673-06-05-69

SEISMIC REFLECTION AND GRAVITY REPORT

BRACKETT LAKE
Northwest Territories

Permit No. 5439 to 5442 inclusive
Permit No. 5545 & 5652
Project No. 673-6-5-73-1

Report by

R. J-M. Weber January 1974

AQUITAINE COMPANY OF CANADA LTD.

673-06-05-69

# SEISMIC REFLECTION AND GRAVITY REPORT

## BRACKETT LAKE

Northwest Territories

for

AQUITAINE COMPANY OF CANADA LTD.

Calgary, Alberta

Contractor

WESTERN GEOPHYSICAL LTD.

Calgary, Alberta

November 1972 - January 1973

Permit No. 5439 to 5442 inclusive

Permit No. 5545 & No. 5652

Project No. 673-6-5-73-1

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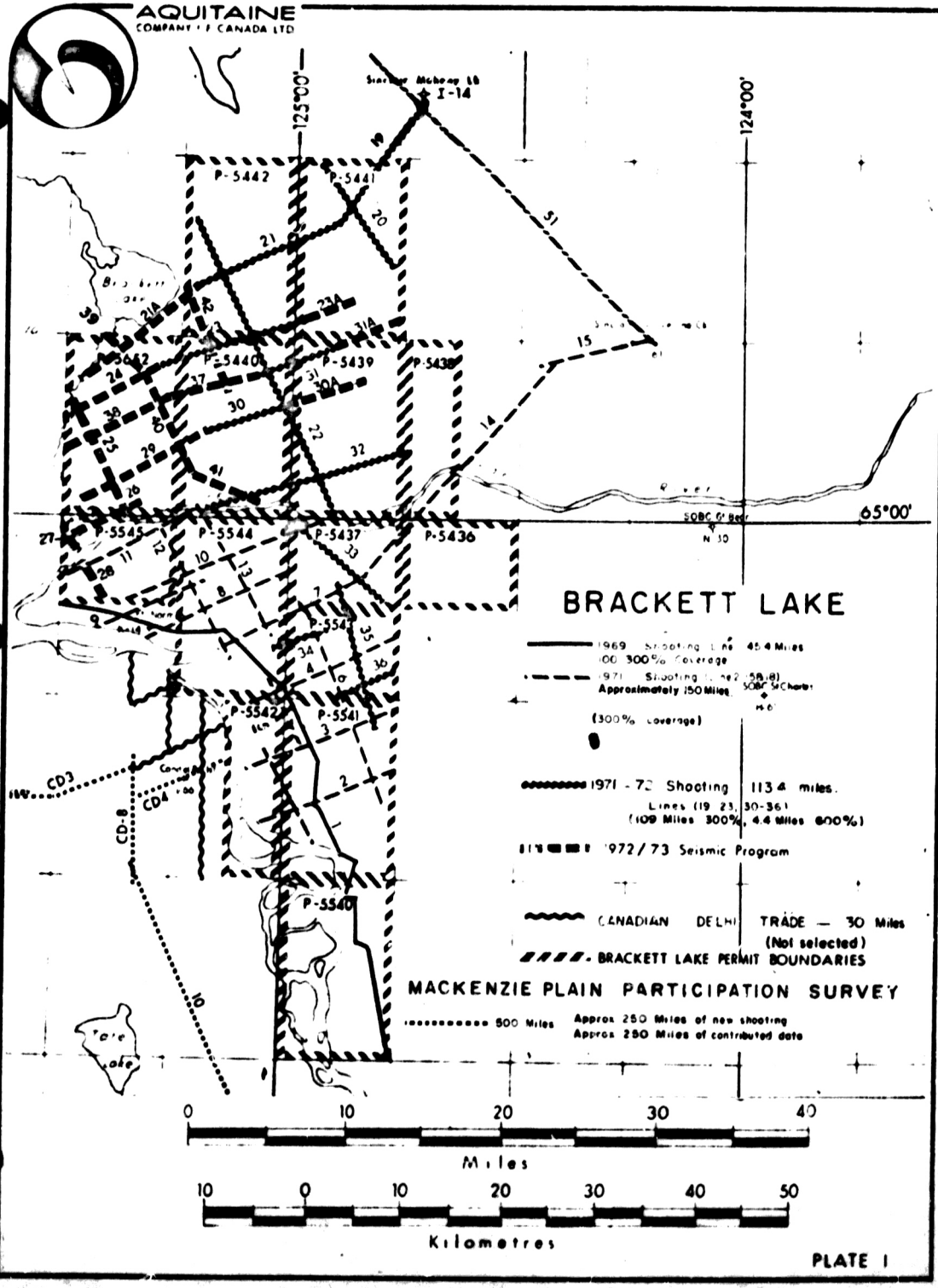
# PART ONE

## FIELD OPERATIONS


AQUITAINE
COMPANY OF CANADA LTD
125°00'
124°00'
65°00'
I-14
P-5442
P-5441
P-5440
P-5439
P-5438
P-5545
P-5544
P-5437
P-5436
P-5543
P-5542
P-5541
P-5540
CD3
CD4
CD-8
BRACKETT LAKE
1969 Shooting Line 45.4 Miles
(100 300% Coverage
1971 Shooting Line 58.8
Approximately 150 Miles
(300% Coverage)
1971 - 72 Shooting 113.4 miles.
Lines (19 23, 30-36)
(109 Miles 300%, 4.4 Miles 600%)
1972/73 Seismic Program
CANADIAN DELHI TRADE — 30 Miles
(Not selected)
BRACKETT LAKE PERMIT BOUNDARIES
MACKENZIE PLAIN PARTICIPATION SURVEY
500 Miles
Approx 250 Miles of new shooting
Approx 250 Miles of contributed data
0 10 20 30 40
Miles
10 0 10 20 30 40 50
Kilometres
PLATE 1

## INTRODUCTION

Situation of the project area: The Brackett Lake permits are located in the Northwest Territories immediately east of Fort Norman. The prospect area lies within the boundaries of latitude 64°30' and 65°20' and longitude 124°30' and 125°30'.

Access is by way of the Pancana Industries Ltd. toll road system from Fort Simpson to Fort Norman, Norman Wells and Pacific Western Airlines from Edmonton to Norman Wells and Charter Aircraft to the camp. Access to the reconnaissance program was gained by utilizing an existing trail from Fort Norman along the north side of the Great Bear River.

Physiography of the area: Generally the area has sparse forest cover, numerous lakes and a few hills. The Franklin Mountains cut across the northeast corner of the permits. The area generally lies between the Mackenzie River, Norman Range and Mackay Range towards the west and St. Charles Range towards the east. The Great Bear River cuts across the center of the area in an east-west direction.

Previous Geophysical Surveys: (See Plate I)

1968-69 : Compagnie Générale de Géophysique shot 45 miles of seismic line across the southwest corner of the permits along the (Calex) Pancana road system. 100 and 300% coverage.

1970-71 : Northern Geophysical Limited shot 150 miles of reconnaissance and detail seismic using a 300% CDP technique.

1971-72 : Western Geophysical Limited shot 156 miles of seismic program and measured approximately 800 gravity stations.

.../2

The 1972-73 seismic program consisted of: (Plate 2)

- a reconnaissance program to evaluate the northwest permits for possible hydrocarbon entrapment (Lines 21A, 24, 25, 26, 27, 28, 37, 38, 39, 40 and 41).
- on the NE permits, three short lines extending previously shot lines toward the St. Charles Range (Lines 23a, 30a and 31a).

The survey was conducted by Western Geophysical Company of Canada, Ltd. Crew P-85. Operations commenced November 28, 1972 after receiving the permit November 27, 1972, and was completed on January 27, 1973. The reconnaissance program north of Great Bear River consisted of approximately 99.5 miles of 300% CDP shooting. South of the river 3 miles of 300% CDP were recorded.

## SEISMIC FIELD OPERATION

### - Crew Composition

#### Personnel

| | |
|---|---|
| Party Manager | W. Cherniak |
| Camp Clerk | Roy Denison |

#### Survey

| | |
|---|---|
| Surveyor | Ken Rollins |
| Surveyor | T. Schellenberg |
| Rodman | D. Kowalishen |
| Chainman | J. Hetchinelle |

#### Recording

| | |
|---|---|
| Observer | Nick Gooliaff |
| Observer | Walter Schawalder |
| Junior Observer | R. K. Dunlop |
| Shooter | G. Fletcher |
| Assistant Shooter | Bob Elliott |
| Cable Driver | J. Garrett |
| Cable Driver | E. Martin |
| Recording Helper | J. MacCauley |

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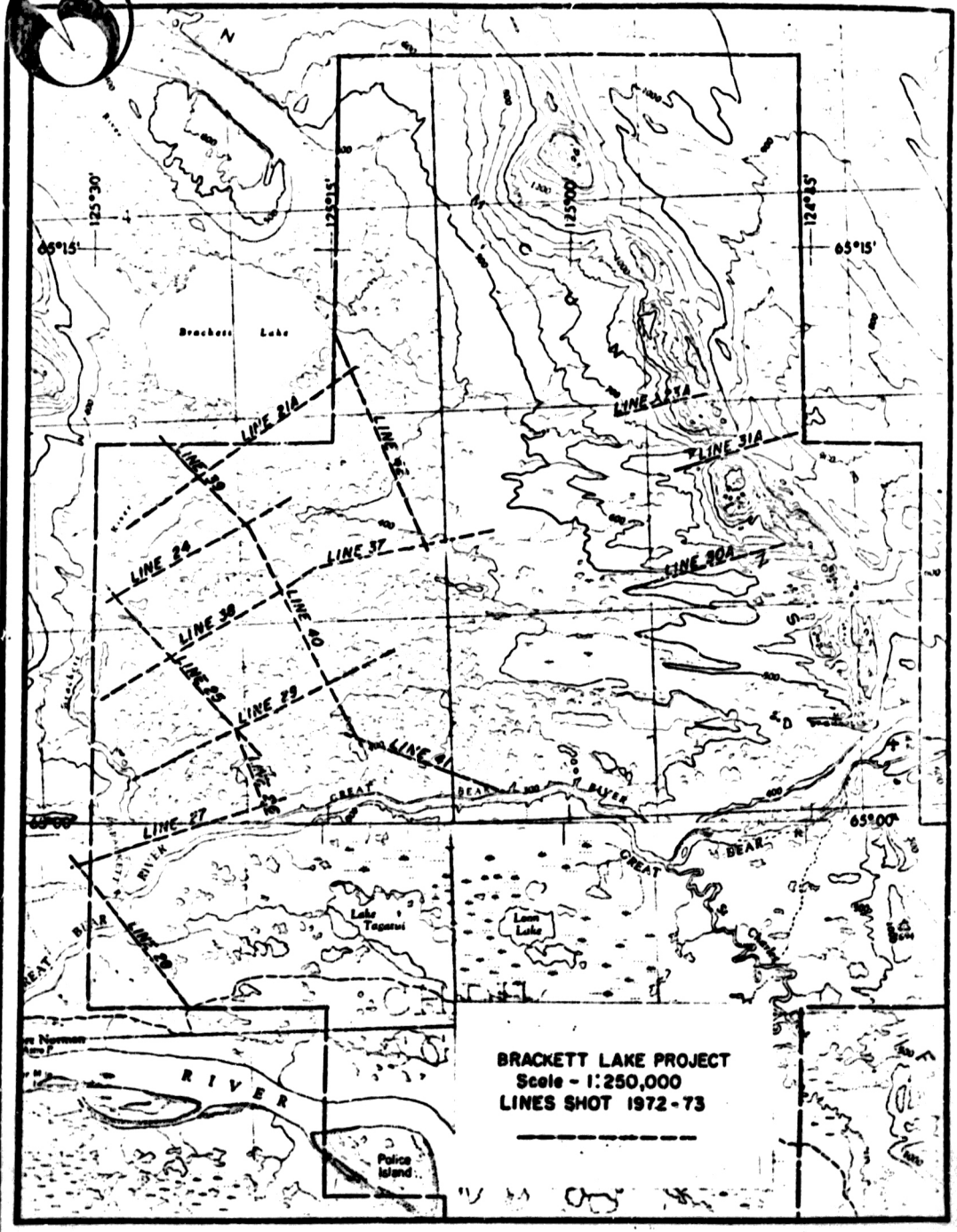


PLATE II

- Crew Composition - cont'd

Recording

| | |
|---|---|
| Recording Helper | R. Horassi |
| Recording Helper | B. Clement |
| Recording Helper | T. Lennie |
| Recording Helper | A. Menacho |

Camp

| | |
|---|---|
| Cook | John Braun |
| Cook's Helper | Fred Allain |
| Camp Attendant | Abe Sidoroff |
| Mechanic | B. Blomer |
| Mechanic | J. Rolston |
| Supplyman | Fern Chailler |

Drilling

| | |
|---|---|
| Driller | T. Bennett |
| Driller | R. Anderson |
| Driller | J. Nash |
| Driller | D. Weinhandl |
| Driller | J. Mostman |
| Drill Helper | B. Rolston |
| Drill Helper | A. Devine |
| Drill Helper | A. Payne |
| Drill Helper | D. McBlain |
| Drill Helper | S. Perrement |

- Summary of Equipment

Technical

1 - SDS-1010 Instrument Set
1 - Potter 151 Tape System
1 - Tektronik Model 453 Oscillograph
1 - RFC-1A Remote Firing System
15 - Portable Cables - 110 foot group intervals, 6 per cable
150 - Strings Geophones, 9 per string, 14 cycle, Mark 1-10

Vehicles

| | |
|---|---|
| 1 - Party Manager Unit | - 4 x 4 Ford Crew Cab |
| 1 - Recording Unit | - RN-110 Nodwell - Gas |
| 1 - Shooting Unit | - RN-110 Nodwell - Gas |
| 2 - Cable Units | - RN-110 Nodwell - Gas |
| 1 - Survey Unit | - RN-110 Nodwell - Gas |
| 2 - Supply Units | - RN-110 Nodwell - Gas |
| 1 - Recording Transportation | - 4 x 4 Chev - Carry-all - Gas |
| 1 - Fuel Truck | - Ford 8000 Tandem - Diesel |
| 1 - Gravity Meter Unit | - Ski-doo - Gas |

.../4

Drilling

| | |
|---|---|
| 2 - Western Model 1500 Air/water | - FN-160 Nodwell - Gas |
| 1 - Western Model 1200 Water | - RN-110 Nodwell - Gas |
| 3 - Water Units | - RN-110 Nodwell - Gas |

Camp

| | |
|---|---|
| 1 - Kitchen/Diner/Sleeper | - RN-110 Nodwell, powered - Gas |
| 1 - Utility/Sleeper | - RN-110 Nodwell, powered - Gas |
| 1 - Office/Sleeper | - RN-110 Nodwell Trailer |
| 1 - Sleeper | - RN-110 Nodwell Trailer |
| 1 - Shop Unit (complete) | - RN-110 Nodwell Trailer |
| 1 - Generator Plant | - RN-110 Nodwell Trailer |

1 - Fuel Sleigh
1 - Propane Sleigh
1 - Sleigh-mounted Cat Camp consisting of:
- 1 Kitchen
- 1 Sleeper
- 1 Shop-Power Plant Unit
- 2 Fuel Sleighs

Bulldozing

1 - D6C
2 - D7F

Miscellaneous

3 - SSB Radios - Main Camp, Cat Camp, and Norman Wells
8 - Motrac Radios - Field Communication

- Summary of Sub-Contractors

MacMillan Construction (Peace River) Ltd.
P.O. Box 1680
Peace River, Alberta

Peace Air Ltd.
P.O. Box 1357
Peace River, Alberta

Dietz Trucking Ltd.
Norman Wells, N.W.T.

FIELD PROCEDURES

Surveying

A WILD-T1-4 instrument was used for this survey. The lines were located by turning angles from known bearings of previously shot lines.

In order to avoid crossing lakes as much as possible, uncontrolled photomosaics and a winged aircraft were used.

The horizontal and vertical control were carried from existing work done the previous winter. All shot points were surveyed.

Shot points and geophone station locations were chained using a surveyor's steel road chain. Group locations and shot points were temporarily marked with flagging or pin flags. An identification tag with permit, shot point and line number was nailed to the nearest tree at each shot point.

Bulldozing

Dozing was done by MacMillan Construction using 3 dozers (2 D7's and 1 D6). With the assistance of the surveyors and aerial photographs the program lines were cut using half of this to pile and walk down timber to meet Forestry requirements. All lines were stopped short of lakes and rivers as stated in permit regulations and Forestry Department.

Drilling

Three drills were used in this survey, with additional shifts being used when necessary. Two drills were air-water combinations and the third a water drill. Drilling conditions were quite good on the western part of the survey, mostly consisting of clay, gravel and sand. However, on the part of the program lying East of the existing NS line 22, extremely hard drilling conditions occurred. Bit consumption was heavy in this area and the formation appeared to be a chert and hard gravel with clay stringers between.

Holes were drilled to a depth of 50' to 55' and preloaded with

..../6

10 lbs of explosives.

The drilling bits used were mostly : Insert bits 4½, Rockbits 4½, Insert bits 4 3/4, Walmac 4 3/4 and 4½.

Recording

A Nodwell kN-110 mounted 24 traces recorder containing a set SDS 1010 instrument and Potter 151 tape system with a 9-track digital tape transport was used for the survey. A string of nine MARK 1-10, 14 Herz geophones were used at each station.

An Electrotech RCF-1A remote control firing system was used to transmit the firing order from the recorder to the shooter and transmit back time-break and up-hole signals. This up-hole time was obtained by placing a single geophone 10 feet from the shot point.

Instrument setting: filters: Lo-cut 8 Hz
Hi-cut 100 Hz

Sample rate 2 ms

Record length = 4 seconds.

Field layout: 300% coverage Plate III
1320' - 110'- 0 - 110' - 1320'

Geophone spacing 9/110'

Group spacing 110'

Shot point spacing : 440'

Holes per location: 1 x 50' deep

Dynamite charge : 10 pounds.

All lines were shot with trace 24 in direction of shooting, beginning and ending with 24 traces. All intersecting lines were extended to give the required coverage at the intersection.

When surface conditions necessitated the skipping of shot points, holes were stacked on last shot point and an expanded spread was

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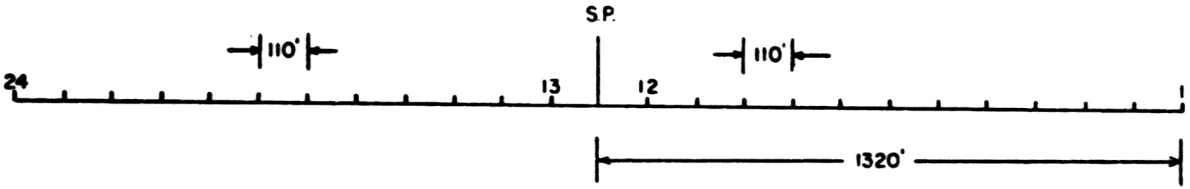
# REGULAR SPREAD DIAGRAM

## 1320'-110'-0-110'-1320'

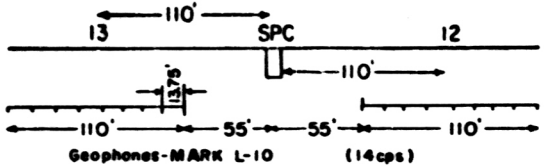



Group Interval - 110'

Shotpoint Spacing 440' for 300% coverage

## GEOPHONE ARRAY

9 Geophones over 110' equally spaced at 13 3/4'




Geophones-MARK L-10 (14cps)

**Note**: Centre of shot point pattern on centre of group (trace) position

PLATE III

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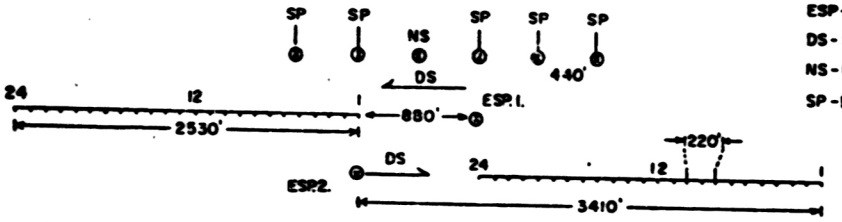
# EXPANDED SPREAD DIAGRAMS

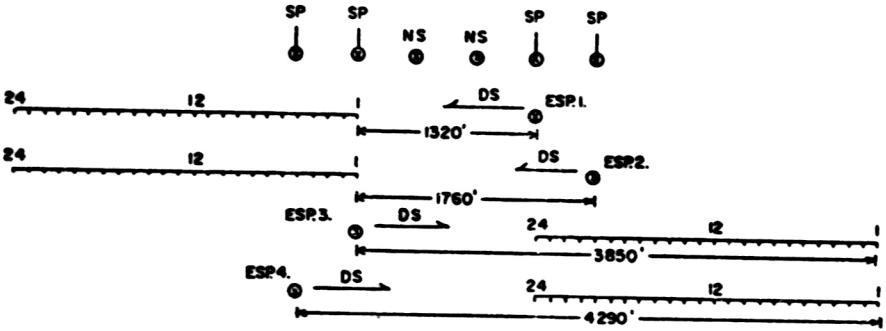
## LEGEND

ESP - Expanded Spread Shot Point
DS - Shooting Direction
NS - Undrillable Location (not shot)
SP - Drillable Shot Location

(Across lake less than 880 feet with one undrillable location (NS))




(Across lake less than 1320 feet with two undrillable locations (NS))




(Across lake less than 1760 feet with three undrillable locations (NS))

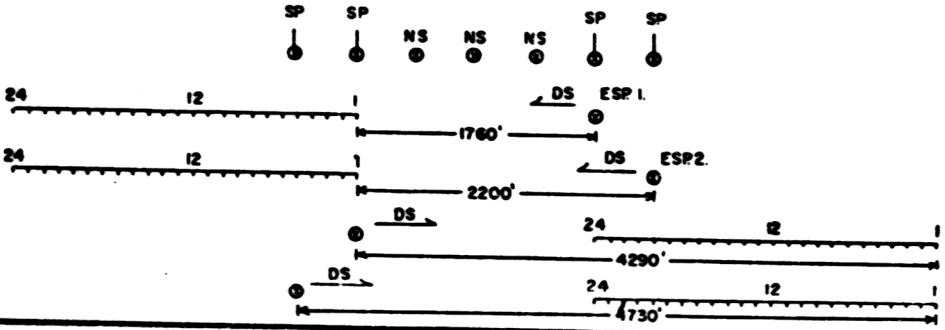



PLATE IV

shot (see plate IV) in order to maintain sub-surface coverage. No holes were drilled or shot within 300 feet of any lake or stream as per instructions of Fish and Game Department. In some instances, the continuity of the subsurface coverage had to be interrupted.

Working Conditions, Supply & Communications

Conditions were generally good due to flat topography and good accessibility to the prospect. However, unexpected warm weather caused minor problems in moving around because of thin ice and muskeg patches not being sufficiently frozen to drive on.

Daylight hours were short and consequently a considerable part of the survey was carried out in darkness.

Norman Wells was used as a base for supplying crew, as daily commercial flights stopped and Western used its own expediting and storage services with 2 airplanes on contract from this point - one an Islander twin engine capable of carrying 2000+ lbs, the other a Cessna 185. From Norman Wells to the crew averaged approximately 30 minutes each way.

Radio communication between field camp and Norman Wells was obtained through SSB radio sets. From Calgary, contact with the crew was only possible by relay from the Norman Wells based expeditor.

GRAVITY METER OPERATION

The gravity measurings were conducted by D.D. Baker, using a LACOSTE & ROMBERG model G-Meter. This instrument had a very low drift rate and excellent check runs were obtained between bases.

The primary base, at the camp landing strip was assigned a gravity value corresponding to the value of the reading on Lacoste &

.../8

Romberg's calibration table, which was established during the 1971-72 season. Bases were set along lines at intervals sufficiently short to allow adherence to the maximum time limit of two hours between checks.

New bases were set by making two overlapping base runs from an established base...(A, B, A, B).... The gravity intervals from each pair of runs were averaged to add algebraically to the established value to yield the value of the new base.

Stations were measured over the seismic network at an interval of 1320' i.e., 4 stations to the mile totalling approximately 400 stations. A detail survey, over 5½ miles on previous year's line 23 was carried out in order to check with a 12 station/mile spacing a questionable gravity feature depicted during the 1971/72 survey (54 new stations).

The field measurings are believed to be quite accurate, within $\pm$0.03 milligal. Part of this consistency must be attributed to the excellent low drift rate of the Lacoste meter and the two hours maximum time allowance between two consecutive base checks.

# PART TWO

## PROCESSING OF THE SEISMIC

## and

## GRAVITY DATA

PROCESSING OF THE SEISMIC DATA

The initial write-up of the field records was done in the field by a computer clerk.

The magnetic tapes were processed in Calgary using Aquitaine's in-house computer system.

Basically, the following flow chart was used:

DEMULTIPLEXING: The field reels were demultiplexed using full gain recovery on automatic gain control sliding window of 250 m.s.

TRACE SELECTING: editing the data in the proper sequence.

100% DISPLAY: first check

AUTOPREP: At this stage structure statics are calculated, using a datum of +500', a replacement velocity of 10,500'/s and weathering velocities around 2000'/s. R.B. Cruz and Associates Ltd. was subcontracted by Aquitaine to do the data preparation for weathering correction, trim static picking and final dressing of the stacked sections.

DATA EDIT:

STRUCTURE STATIC:

POINT SORT: Trace gather with statics applied.

VELOCITY PHASE

CDP VEL : This program scans a suite of CDP gathers of different velocities : 500'/s increment between 4000'/s to 20,000'/s.

DISPLAY and interpretation of the velocity data.

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NMO

DIGITAL FILTER: 15/20 - 65/75

RECREATE: 100% NMO corrected DISPLAY for checks and study of residual statics

OVERLAP STATICS: programme designed to calculate residual statics in the 100% mode.

MUTE

TRIMSTATICS:

STACK: 300%

SAAG: EQUALization by a digital AGC

MIX: three trace mix was used in a 25-50-25 ratio.

FINAL: display on film.

During the processing, some testing was performed in order to design the optimum filter bands and in attempts to enhance poor data areas (optimum stack programs, dip optimized programs...).

REDUCTION OF THE GRAVITY DATA

Latitude corrections were applied to each drift corrected station value on the basis of the "international gravity formula".

$$g = 978.0 \quad (1 + 0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi) \text{ gals}$$

or more practically, using the rate of change (K) in milligal per mile along a North-South line:

$$K = 1.307 \sin^2 \phi$$

$\phi$ = central latitude of the area = 65°05'

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BOUGUER and FREE AIR corrections were made successively using surface densities ranging from 1.8 to 2.7. Although locally high densities or very low densities worked best, a 2.2 density appeared to be a good average for the total area.

Datum: Sea level

Terrain correction, with the exception of three eastern lines ending in the St. Charles Range, most of the program has been carried out in a flat area where terrain effect is negligible.

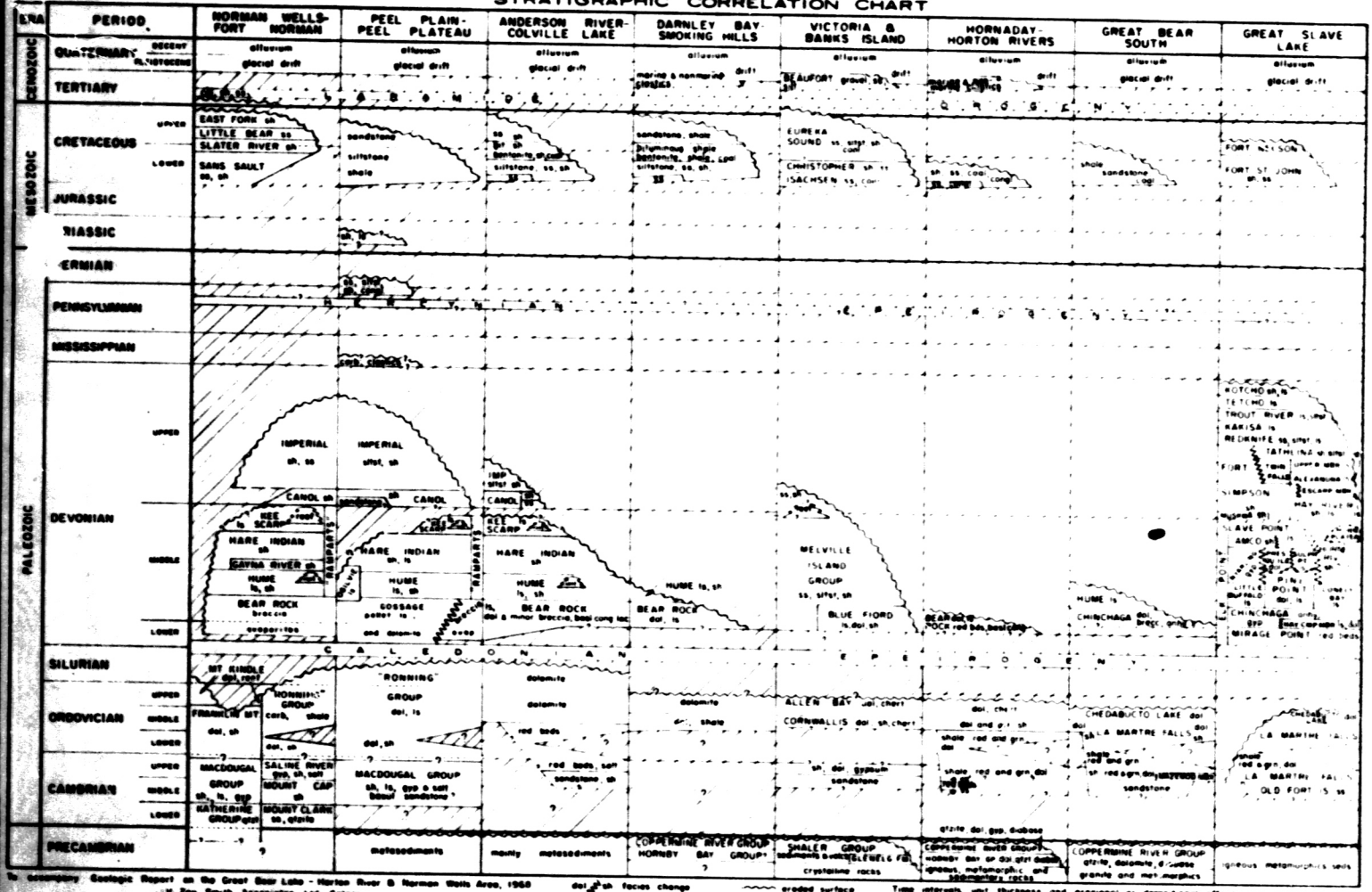
Earth tide correction: The earth tide effect is fully incorporated in the instrument drift correction as the run between two base checks was kept to a maximum of two hours.

The gravity data reduction was done by COMPUTER DATA PROCESSOR, CALGARY. The BOUGUER CURVES were plotted at the same distance scale as the seismic sections in order to facilitate correlation of anomalies.

# PART THREE

## INTERPRETATION

# STRATIGRAPHIC CORRELATION CHART




dol, sh facies change

eroded surface

Time intervals, unit thickness and erosional or depositional effects not shown to scale

To accompany Geologic Report on the Great Bear Lake - Horton River & Norman Wells Area, 1968
W. Ray Smith Associates Ltd., Calgary

PLATE V

REGIONAL GEOLOGY

In the general area, the stratigraphic succession ranges from Precambrian to recent. Thick proterozoic sediments lie beneath the pre-paleozoic unconformity. Overlying these rocks, four major depositional successions are recorded, each one separated by an unconformity:

- base of Tertiary unconformity
- lower Cretaceous unconformity
- middle Devonian unconformity
- lower Paleozoic unconformity

The Brackett basin, over part of which this seismic survey has been carried out, appears as a pronounced basin filled with Tertiary and Cretaceous clastics.

Toward the east, this basin is bordered by the St. Charles Range, to the southwest by the Smith Dome and related structures, and to the west by the Mackay Range.

This basin is interpreted basically as a graben formed by tangential extension during the Laramide orgeny.

Subsurface Information: Close to the area of the survey, four wells intersected parts of the Cretaceous, Paleozoic and Proterozoic sediments, namely

- CANDEL et al Police Island L-66
- CANDEL et al Fort Norman K-14
- AQUITAINE Old Fort Point E-30
- AQUITAINE Brackett Lake C-21.

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## GEOPHYSICAL INTERPRETATION

Quality of the Seismic Data: Some areas of "good results" were experienced, but the overall quality can be graded rather "fair". Limited poor to nil results were encountered at the eastern end of the lines running into the St. Charles Range and on the crest of NW-SE trending "en échelon" anticlinal features.

Principle reflectors and their geological identification

Horizon C : This reflection is the most energetic and continuous event encountered over the area studied. At the Aquitaine Brackett Lake C-21 well, this horizon ties approximately with an unconformity surface at the base of the Cretaceous. To the West, South, East and North, this unconformity surface truncates Paleozoic series, mostly carbonates, ranging in age from Middle Devonian to Silurian/Ordovician.

Over most of the western part of the seismic program, two deep horizons can reasonably be picked:

Horizon E : probably related to an interface within the Proterozoic.

Horizon F : Deeper than E and also of Proterozoic age. This horizon appears often, situated close to a major intra-Proterozoic unconformity.

Some other horizons, of restricted areal extension, have been identified but not mapped, around Aquitaine Brackett Lake C-21 (1972 Seismic Report).

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Description of the time-contour maps : Horizon C (Encl. IV, V and VI)

Basically, the contour maps display a large asymmetric post-Paleozoic basin filled with Cretaceous to Tertiary sediments. These sediments are thinning-out towards the North and to the East where Paleozoic rocks are exposed. (St. Charles Range). The deepest part of the basin trends N-NW-S-SE along prominent faulted "en échelon" anticlinal features trending in the same direction. These upfolds appear rather complex. To the south, the anticline appears to be related to the "Police Island Anticline" drilled by the CANDEL Police Island L-66 well. During the previous surveys, the first prolongation to the north of this Police Island anticline was mapped. The characteristic of this structure is its asymmetric cross-section: regular west-dipping flank to the west, faulted or subvertical flank on the east.

The second offsetted prolongation toward the NW, the actual feature studied during the 1973 survey, appears also asymmetrical but here, the sub-vertical flank is to the west....

More seismic data is necessary to clarify the relationship between these two offsetted high axes. Line 25 and 27 should be extended, the former to the south, the latter to the N.E. in order to permit reliable mapping. On the contour-map, a tentative solution is proposed.

The apex of the northernmost anticline is situated on line 29 (around SP 2060). The axis plunges towards the NW, then curves in to a more northerly direction. The structure still expressed on line 24, becomes hardly visible on line 21A.

West of this "en échelon" anticline trend, some lows and local highs are suggested but here the seismic information is too scarce to allow reliable mapping.

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Superimposed on the time contour maps of the Base Cretaceous unconformity (Horizon C), the areal extent of a "Middle-Devonian Sub-Basin" is outlined. This limit represents in fact, the seismic expression of the disappearance of the HARE INDIAN low velocity section. Outside this limit, the unconformity surface appears to truncate sediments of successively older age and probably all of carbonate nature. Differentiation by means of seismic of the underlying series is therefore, made difficult. For this purpose, additional information has been sought from the gravity measurings.

Interpretation of the gravity data

The Bouguer anomaly map (Encl. VII) has been contoured at an interval of .5 milligals and has been smoothed to remove small local near surface effects of no consequence. This map includes both 1972 and 1973 measurings.

The most prominent anomaly which appears on the Bouguer map is a gravity high related to the St. Charles Range. However, on the NW part of the survey some other gravity highs and lows are suggested.

Due to the irregular pattern of gravity measures (measures only along widely spaced seismic lines...), the true geometry of the anomalies is not attainable, and the interpretation has to remain only qualitative.

Residual interpretations have been attempted in constructing regionals on the profiles. These regionals then have been tied from profile to profile in order to delineate the behavior of the regional field.

When substracted from the Bouguer map, this regional component is eliminating deep-seated effects and those that may be shallow but caused by very gradual lateral change in density.

The residual features obtained have been tested for probable depth of the causative body and contoured on two residual maps: one for intermediately deep causative masses (Encl. X) and one for more shallow masses (Encl. IX).

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On the shallow residual gravity map (Encl. IX) two interesting anomalies can be mentionned. On the NW part of the survey, close to the Brackett Lake itself, a negative anomaly (B) is suggested. (Line 21A, SP 2615). This anomaly is tentatively interpreted as caused by a narrow "salt" accumulation. Although the true amplitude of the anomaly, hence the true depth of the cause, is not known, on line 21A the apparent amplitude would suggest a probable thickness of at least 2500' of salt (?).

A positive anomaly (A) appears related to the anticline delineated by the seismic. (It can be noted that the absence of a pronounced negative anomaly over the anticline seems to deny the existence of an important "salt core" in the fold or if any, this salt accumulation must be deeply buried).

The "intermediate depth residual map" shows an interesting positive anomaly "F) over the western boundary of the mentionned "Middle Devonian" basin. Along this western wedge of Middle Devonian sediments, a noticeable "gradient" occurs. The magnitude of this gradient could be consistent with the wedging out of the CANOL and HARE INDIAN formations against the Base of Cretaceous unconformity. Anomaly (F) appears related to a structural high, possibly Pre-Devonian.

The gravity data, together with the seismic information, do not show unquestionable evidences of existence of Middle Devonian sediments west of the "F" anomaly.

## CONCLUSION

The 1973 reconnaissance by seismic reflection and gravity on the NW permits of Brackett Lake has added valuable information to the

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knowledge of the subsurface west of the Aquitaine Brackett Lake C-21 wildcat.

Major "en échelon" anticlinal features, trending N-NW from the Police Island anticline have been mapped. Although the quality of the seismic data was mainly fair, the nature of the sediments immediately underlying the Base of Cretaceous unconformity (Horizon C) still remain questionable.

Deeper seismic reflections are visible but their age has to be attributed to Intra-Proterozoic velocity discontinuities.

RESPECTFULLY SUBMITTED,

AQUITAINE COMPANY OF CANADA LTD.

R. Weber, Area Geophysicist

REVIEWED AND APPROVED:

D. G. Aubin, Chief Geophysicist