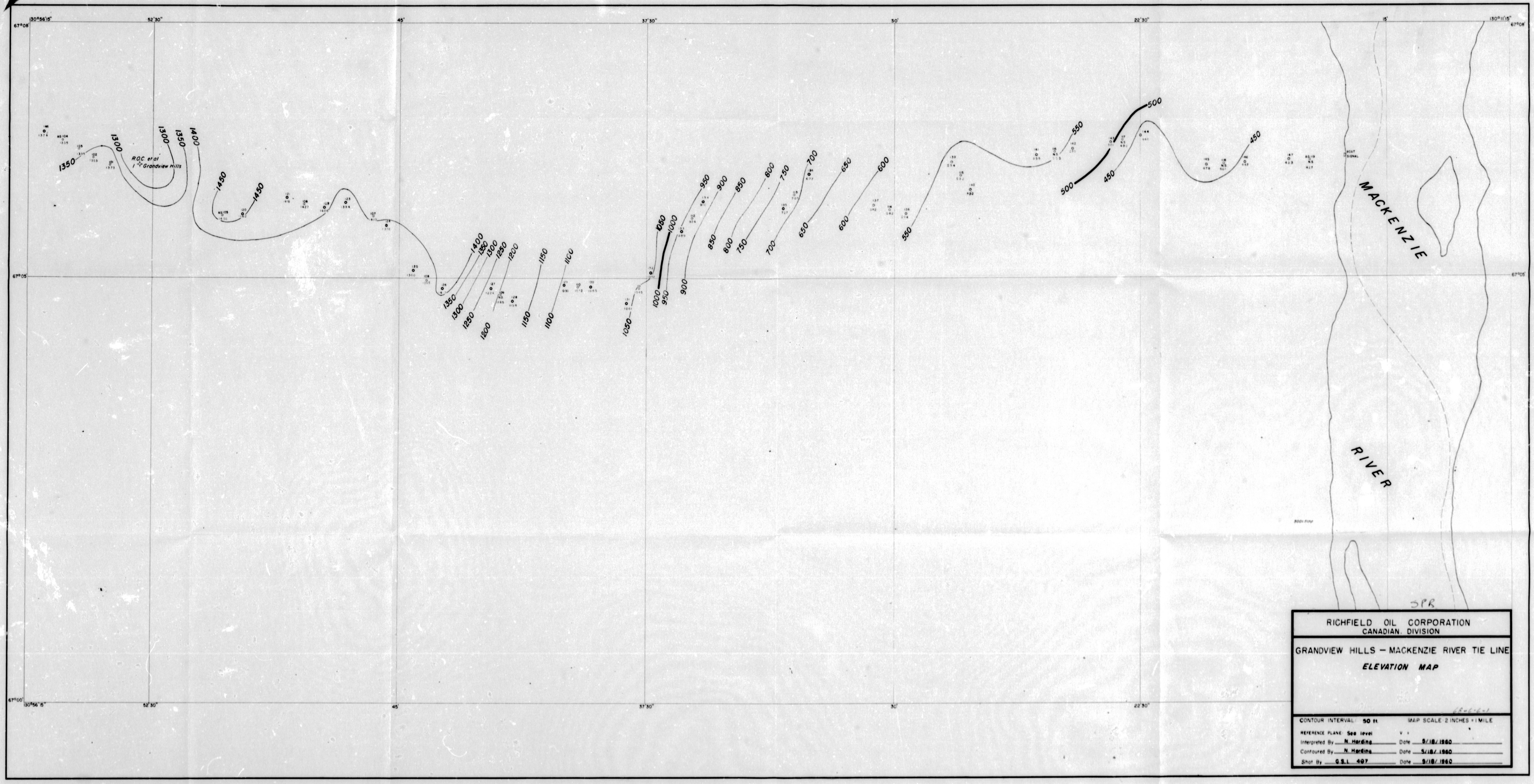


RICHFIELD OIL CORPORATION
CANADIAN. DIVISION

GRANDVIEW HILLS – MACKENZIE RIVER TIE LINE

ELEVATION MAP

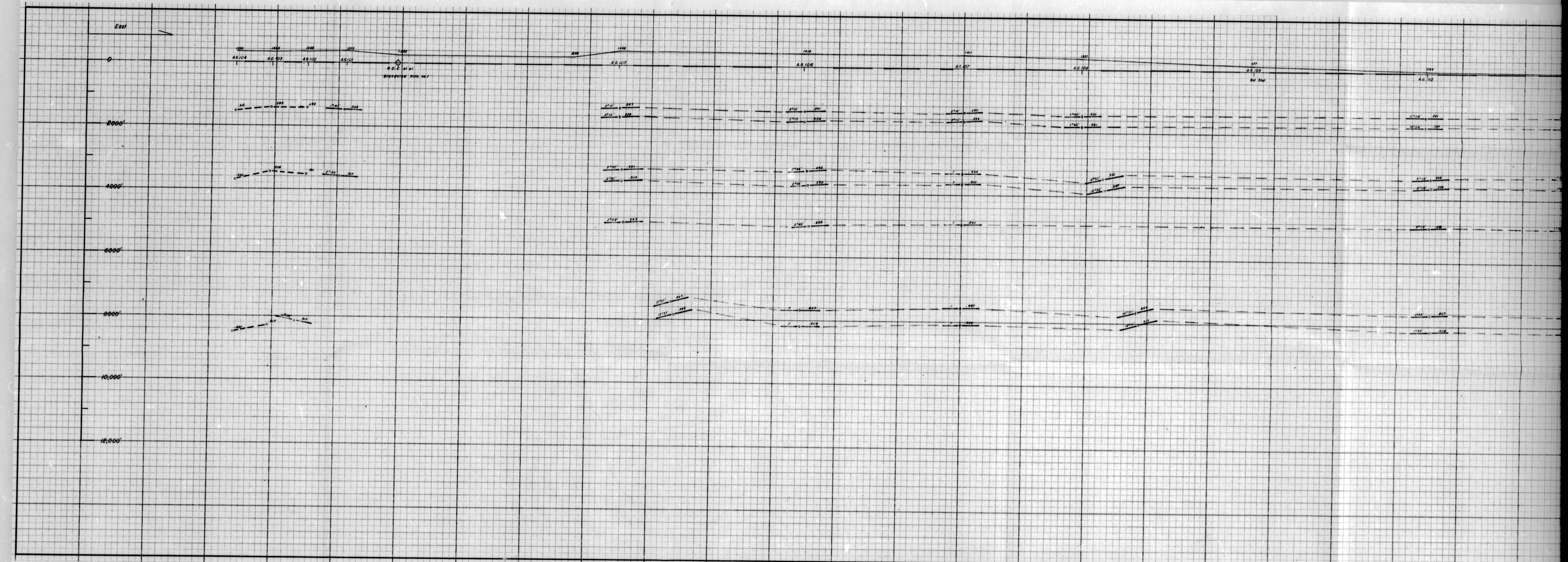
CONTOUR INTERVAL: 50 ft. MAP SCALE: 2 INCHES = 1 MILE

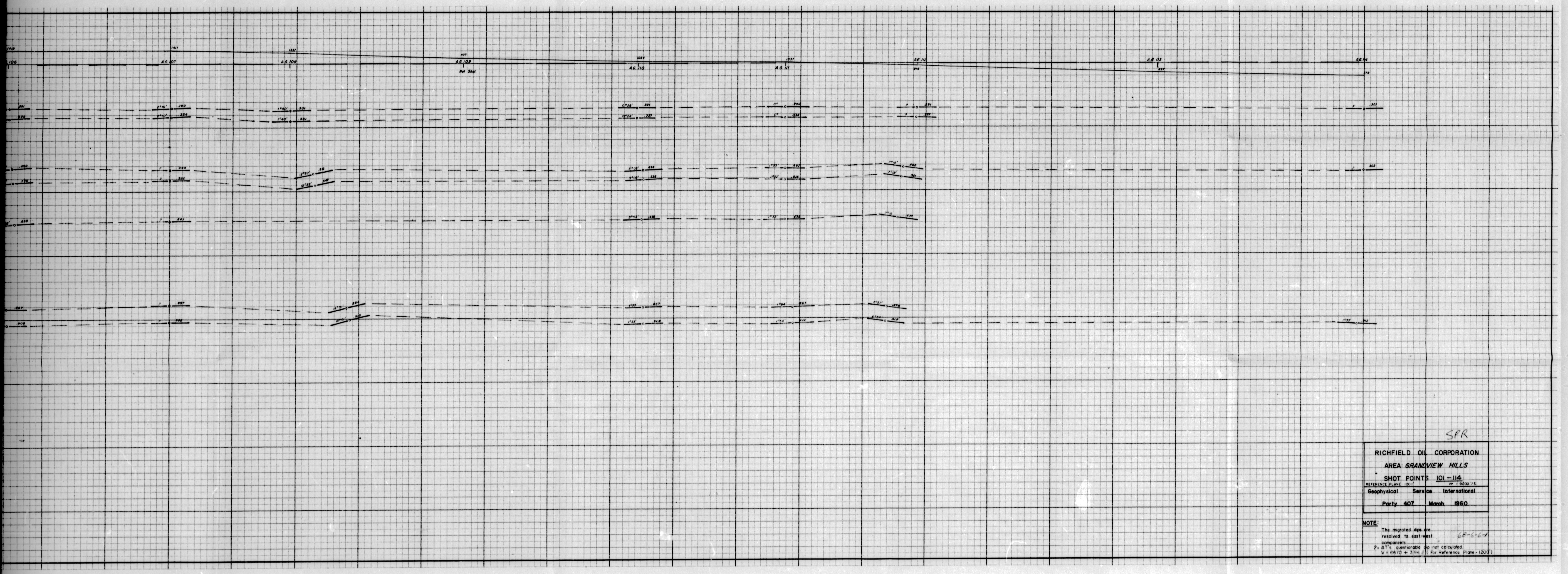
REFERENCE PLANE: Sea level

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


East
0
2000'
4000'
6000'
8000'
10,000'
12,000'
A.G.104
A.G.103
A.G.102
A.G.101
A.G.105
A.G.106
A.G.107
A.G.108
A.G.109
A.G.110


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 (For Reference Plane - 1200')
68-6-6-1

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

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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

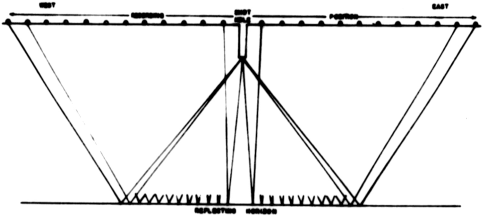
CORPORATION

PLATE I

GRANDVIEW HILLS

N.W.T.

G.S.I. Party 407 -- March 1960



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-8M
Circuit used	Straight

TYPICAL CONDITIONS

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

PLATE II

Report of Seismograph Survey

GRANDVIEW HILLS - ARCTIC RED RIVER AREA

Northwest Territories

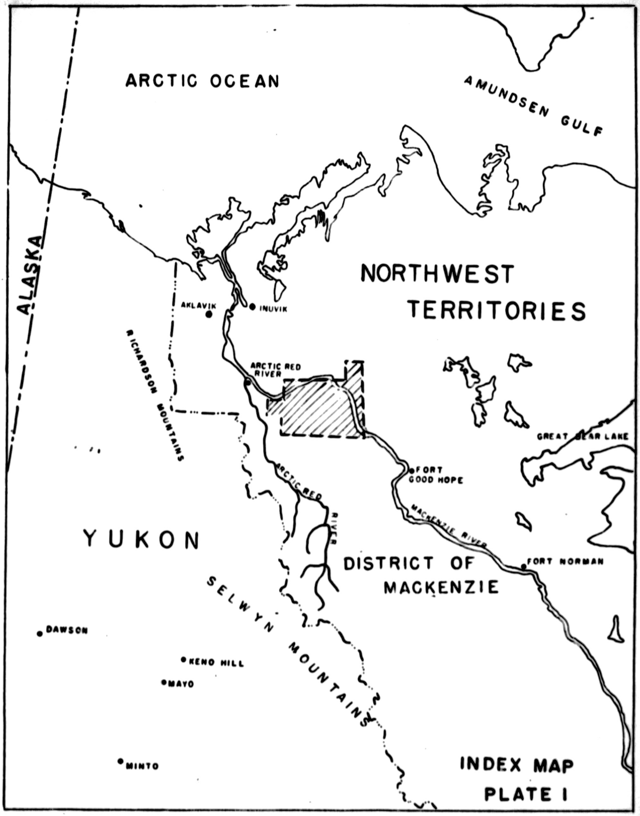
Submitted to

RICHFIELD OIL CORPORATION

Report by

J. W. Loven

WESTERN GEOPHYSICAL COMPANY OF CANADA, LTD.
Calgary, Alberta



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Line Location Map

PLATE III ---------------------------- Follows page 14

Time-Depth-Velocity Graph
used in Computations

PLATE IV ---------------------------- Follows page 15

Specimen Records

1. INTRODUCTION

Party F-69 commenced a seismograph survey of the Grandview Hills Area on November 11, 1960. The work was done on behalf of a partnership with Richfield Oil Corporation as operator.

The Grandview Hills block consists of a roughly rectangular area about 50 miles north-south and 80 miles east-west. The area lies just north of the Arctic Circle and is bounded to the north and east by the MacKenzie River and to the west by the Arctic Red River. Inuvik, the nearest town, is about 130 miles northeast of the centre of the prospect and served as the base for incoming supplies.

The field crew and interpretive staff operated from a trailer camp within the prospect.

Except for two ten-day rest periods at the end of December and at the end of February, operations were conducted continuously through April 18, 1961 for a total of 137 work days. Notwithstanding the two time-off periods, the crew worked at least 208 hours in any calendar month.

The principal purpose of the survey was to evaluate a maximum amount of acreage, on a reconnaissance basis, within the winter work season in hopes of finding a Norman Wells type reef. Only a limited amount of experimental work was done and no detail lines were added to the original reconnaissance loops.

Mr. J. W. Loven was Party Chief and Mr. D. H. Juergens, Party Manager, was in charge of supplies and field operations. Mr. H. G. Redgate of Richfield Oil Corporation supervised the overall operation.

2. TERRAIN AND CLIMATE

2.1 Topography

For the most part, the prospect lies south and west of the MacKenzie River. The Grandview Hills, rising to 1500 feet, occupy the north and east parts of the prospect. The hills slope off to the north and east to the MacKenzie, south to the Ontaratue River, and west to the Arctic Red River. Numerous small streams drain the flanks of the hills into the three major rivers. The area in general is dotted with literally hundreds of lakes and muskegs. The southwestern part of the area is gently sloping, marshy land with an average elevation of 600 feet.

2.2 Plant Life

Over the permafrost layer, there is a layer of moss from six inches to one foot thick. Generally the area is covered with pine, spruce, and birch from 2 to 6 inches in diameter and 25 to 30 feet high. Interspersed among these more common trees, are poplar, tamarac and willow. Along the creek and river banks, the trees grow somewhat larger, some being over 12 inches in diameter and 50 feet or more tall.

2.3 Climate

From the beginning of November until the end of March, the average temperature ranged from 20 to 30 degrees below zero, although temperatures of 40 to 50 degrees below zero were not uncommon during occasional periods extending up to two weeks. In April, the temperature rose to around zero during the day, but dropped to 25 or 30 degrees below zero at night. The winter was considered to be exceptional by the indigenous population because of the warmer-than-usual temperature, lack of wind, and lack of drifting snow.

3. PERSONNEL

3.1 Field Personnel

The field personnel consisted of a seven-man recording crew, six-man drill crew and a two-man survey crew. The two men who would normally be assigned to the third drill, were used much of the time instead, for hauling supplies and fuel from the supply base to the operations camp. The camp staff included a cook, cook's helper and a camp attendant as well as a mechanic.

The cat crew consisted of six catskinners, a cook, a foreman and a mechanic.

3.2 Interpretive Staff

The party chief, party manager and two computers made up the office staff which was headquartered in the field camp.

4. EQUIPMENT, TRANSPORTATION AND SUPPLY

4.1 Recording Equipment

Western Geophysical Company truck-mounted FA-32 amplifiers and associated magnetic equipment were used. A 3/4-ton Mercury pick-up truck served as the reel truck. Three, one-third mile, portable cables were used. A Mercury 600 truck equipped with a 400 gallon water tank served as the shooting unit.

4.11 Instrument Specifications

Amplifiers	WGC FA-32
Tape Transport	WGC Model PF-28
Camera	WGC W-96, with short Miller galvanometers
Seismometers	WGC FBX, 28 cycle
Blasters	Electro-Tech Synchronous.

4.12 Cables and Spreads

Type of Spread	Split continuous
Normal spread length	1800 feet shotpoint to shotpoint
Normal in-line offset	150 feet
Groups per spread	13
Group interval used	150 feet
Seismometers per group	3
Seismometer interval within group	30 feet

4.13 Filters Used

Filter	Phase shift in Milliseconds	Passband (50%)	Remarks
CP	22	30 - 56	Playback filter
2	15	44 - 70	Playback filter
FLh	13	19 - 150	Recording filter

4.2 Drill Equipment

Two, Western Model 1200, air-water combination, rotary drilling rigs, mounted on 190 International trucks, were used. In addition, one, Western Model 1200, conventional water-type drill, mounted on a two-wheel drive Mercury 600, was furnished as a stand-by unit. This drill, which was used mainly for drilling occasional deep holes and gravel holes, averaged about 100 hours of work per month.

The International trucks encountered less difficulty than the Ford trucks in travelling around the prospect; this was particularly true of the four-wheel drive drill, which was most useful on camp moves. This vehicle was capable of towing two trailers on level ground and could tow at least one trailer, without help, over most of the hills.

4.3 Survey Equipment

A transit was used for horizontal and vertical control. For use during the days of little or no daylight, equipment for illuminating the transit crosshairs was available. Reflecting tape was put on the rod and a spotlight on the survey truck was focused thereon, making the markings legible in the twilight.

4.4 Camp

The camp consisted of five, 10' x 32' trailer units, made up of two 12-man sleepers, one combination sleeper and washroom, one combination office and grocery storage, and one kitchen-diner. The trailers were warm and comfortable, and gave good service except: (1) Some trouble was experienced with the tubeless tires going flat in extremely cold weather due to the air seals breaking next to the rim. (2) The spring suspension assemblies were too light and broke off next to the frames.

4.5 Cat Operation

At the commencement of the prospect, two D-7 cats were assigned to the crew. A month later a third cat and a large freight sleigh were brought to the seismic camp from Point Separation. The original cat camp consisted of a wheel-mounted kitchen, a two-man, wheel-mounted office trailer, a wheel-mounted eight-man sleeper, a sleigh-mounted powerhouse-shop unit, a fuel sleigh, a Dodge Power Wagon and a 1/2-ton Ford pick-up. Since there were too many individual units for efficient moving, the two-man office trailer was later discarded and the remaining units were consolidated onto two sleighs.

The cats were originally subcontracted from an independent operator, but for various operational reasons, Western assumed direct responsibility for the cat group. The party manager of the seismic crew was also responsible for the cat operation.

Originally it had been intended that the third cat would move the seismic camp and make fuel and grocery supply runs to the base storage. It was found, however, that the third cat was sorely needed for line cutting and that it was far too slow for fifty or sixty-mile supply hauls. Therefore, a third cat was assigned to line cutting, while the water-truck was assigned to the supply trips. Fuel was hauled in the water truck tank while groceries and parts were transported on the deck of the truck. In place of the cat(s), the trucks normally assigned to the seismic operation, were commandeered as required to move the seismic camp.

4.6 Communications

A battery of four radios was supplied to the crew. A 90-watt single sideband unit was used to contact the Alberta Government Telephone System at Peace River. A 50-watt medium frequency radio provided communications with local Department of Transport stations at Fort Good Hope and Inuvik, a 20-watt unit enabled the seismograph camp to talk to incoming aircraft, and a VHF radio was used to keep in touch with the cat crew. The 50-watt radio was the most reliable and regular daily schedules were kept with both Fort Good Hope and Inuvik.

Occasionally, magnetic storms wrought havoc with radio reception for periods of two or three days at a time. On November 12th a very severe, world-wide magnetic disturbance due to a series of solar flares, blacked out all radio reception for about 10 days.

Radio communication with the supply aircraft was limited to a radius of five miles. Traffic with Peace River was, for all practical purposes, non-existent. Contact was made with Calgary through Peace River about six times in the six months the crew operated.

4.7 Transportation and Supply

For the initial move in, all the equipment and supplies, excluding perishable food, were transported to Hay River, N. W. T. by truck from Edmonton and/or Calgary. At Hay River, the supplies and equipment were transferred to river barges, owned by the Yellowknife Transportation Company, and towed by tug down the river to a landing 860 miles from Hay River on the south bank of the MacKenzie. During the winter, additional supplies and parts were flown to Inuvik via Pacific Western Airlines and from there to the field camp, via a ski-equipped Beaver plane. Freight was also shipped via truck to Dawson City, Yukon, trans-shipped by DC-3 to Inuvik and thence by Beaver to camp. Although shipping via Dawson City was cheaper, it was also much slower than shipping direct from Edmonton.

Fuel for the trucks, cats, and supply aircraft was obtained from Norman Wells, and shipped by barge in 45-gallon drums. Kerosene, used in the camp stoves, was similarly shipped, but from Waterways, Alberta.

All the groceries, some parts, the dynamite, and the caps were housed in prefabricated plywood storage sheds shipped in for this purpose. Larger truck parts, lubricants, mud, and bran were stored in the open under tarps. Groceries were kept from freezing by an oil-burning heater, installed in the grocery storage shed. A large steel sleigh, towed by a D-7 cat was used to transport the crew's immediate requirements of lubricants, fuel, supplies and parts between campsites, while the water truck was used to haul the fuel and supplies from the base storage to the operating camp.

A Beaver aircraft operated by Hudson's Bay Oil and Gas Co. made an average of 3 to 4 trips a week from Inuvik to the field crew with parts, visiting personnel and mail. There were about 15 days throughout the winter when the weather was too poor to permit the Beaver to fly. Pacific Western Airlines scheduled two round trips per week between Edmonton and Inuvik.

At the end of the season's operation, all the equipment and remaining supplies were brought back to the supply base on the MacKenzie River for storage. The trucks, cats, camp units and barrels were placed on platforms, constructed of logs and brush to prevent them from sinking into the ground during the spring thaw. Two men were left at the supply base as guards. A Beaver aircraft from Inuvik made periodic trips as required into the supply base camp with mail, fresh food, and other necessary items.

5. OPERATIONS

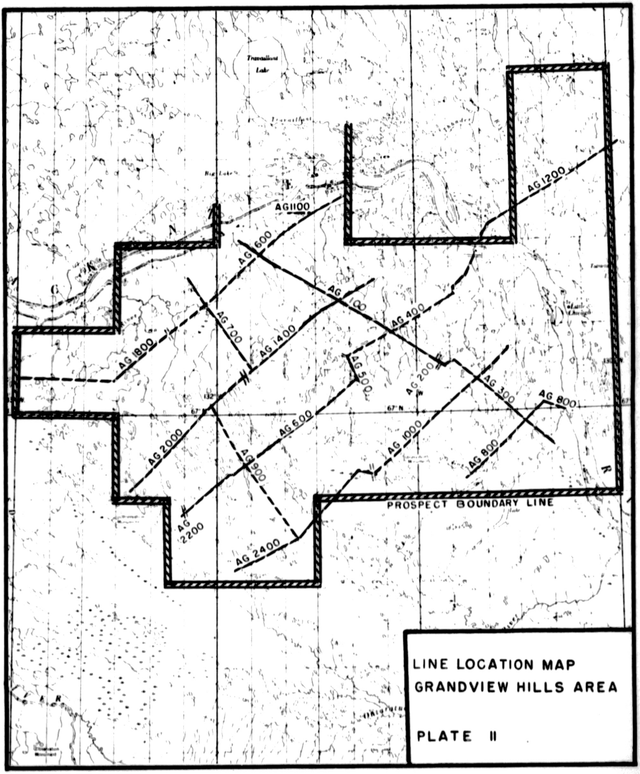
5.1 Program

The initial reconnaissance program was followed except for minor detours around lakes. Sixty-four miles of line were shot in addition to the original assigned program. A small amount of program east of the MacKenzie from the AG-300 line was abandoned because the river crossing appeared too hazardous. Plate II shows the location of lines shot in the area.

5.2 Surveying

Section and township corners are absent in the prospect. Lacking accurate geographical coordinates, the surveyor relied on the locations of creeks and lakes, as transcribed to the base maps from aerial photographs, to establish line locations.

Several Polaris observations were made to orient the seismic line grid relative to true north. The celestial observations were checked against the bearings between prominent surface features. Compass bearings could not be used and hence the exact bearings of the seismic lines were not immediately known until they were plotted on the map relative to surface features and checked by celestial observations. Compass bearings were considered to be unreliable because of the severity and frequency of magnetic disturbances which caused wide variations in the magnetic declination.



LINE LOCATION MAP
GRANDVIEW HILLS AREA

PLATE II

As a matter of convenience in recording his field notes the surveyor arbitrarily referred to northwest-southeast lines as "east-west", and to northeast-southwest lines as "north-south". All angles were turned relative to the arbitrarily assigned line direction. When the true bearing of each day's line segment was finally established, it was written at the top of each survey sheet. Shotpoint location sheets were made up locating each hole relative to adjacent holes. The true bearing of each line appears also on these sheets. Whenever a spread was crooked, a large scale diagram of the spread was drawn and included with the location sheets. The error of horizontal closure of the three large loops averaged about 500 feet. The loops were closed by prorating the error around each traverse. The perimeter of the smallest of these loops was 50 miles.

There were no known government bench marks in the area, therefore an elevation of + 80 feet was assumed on the MacKenzie River just north of shotpoint 101. This elevation was estimated from a contoured Government topographic map. Bench marks were established along each line about every three to four miles. Check shots were made at each bench mark to maintain elevation control. The elevation ties around the three large loops averaged 2.9 feet. The largest mis-tie of 4.6 feet was around the most northerly loop.

All of the seismometer group stations were chained and flagged. The elevations were measured at the shotholes and at seismometer groups nearest the holes. The elevations at intermediate groups were measured as required to maintain an accurate surface profile. For future reference, each shotpoint was marked in the field with a metal tag imprinted with the shotpoint number and nailed to a tree or bush opposite the hole.

5.3 Drilling

Shotholes were logged by the driller and, for a permanent record, the logs are displayed on the time cross-sections. In the north and east part of the prospect, some very sticky clay was encountered which made air-drilling a slow process. In the south and west, hard shale and sandstone were usually encountered. The latter formations are well suited to the air drilling technique. Generally, air drilling can be considered ideally suited to this area, despite the occasional patches of gravel and sticky clay. In the main, the two air drills provided satisfactory production in that they stayed ahead of the recording crew by 5 to 10 holes. However, in sticky clay or gravel, the water drill was used to great advantage.

The type of material encountered did not appear to govern the optimum shot depth. Consequently, most holes were drilled to a depth of 55 feet and every tenth hole from 80 to 100 feet. For the most part, a 4 1/4 inch insert bit proved superior to several other types of bits used. In some shale and sandstone formations, hard formation, two-cone rockbits gave the best performance. Holes were preloaded by the drill crew only if there was a possibility of the hole caving, which was not very often.

5.4 Recording

The shotpoint-to-shotpoint distance was usually 1800 feet, with the group interval being 150 feet, and the seismometer spacing within the group, 30 feet. The spacing between the hole and nearest group was 150 feet. The average charge size was 7.5 pounds. Depending on local conditions, charge sizes varied from ten pounds to two and one-half pounds. In some parts of the prospect, the larger charge sizes appeared to appreciably improve the deeper event in the vicinity of the X reflection. Shot depth did not appear to be critical but generally, the best shooting depth was around 55 feet. Water tamping was generally required, although snow and drill cuttings were used when water was unavailable.

Each shot was recorded in a broad-band filter on tape as well as on a photographic monitor record. Field playbacks were recorded through the CP and again through the 2 filter. Playback filters were selected after studying filter comparison tests taken during the first two weeks' shooting. The CP appeared to produce the best overall records. Filter 2 was chosen to aid in the character correlation of the shallow reflection. Refer to page 5 for filter lags and responses. The filter passbands refer to the overall frequency responses with three Western FBX seismometers in series. The filter lag is the actual correction applied to the played-back records and includes both instrument and tape lags.

At the first thirty holes shot on the AG-100 line, from shotpoint 101 to 131, routine tests were made, and later repeated, to establish optimum shooting techniques. The results of this shooting indicated generally that (1) Single holes were as good as five, (2) Optimum shot depth was at 55 feet, (3) More than three seismometers per group would not appreciably improve record quality. (4) Charge sizes of 2 1/2 to 10 pounds were sufficient. The results of the tests were generally adhered to throughout the prospect. An exception to the general procedure was on the northeast end of the AG-1600 from shotpoint 1692 to 1663. Three-hole patterns were shot here, resulting in a slight improvement in record quality. A repetition of the hole-spacing and multiple-hole tests was taken later in the season at shotpoint AG-1220. Results of this test indicated that 3 holes spaced at 100 foot intervals would improve record quality slightly but not enough to make it practical to shoot multiple-hole setups.

5.5 Statistical Operations Report

Calendar days in prospect	137 days
*Operating time	1,472.30 hours
Non-operating time (holidays)	30 hours

* Operating time includes field time, driving time and moving time.

Reflection Profile Data

Length of line	363.8 miles
Total profiles	2203 profiles
Average profiles/10 hour day	14.96 profiles
Holes shot	1212 holes
Dynamite used	12,017 1/2 pounds
Average dynamite per profile	5.46 pounds
Number of shots	1,602 shots
Average charge size per shot	7.5 pounds
Number of caps used	1,830 caps

work, a time-depth curve was drawn, illustrated by Plate III following this page. This velocity curve was used to compute the reflection time correction to the reference surface of sea level.

The two-way correction time to sea level to be applied to the surface-to-surface reflection times, was found from the time-depth curve by considering the elevation of the shotpoint to be the depth in feet from the surface. Twice the time, as read from the curve opposite the elevation, was subtracted from the surface-to-surface reflection times. All of the reflection times, including those of shotpoints 101 to 160, have been corrected in this manner except at shotpoints AG-699 to AG-643 and AG-337 to AG-362. Here, twice the uphole time, plus twice the chart time, corresponding to the distance from the deepest shot to sea level, was used. However, since the uphole time agreed closely with the time as shown on the time-depth curve for the first 100 feet below the surface, the two correction methods are equivalent.

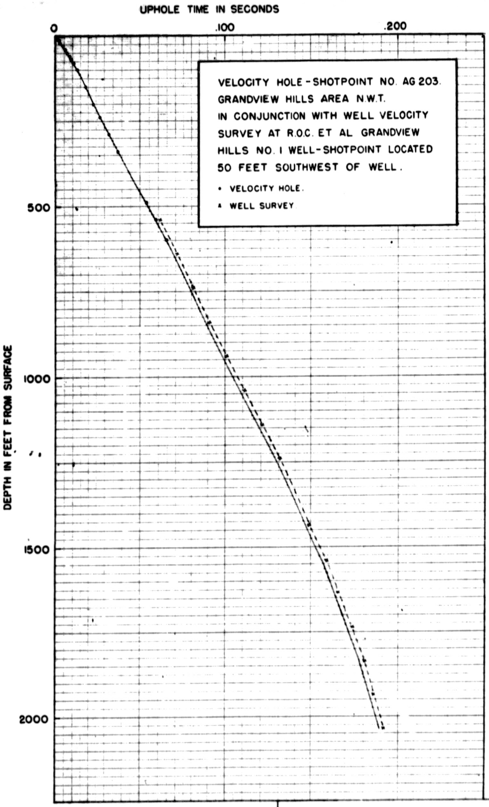
6.2 Cross Sections and Maps

6.21 Record Sections

Specimen records were chosen from field playbacks, timed, and taped together in their proper sequence to make up record sections of ten records each. The records were counted as described under section 6.1. The surface elevation and a plot of the corrected two-way reflection time for the A horizon was shown along the top. For all the shotpoints listed below:

AG-101 to 199
AG-201 to 203
AG-301 to 336
AG-426 to 482
AG-550 to 560, all inclusive,

the A horizon, plotted along the top of the record section, was corrected to the sea level datum using 9,000 feet per second as the replacement velocity. On all the remaining record sections the A horizon was plotted using the corrections obtained from the time-depth curve.



TIME-DEPTH CURVE USED
IN RECORD CORRECTIONS

PLATE III

6.22 Plotted Time Sections

On the seismic-time cross-sections, the driller's logs, the surface profile and a line representing sea level, are displayed at the top. Under this, the corrected reflection times were plotted. The times as plotted on all of the time sections have been corrected using the time-depth curve. The correction to sea level for each hole is listed on the horizon data sheets.

6.3 Reflection Quality

Reflection identifications were made from the Richfield Oil Corporation et al Grandview Hills No. 1 well. The events mapped were the Ramparts Shale Member of Middle Devonian age (A), the Ordovician-Silurian interface, (B), and one other deeper reflection (X), thought to be near the basement. Since this event was deeper than the total depth of the well, this reflection could not be definitely identified.

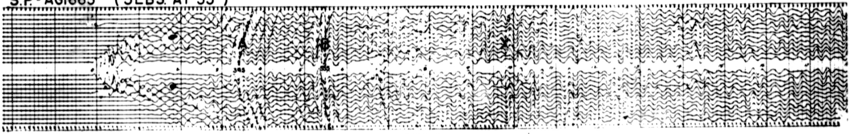
In general, reflection quality was fair; the A-horizon energy in particular was excellent, for example, see Plate IV following this page. Early energy before the A event was intermittent. The B reflection was generally fair and exhibited fairly good character over most of the prospect. Although the B energy was often discontinuous and broken, correlations based on character are considered to be reliable. The X reflection very often was missing, consequently correlations of this horizon are not very reliable.

6.4 Maps

The following maps have been submitted with this report:

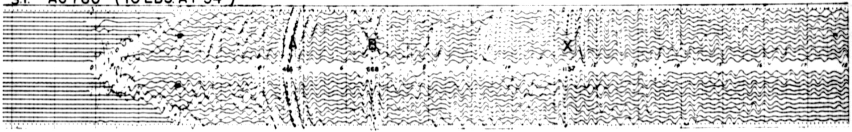
1. A Horizon time-structure map.
2. A Horizon time-structure map corrected to the datum using a constant velocity of 9000 fps.

S.P. - AG1665 (5 LBS. AT 55')



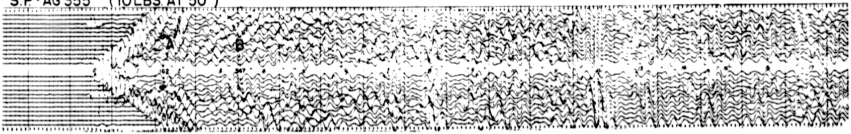
GOOD

S.P. - AG 780 (10 LBS. AT 54')



AVERAGE

S.P. - AG 355 (10 LBS. AT 50')



POOR

SPECIMEN RECORDS
GRANDVIEW HILLS AREA
PLATE IV

3. A Horizon contoured in feet, using the time-depth curve of Plate III as the velocity function.
4. A Horizon time-structure map (scale of 4 miles per inch).
5. B Horizon time-structure map.
6. X Horizon time-structure map.
7. A-B time interval map.
8. A-X time interval map.
9. B-X time interval map.
10. Surface topography map.

The surface topography map has been completely contoured. Except for map number 4, the seismic maps have not contoured much beyond each seismic line. The seismic lines are so far apart that any contours between the seismic lines would lie in the realm of fantasy. Despite this objection, however, map number 4 has been completely contoured in an effort to show what might exist structurally. It should be clearly understood that the interpretation shown on the small-scale map is guesswork.

6.5 Structural Features

Surface and photogeological studies preceeded the seismic operation. The results of the preliminary work suggested that the axes of the major structural features, visible from the surface, were oriented northwest-southeast with regional dip to the southwest. Several transverse faults were indicated. The seismic lines were aligned parallel or perpendicular to the surface strike. From the results of the seismic work, it is believed that the shallow horizons dip to the west and the deep horizon dips to the northwest, nearly at right angles to the regional dip determined from photogeological data.

From the small-scale map of the A Horizon, it will be seen that there appear to be two major anticlinal trends oriented more or less north-south. The first of these runs through the center of the prospect from the intersection of the 900 and 2400 lines, north to the 1100 line. A maximum of 40 ms reversal appears at shotpoints 1148 to 1152. It is interesting that a gas seep occurs at the north end of this feature, about 1 1/2 miles north-west of shotpoint 1141, in the MacKenzie River.

The second major trend lies east of the first and extends from shotpoint 1020, north through the intersection of the 100 and 400 lines, to shotpoint 1467. A maximum of 30 ms of reversal appears on this feature at shotpoints 177 to 182. The two features just discussed tend to form a terrace in the otherwise monoclinal dip. The formation of a reef could be possible along the terrace.

Other high trends are shown on the map, although lack of information prevents their interrelationship from being determined. These possible features appear in the vicinity of Shotpoints 2422, 863, 1256, 737, and 1846. A few faults are indicated on the A Horizon.

The B map resembles the A map structurally, except that there are many breaks in the continuity of the B reflection at locations which are indicated on the maps as dashed lines. Some of the breaks in continuity are believed to be due to faulting, in which case the direction of throw of the fault has been indicated on the maps. Where no such indication has been shown on the maps, the reflection discontinuities are believed to be due to interference from, say, diffracted events or accidental lineups. For want of information, the faults have been shown as being at right angles to the seismic line.

The X reflection is poor and discontinuous; correlations at this level are often unreliable. As a result, the interpretation shown on the X time-structure and time-interval maps are open to question. A few possible faults are indicated on the X map. Generally, the structural pattern resembles that of the A and B maps, except that the northwest regional dip appears to be greater.

The A to B time-interval map was difficult to contour since the interval between the A and B horizons is virtually constant. The spots of significant thickening or thinning occur at the fault zones. The thinning between the A and B is shown on the up-thrown side of the fault, which is most always the northeastern side.

The A-X and B-X map show regional westward thickening primarily due to the slightly steeper regional dip of the X reflection. Both maps show a general thinning in the vicinity of the high trends.

6.51 Structure Test

Norman Wells type reefing should make itself evident as a thickening between the Ramparts shale member and formations directly above. This effect was seen on the 400 line in the vicinity of shotpoint 470. Definite up-dip thickening was seen between the A horizon and reflections in a zone 50 to 100 ms shallower, from shotpoints 470 to 478. From 478 to 485, the shallow section appeared to thin to the northeast although the quality of the very shallow reflections deteriorated somewhat. Since the depth to the Ramparts was only about 1100 feet, it was decided to attempt to use the shothole drill from the seismic crew to drill a structural test hole (Operational details are given in Appendix A) at shotpoint 478.

The hole was successfully completed to 1200 feet, penetrating the Ramparts shale member at the depth predicted by the seismic reflection data. The section found in the core hole resembled that of the ROC Grandview Hills well. No reef was found.

6.52 Gas Seeps

Gas was encountered in shotpoints 732 and 340. The gas from shotpoint 340, when lit, burned with a yellowish flame about twelve feet high for the first few hours, diminishing to four feet for the next three days. A sample of the gas from this hole was sent to the laboratory for analysis. The gas from shotpoint 732 burned with the same yellowish flame but appeared to be under less pressure as the flame was only about three feet high when lit. The flares were later extinguished and the holes were plugged.

7. RECOMMENDATIONS

7.1 Program

The area surveyed was very large. The existing seismic lines are so far apart that it is quite impossible to make a decisive interpretation of the seismic data. The present grid of lines should be approximately cut in half. The new lines should, of course, be laid out with an eye to evaluating the two structural trends discussed in the second and third paragraphs of section 6.5. Future program should be flexible enough to permit the detailing of promising leads that might result from the added work. Except for detours around lakes, the terrain should not, in general, offer resistance to the placement of program wherever desired.

7.2 Equipment

7.21 Cats

Three D-7 cats are recommended for line-cutting. The third cat could be used occasionally for moving the seismograph party's fuel sleigh and assist on camp moves in particularly rough terrain. A cat camp mounted on heavy wooden freight sleighs would be most suitable.

7.22 Trucks

One additional utility pickup truck would be most useful. All of the pickup trucks should be equipped with four-wheel drive. While the remainder of the trucks could carry on their normal operations using two-wheel drive, if they will be obliged to tow the camp trailers, they, also, should be equipped with four-wheel drive.

7.23 Transportation and Supply

7.231 Supply Truck

A vehicle specifically designed for the transportation of fuel and supplies from the supply base, is strongly recommended for any future winter's operation. This unit should be a tandem or four-wheel drive, 4 to 5-ton truck equipped with a front end winch. The body should be equipped with a compartmented 1500+ gallon tank for fuels, with special provision for hauling perishable groceries, dynamite, and caps.

7.232 Sleighs

Two good-sized wooden freight sleighs, capable of hauling 15-ton loads are recommended for transporting the crew's immediate requirements for fuel, parts, and other supplies.

7.233 Fuel Storage

It would probably be more convenient to store liquid fuels in camp, in sloop- or sleigh-mounted, bulk, storage tanks of 500 gallon capacity, rather than in 45-gallon drums.

7.24 Camp

The camp trailers were generally satisfactory. Some work will have to be done to strengthen the spring suspensions before another season's use can be expected from them. Tubes should be inserted into all of the tires not already having them. A good supply of at least 6 tires and tubes should be sent up for spares.

7.3 Schedules

The cat crew should be started at least a week in advance of the seismic crew, to give the new-cut line a chance to freeze and to get sufficient line cut ahead to prevent the rest of the crew from waiting for line.

7.4 Communications

The Department of Transport has installed a three-channel single sideband transmitter at Inuvik using frequencies of 4603, 61177.5, and 9370 kc. It is recommended that the crew be supplied with a suitable radio to take advantage of the new service. Probably a single sideband transceiver for contacting Inuvik and a VHF radio for communicating with the cat camp, should be sufficient.

At different times of the day and at different times of the year, certain frequencies are more useful than other frequencies. Furthermore there are periods of complete blackout. Monthly predictions of the Maximum Usable Frequency and the Lowest Usable Frequency can be obtained from the Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado and at Anchorage, Alaska. We recommend that the monthly prediction charts be obtained and that radio communication equipment be tuned to those frequencies which are expected to be of the most use during the winter season. Some thought might be given to VHF scatter propagation from meteor trails. During severe auroral displays, VHF communication is sometimes possible over long distances (1000 miles) when other channels are blacked out.

APPENDIX A

CORE HOLE OPERATION

The purpose of the core hole operation was discussed in paragraph 6.51.

The fluid type shothole drill was removed from the seismic crew and moved to shotpoint 478, where a temporary, improvised fly camp was set up. The drilling operation commenced about March 24th and continued through April 11th. In addition several days were spent, before and after the operation, in assembling and disassembling personnel and equipment.

In addition to the drill, a water truck, a Dodge pickup truck, and a D-7 Cat were assigned to the core hole. One thousand feet of extra drill stem, 300 feet of casing, a core barrel, an electric logger, production testing equipment, cement, and mud were flown into the site by DC-3, from Dawson City. For safety's sake, a blow-out preventer was also sent up. The shothole drill was converted to heavy-duty service by the addition to the drawworks of larger cable and travelling blocks,

Personnel consisted of an engineer, a tool pusher, a geologist, four drillers, a cat operator, a logger operator-clerk and a cook. Although the camp was catered by an outside caterer, most of the food and fuel was supplied from the seismic base storage.

The core-drill camp was too far (about 70 road miles) from the seismic camp to make surface transportation feasible, so the only means of communication was by air. Flights were made nearly every day except towards the end of the operation when less frequent flights were made.