helicopter surveys using altimeters are not contoured closer than one milligal.

Only one anomaly, the 1.4 milligal high between Shot Points 107 and 113, exceeds this lower limit. Although this gravity feature seems to correlate with a 200-foot basement high, it is probably caused by a fault shallower in the section with a throw on the order of 250 - 300 feet.

If effects smaller than 1.0 milligal are important, line-cutting would be required to permit surveying in greater detail and accuracy, using either pickup trucks or tracked equipment.

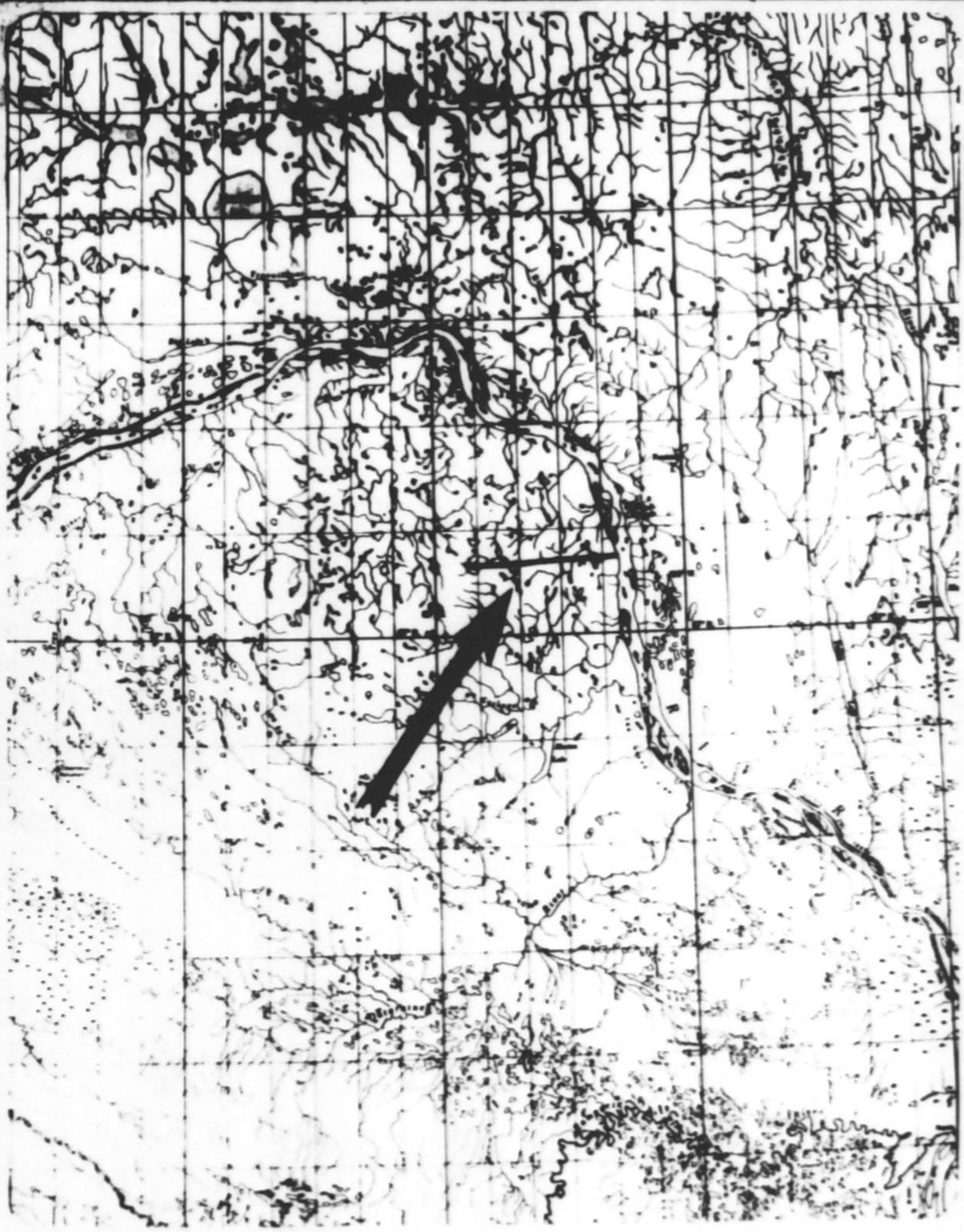
Trucks could not be used in summer, and to take full advantage of the winter season, the survey techniques would have to be modified to secure maximum production despite short to zero daylight conditions. This could be done by using a tellurometer for position control, and a theodolite for the horizontal and vertical angle bearings on lights above the meter vehicle. If the lines are cut straight, elevations can be determined out to three to four miles from one position to an accuracy of two feet, or better, by using tellurometer distances and averaged forward and reverse vertical angles on the theodolite.

All instruments would be mounted in heated cabs so that the surveyors and meter operators would be protected from the cold. Magnetic compasses would not be used, and horizontal bearings would be based on plate angles with the original bearing determined by star shots.

Production of such a crew would be on the order of ten to fifteen miles per day, or over 300 miles per 30-day month, depending upon the type of terrain, the station interval, and how straight the lines could be cut to get maximum production from each tellurometer set up.

A crew of this type surveying in advance of a seismic party would delineate the major areas of interest, and provide cut lines accurately surveyed horizontally and vertically for follow-up seismic detailing in local areas of interest.

Norman C. Harding,
Gravity Supervisor



GEOPHYSICAL SERVICE INTERNATIONAL

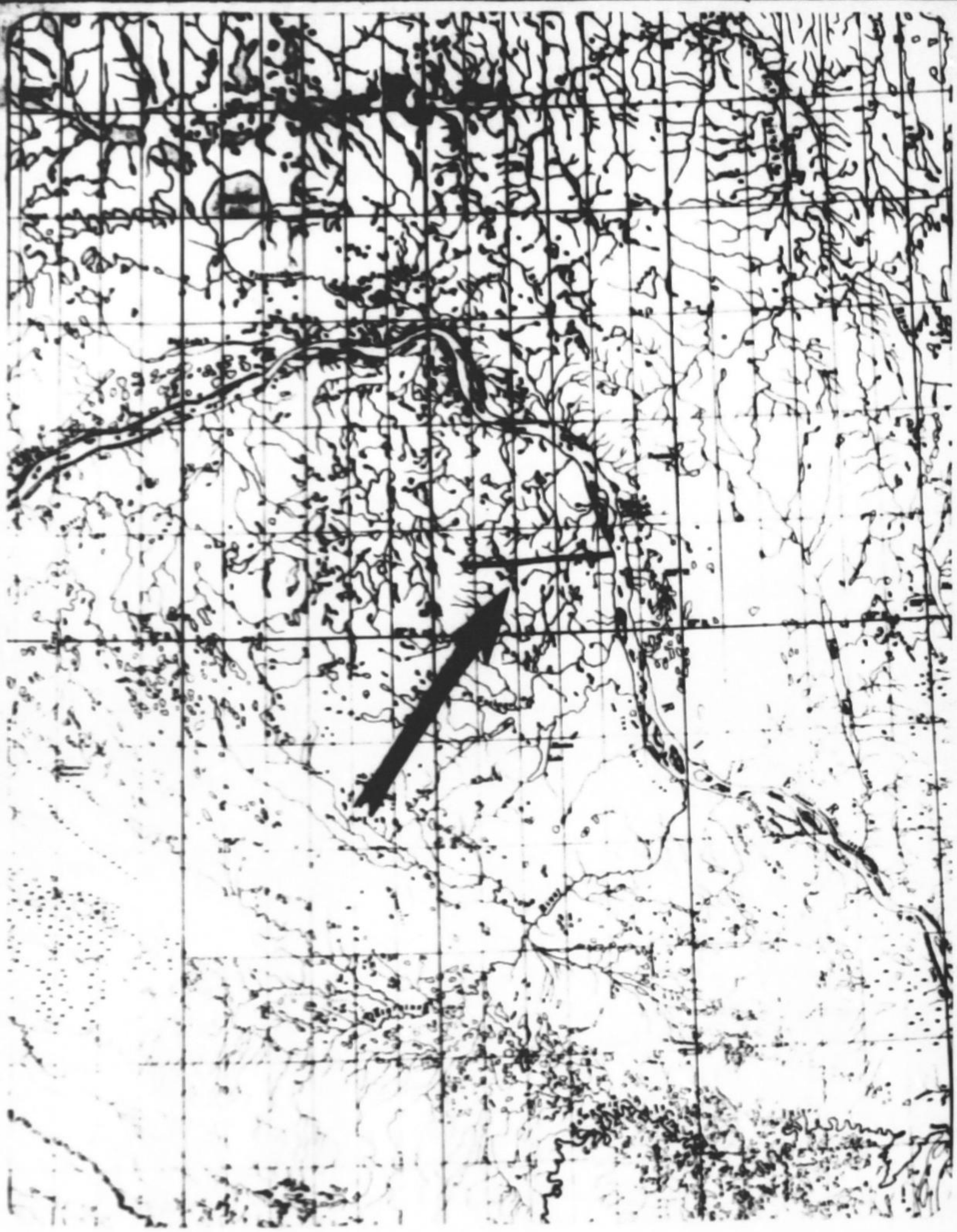
CORPORATION

GRANDVIEW HILLS

N.W.T.

G.S.I. Party 407 — March 1960

PLATE I

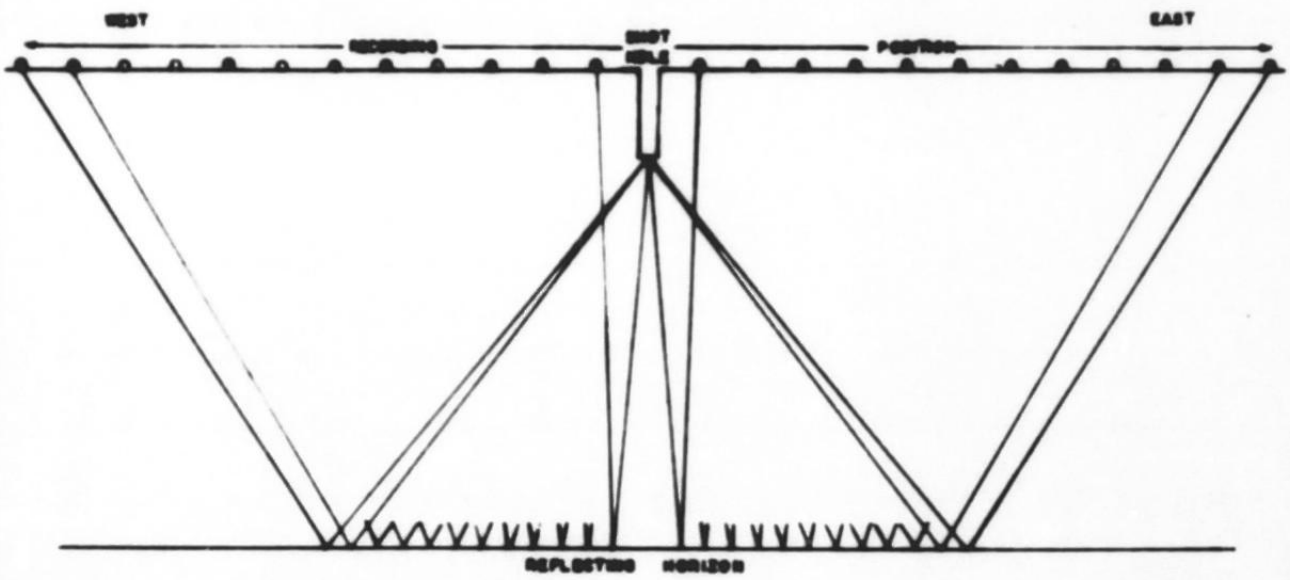


GEOPHYSICAL SERVICE INTERNATIONAL
CORPORATION

GRANDVIEW HILLS
N.W.T.

G.S.I. Party 407 — March 1960

PLATE I



SPREAD ARRANGEMENT FOR SPOT CORRELATION

SPLIT SPREAD

24 TRACE 24 CHANNEL EQUIPMENT

DESCRIPTION OF SPREAD

Seismometers per spread	72
Seismometer groups	24
Seismometers per group	3
Normal distance between groups	110'
Distance to center of first group	55'
Distance between seismometers within group	55'

INSTRUMENTAL DETAIL

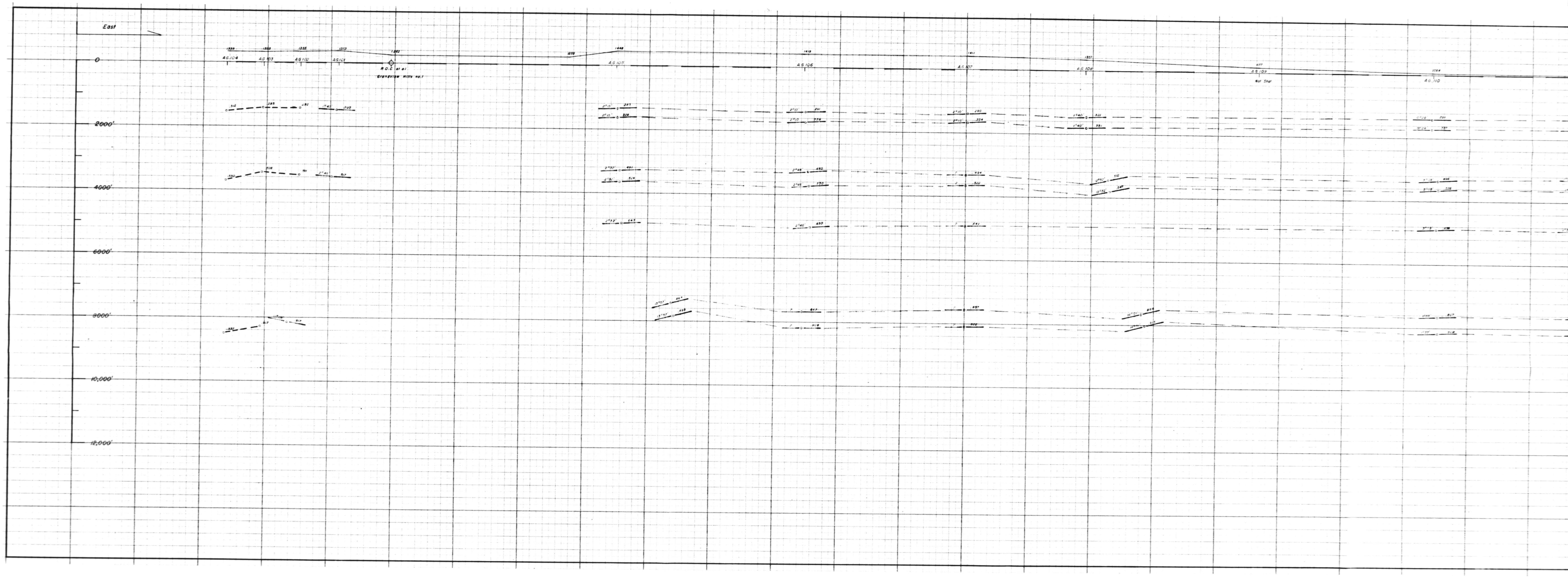
Seismometer series	S-32 (28 cps)
Amplifier number	8000
Camera number	RS-8 M
Circuit used	Straight

TYPICAL CONDITIONS

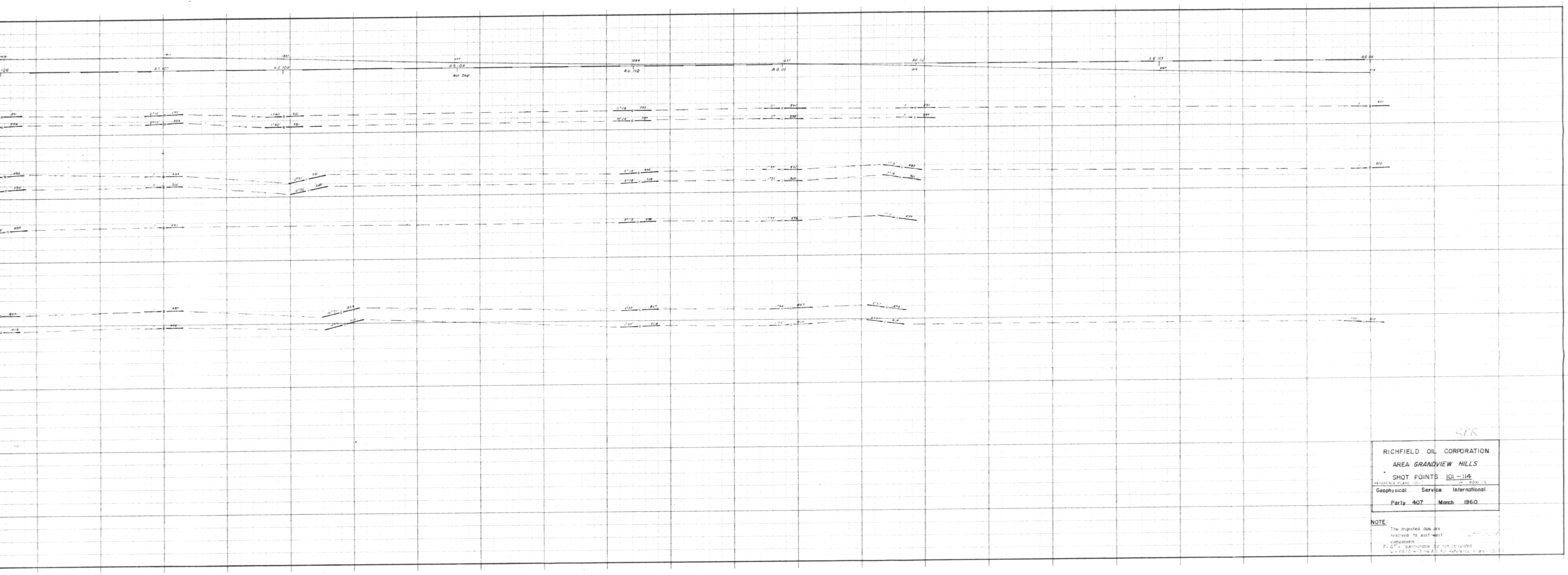
Average hole depth	20'
Average charge(lbs.)	5
Optimum filter	92K-22K
Shooting medium	clay & gravel

PLATE II


MACKENZIE
RIVER
RICHFIELD OIL CORPORATION
CANADIAN DIVISION
GRANDVIEW HILLS — MACKENZIE RIVER TIE LINE
ELEVATION MAP
CONTOUR INTERVAL 50 ft.
MAP SCALE 2 INCHES = 1 MILE
REFERENCE PLANE Sea level
Interpreted By N. Harding Date 5/18/1960
Contoured By N. Harding Date 5/18/1960
Shot By G.S.I. 407 Date 5/18/1960



30x
West Canadian Graphic Industries Ltd.


SPR
RICHFIELD OIL CORPORATION
AREA: GRANDVIEW HILLS
SHOT POINTS 101 – 114
REFERENCE PLANE 1000'
Vᵣ = 9000'/S.
Geophysical Service International
Party 407 March 1960
NOTE:
The migrated dips are resolved to east-west components
?= ΔT's questionable dip not calculated
V = 6670 + 3.94 Z (For Reference Plane - 1200')