# PROJECT ACTION SHEET

RESOURCE EVALUATION BRANCH

PROJECT NUMBER 9229-P28-19E

COMPANY PETRO CANADA

REPORT TITLE 1989 CAMERON HILLS SURVEY

THE FOLLOWING ACTION HAS BEEN TAKEN

RECEIPT ACKNOWLEDGED JAN 2 1990

REPORTS AND MAPS DATE STAMPED YES

REPORTS FOR REVIEW LIST EDITED YES

INVENTORY SHEET MADE YES

MYLAR

REVIEW AND APPROVAL MADE BY

COMMENTS THREE COPIES OF REPORT AND MAPS

***RETURN APPROVED REPORTS TO MIKE MCLINTON***

PROGRAM NUMBER:**9229-P28-19E**

YEAR:**1989** AREA:**CAMERON HILLS**

FILED UNDER:SAME E.A.: **327**

**OPERATIONS REPORTS:** **NUMBER** 1

-GEOPHYSICAL EXPLORATION SURVEY CAMERON HILLS

**INTERPRETATION REPORT** **NUMBER**

-COMBINED WITH OPERATIONS REPORT-

**MAPS**

**SHOTPOINT MAPS** **NUMBER 1**

-Seismic base map

**INTERPRETATION MAPS** **NUMBER 4**

-Time structure map PRE-CRETACEOUS UNCONF.
-Basement fault pattern.
-Time structure SLAVE POINT Limestone.
-Time structure map, Twin Falls.

**OTHER** **NUMBER 4**

-Line L8093
-Synthetic seismograms, CAMERON C-22, SWEDE O-22
CAMERON C-50

**SEISMIC SECTIONS** **NUMBER 7**

L8088
L8089
L8090
L8091
L8093
L8095
L8099

REPORT ON THE
GEOPHYSICAL EXPLORATION SURVEY

PROGRAM NO. 9229-P28-19E



CAMERON HILLS
NORTHWEST TERRITORIES
EXPLORATION LICENCE NO. 327

by

Petro-Canada Inc.
March, 1989

| | |
|---|---|
| Field Work Period: | February 20 - March 31, 1989 |
| Land Use Permit No.: | N88 B062 |
| Area Co-ordinates: | Latitude 60°00'-60°20' N<br>Longitude 117°00'-118°00'W |
| Data Acquisition: | Western Atlas Canada |

Submitted December, 1990

by

Allin Folinsbee
District Geophysicist

D. C. Robertson
Exploration Supervisor

TABLE OF CONTENTS


| | |
|---|---|
| INTRODUCTION | 1 |
| DATA ACQUISITION | 2 |
| Operating Conditions | 2 |
| Seismic Operations | 3 |
| Seismic Data Acquisition | 6 |
| SEISMIC DATA PROCESSING | 8 |
| INTERPRETATION | 12 |
| Regional Geology and Tectonic History | 12 |
| Stratigraphy | 12 |
| Seismic Data | 14 |
| Seismic Interpretation | 15 |
| GRAVITY AND MAGNETICS | 17 |
| CONCLUSIONS | 18 |
| REFERENCES | 19 |

## LIST OF FIGURES


FIGURE 1: Land Overview

FIGURE 2: Spread Diagram

FIGURE 3: Stratigraphy of the Cameron Hills Area

## LIST OF TABLES


| | | |
|---|---|---|
| Table 2.2.1 | Seismic Project Chronology | 4 |
| Table 2.2.2 | Seismic Production | 4 |
| Table 2.2.3 | Seismic Drilling | 4 |
| Table 2.2.4 | Project Organization | 5 |
| Table 2.2.5 | Contractors | 5 |
| Table 2.3.1 | Recording Parameters | 6 |
| Table 2.3.2 | Seismic and Survey Instruments | 7 |
| Table 3.1 | Processing Sequence | 8 |
| Table 3.2 | List of Lines Processed | 11 |
| Table 4.3.1 | Seismic Lines Used in Interpretation | 14 |

## LIST OF ENCLOSURES


| | |
|---|---|
| ENCLOSURE 1: | Seismic Base Map |
| ENCLOSURE 2: | Cameron C-22 Synthetic Seismogram |
| ENCLOSURE 3: | Swede O-22 Synthetic Seismogram |
| ENCLOSURE 4: | Cameron C-50 Synthetic Seismogram |
| ENCLOSURE 5: | Seismic Line 8093 |
| ENCLOSURE 6: | Basement Fault Pattern |
| ENCLOSURE 7: | Slave Point Limestone Time Structure Map |
| ENCLOSURE 8: | Twin Falls Limestone Time Structure Map |
| ENCLOSURE 9: | Pre-Cretaceous Unconformity Time Structure Map |

## 1.0 INTRODUCTION

Petro-Canada Inc. conducted a geophysical survey in the Cameron Hills area during the 1989 winter season. The lands involved were 100% operated by Petro-Canada Inc. under Exploration License Number 327 (Figure 1). The land status shown in this report is after the June 16, 1989 relinquishment date.

The seismic program was designed to infill the western block of the 1985 seismic program (No. 9229-P28-9E) to investigate seismic leads in the area. A total of 113.2 km of seismic data was shot (Enclosure 1).

The report summarizes data acquisition procedures, seismic data processing and the results of the interpretation. All maps produced during the work period are included in the report. Data which were sent separately from this report included one mylar copy of the seismic base map, and one mylar and two paper copies of normal polarity migrated stack sections.

# NORTHWEST TERRITORIES

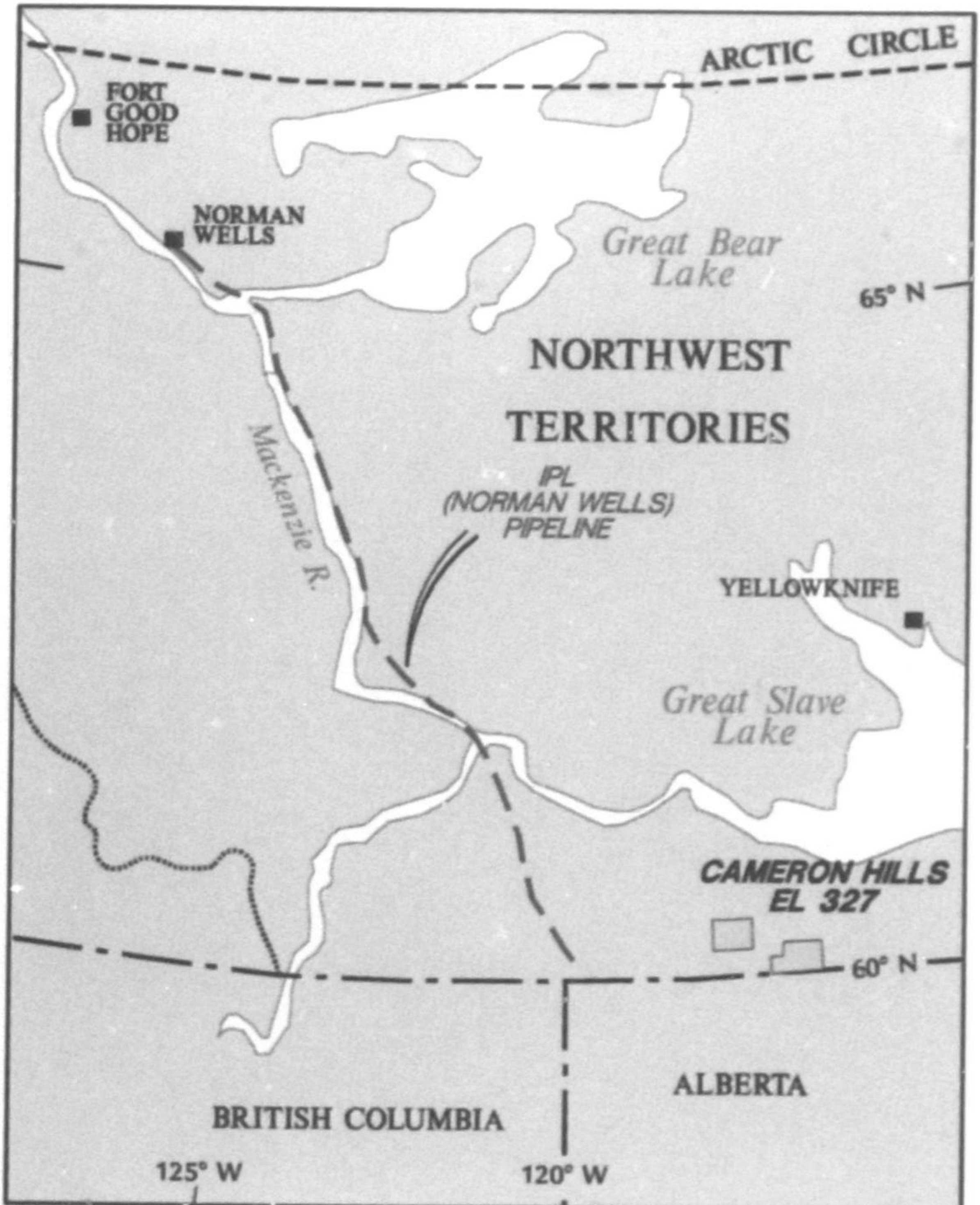


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Figure 1

# 2.0 DATA ACQUISITION

## 2.1 Operating Conditions

The Cameron Hills area is located in the southern region of the Northwest Territories. The area is bounded by Tathlina Lake to the northwest, Bistcho Lake to the southwest, and Buffalo Lake to the east. The survey grid is located 120 km southwest of the Hay River Community.

Topographically, the elevation ranges from 650 to 850 metres above mean sea level. Timber coverage is sparse and when present, is of non-merchantable size. Numerous small lakes, swamps, and the headwaters of the Cameron River form an extensive hydrological network over the area.

Generally, field conditions were good. During surveying, periods of snow and blowing snow were encountered. Due to the sparse timber coverage, frozen ground conditions, and relatively flat terrain, line cutting proceeded rapidly. However, drilling operations experienced major difficulties in penetrating shallow formations of clay rock and cemented gravel laced with granite layers. Drilling problems necessitated the cancellation of several kilometres of seismic lines. Also, rough terrain to the north, and potential environmental damage caused further cancellation of segments of the survey. The recorded field data were fair to good.

Weather conditions during the course of the program were normal with daily temperatures ranging from -40°C to +6°C. No recording production was lost due to adverse weather conditions.

## 2.2 Seismic Operations

Petro-Canada Inc. contracted Western Atlas Canada of Calgary, Alberta as the principal contractor to conduct the survey. Due to the short term of the program, an existing Western Atlas crew from Alberta including five N.W.T. residents, were employed. Western Atlas sub-contracted out catering, line clearing, and drilling to several companies in Alberta and the Northwest Territories. To minimize travel time, a base camp was established on the Cameron Hills acreage. In accordance with Petro-Canada Inc. guidelines, a full-time medic was on site during the survey.

Tables 2.2.1, 2.2.2, 2.2.3, 2.2.4 and 2.2.5 summarize the project chronology, production, drilling, project organization and contractors respectively.

**Table 2.2.1** Seismic Project Chronology

| | |
|---|---|
| Surveying Commenced | Feb. 20, 1989 |
| Dozing Commenced | Feb. 23, 1989 |
| Drilling Commenced | March 3, 1989 |
| Recorders Mob | March 9, 1989 |
| Recording Commenced | March 11, 1989 |
| Surveying Complete | March 21, 1989 |
| Recording Complete | March 30, 1989 |
| Recorders Demob | April 1, 1989 |

**Table 2.2.2** Seismic Production

| | |
|---|---|
| Total km recorded: | 113.2 km |
| Total shots taken: | 1132 |
| Total recording days: | 20 |
| Average daily production: | 5.66 kms recorded |
| Days lost to weather: | None |
| Days lost to equipment failure: | None |

**Table 2.2.3** Seismic Drilling

| | |
|---|---|
| Number of holes drilled | 3396 |
| Total metres drilled | 10,188 |
| Explosives used | 1698 kg |
| Average weight of explosives per location | 1.5 kg |

**Table 2.2.4** Project Organization

| | | |
|---|---|---|
| Party Manager | 1 | |
| Surveyors | 2 | |
| Observers | 2 | |
| Clerk | 1 | |
| Cats | 4 | |
| Cat Push | 1 | |
| Slashers | 2 | (2 natives) |
| Line Helpers | 9 | (3 natives) |
| Line Truck Drivers | 3 | |
| Shooter & Helper | 2 | |
| Drillers | 14 | |
| Water Truck | 1 | |
| Drill Push | 1 | |
| Mechanic | 1 | |
| Medic | 1 | |
| Cook & Helpers | 3 | |
| | 46 | (5 natives) |

**Table 2.2.5** Contractors

Principal Contractors:

Western Atlas Canada
Calgary, Alberta

Sub-Contractors:

Diamond Caterers
Grand Prairie, Alberta

Adrian Erickson Line Clean-up Ltd.
Hines Creek, Alberta

Burnt River Drilling
Fairview, Alberta

Stan Dean and Sons, Ltd.
Hay River, N.W.T.

Park Ambulance Services
Calgary, Alberta

Tri-Bar Drilling Ltd.
Sundre, Alberta

Double H Seismic Consultants Ltd.
Calgary, Alberta

Denham Drilling
Wetaskiwin, Alberta

Tu-Cho Gha Contracting Ltd.
Hay River, N.W.T.

## 2.3 Seismic Data Acquisition

Western Atlas Canada's line shooting procedure consists of rolling in and out of lines with a full live spread and a gap in the normal split position. Make-ups were skidded on-line to ensure that coverage was maintained (Figure 2).

Instrument tests were run according to Petro-Canada's test procedures prior to recording. A bi-monthly instrument test was also run according to Western's test procedures. Daily instrument tests #9001-9008 per Western test procedures were done before shooting.

**Table 2.3.1** Recording Parameters

| | |
|---|---|
| Sample Rate: | 2 milliseconds |
| Record Length: | 4 seconds |
| Recording Filter: | 12/18 - 128<br>60 Hz Notch Out |
| Sub-surface Coverage: | 1200% |
| No. of Groups: | 120 |
| Group Interval: | 20 metres |
| Group Array: | Inline over 20 metres |
| No. of Geophones per Group: | 9 |
| Shotpoint Interval: | 100 metres |
| Spread Length: | 1220-40-x-40-1220 |
| Energy Source: | Dynamite 3 x 0.5 kg |
| Holes per Shot Location: | 3 |
| Hole Depth: | 9 metres |

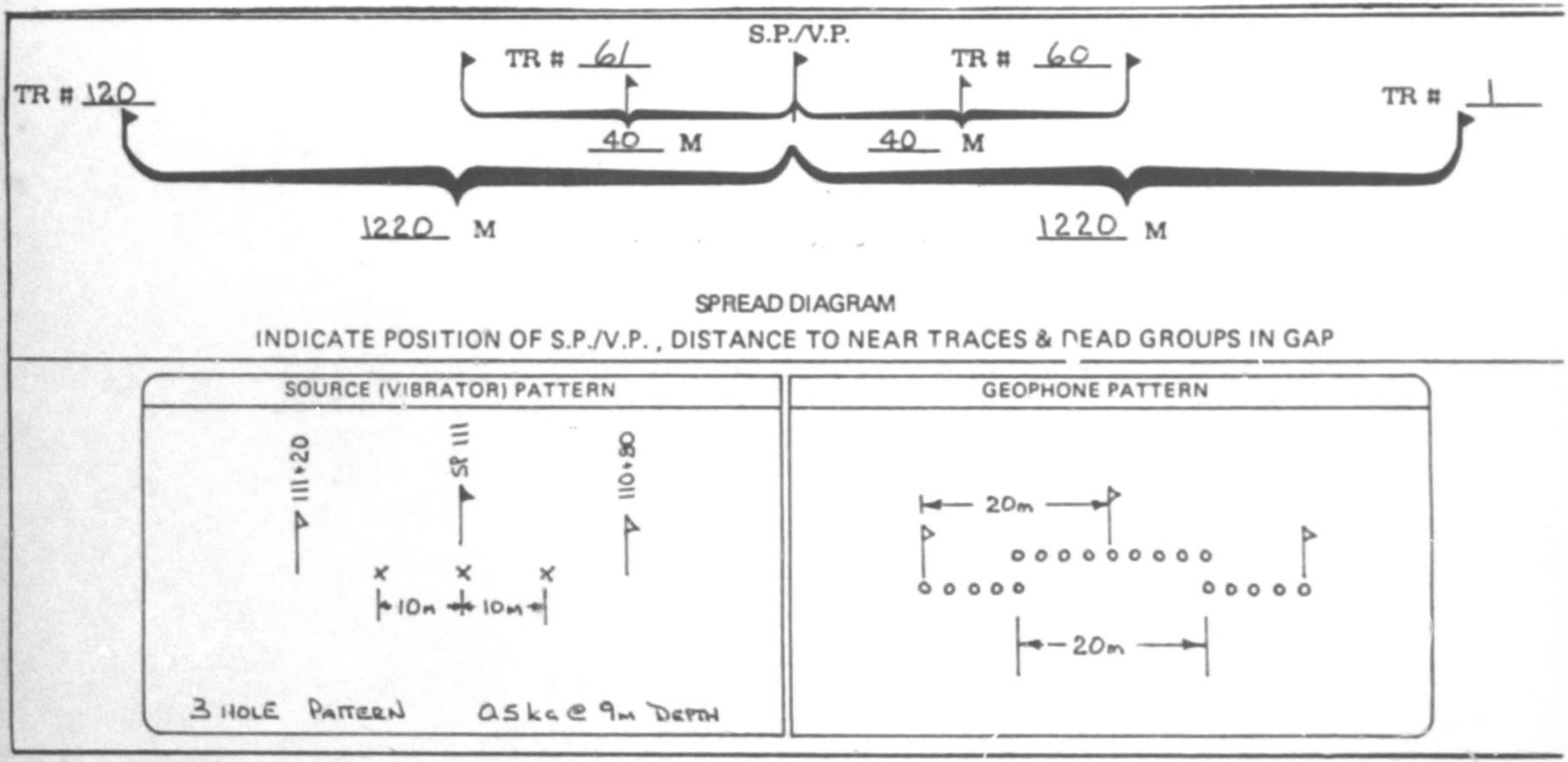

S.P./V.P.
TR # 120
TR # 61
TR # 60
TR # 1
40 M
40 M
1220 M
1220 M
SPREAD DIAGRAM
INDICATE POSITION OF S.P./V.P., DISTANCE TO NEAR TRACES & DEAD GROUPS IN GAP
SOURCE (VIBRATOR) PATTERN
111+20
SP 111
110+80
10m
10m
3 HOLE PATTERN
0.5 kg @ 9m DEPTH
GEOPHONE PATTERN
20m
20m

FIGURE 2

Table 2.3.2 Seismic and Survey Instruments

Drilling

| | | |
|---|---|---|
| 4 | Conventional | (1 wheel, 3 track) |
| 4 | Top Drive | (4 wheel) |
| 11 | Support 4x4 | (11 wheel) |

Line Clearing

4 Cats

1 Cat Push

Surveying

| | | |
|---|---|---|
| 1 | Honda - Quad-runner | 2 EDM (Red II & III) |
| 1 | Theodolite T16's | Survey control used existing wellsite information. |

Steel Chain

Recording

10 Wheel

1 Track

DFSV Amplifier

SEGB Tape System

Detection

Geophone strings — Mark L15 10Hz Spike

Fuel Consumption

600 gallons diesel fuel per day

250 gallons gasoline per day

## 3.0 Seismic Data Processing

The 1989 Cameron Hills recorded seismic data were processed by Western Geophysical, a division of Western Atlas Canada Ltd., during the months of April to June, 1989. Table 3.1 represents the processing sequence used by Western Geophysical and Table 3.2 lists the lines processed.

**Table 3.1** Processing Sequence

1. Demultiplex and edit:
   The Seg-B format field tapes were converted to Western's internal code - 4 trace sequential format. All shotpoint traces were displayed for quality control. The data was processed for three seconds at a demultiplexed sampling rate of 2 msec.

2. Line geometry and elevation statics:
   The stations were renumbered from one station per five receivers to one station per one receiver location. Determination of shot locations and relative receiver cable configurations allowed for the editing out of bad traces.

3. Instrument and geophone phase compensation:
   The phase distortion caused by the DFS-5 instrument and the 10 Hz geophones was determined in order to design and to deconvolve an inverse operator with the recorded data. The inverse operator's length was 225 ms.

4. Amplitude Decay Compensation:

In order to correct for spherical divergence, each sample's amplitude was multiplied by its reflection time to the power 1.75.

5. Deconvolution before stack:

The minimum phase predictive deconvolution was applied in the time domain, using the Weiner-Levinson algorithm. The design parameters used for auto-correlation determination were:

| | |
|---|---|
| Predictive Distance | 2 ms |
| Operator Length | 120 ms |
| Percent white noise | 0.1% |
| Auto correlation windowing | 1 window |
| Start time for near offset | 50 ms |
| Start time velocity | 1685 m/s |
| Stop time | 1700 ms |

Each trace was normalized to a fixed RMS value (2000) to allow equal amplitude treatment between traces.

6. Weathering Statics:

The paths estimation and empirical lattice reduction (PEELR) method was used to compute weathering statics. To calculate shot and receiver statics, the first breaks were used to obtain the thickness of the weathering layer and the velocity of the refractor beneath the shots and receivers.

7. Velocity analysis:

Velocity determination occurred three times:

1) A preliminary velan semblance before automatic statics.

2) An expanded velan including 7 velocity fans with common offset gathers and 7 fan velocity stacks at approximately every 150 CDP's (1.5 km) after the first pass of automatic statics.

3) Same as 2) but determined after FK multiple attenuation.

8. Automatic Reflection Statics:

The first pass of auto-statics used preliminary velocities with a 36 msec. allowable shift on a 100-1200 msec. correlation window. The second pass of auto-statics used final velocities with a 12 msec. allowable shift on a 100-1200 msec. correlation window.

9. FK Filter:

Strong multiple interference was removed by NMO correcting each shot record with a velocity equal to 90% of the stacking velocity, thus over-correcting the primaries and under-correcting the multiples. The FK filter then rejected multiples between .1 and 20 msec/trace dip.

10. Trim stack with outside mute:

The final trim static application used a 100-1200 msec. correlation window with a 3 trace model length and a maximum allowable shift of 8 msec.

Normal moveout corrections were applied to the CMP gathers and stacked with an outside mute as follows:

| Offset(m) | Time (msec) |
|---|---|
| 200 | 0 |
| 201 | 150 |
| 600 | 450 |
| 800 | 700 |
| 1220 | 850 |
| 2000 | 1400 |

11) Finite Difference Migration:

The time-space migration program used approximations to a differential equation which governs wave motion. Ten cascades were run using a migration velocity equal to 100% of the stacking velocity smoothed over 150 CDP's.

12) Band Pass Filter:
The Band Pass Filter applied to the data used a frequency of 12-85 Hz, and a slope of 24/48 db/octave.

13) Amplitude Decay Analysis and Gain:
Application of a time variant scaling function balanced the sections in time. The gain curve, designated by amplitude decay analysis on all seven lines was used on all traces. This process preserves relative amplitude.

14) Bulk Shift to Final Display Datum:
The 850m processing datum was bulk shifted 95 msec. for a final display datum of 750m.

**Table 3.2** List of Lines Processed

| Line Number | Station Range | Number of Shots | Length in Km |
|---|---|---|---|
| 8088 | 101-237 | 136 | 13.62 |
| 8089 | 371-101 | 269 | 27.02 |
| 8090 | 101-269 | 170 | 16.90 |
| 8091 | 101-163 | 62 | 6.22 |
| 8093 | 101-351 | 251 | 25.02 |
| 8095 | 191-269 | 168 | 16.82 |
| 8099 | 178-102 | 78 | 7.72 |
| TOTAL | | 1134 | 113.32 |

# 4.0 INTERPRETATION

## 4.1 Regional Geology and Tectonic History

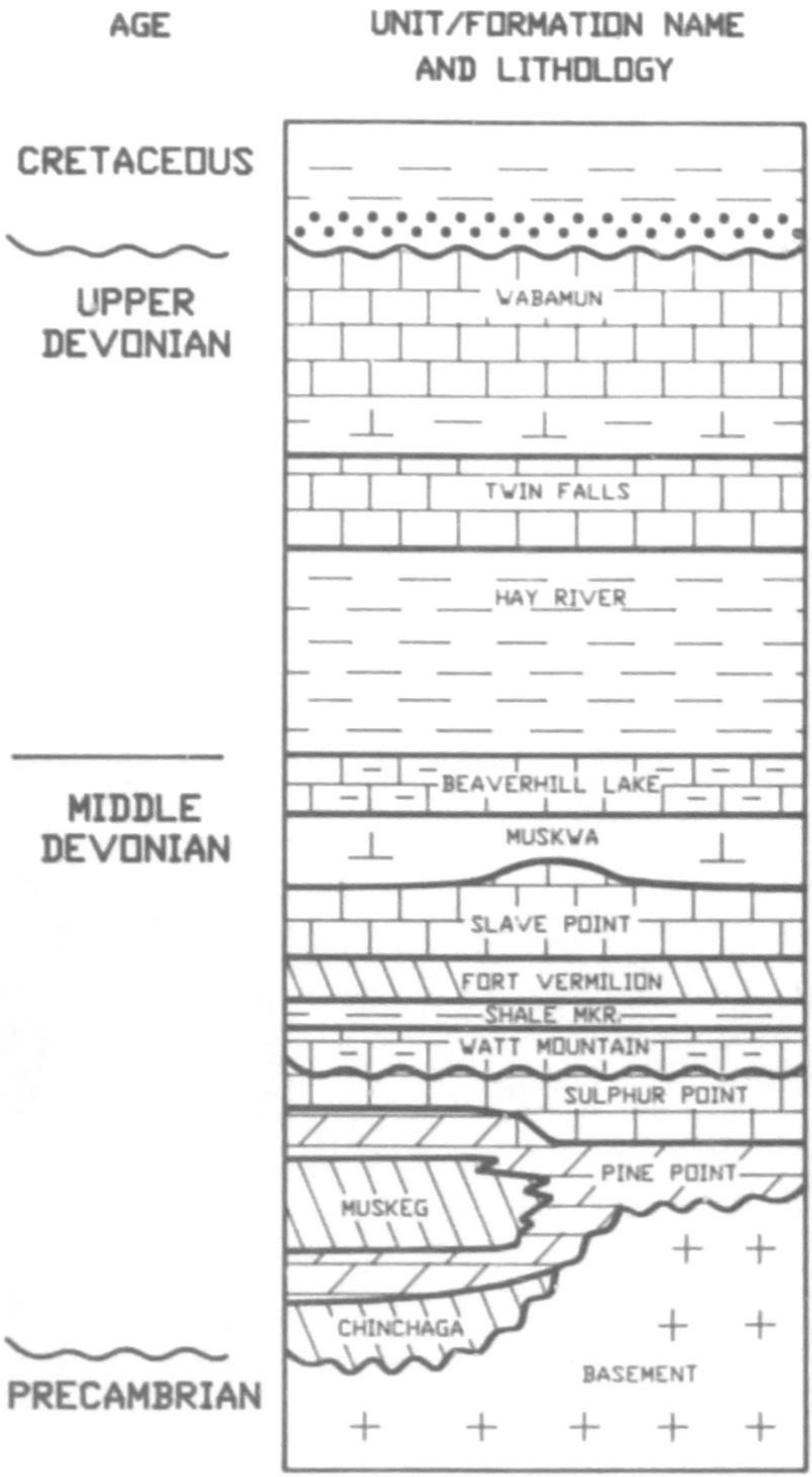
The Paleozoic stratigraphy of the Cameron Hills area was influenced by tectonic activity which culminated in a broad basement high called the Tathalina Uplift. This uplift combined with pre- and syn-Devonian fault reactivation, developed a horst and graben basement geometry which influenced the depositional pattern of the mid-Devonian carbonates and evaporites.

## 4.2 Stratigraphy

The stratigraphy of the Cameron Hills area can be grouped into four major lithological units: the Pre-Cambrian basement, the Middle Devonian carbonates, the Upper Devonian shales and carbonates and the Cretaceous shales and sands (Figure 3).

The Pre-Cambrian basement is predominantly composed of basic meta-volcanics with frequent intrusions of ultra-basic dykes.

The Middle Devonian is a thick section of carbonate and evaporite sediments which rest unconformably on the basement. The oldest of these mid-Devonian formations is the Basal Red Beds, which are predominantly shale. Above the Red Beds is the Chinchaga Formation. The Chinchaga is a thin unit of anhydrite locally dolomitized, which onlaps basement highs. Overlying the Chinchaga is the regionally continuous Keg River Formation. This broad, basal carbonate platform is extensively dolomitized. The platform acts as a base for Keg River pinnacle reef development. Overlying the Keg River Platform and encasing the pinnacle reefs is a thick section of anhydrite with thin dolomite beds referred to as the Muskeg Formation. The Muskeg Formation changes facies laterally into a thinner dolomite called the Pine Point Formation. This facies development occurs above topographical basement highs which are located proximal to the Presqu'ile Barrier. The




CAMERON HILLS - SWEDE AREA

STRATIGRAPHIC CHART

(REFERENCE 1) FIGURE 3

Sulphur Point formation lies conformably on top of the Muskeg and is subdivided into two units - a basal dolomite unit and an overlying limestone unit. Uplift of the area allowed for sub-areal exposure of the Sulphur Point unit and subsequent karsting. The area was then submerged and the deposition of the Watt Mountain carbonates and shales occurred. The Slave Point limestone lies conformably on the Watt Mountain formation and is capped by the Muskwa bituminous shale and the Beaverhill Lake argillaceous carbonates.

Upper Devonian limestones and shales were deposited above the Slave Point. Progressing up section from the Slave Point, the formations are the Muskwa shale, the Hay River shale, the Twin Falls limestone, the Fort Simpson shale, and the Wabamun limestone, which has been truncated by the Pre-Cretaceous Unconformity. (Figure 3)

The Cretaceous section consists mainly of shale and is most often overlain by Quaternary gravels.

## 4.3 Seismic Data

Both 1985 and 1989 seismic data were used for the interpretation. Data quality from both surveys are good. However, line ties between the two vintages mistie as much as 12 milliseconds. Consequently, the interpretation honoured the 1989 data over the 1985 data.

Sixteen lines were used in the interpretation. Table 4.3.1 listed the lines used and shotpoint locations are shown on the Base Map (Enclosure 1).

**Table 4.3.1** Seismic Lines used in Interpretation

| Line No. | Station Range | Vintage |
|---|---|---|
| 8088 | 101-237 | 1989 |
| 8089 | 101-371 | 1989 |
| 8090 | 101-269 | 1989 |
| 8091 | 101-163 | 1989 |
| 8093 | 101-351 | 1989 |
| 8095 | 101-269 | 1989 |
| 8099 | 102-178 | 1989 |
| 8000 | 101-352 | 1985 |
| 8021 | 101-322 | 1985 |
| 8023 | 101-275 | 1985 |
| 8025 | 853-1031 | 1985 |
| 8027 | 95-272 | 1985 |
| 8029 | 100-378 | 1985 |
| 8031 | 98-276 | 1985 |
| 8033 | 99-265 | 1985 |
| 8035 | 105-230 | 1985 |

### 4.4 Seismic Interpretation

Three seismic events were picked, correlated, and mapped over the area of interest:

1. Pre-Cretaceous Unconformity
2. Twin Falls Limestone
3. Slave Point Limestone

These three events tied Cameron C-22, Swede O-22 and Cameron C-50 using the synthetic seismograms (Enclosures 2, 3, 4). The seismic line 8093 (Enclosure 5) illustrates the three seismic events that were picked for this interpretation.

The Pre-Cambrian basement is difficult to identify and correlate on seismic lines, but a unique fault pattern has emerged from the interpretation (Enclosure 6). These basement faults can be recognized on seismic to cut the Middle Devonian section up to the Muskeg. Some subtle evidence from the seismic may support displacement of the Slave Point Limestone unit by these same basement faults.

#### The Slave Point Limestone - (Enclosure 7)

The Slave Point event is identified as a strong peak that correlates throughout the area between 850ms - 980 ms. This peak, in places, transforms into a doublet. This report interpretation has chosen the lower peak of the doublet to represent the top of the Slave Point unit.

The map of the Slave Point Limestone shows a gentle dip towards the west and southwest. Basement paleotopograpby and subsequent tectonism have influenced the structure at this event. Several structural closures are mapped. Due to mistie problems toward the west and southwest of the seismic coverage, structural uncertainty has been noted.

**The Twin Falls Limestone - (Enclosure 8)**

The Twin Falls event is identified as a strong peak that correlates well throughout the survey area between 550 ms to 690 ms on the seismic lines.

The map for the Twin Falls Limestone is structurally simple. The event dips gently towards the southwest. Simple structural noses tread north-north-east over the area. Some (less than 10 ms) low relief structural closures are mapped. These structures are influenced by the deeper Middle Devonian structure. Line misties are a problem for the time structure map over the west and south west edge of the seismic survey.

**The Pre-Cretaceous Unconformity - (Enclosure 9)**

The Pre-Cretaceous Unconformity is identified as a strong peak that correlates well throughout the survey area between 450 ms to 490 ms on the seismic lines.

The event map for the Pre-Cretaceous Unconformity is structurally simple. The event dips gently southward and westward. Simple structural noses trend north-north-west at this level. Some structural closures with less than 10 ms of structural relief have been mapped. There is noted structural uncertainty towards the west and southwest edge of the seismic lines due to misties.

## 5.0 Gravity and Magnetics

Gravity and magnetic data were not recorded during the acquisition of the 1989 data.

## 6.0 Conclusions

The quality of the Petro-Canada 1989 Cameron Hills survey is good and it will serve as an infill to the 1985 survey. Mistie problems are generally noted on the maps. Three events have been mapped over the survey area. The Pre-Cambrian basement, although seismically difficult to identify and correlate, has mappable fault patterns. These basement faults influenced the Slave Point structure and possibly the Twin Falls structure. The regional dip of the area is toward the south and west. Well results in the vicinity demonstrated hydrocarbon potential in the Middle Devonian section. The survey area has potential for future discoveries.

## References

1. **H. Skall** 'Paleoenvironment of the Pine Point Lead-Zinc District' Economic Geology, Vol. 70, No. 1 (1975), pp.22-47.