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246-06-05-108

OTTAWA COPY

GEOPHYSICAL EXPLORATION REPORT

1978-1979

COLVILLE/ANDERSON PLAINS PROJECT

NORTHWEST TERRITORIES

ACTION SLIP

FINAL REPORTS 246-6-5-78-17

Project No 246-6-5-108.....

The following action has been taken:

Receipt acknowledged .....

Branch Card made .....

Reports and maps date-stamped.....

Reports and maps labelled.....

Date rec'd entered in project ledger.....

Memo sent to Land Management.....

Reports for review list edited.....

Inventory sheet made .....

REVIEW and APPROVAL made by:

Eng. and Control .....

Resource Eval. ..... Dec 10/82

Env. and Protect. .....

PLEASE STATE COMMENTS ON ATTACHED SHEET.

246-6-5-78-17

PROJECT NUMBER: 246-6-5-108

COMPANY: PETRO CANADA

REPORT TITLE: COLEVILLE/ANDERSON PLAINS GEOPHYSICAL PROJECT

COMMENTS:

ENGINEERING AND CONTROL BRANCH

ENVIRONMENTAL AND PROTECTION BRANCH

RESOURCE EVALUATION BRANCH

CANADA BENEFITS BRANCH

246-06-05-108

GEOPHYSICAL EXPLORATION REPORT

COLVILLE/ANDERSON PLAINS PROJECT
(COLVILLE & TWEED LAKE EXPLORATION AGREEMENT AREA'S)
NORTHWEST TERRITORIES

PROJECT 246-06-05-78-17

Land Use Permit No. N78B-872

Permittee
WESTERN GEOPHYSICAL COMPANY OF CANADA, LTD.

Leasee
PETRO-CANADA EXPLORATION INC.

Report by H. Kim
May, 1982

Survey Type - Reflection Seismograph (Dynamite)
Work Period - 1978 through 1979

TABLE OF CONTENTS

INTRODUCTION

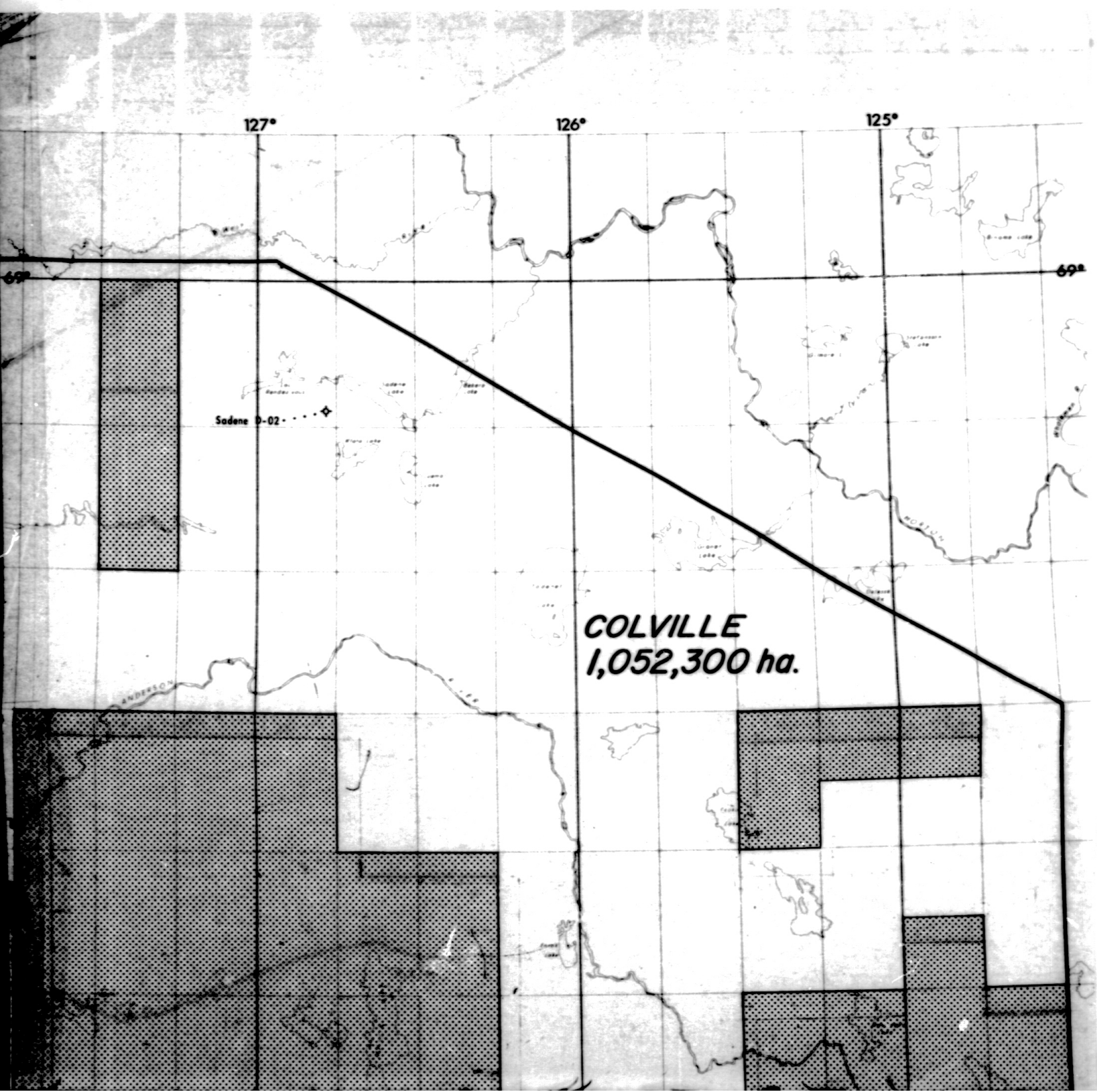
The 1978-79 Colville/Anderson Plains Project area is located in the north central portion of the Northern Interior Plains of the Northwest Territories. Approximately 4,572,888 acres or 1,851,372 hectares of Crown lands have been nominated by Petro-Canada Exploration Inc. in the Colville and Tweed Lake exploration agreement areas under Sections 33(1)(a) and 33(1)(b) of the Canada Oil and Gas Land Regulations (Figure 1).

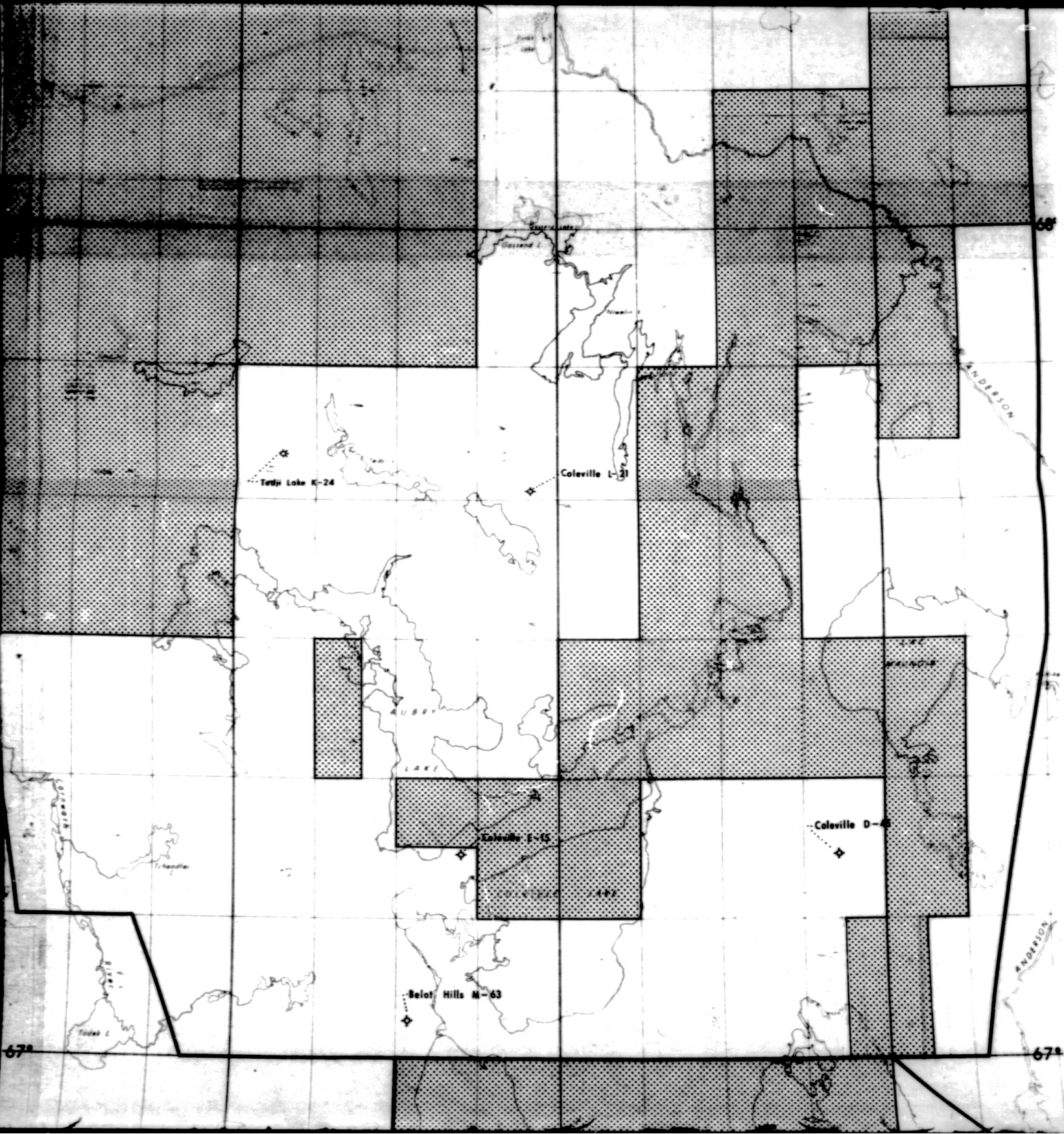
The physiography of this area is a generally low, constant topography that is highly glaciated and covered with gravels. The drainage system is diffused with a myriad of lakes and swamps. This area is heavily vegetated with muskeg and has a very limited amount of outcrop exposures.

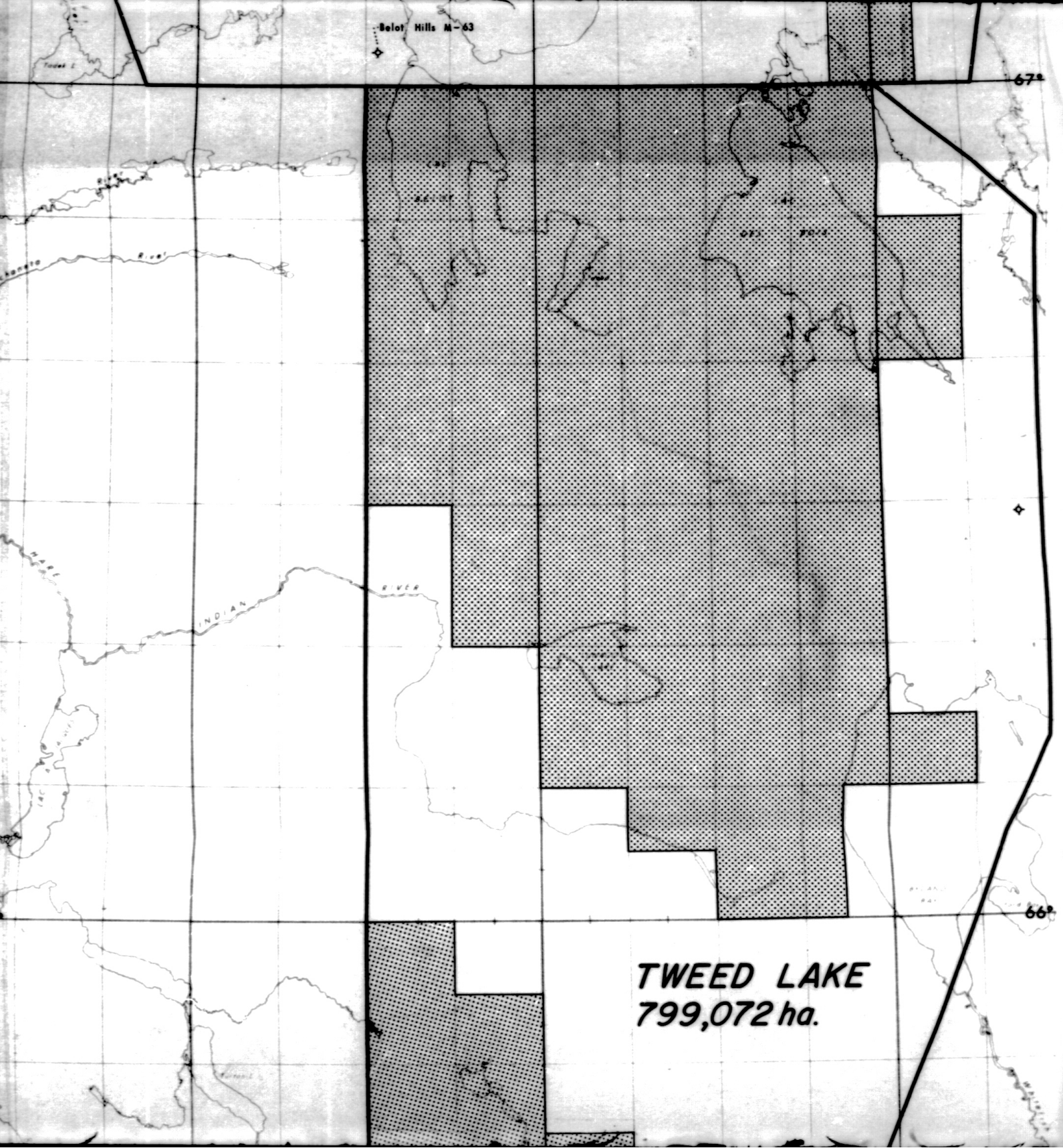
In 1979, three seismic programs were conducted in three different regions within this area (Figure 2); the northern (Block 1), the central (Block 2) and the southern (Block 3) regions. The seismic lines were shot to evaluate the nominated Crown lands and to determine the correlation between the seismic and gravity anomalies. In the southern (Block 3) region, the seismic lines were located over a LANDSAT anomaly which coincided with a gravity anomaly.

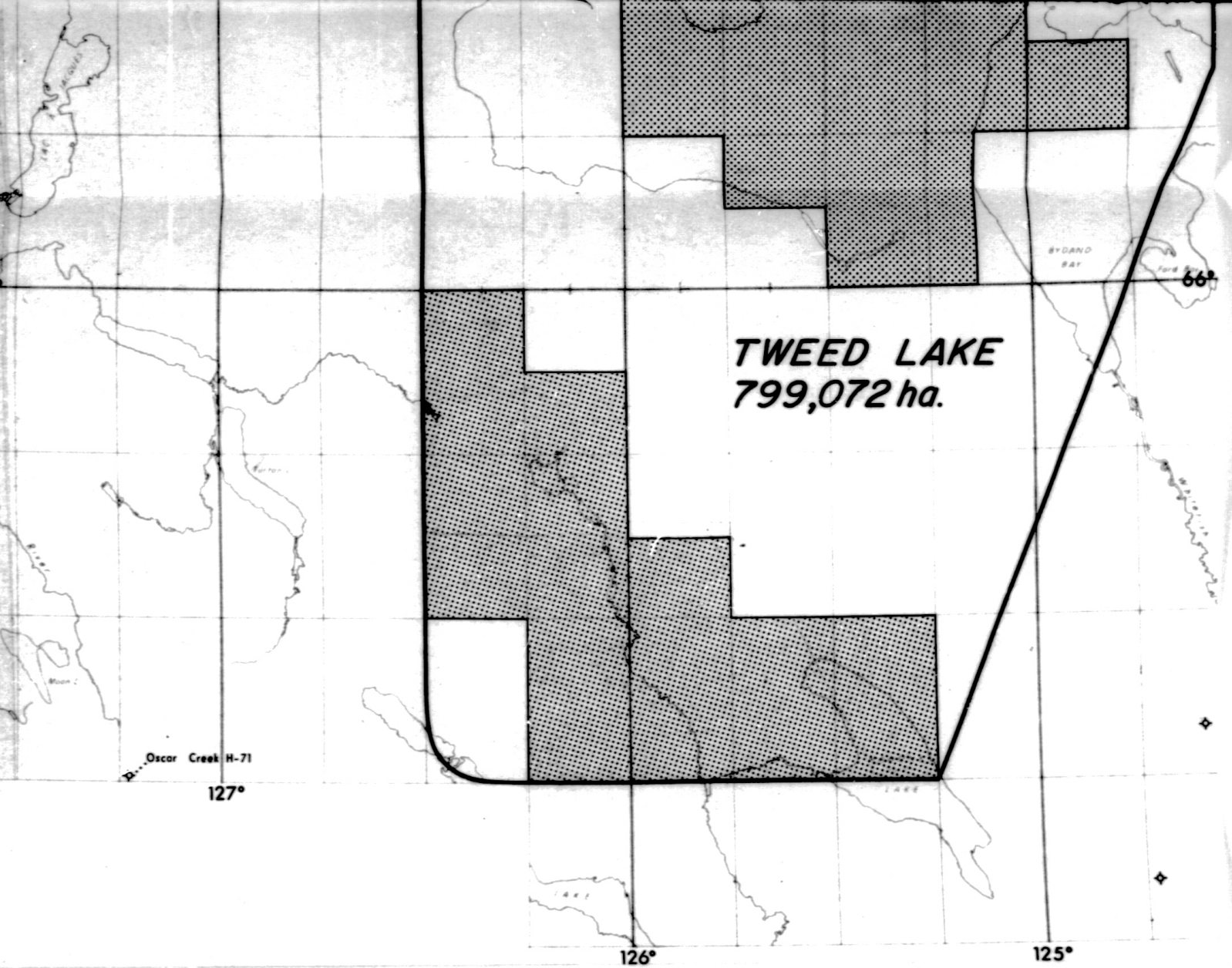
Petro-Canada contracted a regional gravity survey in the Anderson Plains area in 1976. Among several large gravity anomalies that were found, one was near the Tedji Lake gas well, and other gravity anomalies were near lands which Petro-Canada wished to evaluate. Several of these gravity leads were detailed by the 1979 seismic program. Additional gravity data was collected along with the new seismic lines to supplement seismic interpretation. It has been apparent in the recent years that LANDSAT images can be a viable aid to exploration for structures which may contain commercial deposits of hydrocarbons. Subtle tonal anomalies and curvilinear or linear features on LANDSAT images might indicate the areas of structural anomalies. Limited access to the land and geological outcropping plus the short field season make the use of LANDSAT images a good exploration tool for reconnaissance mapping in this area.

A total of 471.5 kilometres of seismic was shot in the 1979 program and this data was interpreted in addition to purchased data. This report summarizes the procedures of data acquisition, processing and the results of the interpretation.


127°
126°
125°
69°
69°
Sadene D-02
COLVILLE
1,052,300 ha.


68°
67°
67°
Tedji Lake K-24
Coleville L-21
Coleville E-15
Coleville D-
Belot Hills M-63
ANDERSON
ANDERSON
AUBRY
LAKE


Belot Hills M-63
67°
66°
INDIAN
RIVER
TWEED LAKE
799,072 ha.



PETRO-CANADA

REVISIONS	
DATE	BY

FIGURE 1

NORTHWEST TERRITORIES

LAND MAP

SCALE: 1 : 500,000		DFTG : U.K.
DATE : OCT., 1981	MAP:	WELLS:
MAP REFERENCE	SEISMIC:	LAND:

LEGEND:

SIGNED EXPLORATION AGREEMENTS

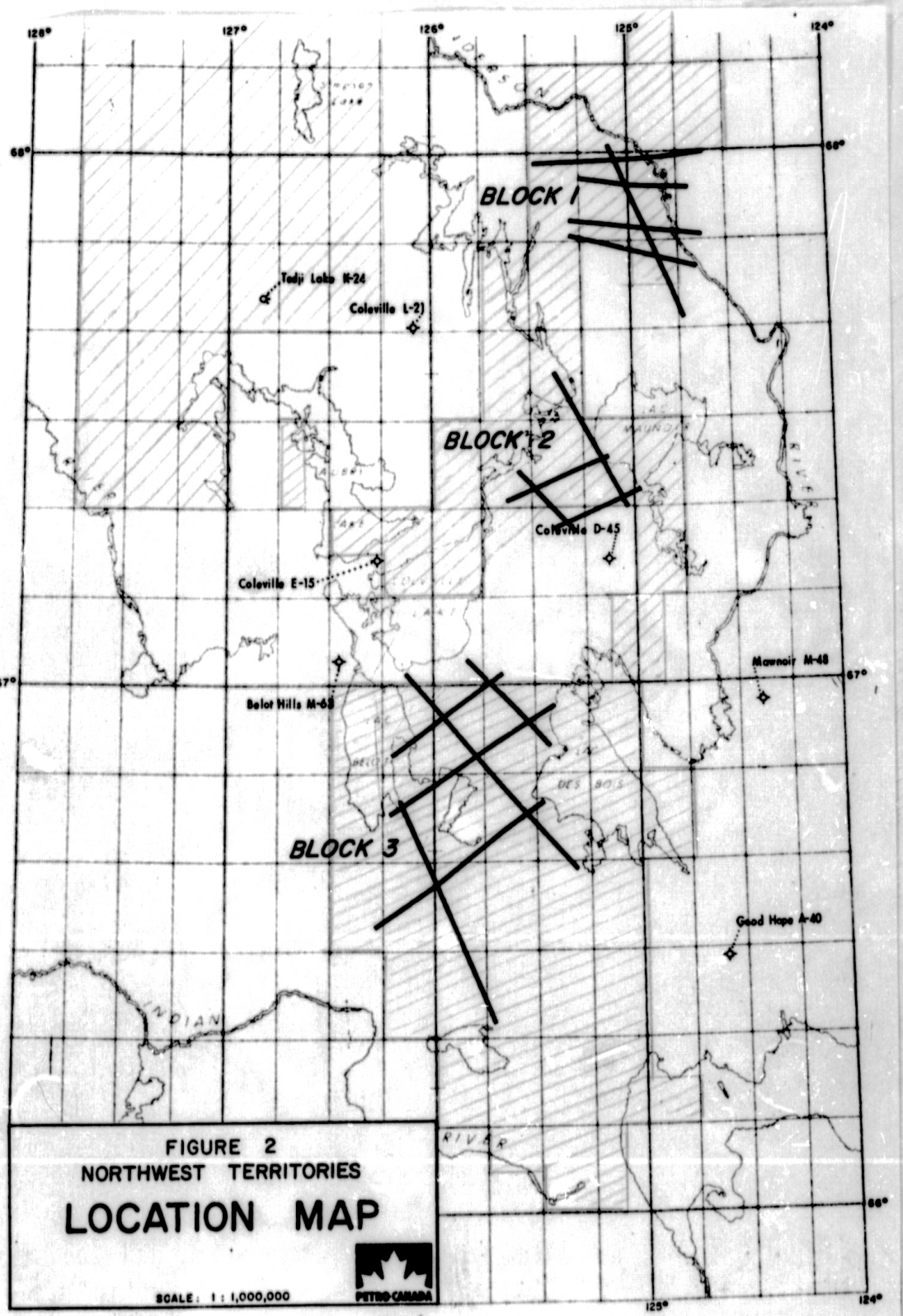


FIGURE 2
NORTHWEST TERRITORIES

LOCATION MAP

SCALE: 1 : 1,000,000

PETRO-CANADA

STATISTICAL DATA

Dates:

1978/November/1 - The Norman Wells expediting operation was mobilized.

1978/November/16 - The "start-up" crew left base for Little Chicago by an aircraft.

1978/December/12 - Recording operations were commenced.

1979/March/31 - Recording operations were completed.

1979/April/16 - All operations were ceased and crew was demobilized.

Production:

Number of kilometres	471.5
Number of shots	3942
Number of stations	15767
Total recording days	81

Equipment:

The equipment is listed as follows:

	Type
1 Party manager vehicle	FN-5
1 Recorder vehicle	FN-110
1 Shooting vehicle	CF-60 crew cab
3 Cable trucks	FN-110 crew cab
2 Survey trucks	CF-60 crew cab
6 Vehicles mounted with drilling rigs	CF-110 Mayhew model 1000-air

2 Water trucks	FN-110 Gin Poles
1 Mobile shop vehicle	FN-110
1 Fuel haul support truck	F-350 Half-truck
1 Kitchen-diner	Sleigh mounted
1 Utility	Sleigh mounted
1 Office-sleeper	Sleigh mounted
4 Sleepers	Sleigh mounted
1 Recreational hall-sleeper	Sleigh mounted
2 Power-shop-storage	Sleigh mounted
8 Fuel sloops	Sleigh mounted
2 Powder magazines	Sleigh mounted
2 Kitchen-diner-utility	Sleigh mounted
1 Incinerator	Sleigh mounted
2 Shop-power unit	Sleigh mounted
1 Kitchen-diner-sleeper	Sleigh mounted

Pacific Western Airlines' jet service was used to carry supplies and personnel between Alberta and Norman Wells. Aklavik Air and Ken Borek Air were chartered to fly men, fuel and supplies from Inuvik and Norman Wells to the work location. Geophysical field equipment was barged to Norman Wells and Little Chicago from Inuvik.

The geophyscial instruments were as follows:

	Type
Amplifiers	Texas Instruments DFS V
Tape systems	Texas Instruments DFS V
Oscillograph	Tektronic

Camera	S.I.E. ERC-10C
Remote firing system	Input-Output Encoder/Decoder
Cables	Mark Products Ltd. 1410 ft.
Geophone Strings	Mark Products Ltd L-28
	A-1-10 Hz.
	Litton Resources Systems
	20-D 10 Hz.

Personnel:

Recording (13 men)

1 - observer, 1 - assistant observer, 1 - shooter, 1 - assistant shooter,

3 - cable truck drivers, 6 - recording helpers

Drilling (15 men)

7 - drillers, 7 - drill helpers, 1 - drill mechanic

Surveying (4 men)

2 - surveyers, 2- rodmen

Catering (5 men)

2 - cooks, 2 - assistant cooks, 1 - camp attendant

Additional (6 men)

1 - party manager, 1 - clerk, 1 - supplyman, 2 - mechanics,

1 - mechanics helper

Line cutting and Cleaning (13 men)

10 - machine operators, 1 - foreman, 1 - cook, 1 - native monitor

Gravity (1 man)

1 - operator

Total Personnel (57 men)

Survey:

All seismic lines were laid out and surveyed by the normal chain and transit method. Two wild T-16 theodolite survey instruments were used for horizontal and vertical control. New cut line locations were obtained from topographic features, star shots and sun shots. Station elevations were computed by stadia and horizontal locations by latitutdes and departures. A tellurometer survey was performed to run control in Block 1 in January and to tie the three regions in March.

Conditions:

Weather conditions were abnormal during the project period. Ice building was hampered due to above-average temperatures in December and January. Because of poor ice the use of DC-3 aircraft for fuel supplies had to be temporarily abandoned in favor of the lighter turboprop Twin Otter aircraft resulting in substantially higher fuel costs. February and March brought below-average temperatures, resulting in some equipment problems and the necessity of Twin Otter flights when temperatures were too cold for DC-3 aircraft. Several days' production was lost due to extreme cold temperature in February and March. Inclement weather did not present a problem during the data gathering period; however, problems were encountered during demoblization due to a storm in the first week of April.

Telex, telephone and radio communication were installed at Norman Wells for expediting service.

FIELD PROCEDURES

Operating Techniques:

A 206-B helicopter was utilized for tellurometer survey in conjunction with the tie-in gravity control work.

Five dozers were assigned to the operation: two D-7's cut and cleared the lines, two D-7's moved the camps and did line clean-up, windrowed the slash and removed creek crossings, a D-6 built airstrips and hauled fuel.

Six rotary drills were mounted on F-67 for the project. All holes were drilled by air. Shot points were single holes drilled to a depth of 15 metres. All production holes were preloaded with 2.25 kilograms of Geogel 60 and tamped with the cuttings.

Recording Techniques:

Sample rate:	2 milli-seconds
Record length:	6 seconds
Precentage of stack:	1200
Number of groups:	96
Group interval:	30 metres
Geophone array:	1-2-3-4-4-3-2-1 tapered (56 metres) or 9 geophones
Shot point location:	120 metres
Geophones per group:	20 or 9
Standard spread length:	1440-30-0-30-1440

DATA PROCESSING

Sefel J. and Associates S.E.L. (Scientific Electronic Laboratories) Model 32-55 system was used for processing the field data and constructing the seismic cross sections. Petro-Canada applied migration step for certain lines. The following parameters were used for the structural correction and digital processing.

Structural Correction

Weathering correction and elevation correction

Datum plane: 305 meters above sea level

Datum correction velocity: 6,000 meters per second

Digital Processing:

1. Demultiplexing
2. Amplitude recovery
3. Filter application (Bandpass 10-90)
4. Static corrections
5. Deconvolution
6. Velocity analysis
7. Normal moveout
8. Filter application (Bandpass 15-75)
9. Automatic statics
10. Mute

11. Stack

12. Migration (applied in Petro-Canada processing center)

13. Filter application (tim.. .arying)

14. Automatic gain control

Section Display:

Sefel J. and Associates (500 Bow Valley Square Two, Calgary)

Vertical scale: 3.75 inches per second

Horizontal scale: 16 traces per inch

Petro-Canada Exploration Inc. (1027 - 8th Avenue S.W., Calgary)

Vertical scale: 3.75 inches per second

Horizontal scale: 80 traces per inch

For the convenience of handling, Sefel sections (six out of fifteen) were squeezed horizontally by camera and these squeezed sections were used for interpretation and correlation.

RESULTS AND INTERPRETATIONS

Seismic:

From the seismic sections, two horizons were identified on the basis of amplitude character, reflection terminations and correlation with well data. They are "top of Saline River formation" (Upper Cambrian) and "top of Proterozoic". Synthetics generated from sonic logs of wells in the area were of relatively little value due to their incomplete coverages of the interesting zone, thus making character comparison to seismic sections unreliable.

The seismic data quality varies from area to area and also vertically. The shallow horizons to the base of Cambrian are generally horizontal and easily traceable. However, structural features in thick Proterozoic section indicate that the area had undergone tectonic activity during Proterozoic time: normal faulting, steeply dipping beds and massive losses of sediments due to erosion or non-deposition. Where the land surface is swampy or has a large number of small lakes and ponds, the data quality severely deteriorates (e.g., southeastern corner of Block 3 in figure 2: line WG 135A).

The top of Proterozoic is generally gently dipping to the west and south, showing remnants of minor tectonic activity. Much of the faulting and minor undulations are considered to be of Laramide age (Davis and Willot, 1978). This hypothesis, however, can not be

verified by the existing seismic data because no post Cambrian formations can be identified. The top of Saline River formation is generally conformable with the top of Proterozoic. Time structure maps of these two hororizons are in Enclosure 4. An ischron map between these two horizons is not included because the horizons are generally conformable with each other.

The Cambrian section is composed of Lower Cambrian sandstone (Mount Clark formation), Middle Cambrian shale and dolomite (Mount Cap formation) and Upper Cambrian salt and dolomite (Saline River formation). The primary hydrocarbon target is the Lower Cambrian Mount Clark formation. The Middle Cambrian shale is regarded as the source rock and the Upper Cambrian Saline River formation as cap rock. The slight thickness variations in the Cambrian section are probably due to salt buildup or removal in the Saline River formation.

Velocity analyses (R.M.S. and Interval velocities) are shown on the top of the seismic sections. Migration velocities were obtained from stacking velocities. However, because they were very high (up to 30,000 feet per second), velocities reduced at increments of ten percent were tried and final velocities were picked from the best looking sections. As a result, the velocities used for migration were sixty to seventy percent of the initial velocities obtained from the stacking velocities.

LANDSAT:

With the discovery of gas in the Cambrian Mount Clark formation at the Tedji Lake well, follow up work has indicated that Proterozoic paleotopographic highs may be the prime control for this type of hydrocarbon trap. The Proterozoic topography at least partly controlled the Early Cambrian sand deposition. Ancestral highs and arches may represent loci for hydrocarbon accumulation in other areas such as Bulmer Lake Arch, Wolverine Arch, Mahony High and Colville High.

The limited access and poor outcrop exposures in this area make the use of LANDSAT images a useful exploration tool. Subtle tonal anomalies and curvilinear or linear features on LANDSAT images might indicate the areas of structural anomalies. In the northern and central regions (Block 1 and 2, figure 2), diffuse drainage, muskeg and a limited amount of outcrop exposures have made the recognition of tonal anomalies and structural trends difficult. However, in the southern region (Block 3 in figure 2 - Tweed Lake area) four composite LANDSAT anomalies have been found and are referred to as Mahony Lake, Tweed Lake, Tunago Lake and Lac Belot anomaly.

Seismic line WG 110A-116A, was shot across the Tweed Lake LANDSAT anomaly. This section showed a strong correlation between the seismic structural high and the LANDSAT anomaly. The coincidence between the LANDSAT and seismic anomaly has provided the incentive to do seismic detail over the Tweed Lake LANDSAT anomaly with the 1980-81 Program.

Gravity:

The Gravity operation was recorded by Airborne Geophysical Surveys. Due to the wide spacing of the lines, the contour map is most useful as an indicator of the regional trends. Bouguer gravity anomaly maps for the three regions (Block 1,2 and 3 in figure 2) are included (Enclosure 6).

The gravity anomalies in the northern and central region are composed of a wide range of wavelength with both positive and negative anomalies. These anomalies appear to be responding to several sources, i.e., the Saline River formation salt, an inferred Proterozoic salt and some sources with positive density contrasts which produce positive gravity anomalies over anticlines which contain no salt in them.

In contrast, the negative gravity anomalies of short wavelength in the southern region suggest that the only gravity source is the Saline River formation salt. Assuming density increases with depth, structural highs of Cambrian age are expected to give gravity highs on the surface. On the contrary, a residual gravity low was observed associated with Tweed Dome Structural high. Therefore, the gravity low on Tweed Dome is considered to be casued by low density salt in the Upper Cambrian Saline River formation.

SUMMARY AND CONCLUSIONS

The 1978-79 seismic program in the Colville Plains Project was carried out to evaluate Crown lands and to establish the correlation of seismic anomalies with gravity and LANDSAT anomalies. Two mappable marker horizons were identified on the seismic sections, i.e., "top of Saline River formation" and "top of Proterozoic". The Cambrian section in-between these two horizons is composed of Lower Cambrian sandstone, Middle Cambrian shale and dolomite and Upper Cambrian salt and dolomite.

LANDSAT and gravity anomalies in the southern region (Block 3 of figure 2) appear most promising. In particular, the Tweed Dome is a seismic high which correlates well with a LANDSAT anomaly and with a residual gravity anomaly. Therefore, it is recommended that this relationship be further checked in the Tweed Lake Project Area.

The 1980-81 seismic program has been conducted in Tweed Lake Work Agreement Area and is now being interpreted. The results of this detailed study of the Tweed Dome structure will hopefully define a firm drilling location.

Submitted by: Haeyoun Kim
H. Kim

Date: May 26, 1982

Approved by: A.E. Calverley
A.E. Calverley
Prof. Geologist

References and Enclosures

Reference:

1. J.W. Davis and R. Willot, 1978, Structural Geology of the Colville Hills: Bull. Can. Petrol. Geol., V. 26, n. 1, p. 105-122.

Enclosures:

1. 4 Topographic maps: NTS 96 K,L,M,N
2. 5 Shot Point base maps: NTS 96 K,L,M,N, 97B NE/SE
3. 15 Seismic sections: WG 120A, WG 116A, WG 104A, WG 100A, WG 77A, WG 48A, WG 42A, WG 91A, WG 121A, WG 110A-116A, WG 90A-106A, WG 72A-84A, WG 139A, WG 135A-7A, WG 129A
4. 2 Time structure maps: Top of Saline River formation (by Wayne Kirchner) Top of Proterozoic
5. 1 Gravity station map
6. 3 Bouguer gravity maps: Northern, Central and Southern Regions (by Chin C. Chang)
7. 15 Gravity profiles: Line 120, Line 116, Line 104, Line 100, Line 77, Line 48, Line 42, Line 91, Line 121, Line 1160 (110-116), Line 106 (90-106), Line 84, (72-84), Line 139, Line 135 (135-7), Line 129