PETRO-CANADA

Report on the
GEOPHYSICAL EXPLORATION SURVEY

PROGRAM No. 9229-P28-4E

in

LAC-A-JACQUES
NORTHWEST TERRITORIES

Exploration Agreement No. 163

APRIL, 1986

Report on the
Geophysical Exploration Survey

PROGRAM NO: 9229-P28-4E

in

Lac-A-Jacques Survey
Northwest Territories
EXPLORATION AGREEMENT NO.'s 160 AND 163

by

Petro-Canada Inc.
April 1986

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FIELD WORK PERIOD:	December 1984 - February 1985
LAND USE PERMIT NO.:	N84-B268
AREA COORDINATES:	Latitude 67° 15' - 68° North Longitude 126° - 128° West
DATA ACQUISITION:	Seismic - Seiscom Delta United (Int'l) Corp. Gravity - Airborne Resource Development Ltd.

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NWT Region

J.B. [illegible]
Regional [illegible]
NWT Region

CONTENTS

CONTENTS (Cont'd)

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF DATA TRANSMITTED UNDER SEPARATE COVER

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1. 1 Mylar Shot Point Map: 96M, 97B west, 106P composite

2. 15 Seismic Sections: 8700, 8700A, 8701, 8702, 8703, 8704, 8705, 8706, 8707, 8708, 8709, 8710, 8711, 8712, 8713

   1 mylar and 2 paper copies of each section, 7.5 inches/second (normal and reverse polarity)

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REFERENCES

Cook, D.G. and Aitken, J.D.; 1973: Tectonics of Northern Franklin Mountains and Colville Hills, District of Mackenzie, Canada. In Pitcher, M.G. ed. Arctic Geology. AAPG Memoir 19, pp 13-32.

Davis, J.W. and Willott, R; 1978: Structural Geology of the Colville Hills. Bulletin of Can. Petr. Glgy., Vo.26, No.1, pp. 105-122.

SECTION ONE

INTRODUCTION

A geophysical survey was completed by Petro-Canada Inc. during the 1984-1985 winter season over a part of the north-central Northern Interior Plains in the Northwest Territories. The survey was operated by Petro-Canada over lands covered by Exploration Agreement 163 as well as a small block of Exploration Agreement 160. These two areas, Lac-a-Jacques and Colville respectively, are shown in Figure 1.1.

The purpose of the survey was to delineate potential hydrocarbon prospects interpreted from the 1984 seismic survey. Three hundred and forty-two kilometres of seismic reflection data were shot and three hundred and forty-two kilometres of gravity data were measured along the seismic lines.

This report summarizes data acquisition, processing, and interpretation of the 1984-1985 survey, and is submitted to COGLA as required by the Exploration Agreements.

The interpretation of the 1984-85 data was augmented with the use of existing Petro-Canada seismic data, especially that obtained during the 1983-1984 season. Seismic time structure and isochron maps of this interpretation are enclosed in the report along with a contoured Bouguer gravity map.

Other data, including mylar copies of seismic base maps and sections and paper copies of seismic sections are being sent separately from this report.

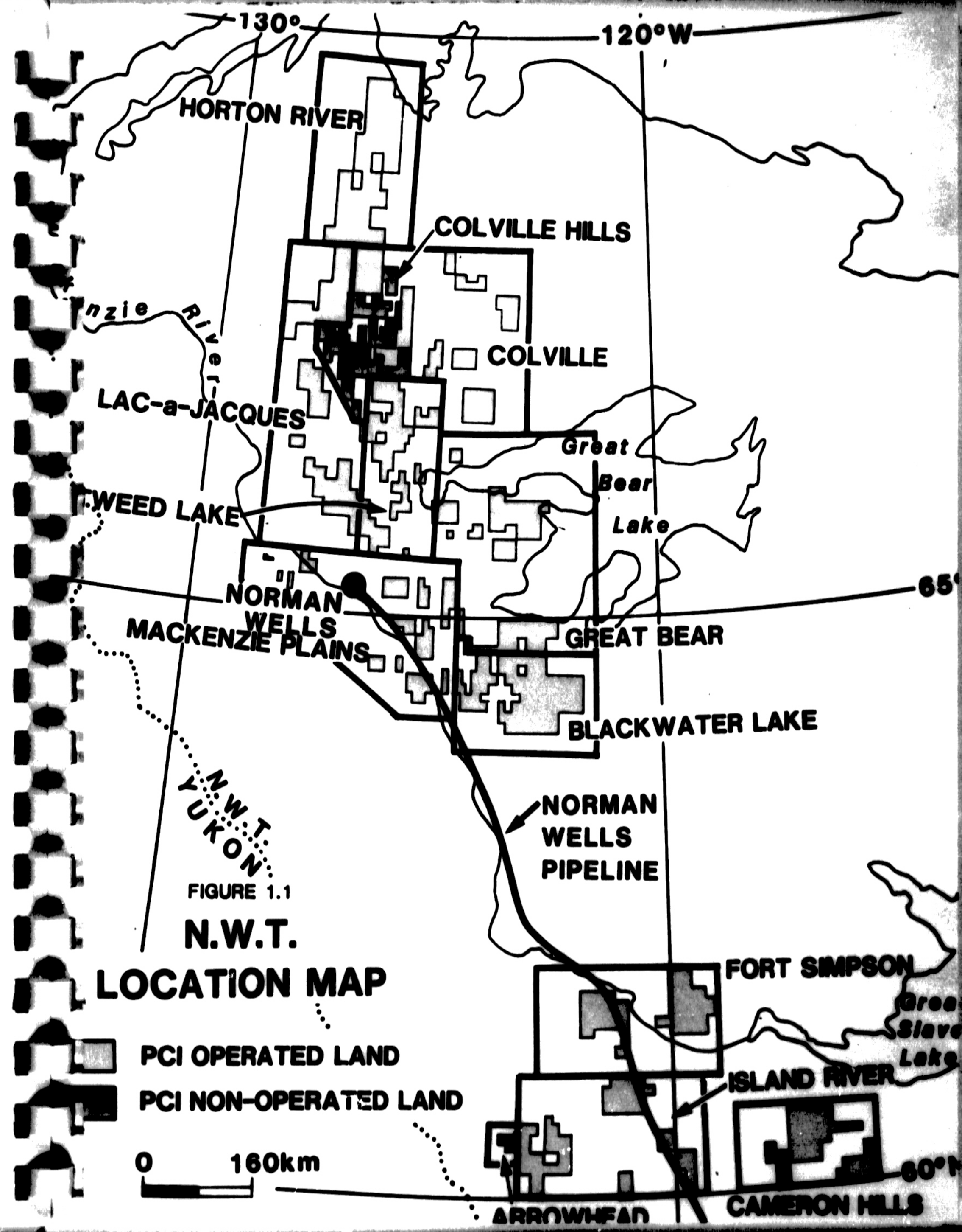

FIGURE 1.1

N.W.T.

LOCATION MAP

SECTION TWO

DATA ACQUISITION AND REDUCTION

2.1 Field Operations Summary

2.1.1 Field Conditions

Few field problems were encountered. Early mobilization allowed drilling and recording to begin before the Christmas break. The first camp move was slowed down by a lack of snow cover which resulted in numerous mechanical failures.

Weather conditions caused many problems with equipment as temperatures ranged from -40°C to -50°C throughout December, and storms and low overcast skies were frequent.

Very rough terrain in the north-east and around Aubry Lake in the south forced the use of detours, and the lack of snow cover hampered all aspects of the operation. Drilling conditions were fairly good with the presence of clay, rocks, and only a few hard ledges. There were difficulties in areas of gravel and hard rock formations.

Production performance increased as weather conditions and daylight hours improved. Because the survey program consisted of three distinct areas, some production time was lost during camp moves.

2.1.2 Seismic Operations

The major contractor was Seiscom Delta United, who subcontracted surveying, bulldozing, and drilling. A total of 64 people were employed, 61% of whom were residents of the Northwest Territories.

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Tables 2.1, 2.2, 2.3, and 2.4 summarize project chronology, production, drilling, and organization.

Mobilization	December 4, 1984 Drill Camp December 9, 1984 Recording Camp
Recording started	December 18, 1984
Completion of recording	February 13, 1985
Demobilization date	February 14, 1985

Table 2.1 Seismic Project Chronology

Total Recording Days*	45
Total Poor Weather Days	nil
Total Moving Days*	20
Production Profiles Shot*	2,592
Kilometres Shot	342.14
Average Profiles per Production Day	68
Average Kilometres per Production Day	8.97
Total Days Mobilization/ Demobilization*	14
Total Crew Days in the Field*	60

Table 2.2 Seismic Production

Total Drilling Days*	47
Total Poor Weather Days	Nil
Total Moving Days*	20
Number of Holes Drilled*	2,782
Average Hole Depth	15 metres
Average Holes per Day	68
Total Metres Drilled*	41,730
Powder Consumed*	5,564 kilograms
Average Charger per Hole	2 kilograms
Total Days Mobilization/Demobilization*	15
Total Crew Days in the Field*	60

Table 2.3 Seismic Drilling

* Note: The operations report submitted by Seiscom Delta United covered two geophysical surveys, Lac-a-Jacques and Great Bear. Unfortunately, the statistics were not given separately for the two areas and consequently production and drilling statistics for this report were estimated using what information was available from Petro-Canada's Operation department and the 1984-85 seismic data. Production and drilling days were based on dates given in Seiscom Delta United's operations report.

Seiscom Delta United Recording Crew:			
Party Manager	2	Observer	1
Clerk/Supplyman	1	Jr. Observer	1
Expeditors	2	Shooter	1
Mechanics	2	Shooter's Helper	1
Mechanic's Helper	1	Cable Truck Drivers	4
Monitor	1	Recording Helpers	8
Drilling: (Hugh Denham Enterprises)		**Catering:** (Seiscom Delta United)	
Drilling Push	1	Cooks	2
Drillers	8	Cook's Helper	2
Drill Helpers	8	Camp Attendants	2
Water Truck Drivers	2		
Bulldozers: (Borek Construction Ltd.)		**Survey:** (Seisurv Exploration Inc.)	
Cat Push	1	Surveyors	2
Cook	1	Rodmen	2
Fuel Camp Operator	2		
Cat Skinners	6		

Table 2.4 Project Organization

2.1.3 **Gravity Operations**

Airborne Resource Developments was contracted to conduct the gravity acquisition. Because of transportation problems, two operators were required at times in order to catch up with the seismic crew. An extra line, #92X, was included because it was missed in the 1984 gravity survey.

Table 2.5 summarises the project chronology and production.

Project Chronology

Mobilization Date	December 11, 1984
Demobilization Date	February 14, 1985

Production

Total number of stations	1,218
Total number of lines	16
Total distance run	340 km.

Table 2.5 Gravity Project Chronology and Production

2.2 Seismic Data Acquisition

2.2.1 Instruments

Table 2.6 summarizes equipment used in drilling, recording, detection, and surveying.

Drilling		
8 Drilling Rigs	6 - TF - 110 Mayhew Air Drills (2 with Air/Water)	
	1 - TF - 110 Mayhew Air Drill with down hole hammer	
	1 - TF - 110 Top Drive Air/Water with down hole hammer	
Recording		
Amplifiers	Texas Instruments	DFSV
Tape Systems	Texas Instruments	DFSV
Camera	S.I.E.	ERC-10C
Detection		
Remote Firing System	Input - Output, Encoder/Decoder	
Cables	Mark Products, 430m cables with 16.7m take outs	
Geophone Strings	Geosource, 10 HZ (winter base)	
Surveying		
2	Wilde T-16 Theodolite	
1	D14L Distomat	

Table 2.6 Seismic and Survey Instruments

2.2.2 Parameters

The source-detector geometry was 1584-33-X-33-1584(m) with a group interval of 33 metres. The detector array geometry used was 9 geophones in line over 66 metres.

Table 2.7 lists the recording parameters used.

Sample Rate	2 milliseconds
Record Length	6 seconds
Recording Filter	Low cut-8 Hz., high cut-128 Hz.
Sub-surface Coverage	1200%
No. of Groups	96
Group Interval	33 metres
Group Array	Inline array over 66 metres
Seismometres per Group	9
Shotpoint Interval	132 metres
Spread Length	1584-33-X-33-1584
Energy Source	2 kilograms of 60% geogel (dynamite)
Holes per Shot Location	1
Average Hole Depth	14.8 metres

Table 2.7 Recording Parameters

2.2.3 **Survey System**

New cut lines were surveyed-in using topographic features and sun shots. Stations elevations were computed by stadia, and horizontal locations by latitudes and departures. Shot point and station intervals were measured with a chain and rod.

Accuracy of positioning is ± 1 metre in elevation and ± 10 metres in horizontal distance.

2.3 Gravity Data Acquisition

2.3.1 Field Techniques and Measurements

The aircraft and equipment used were:

1 Terra jet
1 Lacoste and Romberg G-Meter #232 (Conversion Constant = 1.05506)
1 Lacoste and Romberg G-Meter #442 (Conversion Constant = 1.04678)
1 Lacoste and Romberg G-Meter #732 (Conversion Constant = 1.02085)

The observed gravity at Government station #9549-59 (Norman Wells airport terminal) was tied by aircraft to the primary field base 8700 A.A. Successive field bases were established using a "step-by-step" method, where each previously set base became the initial base for the next one.

Gravity was observed every 264 metres along the seismic lines, or every other shot point. Three readings were taken at each station.

Table 2.8 summarizes the gravity measurements taken.

Gravity station interval	264 metres (each second S.P.)
Number of independent readings at each station	3
Meter setting	On the ground
RMS accuracy of single gravity observation (115 repeats)	+/ 0.04 mgal

Table 2.8 Gravity Measurements

2.3.2 Accuracy of Data

Elevation and co-ordinates of each shot point were provided by the seismic reflection survey group.

The absolute accuracy of the Bouguer gravity is affected by the accuracy of the:

Base network	± 0.05 mgal
Observed gravity	± 0.04 mgal
Loop elevation	+/- 0.55m or +/- 0.17 mgal (@ 0.3086 mgal/m)
Positioning	Negligible
Terrain and tidal corrections	Negligible
Total	+/- .18 mgal

The total absolute accuracy is calculated as the square root of the sum of squares of all the above RMS accuracies.

2.4 Geophysical Data Processing

2.4.1 Seismic

The seismic data recorded was processed at Pulsonic Geophysical Ltd. and completed in April, 1985 using the following format:

1. Demultiplex/Display/Edit: 2 msec sample rate
2. Amplitude Recovery: Spherical divergence
3. Spiking Deconvolution: a) Operator length: 80 msec
   b) Prewhitening: 1%
   c) Design Window: 300-1800 msec @ 33 metres offset
   600-1800 msec @ 1584 metres offset
4. CDP Trace Gather
5. Velocity Analysis: Coherency spectra and common offset stacks
6. Normal Moveout Application
7. Structural Corrections: a) Drift corrections obtained by Intercept Method
   b) Elevation corrections applied using:
   Datum - 305 metres
   Replacement velocity - 5500 metres/sec
8. Automatic Surface Consistent Statics: 300-800 msec window
9. Automatic Trim Statics: 250-900 msec window

10. Filter Application: Zero Phase Bandpass
20/25 - 80/90

11. Trace Muting: Offset (metres) 530 560 1584
Time (msec) 0 300 600

12. CDP Stack: 1200%

13. AGC Scaling: 300 msec window

14. Display to Film: Scale - horizontal: 24 traces/inch
- vertical: 7.5 inches/sec
- CDP interval: 16.5 metres

After residual statics were done, common shot and common geophone stacks were used to check and improve statics further.

2.4.2 Gravity

Field processing was done by the contractor and included conversion of meter reading to milligals, plus drift and tidal corrections. The inner zone terrain correction was estimated by the operator in the field. In Calgary, the contractor sorted the field data by lines, rather than by daily loops, and calculated Bouguer gravity using a crustal density of 2.35 grams/cc. The outer zone terrain correction was calculated and, together with the inner zone corrections, were added to the Bouguer gravity. The data were then transcribed onto magnetic tape and delivered to the Gravity and Magnetic Group of Petro-Canada Inc. for final processing as follows:

1) Merging the line oriented data into the Merged Survey File (MSF).

2) Correcting for discrepancies at line intersections using systematic adjustments.

3) Low-pass filtering of the Bouguer anomalies.

4) Plotting of the gravity profiles, index map, and fence diagram.

SECTION THREE

INTERPRETATION OF RESULTS

3.1 Regional Geology

The Lac-a-Jacques geophysical survey covered a portion of the Anderson Plain physiographic province, Figure 3.1. The area is bounded to the south and east by prominent ridges and highlands of the Colville Hills.

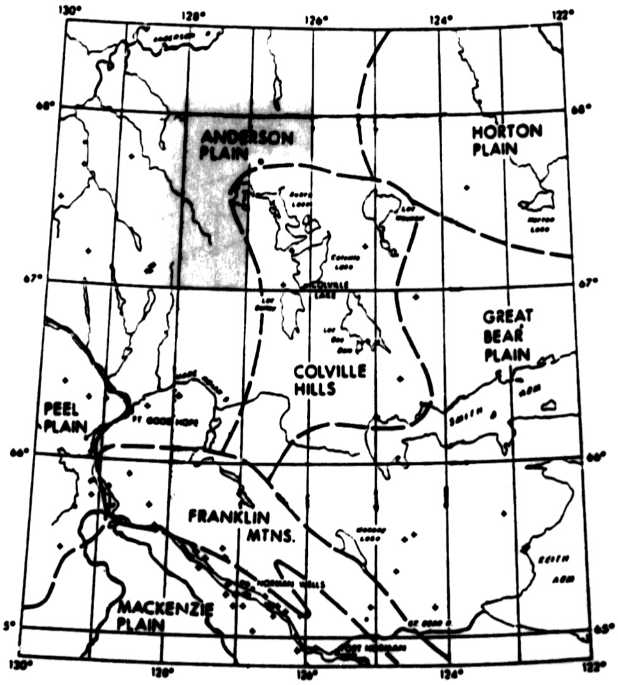
3.1.1 Structural Geology

The region was uplifted and eroded after deposition of massive units of proterozoic strata. Several lesser movements occurred throughout the Paleozoic, but overall a stable platform existed until the end of Devonian time. Post Devonian major uplift and erosional cycles, and particularly the Laramide Orogeny, caused deformation of all units. These latter compressive stages produced or accentuated numerous folds and faulted anticlines in the Colville Hills. The majority of these structures appear to die out in the program area, where surface topography is generally of low relief. Surficial features strike northwest to southeast.

Figure 3.2 shows prominent local features such as the Colville High and K'ahbami Arch.

3.1.2 Stratigraphy

The stratigraphic succession ranges in age from Pre-Cambrian to Recent, Figure 3.3. Thick Proterozoic clastics and carbonates underlie the pre-Paleozoic unconformity. Paleozoic sediments represent a shallow marine environment on a shelf between the eastern craton and a mobile positive feature to the west.



Project area

Figure 3.1 Map of the physiographic provinces in the Lac-a-Jacques area.

(modified from Davis and Willot, 1978)

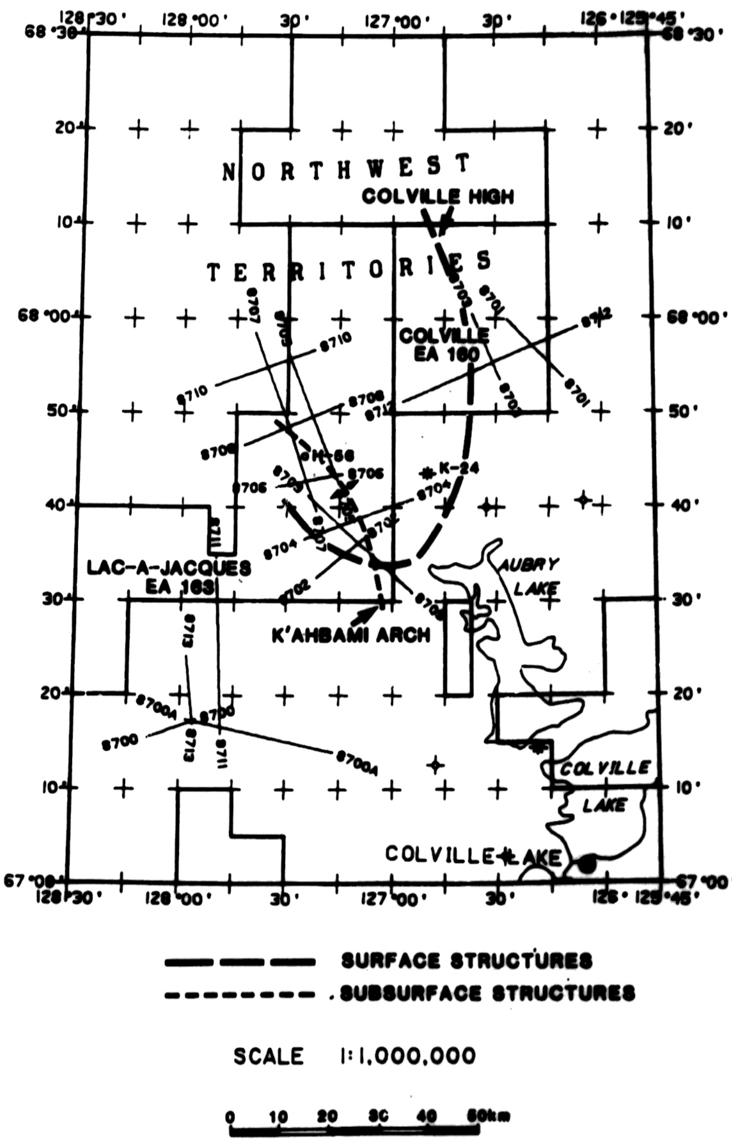


FIGURE 3.2 LOCATION MAP OF THE 1984/85 GEOPHYSICAL PROGRAM IN THE LAC-A-JACQUES AREA SHOWING MAJOR STRUCTURAL FEATURES

UPPER CRETACEOUS	Unnamed: shale	
? —— ?	? Disconformity ?	
LOWER CRETACEOUS	Unnamed: sandstone	
Regional Unconformity		
MIDDLE DEVONIAN	HARE INDIAN FORMATION	
	HUME FORMATION	
	BEAR ROCK FORMATION	
Regional Unconformity		
SILURIAN UPPER ORDOVICIAN	MOUNT KINDLE FORMATION	
	Regional Unconformity	
LOWER ORDOVICIAN	FRANKLIN MOUNTAIN FORMATION	Cherty unit
? —— ?		Rhythmic unit
UPPER CAMBRIAN		Cyclic unit
? —— ?	SALINE RIVER FORMATION	
MIDDLE CAMBRIAN	MOUNT CAP FORMATION	
	MOUNT CLARK FORMATION	
Regional Unconformity		
PROTEROZOIC	DIABASE DYKES	
	COPPERMINE RIVER SERIES	
	Regional Unconformity	
	DIABASE DYKES	
	HORNBY BAY GROUP	Unnamed: stromatolitic dolomite
		Unnamed: sandstone, conglomerate, quartzite

FIGURE 3.3 Stratigraphic column for the Lac-a-Jacques area.

The Mount Clark sandstone unconformably overlies Proterozoic strata. The Mount Cap Formation succeeds this with interbedded shales and dolomite, and sand stringers in some areas. A green shale bed and dolomite stringers near the base of the formation can be traced over most of the area. The Saline River Formation above this consists of shale, dolomite, and an evaporite of varying thickness.

Capping the Saline River Formation are Silurian-Ordovician carbonates of the Franklin Mountain and Mount Kindle Formations. Above these are a second set of carbonates, the Devonian Bear Rock and Hume Formations. These units are unconformably overlain by Cretaceous clastics and glacial drift.

3.1.3 The Prospect

The primary hydrocarbon reservoir in this area is in the blanket sands of the Cambrian Mount Clark Formation. Derived primarily from the Canadian Shield to the east and possibly from the north, the depositional limit of the sands is thought to be near the western edge of the program area.

Traps are expected on post depositional structural highs or on flanks of Proterozoic highs. The Mount Clark sands may be absent over paleo-highs.

Sand stringers within the Mount Cap Formation provide a secondary target and demonstrate more favourable sand development to the east. To the west, the Mount Cap Formation becomes increasingly carbonaceous.

The Mount Cap Formation should act as both source and seal for the Mount Clark Formation and the Saline River Formation provides a seal for both.

3.2 Correlation of Geology With Geophysics

A synthetic seismogram for the K'ahbami H-56 well is shown in Figure 3.4, with the location given in Figure 3.2. Seismic lines in the 1984-1985 program area are also shown in Figure 3.2.

Five events are correlated in the Lac-a-Jacques area. The top of Proterozoic and the near top of Saline River Formation salt can be traced over much of the area. The synthetic shows that the strong event near the top of the salt is probably due to a low velocity, low density shale.

The other three events are all within the Mount Cap Formation. A reflection near the top of the Mount Cap Formation is probably a high velocity, high density carbonate. A band of green shale below this, and a section of dolomite stringers at the base of the Mount Cap Formation produce the two strongest reflections in the area.

3.3 Presentation of Results

3.3.1 Data Quality

Seismic data quality is fair to good in most of the Lac-a-Jacques area where carbonates are overlain by 70 metres or more of Cretaceous or younger material. Noisy discontinuous zones occur on seismic sections where subsurface solution collapse in Devonian carbonates has been filled in with Cretaceous clastics. To the east in the Colville area Siluro-Ordovician carbonates are very near the surface causing severe reverberations.

3.3.2 Seismic Maps

The Lac-a-Jacques project involves NTS grids 96M, 97B West, and 106P. Figure 3.5 is a composite seismic map for the area and shows the location of the 1984-1985 seismic survey, as well as other lines used in interpreting the data. Because data from the past two years was so much better than previous years, earlier data was used primarily to fill in gaps in the data. 1984-1985 was adjusted to 1983-1984 data with few problems. Earlier data required larger adjustments due to variations in static corrections, resolution, and polarity.

The following maps were produced at a scale of 1:100,000:

1) Top Proterozoic Time Structure - Figure 3.6
2) Near Top Cambrian Salt Time Structure - Figure 3.7
3) Near Top Cambrian Salt to Proterozoic Isochron- Figure 3.8
4) Mount Cap to Proterozoic Isochron - Figure 3.9
5) Near Base Mount Cap to Proterozoic Isochron - Figure 3.10

3.3.3 Gravity Maps

A Bouguer gravity contour map was produced at a scale of 1:100,000, Figure 3.11, by merging data from the 1983-1984 and 1984-1985 geophysical surveys.

3.4 Discussion of Results

3.4.1 Proterozoic and Cambrian Present Day Morphology

The two time structure maps, Proterozoic and near top of Cambrian salt (Figures 3.6 and 3.7), show a gradual regional dip to the southwest. A structurally high feature, the K'ahbami Arch, trends from the southeast near Aubry Lake to the northwest (Figure 3.2). It is broken by high angle normal and reverse faults on the Proterozoic map providing a dramatic contrast to the flatter, more continuous areas between the Lac-a-Jacques and Colville areas and the regions to the west and south.

The K'ahbami feature actually contains two structural highs separated by a saddle. The interpreted southern structure was delineated by this year's program.

An additional structural high was found in the Colville Exploration Agreement near Simpson Lake.

The three isochron maps - Cambrian Salt to Proterozoic, Mount Cap to Proterozoic, and Near Base Mount Cap to Proterozoic, show sediments above the Proterozoic thickening to the southwest, Figures 3.8, 3.9 and 3.10. This is due mainly to the thickening of evaporites within the Saline River Formation, although the other two isochrons below the salt show some thickening within the lower units as well. Thinning trends over the K'ahbami and Tedji Lake wells are observed and appear to occur over the Southern K'ahbami structure as well. A similar thinning trend also occurs in the Simpson Lake area but is not as obvious.

3.4.2 Age of Deformation

The K'ahbami Arch is associated with the Colville High, Figure 3.2. Southwest of the Colville High, seismic sections show westward dipping Proterozoic strata. Proterozoic strata northeast of Tedji Lake dip to the east. Thus, the Colville High can be dated as probably pre-Cambrian in age. It would have been a local feature in a shallow Cambrian trough. Post Devonian and later uplift resulted in this entire region being inverted so that the program area is now topographically lower than the original lowlands.

Thinning of Cambrian units such as the Mount Cap Formation over the K'ahbami structures suggest that the K'ahbami Arch was a structural high at least by early Cambrian time, with possible Proterozoic ancestry. Time structure and isochron maps appear to reflect Proterozoic structure in other parts of the mapped area as well, however additional seismic control is required for a good comparison.

3.4.3 Interpretation of Faults

The K'ahbami Arch is thought to be associated with the Belot Ridge south of the Lac-a-Jacques survey area. A major thrust fault controls the K'ahbami Arch to the east, the downthrown side being on the east side of the fault (Figure 3.12). Older lines show the Belot Ridge faulted down to the west. Strike-slip faulting may account for this reversal in fault direction as similar structures and reversals have been observed to the south in the Franklin Mountains (Cook

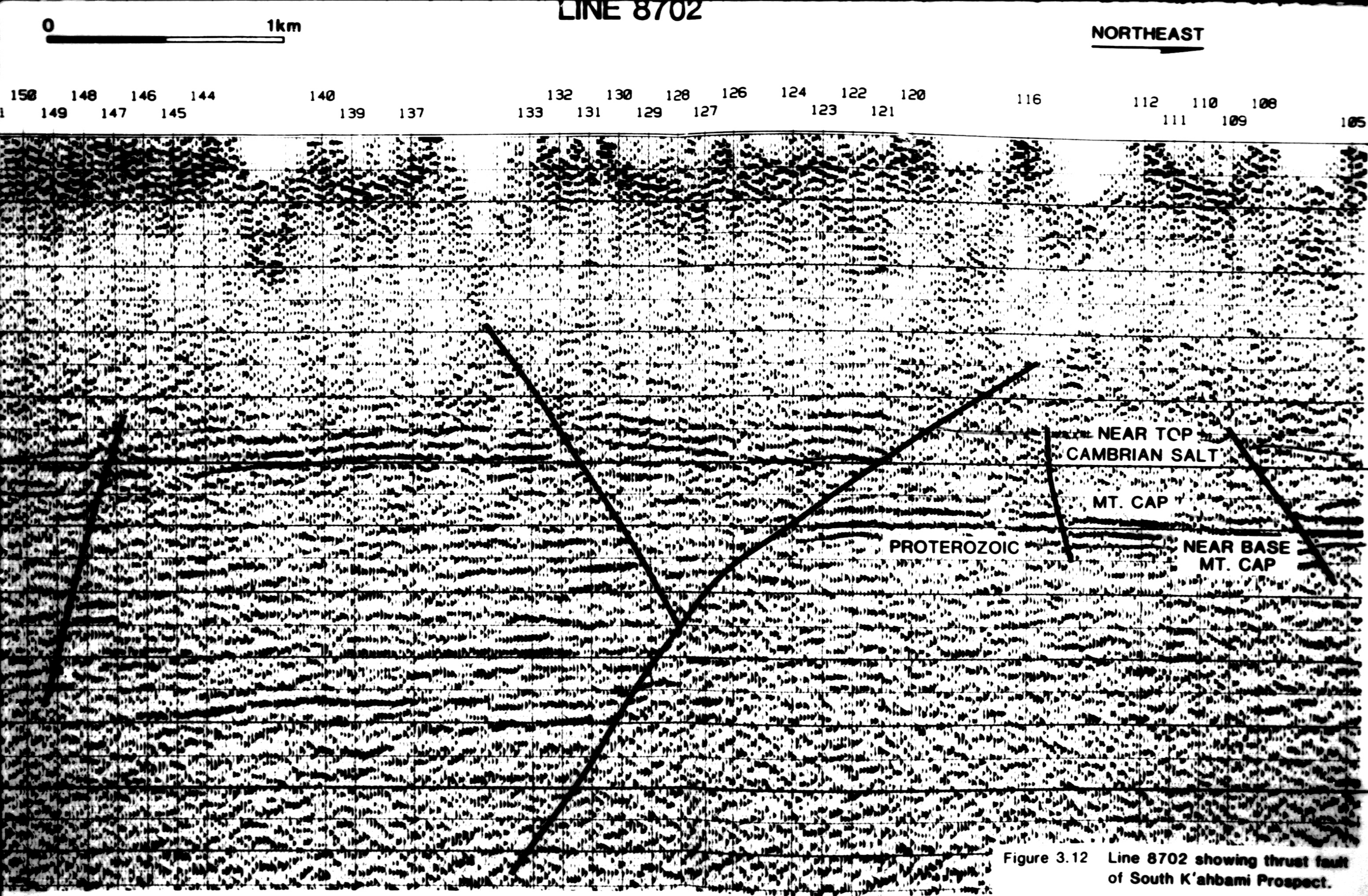


Figure 3.12 Line 8702 showing thrust fault of South K'ahbami Prospect.

and Aitken 1973). Thick portions of sediments in the vicinity of lines 101X and FR-13 appear to have been sheared or pulled along a northeast-southwest axis, again suggesting strike-slip faulting (Figures 3.8, 3.9, and 3.10).

Comparison of the two time structure maps reveals much less faulting in the near top Cambrian Salt. This suggests faulting prior to salt deposition, or flowage but not breakage of the salt during post depositional faulting. Line 8708, Figure 3.13, shows variations in salt thickness associated with faulting over the north K'ahbami structure.

A number of faults penetrate from deep within the Proterozoic up into the Cambrian salt. An excellent example of this can be seen on Line 8710, Figure 3.14, where faults of a Proterozoic graben are also seen in the overlying Cambrian section.

3.4.4 Interpretation of Gravity

The contoured Bouguer gravity map (Figure 3.11) shows a trend along major faults whereby values on the downthrown side are more negative than on the upthrown side. For small faults, this results in anomalies which are not seen on a regional scale. A general gravity high occurs over the K'ahbami Arch in the north. Gravity decreases to the northeast and southwest of the arch.

Gravity lows over the southern K'ahbami Arch and Simpson Lake prospects may be due to a decrease in thickness of near-surface carbonates.

A second gravity high southwest of the K'ahbami Arch is probably due to a prominent intra-Proterozoic high which is visible on older seismic sections in the area.

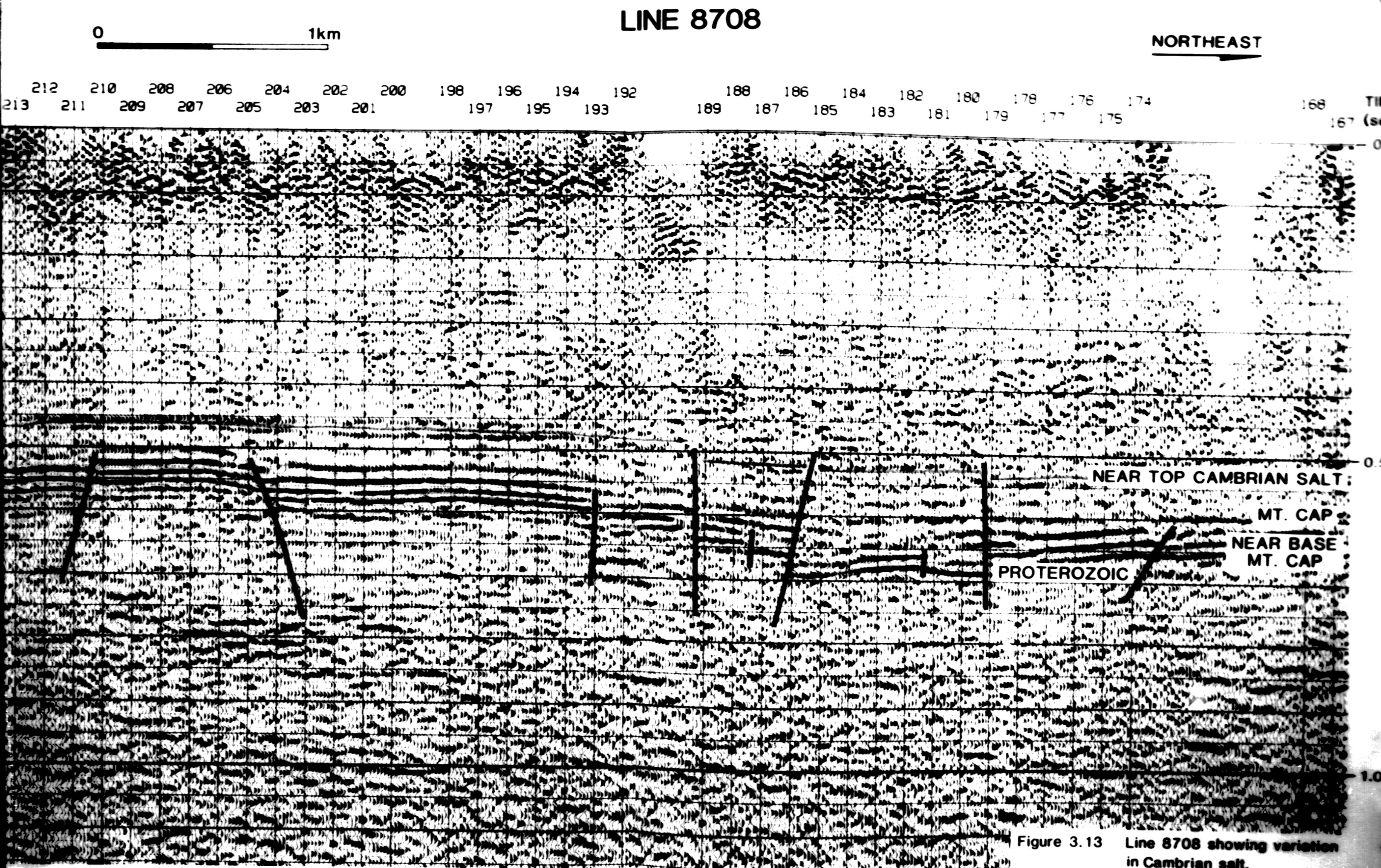


Figure 3.13 Line 8708 showing variation in Cambrian salt.

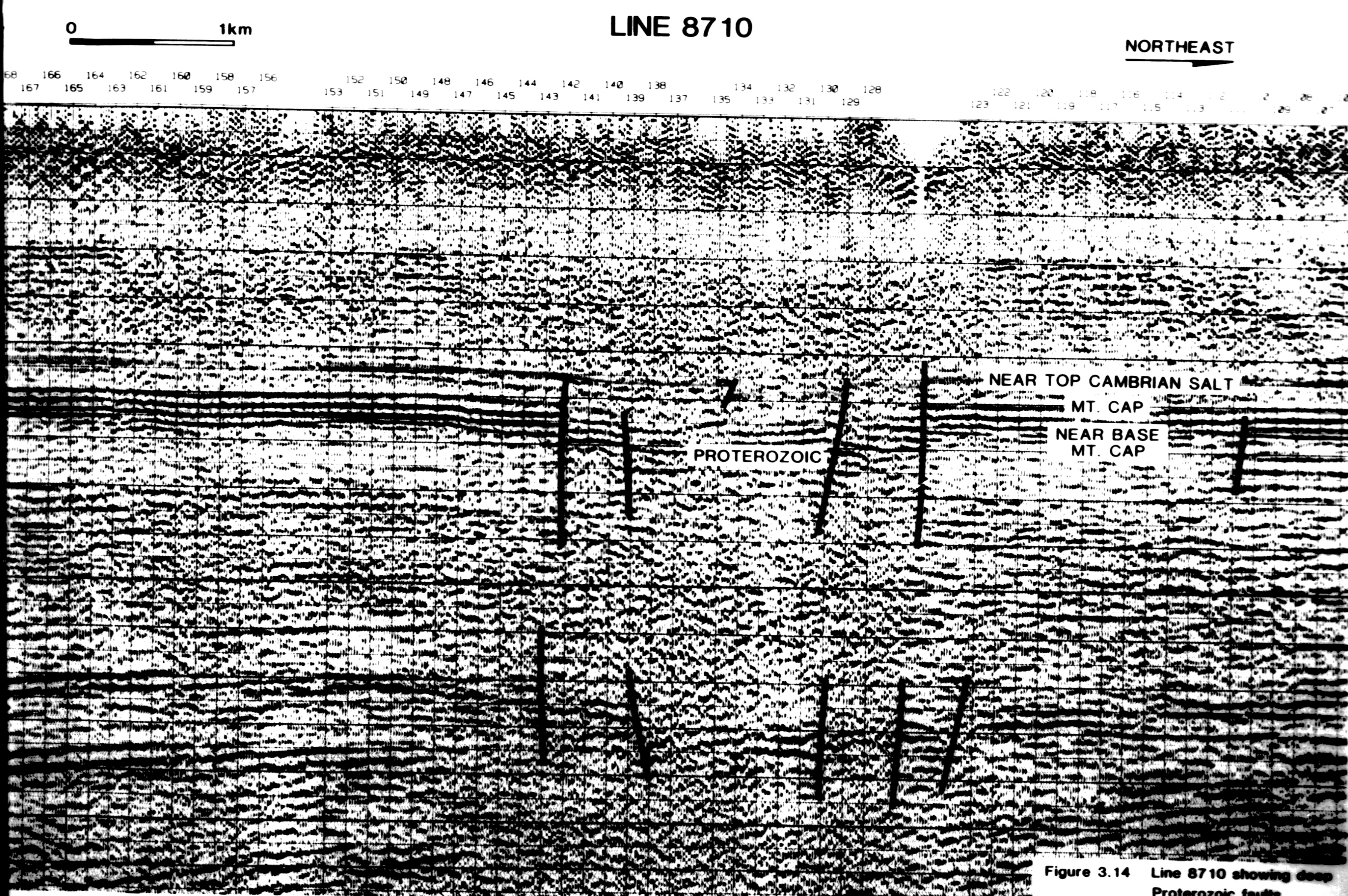


Figure 3.14 Line 8710 showing deep Proterozoic faults.