Report on Seismograph Survey

L I A R D R I V E R A R E A

Northwest Territories

for

Murphy Canada Oil Company

J.R. Walker
October 7, 1959

Exhibit Removed

REFLECTION SEISMOGRAPH SURVEY OF THE LIARD RIVER AREA, NORTHWEST TERRITORIES

Introduction:

The seismograph survey of the Liard River Area, Northwest Territories, was conducted for Murphy-Canada Oil Company with offices in Calgary, Alberta, by General Geophysical Company with Canadian offices in Edmonton, Alberta. It was done during the period, January 5, 1959, through March 19, 1959. This general reconnaissance reflection seismograph program covered some 145,000 acres, and 465 shot points covering 115¼ miles of seismic control were recorded. It was conducted as an exploratory measure toward the structural evaluation of Oil and Gas Exploratory Permit areas number 1034, 1035, 1045, 1046, and 1047, acquired in December, 1956, and number 1648 acquired in September, 1958. These permit areas total 373,788 acres.

Location and Accessibility:

The general survey area is approximately 190 miles north of Fort Nelson, British Columbia, and is situated between 60° 40' North Latitude and 61° 00' North Latitude, and between 122° 00' West Longitude and 123° 30' West Longitude. Operations were conducted from portable camps with the use of equipment transported from Edmonton, Alberta. The area was accessible from Fort Nelson, British Columbia via mile 317 on the Alaska Highway by bull-dozed trail. This trail extended northward for a distance of approximately 170 miles to the boundary of the survey area. The Liard River affords a comparatively good access route during the summer months.

Terrain and Field Conditions:

Topographical elevations ranged from slightly over 700 feet above sea level to 2350 feet above sea level as indicated on the accompanying map (Exhibit "A") which is included as a part of this report. These extremes occurred at the Netla River in the southwestern portion of permit area number 1047 and in the south central portion of permit area number 1045 respectively. This difference of some 1650 feet is distributed rather uniformly over the central two thirds of the survey area. It forms a comparatively smooth easterly rising surface for a distance of some thirty miles. This gentle sloping, along with the Netla River, affords good drainage into the Liard River which bounds the general area on the north and west. An alluvial flood plain is in evidence in the extreme western portion of the area along the Liard River. With the exception of an occasional patch of heavy timber most of the area is covered with small spruce trees and muskeg.

There were no surface outcrops in evidence on lines traversed during the survey. Muskeg and/or glacial drift covered Cretaceous formations in the eastern portion of the area and covered Paleozoic formations in the western portion.

Operations had to be conducted during the winter freeze-up period because a large part of the area was covered by muskeg. This was done with the use of bulldozer, truck, Bombardier track, and Road Patrol equipment. Extremely severe weather conditions (-60°F) and heavy snowfalls were encountered during the earlier part of the survey.

Field Operations:

Two drill units were employed during the entire period and three

water tank units were employed during most of the period for drilling shot holes. These drills were a Failing CFD-1 mounted on a five-ton G.M.C. truck and a Sewell auger type drill mounted on an M-5 Bombardier track vehicle. The water tank units were two conventional vehicles mounted by 800 gallon tanks and one M-5 track unit mounted by a 200 gallon tank. Drill bits used in the operation were both rock and finger type. The average shot hole depth was approximately 45 feet. They encountered up to 10 feet of muskeg and 30 feet of glacial drift covering the underlying beds in the western part of the area. These underlying beds were, for the most part, hard clays and shales. Holes drilled in the vicinity of the Liard River encountered a dark silty sand believed to be alluvial in nature. Shot holes in the eastern portion of the area encountered up to 10 feet of muskeg and up to 50 feet of glacial drift. Several deep holes were attempted, but maximum penetration was only 100 feet. This limited penetration was due to encountering a so-called hard shattered sandstone. No casing or charge anchors were used in these operations. Sand points were used when necessary.

Recording was done on 24 trace magnetic recording equipment employing a 2640 foot split-continuous type spread with shot points spaced at 1320 foot intervals. Two seismometers were spaced 30 feet apart per group on each of 24 groups having intervals of 110 feet. The first shot for all recording was taken at the bottom of the hole; and subsequent shots, whenever possible, were taken up the hole to check the optimum shooting level. The best average shot depth in most of the area was found to be about 35 feet. Explosive charges varied from 1¼ to 15 pounds of dynamite, but best average results were obtained by using a 2½ pound charge. Throughout the recording operation magnetic monitor tapes were played back on

various filter settings but were not adjusted for static and dynamic corrections.

Surveying for horizontal and vertical control was done with transit and chain and with alidade and plane table. The take-off point for this control was received from Sun Oil Company and is based on elevation and position of a station from their surveys within Oil and Gas Exploratory Permit number 1037 immediately to the south of Murphy-Canada permit number 1047. No other points or bench marks were known to be in the area. A vertical tie of 2.9 feet was obtained for the 37 mile closed traverse from the take-off point to this survey. All unclosed lines within the survey were double-run or duplicate readings were made.

Cost of Survey:

A cost analysis has been made of the seismic survey conducted in the Liard River Area, Northwest Territories, during the period January 5, 1959, through March 19, 1959. The costs have been distributed insofar as they were identifiable into major cost categories as follows:

Crew cost including explosives, drilling, bits, mud, water, etc.	$69,281.43
Line Cutting and Road Construction.	36,292.00
Transportation of Seismic equipment, camp equipment, personnel, etc.	20,158.40
Camp including cooks, helpers, food and supplies. Equipped for 28 men.	14,946.75
Total Cost of Survey	$140,678.58

Further analysis shows the cost of this reconnaissance program to be $0.97 per acre surveyed. It also shows that the cost was approximately $300.00 per shot point and approximately $1,220.00 per mile of seismic control.

The total cost of the survey as set forth above includes approximately $22,000.00 in expenditures for road building and

geophysical examinations outside the Oil and Gas Permits held by Murphy-Canada. These "Off-Permit" expenditures are approximated as follows:

Geophysical Examinations	$13,000.00
Road Construction & Snow Clearance of Access Road	9,000.00
Total Off-Permit Expenditures	$22,000.00

Computing and Data Reduction:

Weathering corrections were made for each position recorded by use of the up-hole time plus the rectilinear sub-shot method of computing delay times. The refraction breaks were plotted from reflection seismograms and used in conjunction with up-hole times in computing delay times. Refraction break corrections were made to a horizontal velocity of 10,000 feet per second. This velocity was also used to reduce reflection times to a reference plane of 1,500 feet above sea level.

Practically all reflected energy was picked and plotted on standard cross-sections after having been corrected for weathering and elevation variations and for play-back and filter delays. Allowances were made for normal move-out and end traces were also plotted. Because of the lack of depth velocity control all cross-sections were plotted in corrected two-way travel time to a reference plane of 1,500 feet above sea level.

Record quality varied considerably over the entire area but could be considered generally fair. The most marked deterioration in record quality was observed from holes shot in the Liard River flood plain. Several continuous shallow reflections, ranging in two-way corrected travel time between .100 and .400 seconds, were

observed in the central and eastern portions of the area. One of these shallow reflections, possibly from the Lower Cretaceous, was observed at corrected times between .190 and .300 seconds. The quality of these reflections could be considered generally fair.

Of the deeper reflections, one was observed at corrected times between .470 and .770 seconds. This reflection, possibly from the Techo member of the Upper Devonian, was very poor in a few places but could be considered generally good. It showed evidence of fair correlation in the eastern portion of the area.

The only reflection observed to be continuous and correlative to most of the area varied in corrected times from .600 to 1.030 seconds. This reflection, possibly from the Ramparts formation of the Middle Devonian, was of good quality over approximately 80% of the area.

Structural Interpretation:

The recording and computing procedures were adequate for obtaining and reducing seismic data necessary to map three separate horizons over a considerable portion of the area. No well control was available for more positive geological information but the three horizons are believed to be from the Lower Cretaceous, the Techo member of the Upper Devonian, and the Ramparts formation of the Middle Devonian. Each of these horizons has been delineated in corrected reflection times to a datum plane of 1,500 feet above sea level with ten millisecond contour intervals. This was done because of the lack of depth velocity control. The limited experimental work which was done for velocity control indicated the average velocity from the base of the weathered zone to the Ramparts formation to be about 11,000 feet per second. However, this was

~~incomplete and inconclusive.~~

The shallow, possibly Lower Cretaceous, horizon showed dip in a southerly direction at the rate of about sixteen milliseconds per mile. The complete absence of this reflection in the western portion of the area, in conjunction with the westerly decrease in surface elevation, may postulate its approach to a post-Paleozoic errosional surface. No structural development of any significance was observed on this horizon.

Structural development of the Upper Devonian (possibly Techo Horizon) showed generally south dip of approximately .022 seconds per mile over most of the portion surveyed in permit areas 1034, 1045, and 1046. There are indications that this zone is interrupted by minor normal faulting in the western portion of permit area 1046 and in the northeastern portion of permit area 1045. However, because of the limited seismic control afforded by this reconnaissance program, the strike or trends of these faults are somewhat indefinite. Correlation of reflections from this Upper Devonian horizon could not be positively established in the western 40% of the survey area. It is felt, however, that subsequent seismic control will establish its correlation to an unmapped horizon which lies about .110 seconds above the Ramparts formation of the Middle Devonian.

The structural delineation of the Middle Devonian (possibly Ramparts formation) on the accompanying map (Exhibit "B"), included as a part of this report, shows a complexity of faulting throughout most of the area. The problem of resolving the strike at this level, as in the case of the Upper Devonian horizon, was most difficult because of the broad programming of seismic lines. The most salient structural development of the Middle Devonian as associated with faulting is the large anticlinal nose located in the

eastern part of permit area 1047. The axis of this nose is indicated to be about due north-south along seismic line 26-"0". Southerly dip along this axis is measured at the rate of approximately .029 seconds per mile. East and west dip off the nose along line 26-10, through the central portion of permit area 1047, is at the rate of about .022 seconds per mile. The apparent northwest-southeast striking faults across this large nose make possible two or more structural closures. However, because of insufficient control, due to the nature of the survey and to some poor data, these possible closures could not be definitely confirmed. Structural control for the western side of this major feature was interrupted by a rapid deterioration of record quality in the flood plain of the Netla and Liard Rivers. Records taken in this flood plain (26-7-33 to 26-7-54) did not enable a definite correlation of the Possible Ramparts formation reflection with those taken on the extreme western end of line 26-7. The application of datum values to that portion of line 26-7 was made to indicate the rate of dip of approximately .070 seconds per mile.

Although the large nose in permit area 1047 appears to be the feature of major interest on the Middle Devonian horizon, another feature of some significance is indicated by apparent dip reversals and change of strike along line 26-A in the extreme eastern portion of the survey. However, there is insufficient seismic control to establish the full significance of this possible anomaly which has been predicated on the application of somewhat questionable data.

<u>Conclusions</u>:

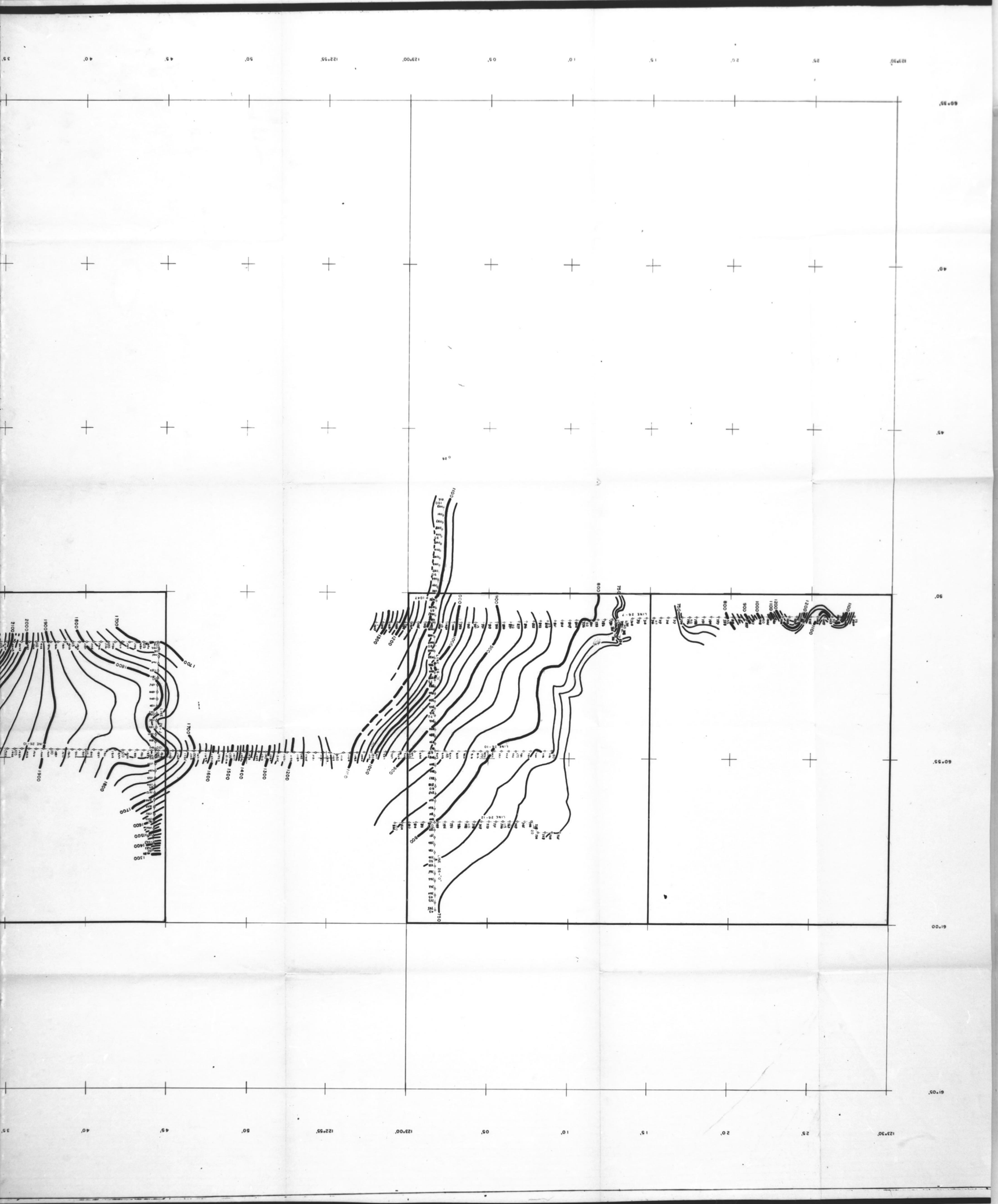
This reconnaissance reflection seismograph survey of the Liard

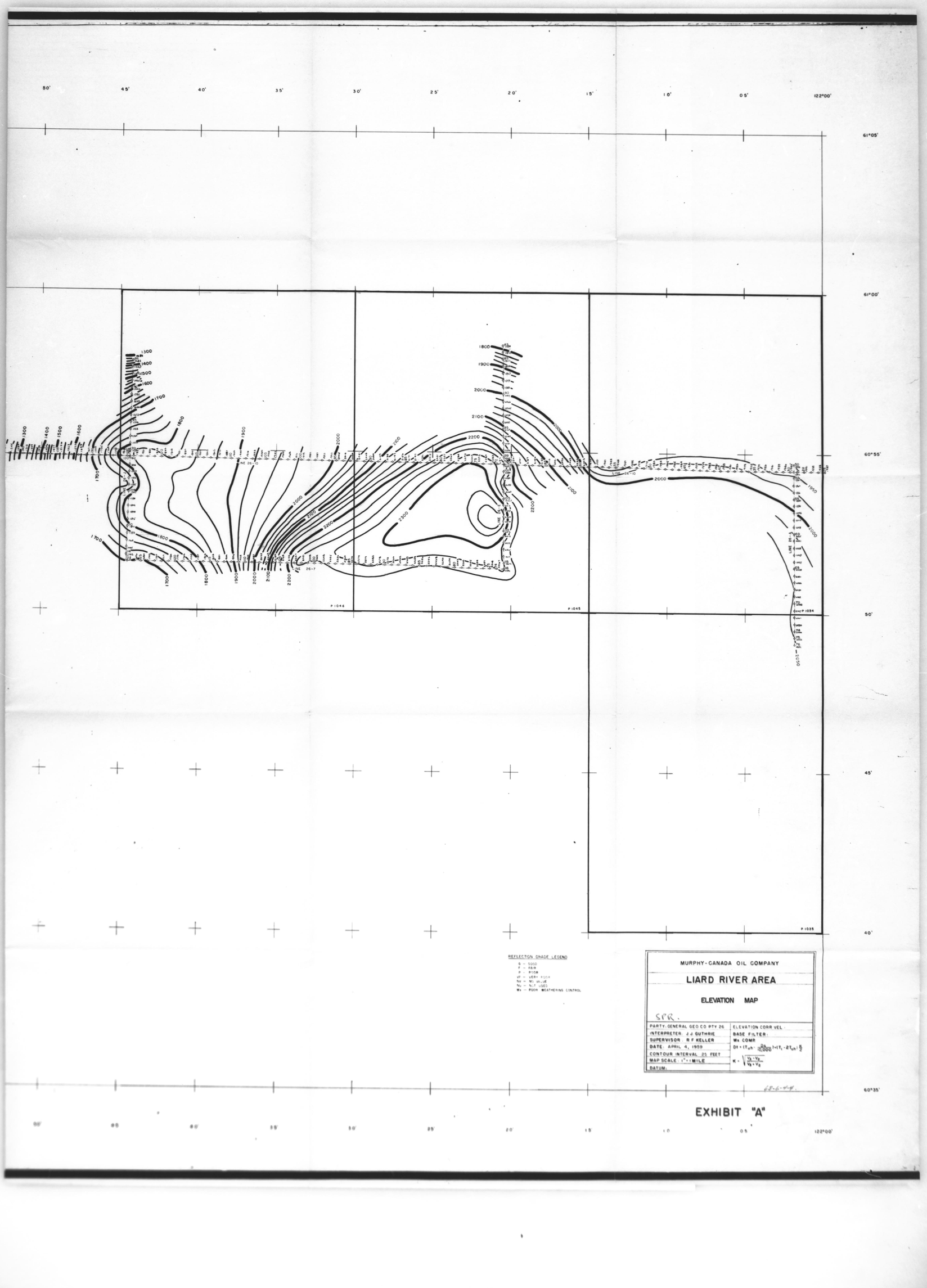
River Area, Northwest Territories, was conducted in an effective and satisfactory manner and fulfilled the objective of completing at least the preliminary phase toward the structural evaluation of Oil and Gas Exploratory Permit areas numbered 1034, 1035, 1045, 1046, 1047, and 1648. It will be necessary to conduct a supplementary seismograph survey in order to make a structural evaluation of the entire area covered by these permits, and to obtain the necessary information to resolve the significant structural possibilities indicated by this survey.

Respectfully submitted,

J. R. Walker
Staff Geophysicist,
MURPHY CORPORATION

October 7, 1959




50'
45'
40'
35'
30'
25'
20'
15'
10'
05'
122°00'
61°05'
61°00'
60°55'
50'
45'
40'
60°35'
P 1046
P 1045
P 1035
P 1034
LINE 26-6
LINE 26-7
LINE 26-10
LINE 26-3
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
REFLECTION GRADE LEGEND
G = GOOD
F = FAIR
P = POOR
VP = VERY POOR
NV = NO VALUE
NU = N.I.T. USED
Wx = POOR WEATHERING CONTROL
MURPHY-CANADA OIL COMPANY
LIARD RIVER AREA
ELEVATION MAP
SPR.
PARTY: GENERAL GEO CO PTY 26
INTERPRETER: J J GUTHRIE
SUPERVISOR: R F KELLER
DATE: APRIL 4, 1959
CONTOUR INTERVAL: 25 FEET
MAP SCALE: 1" = 1 MILE
DATUM:
ELEVATION CORR VEL:
BASE FILTER:
Wx CORR:
DT = (T_sh - D/10,000) + (T_s - 2T_sh) S/2
K = sqrt((V_s - V_f)/(V_s + V_f))
EXHIBIT "A"