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Digital Seismic Survey

FORT NORMAN AREA, N.W.T.

for

CanDel Oil Ltd.
Calgary, Alberta

by

Geophysical Service Incorporated
Calgary, Alberta

during the period

March and April, 1971
November 1971 to January 1972

over

Permits 5525, 6278, 5523, 5422,
5423, 5421

REPORT

BY

McGee Exploration Ltd.

SEPTEMBER 1972

Project #821-6-5-71-1

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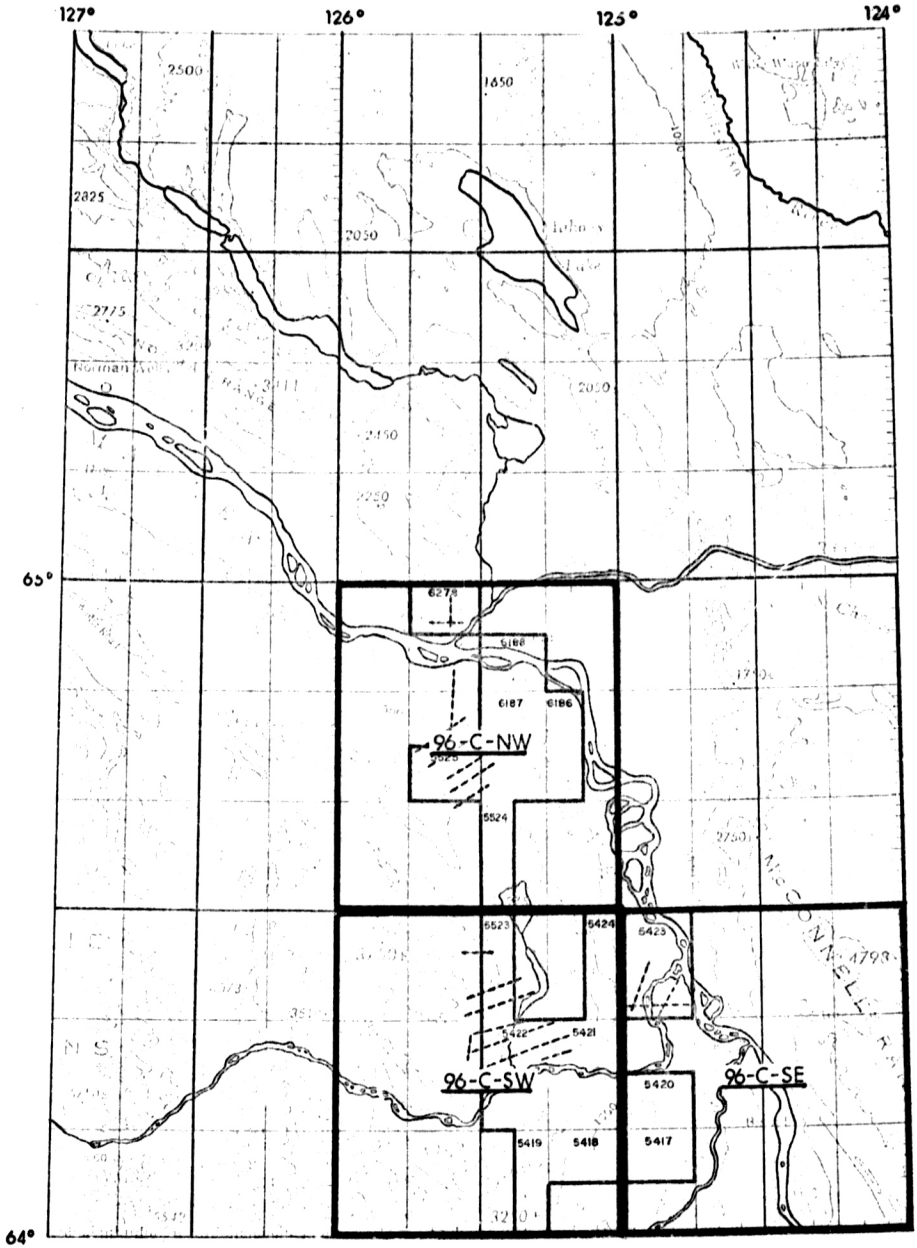
INTRODUCTION

A seismic reflection survey was conducted for CanDel Oil Ltd. in the Fort Norman Area, N.W.T., during two time periods; the first was in March and April, 1971, followed by later work in November and December, 1971, and January, 1972. The work was carried out by a digital seismic crew contracted from Geophysical Service Incorporated, of Calgary, Alberta.

Initially, the seismic crew was trucked to the Ft. Norman Area from the Zama Lake Area of Alberta. After the first phase of work, the crew equipment was left at the conjunction of the Keele and Mackenzie Rivers in April 1971. Some equipment was taken out by barge and other equipment, fuel, and supplies were brought in by barge for the second phase of the work.

The first phase of the work consisted of Lines A, through I. The second phase carried on with lines J through T. The seismic work was divided into three parts as shown by the accompanying maps of NTS 96-C-NW, 96-C-SW, and 96-C-SE.



CANDEL OIL LTD. CALGARY ALBERTA	REVISED	FORT NORMAN AREA NORTHWEST TERRITORIES
INTERPRETATION BY		
DRAWN BY C.B. JAMES — DATE JAN 23/73		
CHECKED BY — DATE		
SCALE MILES 10 5 0 10 20		

STATISTICAL DATA - PHASE I

Dates

March 25, 1971	Camp and recording equipment arrived at Fort Norman from Alberta
March 26, 1971	Surveyors, cooks and gyro drill and water Nodwell arrive
March 27, 1971	Trucks arrived with remainder of drilling equipment
March 28, 1971	Cats start cutting line
March 30, 1971	Drilling started
April 2, 1971	Recording crew arrives
April 4, 1971	Recording crew commences
April 9 - 10, 1971	Camp moved to south part of area
April 18, 1971	Cats completed cutting
April 25, 1971	Drills finish up
April 26, 1971	Recording crew finish up
April 28 - 29, 1971	Camp and equipment moved to Keele River by the Mackenzie River. All men out.

Production

Production Days	15
Weather Days	0
Days moving camp within prospect	2
Days lost waiting on drills	6
Days mobilizing	5
Days demobilizing	3
Total days spent on prospect	31
Profiles shot	483

Miles of coverage shot	54.90
No. of rock bits used	54
No. of insert bits used	144
Powder used	5870#
Caps used	501
No. of holes drilled	496
Normal Hole depth	40 feet
Total footage drilled	20,970 feet
Normal charge size used	10# and 15#

Equipment

Camp

G.S.I. Foldout Camp consisting of 4 units:

Kitchen, Diner, Sleeper
Utility, Sleeper
Office, Sleeper
Workshop Power Plant

Recording Equipment

S-200 Foremost with mounted doghouse
6T Foremost Jug Truck
6T Foremost Shooting Unit
8T Foremost Supply Unit

Survey Unit

6T Foremost

Drills

Redwing Drilling - 2 Carey Auger Drills on Nodwells plus spare Water Nodwell
Tipo Drilling - 2 Conventional Drills on Nodwells

Cats

Bain Bros. - 2 D7E Cats and 1 D6C
Borels Const. - 2 D7E Cats and 1 D6C

Auxiliary Recording Equipment

1 - DFS III 1 Inch TI Series, Binary Gain, 48 Channel Digital Recording System.
1 - 48 Trace dry write camera
2 - Montrae radio and tone boxes
2 - Pye radios
80 - Groups of geophones

Personnel

1 Party Manager

1 Instrument Engineer

1 Shooter

1 Surveyor

1 Mechanic

1 Cook

4 Drillers

4 Drill Helpers

12 Catskinners

2 Camp attendants

1 Rodman

5 Recording helpers

Recording Parameters

Sample Rate	2 ms
Recording Filters	8 cps - 124 cps/36 db slope
Record length	4 sec
Upholes Seis Offset	10 feet
Gain Mode	Operate
Gain Constant	30 db

Initial Gain	Varied
Final Gain	90 db
Upper Set Limit	75%
Lower Set Limit	25%
60 Hz Notch Filters	Out

Instrument tests to check dynamic range, amplifier noise, DFS noise and AGC circuitry were run daily before commencing Production Shooting.

Shooting and Spread Details

Type of Coverage	6 Fold CDP
Group Interval	150 feet
Spread Layout	Split, Roll-along 3600-0-3600
Number of Groups	48
Group Length	144 feet
Group Pattern	Inline with Spread
Seismometers	Type HSJm 14 Hz, 9 phones in series parallel, interval 18 feet
Shot point Spacing	600 feet
Shot pattern	Single Holes

STATISTICAL DATA - PHASE II

Dates

September, 1971	Equipment, fuel and dynamite barged into Keele River location.

November 14, 1971	Cat personnel and cooks arrive at camp
November 16, 1971	Cats start cutting line
November 17, 1971	Drills begin work
November 20, 1971	Recording crew arrived at camp. Cats move to Stewart Lake.
November 23, 1971	Recording crew starts shooting. Drills move to Stewart Lake.
November 28, 1971	Camp moved to Stewart Lake
December 5, 1971	Cat camp moved back to Keele River to make ice bridge.
December 15, 1971	Stewart Lake area completed
December 16, 1971	Camp moved to Keele River
December 21, 1971	Crew out for Christmas
December 27, 1971	Crew returns after Christmas
January 2 - 5, 1972	Long camp move from Keele River to Fort Norman.
January 14, 1972	Fort Norman area completed

Production Statistics

Profiles Shot	520
Miles Shot	54.13
Recording Time	302.50 hours
Recording travel and move time	160.25 hours
Total Recording Hours	462.75 hours
Holes drilled	533
Footage drilled	23,935 feet
Drilling hours	838.50 hours
Drill travel and move time	587.50 hours
Total Drill Hours	1426.00 hours

Dynamite used	8080 lbs.
Caps used	579
Normal Charge Size	15 lbs.
Normal Hole Depth	45 feet
Rock Bits used	104
Insert Bits used	83
Mud used	4050 lbs.
Bran used	600 lbs.
Total Cat hours	2495.00 hours

Equipment

1. Camp (All sleigh mounted)

   3 - 10' x 32' - twelve man sleepers
   1 - 10' x 30' - utility trailer
   1 - 10' x 32' - kitchen/diner
   1 - 10' x 30' - workshop with 30 KW light plant
   1 - 10' x 40' - flat deck trailer with 3-500 gallon fuel tanks
   1 - 10' x 40' - flat deck trailer with 5-500 gallon fuel tanks

2. Basic Party (All G.S.I. owned)

   1 - 6T Foremost Recorder with instrument doghouse and a 5 KW light plant
   1 - 5100 Foremost Shooting Unit
   2 - 6T Foremost flatdeck cable units
   1 - 4 x 4 1969 Dodge ½ ton pick-up P.M. unit
   1 - S-100 Foremost flatdeck survey unit

3. Drills

   2 - G.S.I. owned 6T Foremost mounted Carey Auger drills
   2 - Yukon mounted Mayhew 1000 air water combination drills (Seisform Drilling)
   2 - Nodwell mounted water tank units (Seisform Drilling)

4. Cats (Lyle Adam Construction)

   1 - kitchen/diner sleeper)
   1 - sleeper trailer) sleigh mounted
   1 - power plant fuel storage workshop)

2 - D7E cats with winches and canopies
2 - D6C cats with winches and canopies

5. Auxiliary Recording Equipment

1 - DFS III ½ inch binary gain 48 trace digital recording system with spare parts kit, complete with radios, tone boxes and other necessary equipment.
14- sections of cable (220' group interval with communication take-outs) (6 groups/section)
90- Groups of Geophones (9 per string spaced at 18 feet)
1 - Dry write 48 trace camera

Key Personnel

Party Manager	Les Werle
Instrument Engineer	Barney Stone
Junior Observer	George Moskal
Surveyor	Al Bourget
Mechanic	Mel Cole
Cook	Stan McIlroy

Recording Parameters

Sample Rate	2 ms
Record length	4 sec
Recording Filters	12 Hz - 12 Hz/12 db slope
Uphole seis offset	10 feet
Gain Mode	Operate
Gain Constant	30 db
Initial Gain	Varied
Final Gain	90 db
Upper Set Limit	75%
Lower Set Limit	25%
60 Hz Notch Filters	Out

Instrument tests to check dynamic range, amplifier noise, DFS noise and AGC circuitry were run daily before commencing production shooting.

Shooting Spread Details

Lines J, K, L, Q, R, S, T

Type of Coverage	6 Fold CDP
Group Interval	110'
Spread Layout	Split, 2585-55-0-55-2585
No. of Groups	48
Group Length	110'
Group Pattern	Inline with Spread
Seismometers	Type HSJ, 14 Hz. 9 phones in series parallel
Shot point Spacing	440 feet
Shot Patterr.	Single holes

Lines M, N, O, P

Type of Coverage	6 Fold CDP
Group Interval	220'
Spread Layout	Split 5170-110-0-110-5170
No. of Groups	48
Group Length	144 feet
Shot point spacing	880 feet
Shot Pattern	Single holes

FIELD PROCEDURES

1. Instrumentation

The instruments were a 48 trace, 9 track TI series DFS III digital field system with binary gain amplifiers. The instruments were mounted in a doghouse in a 6T Foremost. The instrument batteries were charged with a 5 KW Wisconsin generator mounted on the back of the Foremost. Field recordings were displayed on dry write paper with the use of a 50 trace camera. The records were displayed either as direct playbacks (DPB) or as read after write monitors (RAW).

The direct monitor is produced by reading the recorded data from tape just after it has been written by the write head. Therefore on the direct monitor the time break and timing lines are displayed at true times and all other displayed information including uphole break and seismic data are delayed an amount, dependent on tape speed.

Playbacks can be made either as amplifier playbacks or direct playbacks. Amplifier playbacks are made through the binary gain amplifier system where bandpass filtering and playback gain can be selected as desired. On direct playbacks, the signal is generated from the digital to analogue converter and goes directly to the camera.

Instrument test to check dynamic range, amplifier noise, DFS noise and AGC circuitry were run daily before commencing production shooting.

2. Drilling

Shothole drilling in the Fort Norman Area was quite difficult. Gravel was encountered in all the area of NTS 96-C-SW and on most of the lines in NTS 96-C-SE. In the gravel area mud had to be used and drilling with air was not possible. The auger drills could not be used in the gravel. Since a 40 to 50 foot hole depth was quite satisfactory for record quality, no deeper drilling was attempted.

3. Line Clearing and Land Use

Because of the limited time in April, 1971, for the first phase of the work and because the work was divided into two parts which were a significant distance apart, two sets of Cats were used on the job. Borel Construction began the work in NTS 96-C-NW using 2 D7E Cats and 1 D6C Cat. These were supplemented by Cats from Bain Bros. to begin the line clearing in the south part of the work in NTS 96-C-SW; Bain Bros. used two D7E Cats and 1 D6C. When the first part of the work was completed in NTS 96-C-NW, all 6 cats were used for the remainder of the work, because of the difficult terrain in NTS 96-C-SW.

All areas were covered with small spruce trees and were very sparse in places. No line lopping had to be done with the exception of the odd line where the crew did it themselves with a chainsaw carried on the recording crew. This was satisfactory and passed inspections made by the Department

of Forestry. All creek crossings were removed by the Cats after the crew had passed through, to the satisfaction of the Ranger. No timber was encountered in any of the areas worked.

All garbage was saved, burned and buried in either a pit dug by the Cats or in holes dug to a depth of 10 feet with a 12 inch bit especially made for this purpose.

All Cats were equipped with shoes on the dozer blades and damage to the surface of the ground was kept to a minimum. Various inspections on this were made by the Ranger. Approximately six inches of snow and trash was left as a cover on all lines cut.

DATA PROCESSING - PHASE I

Fort Norman Data Processing

Production Processing Parameters

1. Record Split and Translation

   (a) 48 trace field record split into two 24 trace records (#1-24; #25-48) for subsequent processing.

2. Binary Gain True Amplitude Recovery

   B = 25.000
   1 = 8.000
   T_o = 0 secs.
   Tmax = 2.0 secs

3. Normal Moveout

   Typical Function: Vo = 8500 ft./sec. (i.e. Velocity intercept at time zero)

Time (secs.)	Velocity (ft./sec.)
0	8500
1.200	10250
1.400	12250
4.000	13500

Functions compiled from picking Ts off the records.

4. Structure Statics

Computed by uphole-elevation method using reference plane of 1000 feet and replacement velocity 8000 ft./sec.

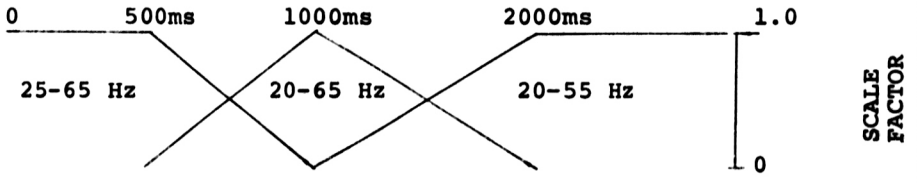
5. Deconvolution (Time Variant)

No. of filters per trace	4
Operator Length	60 ms
To	300
Tmax	3900

6. Digital Filter

Number of Filters = 3
Length of Filters = 116 ms

Filter Application Diagram:



7. C.D.P. Gathers

Two sets of 3 fold common depth point gathers were produced one containing traces 1-24 only, and the other containing traces 25-48 only.

8. Statics

Hand Smoothed.

9. First Break Suppression

10. Stack

2 sets of 3 fold common depth point gathers combined to give 600% C.D.P. Stack.

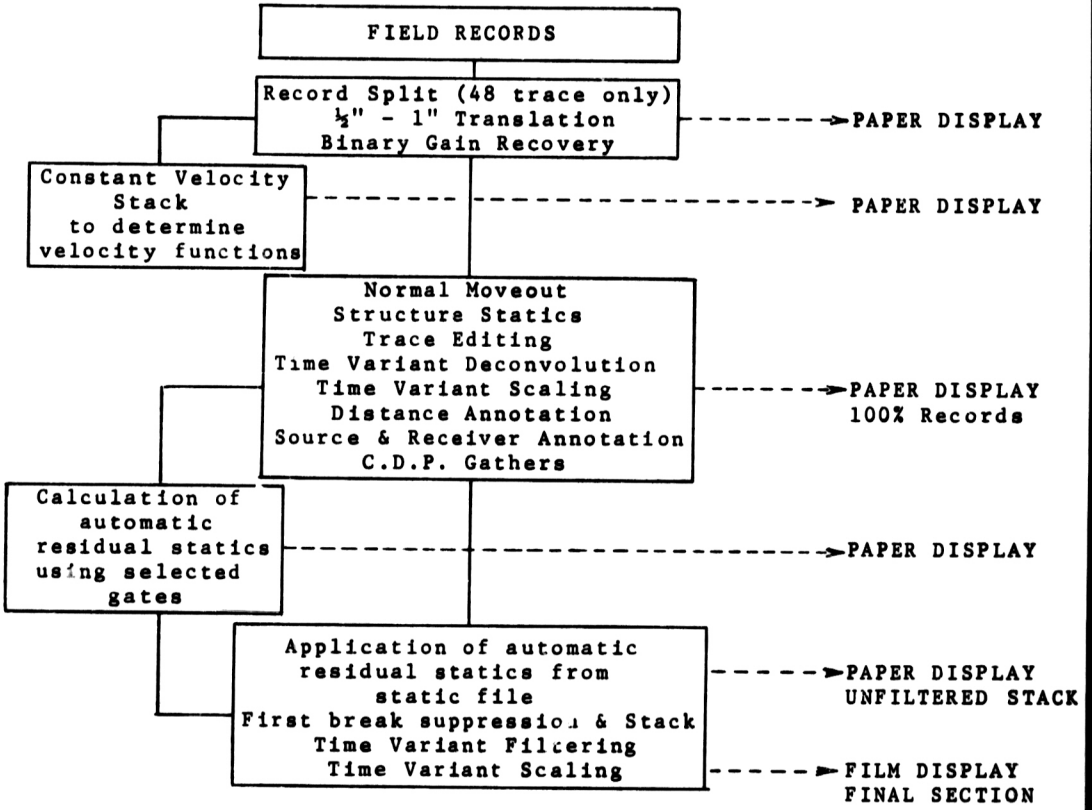
11. Time Variant Scaling

Applied to stack records so as to give same modulation level on data traces as would be seen on a synthetic seismogram.

No. of Gates	8
Start Time	.520 to 3.500

DATA PROCESSING - PHASE II

General Processing Sequence



I. Production Processing Parameters

1. Record Split and Translation

(a) 48 trace field record split into two 24 trace records (#1-24; #25-48) for subsequent processing.

(b) ½" 9 track DFS III format translated to 1" 21 track DFS III format.

2. Binary Gain True Amplitude Recovery

B	=	-30.000 db
$\alpha 1$	=	36.000 db/sec.
$\alpha 2$	=	10.000 db/sec.
T_o	=	0 secs.
T_1	=	0.8 secs.
Tmax	=	2.0 secs.

3. Normal Moveout

Typical Function:

Vo = 9000 ft./sec. (i.e. Velocity intercept at time zero)

Time (secs.)	Velocity (ft./sec.)
0	9000
.510	9800
.990	12880
1.400	14000
4.000	16400

Functions compiled from Constant Velocity Stacks, run where required.

4. Structure Statics

Computed by uphole-elevation method using reference plane of 1000 ft. and replacement velocity 10000 ft./sec.

5. Deconvolution (Time Variant)

Number of Gates	=	4
Gate Lengths	=	1067 ms
Operator Length	=	60 ms
To	=	300 ms
Tmax	=	3500 ms

6. Time Variant Scaling

Applied to 100% records to bring each trace to the same average modulation level.

Start Time = 200 ms
No. of gates = 12
Gate Length = 300 ms

7. C.D.P. Gathers

Two sets of 3 fold common depth point gathers were produced one containing traces 1-24 only, and the other containing traces 25-48 only. These gather records were used for all subsequent processing.

8. Automatic Residual Statics

Gate Length = variable - 100-400 ms depending on data quality

Digital Filter = 20-60 Hz
No. of Interations = 8

9. First Break Suppression

Offset dependent:

Offset = 0 ft. Time = 0 msecs.
= 2585 ft. = 400 msecs.

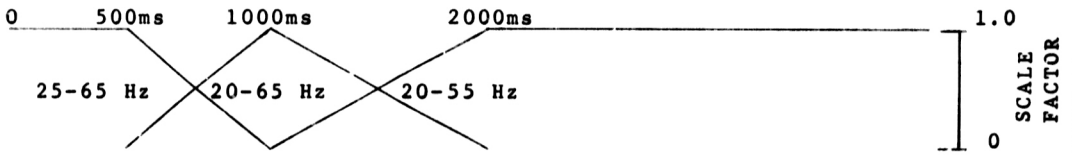
10. Stack

2 sets of 3 fold common depth point gathers combined to give 600% C.D.P. Stack.

11. Digital Filter

Number of Filters = 3
Length of Filters = 200 ms

Filter Application:



12. Time Variant Scaling

Applied to stack records so as to give same modulation level on data traces as would be seen on a synthetic seismogram.

II. Experimental Processing

Prior to starting the production processing analyses were made to determine various parameters.

(a) 10 typical records from line K were used to determine the T.A.R. parameters.

(b) Deconvolution and digital filtering parameters, were identical to those used on the Fort Norman data the year previous.

RESULTS AND INTERPRETATION

Maps are enclosed for NTS 96-C-NW, NTS 96-C-SW, and NTS 96-C-SE on a scale of one inch equal one mile.

Reflections

Maps have been prepared on a reflection from The Unconformity at the Base of the Cretaceous, from the Devonian Hume, and from the Base of the Ronning. All of these reflections are of fair to good quality except in portions of the area located mainly in 96-C-SW where general record quality becomes quite poor. In addition to the mapped reflections, energy is present shallower in the Cretaceous, but conforming to the Base of the Cretaceous reflection, and locally west of a fault in 96-C-SW energy is present from a reflection originating at an Upper Devonian limestone.

Maps

As mentioned above structure maps in time have been prepared from three horizons. All of the data for these have been adjusted to a datum level of 1000 feet above sea level using a correction velocity of 10,000 feet per second.

In addition, a shotpoint elevation map has been prepared and an interval map has been made of the interval from the Unconformity at the Base of the Cretaceous to the Base of the Ronning.

Discussion of Results - NTS 96-C-NW

The shotpoint elevation map shows that work was carried out north of the Mackenzie River, north of the Great Bear River where it enters the Mackenzie, and east of Bear Rock Mountain. The Area worked is one of fairly gentle relief dipping toward the Mackenzie River from a maximum elevation of 780 feet above sea level to a minimum elevation of 277 feet above sea level.

Also, work was carried out immediately south of the Mackenzie River and bounded on the west by the Mackay Range of Mountains. Again the surface dips are relatively gentle showing a range of a maximum elevation of 1194 feet above sea level at the south end of the work and a minimum elevation of 200 feet above sea level at Mackay Creek near the north end of the work.

The map of the Unconformity at the Base of the Cretaceous shows primarily south dip in the area north of the

Mackenzie River changing to east dip south of the Mackenzie. A reversal of dip on the west edge of the work and just east of the Mackay Range creates a probable closure on which the CanDel DECKMG et al East Mackay B-45 well was drilled as an oil discovery.

The Hume map indicates that older structure than Cretaceous has existed in the area inasmuch as the Hume subcrops both north and south of the Mackenzie River and, in the area of the Mackay test well, is located only on the west side of a major fault.

The Base of Ronning reflection shows south dip north of the Mackenzie River changing to east dip south of the Mackenzie. A major down to the west fault is located just west of the CanDel Mackay test well. This fault has a possible vertical displacement of 400 milliseconds and could set up a large area of closure which is not completely defined by the present seismic control.

The Interval from the Unconformity at the Base of the Cretaceous to the Base of the Ronning indicates that a pre-Cretaceous structural low existed centering on the south edge of the Mackenzie River and shows the pre-Cretaceous high which existed at the East Mackay well location.

To summarize, one structural feature is present in the area. It exhibits both pre-Cretaceous and post-Cretaceous (Laramide) structural movement. The limits of the closure are

not defined by the present seismic control. The structure was tested successfully by the East Mackay hole in a position that appears to be quite close to the optimum location on the structure.

Discussion of Results - NTS 96-C-SW

The area worked has quite rugged surface relief; the elevations vary from a minimum of 658 feet above sea level on Line H where it crosses Stewart Creek to a maximum of 2000 feet above sea level on Line 0 at the north end of the work. The topography seems to have had an effect on seismic record quality since the poorest data is located in this area.

The map from the Unconformity at the Base of the Cretaceous indicates west dip of nearly 500 milliseconds. The biggest portion of this occurs on the west edge of the mapped area. Three faults, all down to the west are shown. A small structural closure is indicated at the CanDel Stewart dry hole.

The Hume structure map indicates nearly 1000 milliseconds of west dip across the area, which is nearly twice that as at the Base to the Cretaceous Unconformity. The extra dip is primarily across the three faults shown. These faults have had substantial pre-Cretaceous movement and some additional post-Cretaceous movement. A structural nose is shown at the unsuccessful Stewart location. Structural closures may exist on both the up and down sides of the most westerly fault at the

north end of the area. However, with the present seismic control, the structure is open to the north. The structure on the east side of the fault was tested unsuccessfully by the CanDel DECKMG et al Tate J-65 dry hole.

The structure map of the Base of the Ronning looks similar to that of the Hume with a similar amount of west dip broken by faulting. It does indicate a greater component of south dip and has less evidence of structure, but the latter is probably because of poor data over the more anomalous areas.

The interval from the Unconformity at the Base of the Cretaceous to the Base of the Ronning shows that a pre-Cretaceous low existed at the south end of the mapped area. The interval thickens to the south a maximum of 400 milliseconds in nine miles. The map also indicates that the interval thickens by as much as 600 milliseconds to the west also in a distance of nine miles; the latter thickening takes place across the pre-Cretaceous faulting.

In summary, this area shows some post-Cretaceous structure and a substantial amount of pre-Cretaceous structure. Two tests have been drilled in the area unsuccessfully.

Discussion of Results - NTS 96-C-SE

This small area of seismic surveying is located near the confluence of the Keele and Mackenzie Rivers. The area is relatively flat topographically with the exception of a large

hill on the west side of the Keele River. The minimum elevation is 222 feet above sea level on the north end of the Line J, and the maximum elevation is 1013 feet above sea level just west of the Keele River on Line L.

The reflection from the Unconformity at the Base of the Cretaceous shows a thrust fault trending ESE-WNW and dip in a SSW direction. Closure is not indicated laterally along the thrust fault. This reflection originates from the contact of the Cretaceous and Paleozoic carbonates to the southwest and Cambrian sediments to the northeast.

This is illustrated by a structure map of the Base of the Ronning which shows the approximate subcrop edge of the Base of the Ronning.

This map also shows dip in a SSW direction of a greater amount than on the Unconformity at the Base of the Cretaceous.

This is confirmed by the interval map which shows a thickening to the SSW of over 200 milliseconds in three miles.

The subcrop of the Base of the Ronning is located SSW of the thrust faulting shown on the map of the Unconformity at the Base of the Cretaceous. Therefore, a well drilled on the crest of the thrust structure would be expected to penetrate only Cretaceous and Cambrian sediments and would find none of the possible Paleozoic reservoirs.

SUMMARY AND CONCLUSIONS

The Ft. Norman area shows substantial post-Cretaceous structural movement in NTS 96-C-NW and substantial pre-Cretaceous movement in all three areas worked: NTS 96-C-SW and NTS 96-C-SE in addition to NTS 96-C-NW.

Three tests have been drilled in the area resulting in one oil discovery, the CanDel DECKMG et al East Mackay well. The latter well seems to have been drilled at near an optimum point on the structural feature.

We suggest that the combination of early and Laramide structural movement presents good possibilities for the trapping of hydrocarbons, and therefore, the area warrants further exploratory efforts.