RANGER OIL LIMITED

REPORT ON SEISMIC SURVEYS

CONDUCTED ON

EL 362 , EL 363

FORT LIARD AREA, N.W.T.

COVERING PROGRAMS CONDUCTED BETWEEN

AUGUST 1995 - JULY 1996

SUBMITTED TO THE NATIONAL ENERGY BOARD

CALGARY, ALBERTA

OCTOBER 1996

by

JEFF R. SLUGGETT, P.GEOPH.
CHIEF GEOPHYSICIST

NEB AUTHORIZATION #s - 9229-BO-59-002E and 59-004E 4 3E

RANGER OIL LIMITED
1600, 321 - 6 Avenue S.W., Calgary, Alberta, Canada T2P 3H3 Telephone (403) 232-5200 Fax (403) 263-0090

9229-B59-2E

October 28, 1996

B.F.R. Geophysical Consultants Ltd.
#1730, 140 - 4th Ave. S.W.,
Calgary, Alberta,
T2P 3N3

Attention: Ms. Melanie Matthews

Dear Melanie,

Regarding the submission of Seismic Data to the NEB, a cover letter explaining the Synthetic Seismograms should read (or something to this effect)...

Synthetic Sysmograms

1. Used for Velocity Control For Depth Migration Conversion:

b-21-K	H-3 East Flett
c-51-B	M-31 Netla
C-07 Netla	N-02

2. Used for Seismic Ties:

F-25 - on Line NAD-831
F-25A - on Line NAD-831
D-29 - on Line NAD-008
E-54 - on Line NAC-005

If I can be of further assistance regarding this matter, please call me at 232-5315

Regards,

Cheryl Ptak

Cheryl Ptak
Geophysical Technician

TABLE OF CONTENTS

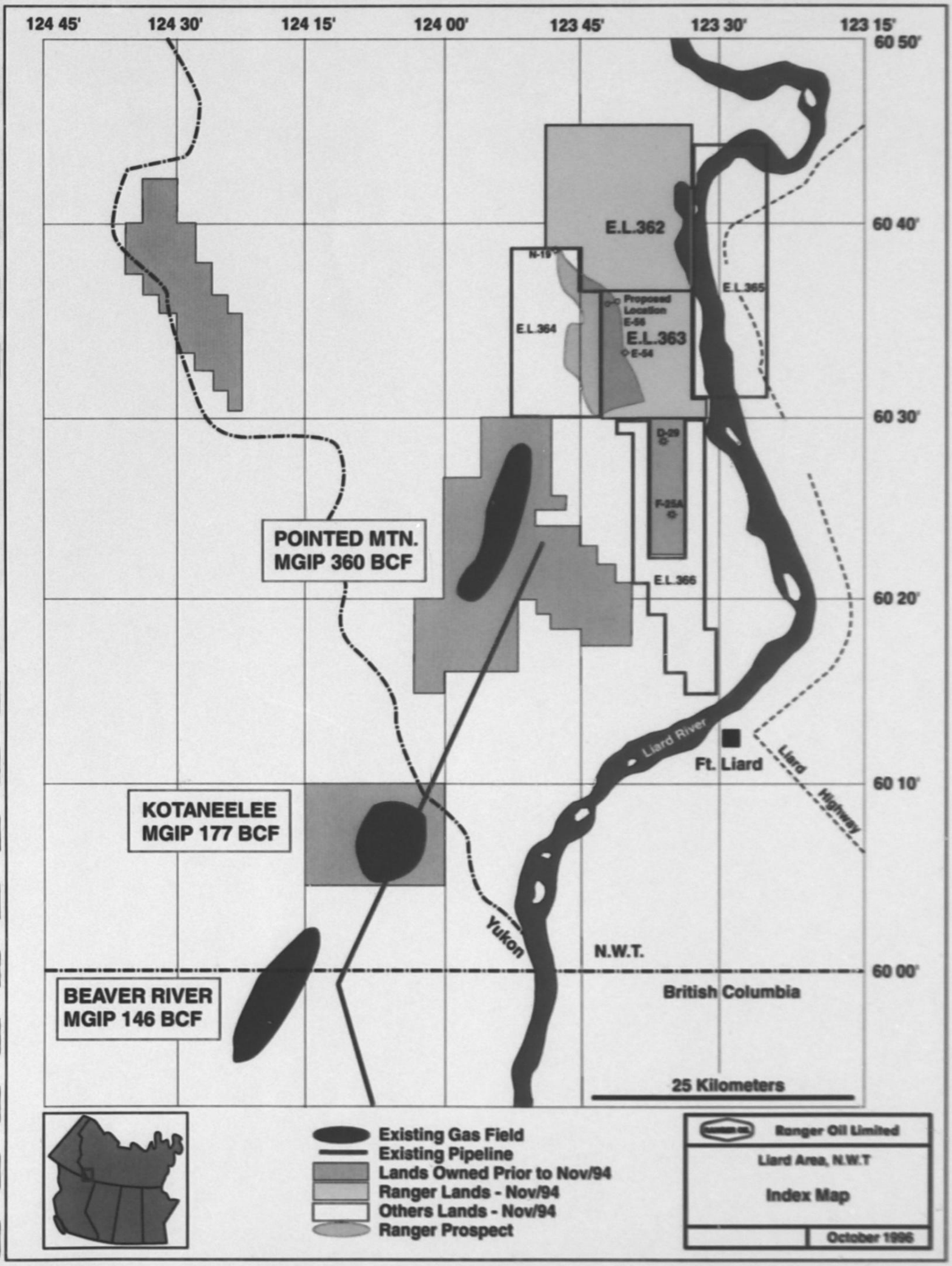
I ABSTRACT

Three separate seismic surveys were conducted across Ranger's EL 362 and 363 in SEPT 1995, MARCH 1996 and JULY 1996 (see INDEX MAP). The two summer programs were heliportable while the winter program was vibroseis. All three programs were designed to delineate the thrusted structures of the Middle Devonian Nahanni formation, specifically the porous Manetoe facies which is the reservoir rock in the Pointed Mountain field to the southwest.

After a lengthy processing sequence including pre-stack time migration, velocity modelling and pre-stack depth migration a depth map was prepared on the Nahanni carbonate. This map clearly shows a NNW-SSE trending Laramide trust fault with a vertical relief from the crest of some 900m. The structure dips to the west, is closed to the north (NAB-004 is 600m lower) and is interpreted to be separated from the F-25 well to the south by a cross fault. This cross fault is evidenced in lines NAD-008 and by surface geology.

The areal extent and pay thickness assumed by comparison with the Pointed Mountain field indicate an economic target for Ranger to drill. A 3200m exploratory test with a surface location at E-56 deviated to a bottom-hole location at SP 415 on line NAC-003 is recommended for the 1st quarter of 1997. This test is intended to penetrate the Nahanni in the updip crest of the mapped Liard structure.

II INDEX MAPS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124 30'
124 15'
124 00'
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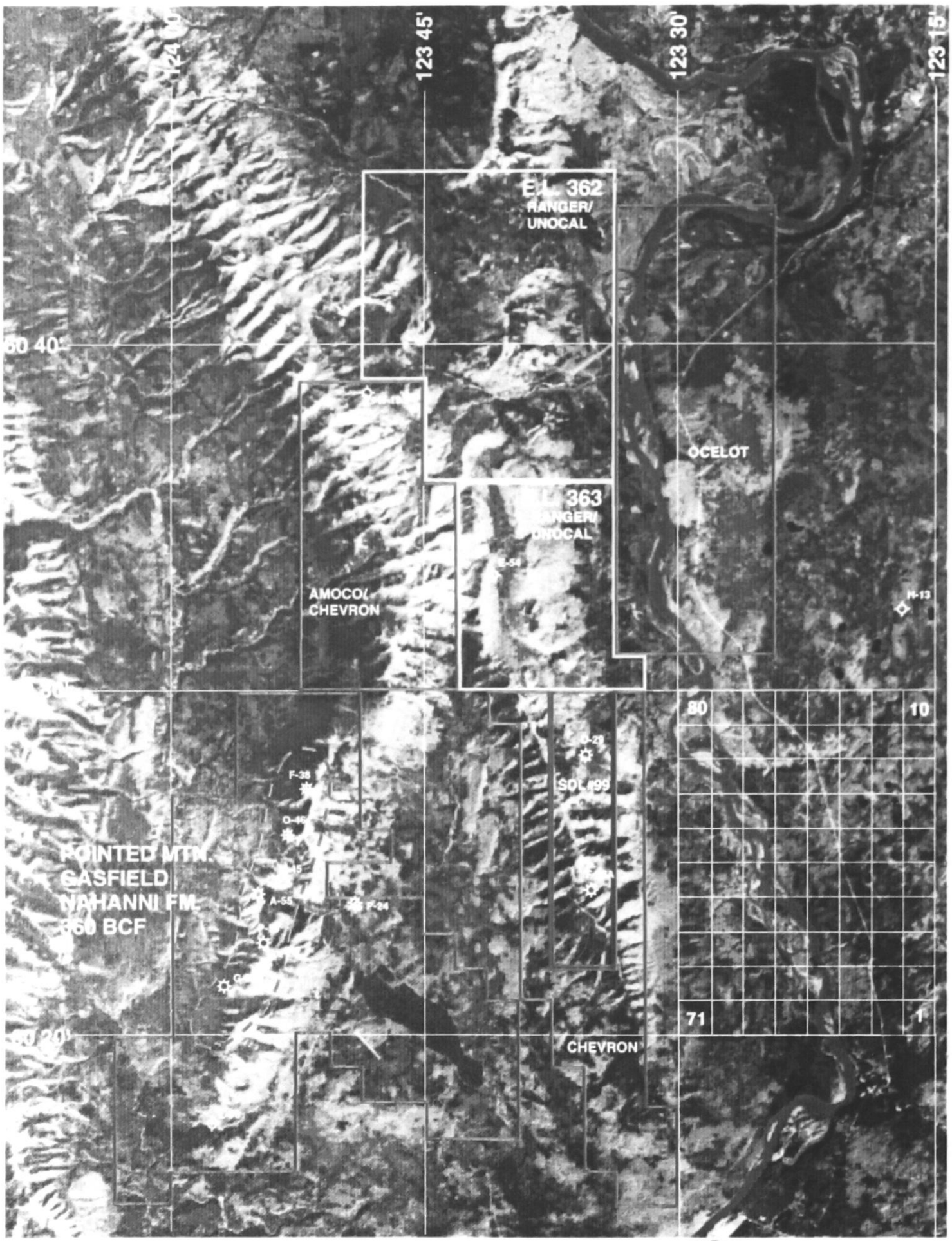
123 30'
123 15'
60 50'
60 40'
60 30'
60 20'
60 10'
60 00'
E.L.362
N-19
E.L.365
Proposed Location E-56
E.L.364
E.L.363
E-54
D-29
F-25A
E.L.366
POINTED MTN.
MGIP 360 BCF
KOTANEELEE
MGIP 177 BCF
BEAVER RIVER
MGIP 146 BCF
Liard River
Ft. Liard
Liard Highway
Yukon
N.W.T.
British Columbia
25 Kilometers
Existing Gas Field
Existing Pipeline
Lands Owned Prior to Nov/94
Ranger Lands - Nov/94
Others Lands - Nov/94
Ranger Prospect
Ranger Oil Limited
Liard Area, N.W.T
Index Map
October 1996



0 5 10 Km.

RANGER / UNOCAL LANDS-NOV/94

PREVIOUS LANDS

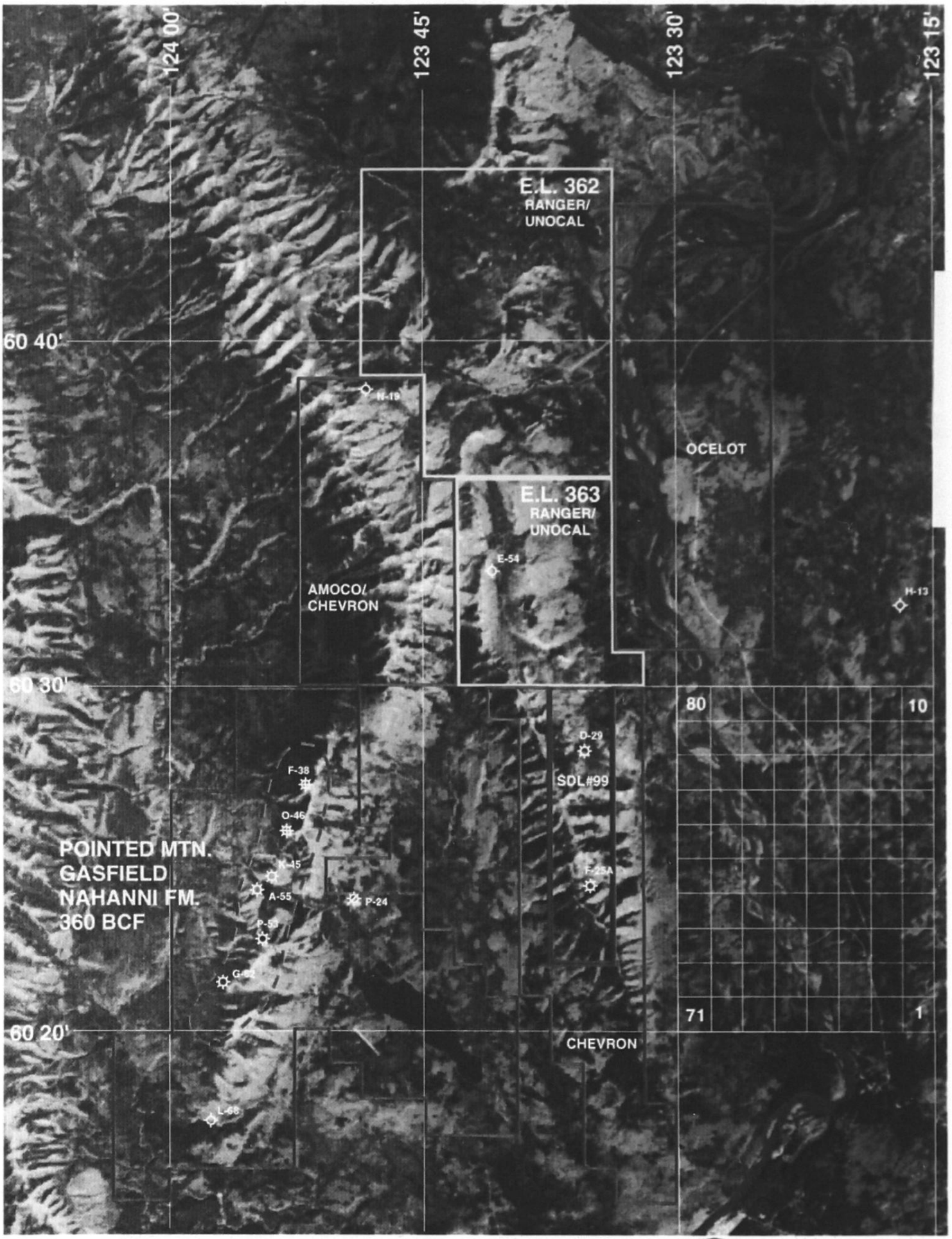
OTHERS LANDS-NOV/94

RANGER OIL

UNOCAL

October 1996

LIARD AREA, N.W.T



0 5 10 Km.

October 1996

RANGER / UNOCAL LANDS-NOV/94

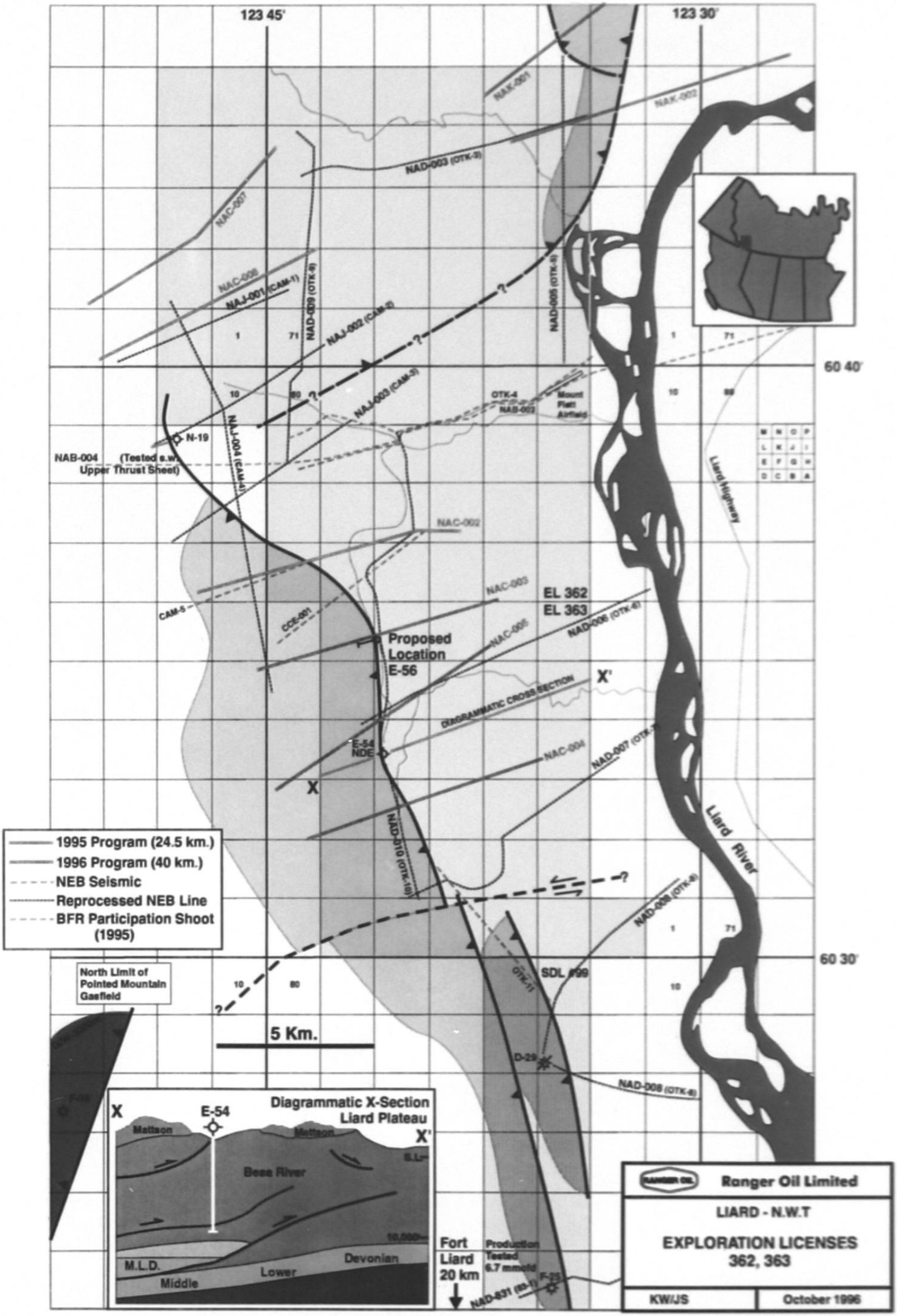
PREVIOUS LANDS

OTHERS LANDS-NOV/94

RANGER OIL

UNOCAL

LIARD AREA, N.W.T


123 45'
123 30'
60 40'
60 30'
NAK-001
NAK-002
NAD-003 (OTK-3)
NAC-007
NAC-008
NAJ-001 (CAM-1)
NAD-009 (OTK-9)
NAJ-002 (CAM-2)
NAD-005 (OTK-5)
NAJ-003 (CAM-3)
OTK-4
NAB-002
Mount Flett Airfield
N-19
NAB-004 (Tested s.w. Upper Thrust Sheet)
NAJ-004 (CAM-4)
Liard Highway
NAC-002
NAC-003
CAM-5
CDE-001
EL 362
EL 363
Proposed Location E-56
NAC-005
NAD-006 (OTK-6)
X'
DIAGRAMMATIC CROSS SECTION
E-54 NDE
X
NAC-004
NAD-007 (OTK-7)
NAD-010 (OTK-10)
Liard River
NAD-008 (OTK-8)
OTK-11
SDL 999
D-29
NAD-008 (OTK-8)
1995 Program (24.5 km.)
1996 Program (40 km.)
NEB Seismic
Reprocessed NEB Line
BFR Participation Shoot (1995)
North Limit of Pointed Mountain Gasfield
5 Km.
Diagrammatic X-Section Liard Plateau
X
E-54
X'
Mattson
Mattson
Bosa River
M.L.D.
Devonian
Lower
Middle
Fort Liard 20 km
Production Tested 6.7 mmcfd
F-23
NAD-031 (83-1)
Ranger Oil Limited
LIARD - N.W.T
EXPLORATION LICENSES 362, 363
KW/JS
October 1996

III OPERATIONS REPORT FOR LINES NAC-003, 4, 5
(SHOT IN AUG/SEPT 1995)

1. Introduction

NEB authorization #9229-BO-59-002E on EL 363.

In August 1995 a seismic survey for Ranger Oil Limited was undertaken by Geco-Prakla (Party 1267) in the Fort Liard area of the Northwest Territories. This section covers pertinent operational information from the survey required by the Canada Oil and Gas Geophysical Operations Regulations.

The survey consisted of three 2D lines of approximately 8.0 kilometers each over mountainous topography. The lines, labeled NAC-003, NAC-004, NAC-005, appear on the accompanying location map.

Poor weather including fog and high winds during the course of the survey resulted in the loss of four recording days.

Fort Liard was used as the main staging area and base for all expediting and supplying of fuel, explosives, groceries, supplies and parts.

All data acquired during this survey was processed in Calgary by Kelman Seismic Processing.

2. Statistical Data

1.0 Personnel

Recording Crew Personnel

1	Supervisor
1	Party Manager
1	Relief PM
1	Drill Push
2	Field Administrators
1	Instrument Technician
2	Observers
1	Shooter
2	Cable Repair
12	Total in Basic Crew

Survey Personnel

1 Head Surveyor
1 Surveyor

2 Total in Basic Crew

Field Positions

Supplied by Beaver Enterprises and Tundra Seismic Service.

Nineteen northern residents employed by the above companies.

Additional Employment

E&D Catering Employed 5 northern residents.

Total Personnel

12	**Recording Crew Personnel**
2	**Survey Personnel**
19	**Field Positions**
5	**Additional Employment**
38	**Total Personnel**

2.0 Equipment

Recording Equipment

1 Heliportable INPUT/OUTPUT SYSTEM TWO digital telemetry system, comprising:

167	MRX's with solar batteries
250	Spare battery modules
1	Battery Management System
4	ALX's (Advance Line Taps)
2	LTU's (Line Tap Units
1	LIM's (Line Input Module)
1	SCM (System Control Module)
1	SIM (System Interface Module)
1	TTM (Tape Transport Module)

1	OCM (Operator Control Module)
3	HHT's (Hand Held Terminal)
2	RANDOM ASCII terminals
1	Printer

1000 Strings of GS20AX 10 Hz geophones (12 phones/string spaced over 15m)

167 Tescorp RSC interconnect cables (9 takeouts @ 35m)

3 I/O SSS-301 Digital Decoder (blaster)

2 I/O SSS-301 Digital Encoder

40 Heli-bags

2 Portable Shooter's equipment

1 Mechanic Unit - F250 4x4

1 Party Manager Unit - F250 4x4

1 F250 Fuel Unit

2 4x4 GMC Suburban personnel units

Survey Equipment

Wild T1, T16 or DI-4L theoldolites and edm (electronic distance measurers).

2 F250 4x4's

2 Honda ATV's

Drilling Equipment

Destiny Resources Inc. - Six heliportable air hammer drills

Communication/Office Equipment

8	VHF handheld radio transceivers
16	VHF mobile radio transceivers fitted to vehicles
1	Facsimile machine
1	Photocopier
1	Portable computer
2	IBM Compatible P.C.'s for automated OB logs, administration and cost control
1	RX/TX Communication Repeater

Camp

1	80 man camp consisting of sleeping accommodations, offices, kitchens, dining and recreation facilities, heated workshops, first aid station, washroom facilities and generators.

3.0 Significant Dates

August 14	Drilling commenced.
August 27	Recording commenced.
September 4	Recording completed.

4.0 Production Statistics

	Fort Liard
Profiles Shot	267
Days Worked	6
Kms Recorded	24.84
Weather Days	4
Total Days	10
Total Hours	133.5
Total Holes Drilled	281
Total Meters Drilled	6,053
Total No. Shifts	58
Total Shifts Lost (weather)	15

3. Field Procedures

1.0 Conditions

Weather in the Fort Liard area during the survey was less than ideal. Temperatures ranged from zero degrees Celsius at night, to plus fifteen during the day. Fog, wind, and rain produced problems not only for helicopter accessibility, but also for the recording process. In all, four days were lost due to severe conditions.

2.0 Topography

The terrain of the area is mountainous. Steep cliff sections with sheer drops of up to 100m are present along the lines shown on the topography map provided. Due to the slope of the terrain, there was some danger of falling rocks. The topography of the region did not have any significant effect on the operation. Telemetry was used across the steepest cliff on lines 3, 4 and 5.

3.0 Survey

The survey was done by conventional methods, using theodolite, EDM and chainage.

4.0 Camp

One camp was in operation for this survey and was located 3.0 kms north of Fort Liard. Access to the survey area was achieved via the Fort Simpson highway.

5.0 Data Acquisition

5.1 Energy source parameters

No. of Holes	1
Hole Spacing	90 m
Hole Depth	20 m
Charge Size	20 kg

5.2 Recording system parameters

Instrument Type	INPUT/OUTPUT SYSTEM TWO digital telemetry system
Filters Low Cut	3/12
Filters High Cut	75/135
Record Length	16 sec
Notch Filters	out
Pre Amp Gain	36 dB
Sample Rate	2 ms

5.3 Spread Parameters

No. of Traces	600
Source Interval	90 m
C.D.P. Size	7.5 m
Group Interval	15 m
Geophone/Group	12
Geophone type	OYO 20 DX, 10Hz
Fold	50

5.4 Spread Configuration

TRACES: 1-300-x-301-600 TRACE 1 N.E.
4507.5-22.5-x-22.5-4507.5 m

4. Data Processing Parameters

1.0 Seismic Data Processing Sequence

The data acquired from the Mt. Flett area was processed by Kelman Seismic Processing. To all three lines in the survey, the following sequence was applied:

Demultiplex:

Process sample rate:	2.0 ms
Process record length:	4.0 sec

Amplitude Recovery:

Exponential gain curve	K[T]PWR[N][EXP[AT]] K=1 A=0 N=2

Trace editing

Phase compensation

Type:	Instrument and geophone

FK Filter

Transparent:	For calculation of deconvolution operators only

Deconvolution

Type:	Surface consistent spiking
Operator Length:	80 ms
Prewhitening:	1%
Design gate:	700 - 2500 ms at 25m offset 1600 - 2900 ms at 3500m offset
Offset range:	25 - 3500 m

Partial Spectral Balancing:

Frequency	8 - 120 Hz

Equalization:

Design gate	Same window as decon.

Statics (Refraction)

Method	GLI
Frequency spacing	Every shot
Datum elevation	500 m
Weathering velocity	762 m/sec
Replacement Velocity	4000 m/sec

Sort:
To common depth point

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual):

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum Shift:	+/- 32 ms
Correlations per trace	15
Number of iterations	2

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual): Second Pass

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum shift:	+/- 16 ms
Correlations per trace	15
Number of iterations	2

Pre-Stk Mig. Vel. Analysis:

Type	Constant percentage moveout

Mute Pattern:

Distance	250 450 1800 5000 m
Time	-500 200 700 1600 ms

Equalization:

Design window	500 ms AGC

Full Pre-Stack Time Migration:

Type	Kirchoff summation

Datum referenced, to plotted weathering replaced surface, separately at shot and receiver

Stack:

Spike Suppression	3:1 threshold
Fold	50

Filter:

Frequency	8/13 - 50/58 Hz

Equalization:

Design window	600 ms AGC

Display Parameters

Film Display:	Horizontal: 48 Traces/Inch Vertical: 5 Inches/second

IV OPERATIONS REPORT FOR LINES NAK-001, 2
(SHOT IN MARCH 1996)

1. Introduction

NEB authorization #9229-BO-59-004E on EL 362.

In March 1996 a seismic survey for Ranger Oil Limited was undertaken by Geco-Prakla (Party 1264) in the Fort Liard area of the Northwest Territories. This section covers pertinent operational information from the survey, as required by the Canada Oil and Gas Geophysical Operations Regulations.

The survey consisted of two Vibroseis 2D lines of approximately 8.0 kilometers each for a total of 16 kms. The program was located north of the town of Fort Liard, on the west side of the Liard River. The lines, labeled NAK-001 and 002, appear on the accompanying location map.

The topography was low ground, with lots of muskeg located at the base of the eastern slopes of the Liard Range. The near surface consisted of alluvial river channels of up to 300m as seen on the seismic.

The main staging area was km 91 on the McKenzie Highway north of Fort Liard.

Food, fuel and supplies came generally from Fort Liard and Fort Nelson.

All data acquired during this survey was processed in Calgary by Kelman Seismic Processing.

2. Statistical Data

1.0 Personnel

Recording Crew Personnel

1	Supervisor
1	Party Manager
1	Vibe Tech
1	Head Surveyor
1	Surveyor
1	Field Administrator
1	Instrument Technician
1	Observer
1	Cable Repair
9	Total in Basic Crew

Survey Personnel
Survey was conducted by All Terain Surveys Ltd
with a total of 2 Personnel

2 Total in Basic Crew

Field Positions

Supplied by Beaver Enterprises Ltd. and Nahanni Slashing.

Twenty-four northern residents were employed by the above companies.

Additional Employment

E&D Catering Employed 6 northern residents.

Total Personnel

9	**Recording Crew Personnel**
2	**Survey Personnel**
24	**Field Positions**
6	**Additional Employment**
41	**Total Personnel**

2.0 Equipment

Recording Equipment

1 Heliportable INPUT/OUTPUT SYSTEM TWO digital telemetry system, comprising:

133	MRX's with solar batteries
133	Spare battery modules
1	Battery Charging System
14	ALX's (Advance Line Taps)
1	LIM's (Line Input Module)
1	SCM (System Control Module)
1	SIM (System Interface Module)
1	CSM (Correlator/Stacker Module)
2	SCSI (3480 Cartridge Drives)
1	OCM (Operator Control Module)
2	HHT's (Hand Held Terminal)
1	Printer

1 TOR GEOscience SRM-48P Digital Field Monitor w/Vibrasig monitoring.

800 Strings of 10 Hz geophones (9 phones string)

133 Tescorp RSC interconnect cables (6 takeouts @ 42m or 84m)

1 Pelton Advance II ESG

Vehicles - Recording Crew

1 Air Conditioned Recording Cabin mounted on a F700 4x4. Separate diesel driven 17
kVA generator supplying power for Air Conditioning and instrumentation.

1 Party Manager Unit - F250 4x4

3 Line Units - F350 4x4

1 Transport Units - F700 4x4 (or equivalent)

1 Support Unit - F250 4x4

1 Mechanic Unit - F250 4x4

1	Personnel Carriers
1	Battery Charging Unit
1	Cable/Geophone Repair Trailer
2	Snowmobiles
1	Vibrator Technician Unit
1	Fuel Unit and Spare Parts Trailer
4	Mertz M18HD Buggy Vibrators

Survey Equipment

The survey was done using conventional methods, using theodolites and EDM (electronic distance measurers). The crew had 8.5 shifts with no shifts lost to weather.

Communication/Office Equipment

8	VHF handheld radio transceivers
16	VHF mobile radio transceivers fitted to vehicles
1	Facsimile machine
1	Photocopier
1	Portable computer
2	IBM Compatible P.C.'s for administration and cost control

Camp

1	68 man camp consisting of sleeping accommodations, offices, kitchens, dining and recreation facilities, heated workshops, first aid station, washroom facilities and generators.

3.0 Significant Dates

March 8	Survey commenced.
March 11	Recording commenced.
March 12	Recording completed.

4.0 Production Statistics

	Fort Liard
Total VPS	402
Days Worked	4
Kms Recorded	16
Weather Days	0
Total Days	4
Total Hours	30

3. Field Procedures

1.0 Conditions

Weather in the Fort Liard area during the survey was good for winter recording. Temperatures ranged from minus 20 to minus 40. One day was lost due to weather for the cutting crew but the survey and recording crews did not lose any days.

2.0 Topography

The terrain of the area is flat with muskeg sections. The topography of the region did not have any significant effect on the operation. The only logistical problem was crossing the Liard River but the ice bridge was good throughout the project.

3.0 Survey

The survey was done by conventional methods, using theodolite, EDM and chainage.

4.0 Camp

One camp was in operation for this survey and was located 3.0 kms north of Fort Liard. Access to the survey area was achieved via the Fort Simpson highway.

5.0 Data Acquisition

5.1 Energy source parameters

4 Mertz M18HD Buggy Vibrators with Pelton Advance II Electronics (Version 5E).

5.2 Recording system parameters

Instrument Type	INPUT/OUTPUT SYSTEM TWO digital telemetry system
Filters Low Cut Hz/Db	3/12
Filters High Cut Hz/Db	75/12
Record Length	16 sec
Notch Filters	out
Pre Amp Gain	36 dB
Sample Rate	2 ms

5.3 Spread Parameters

No. of Traces	600
Source Interval	90 m
C.D.P. Size	7.5 m
Group Interval	15 m
Geophone/Group	12
Type	OYO 20 DX, 10Hz
Fold	50

5.4 Spread Configuration

TRACES: 1-300-x-301-600 TRACE 1 N.E.
4507.5-22.5-x-22.5-4507.5 m

4. Data Processing

1.0 Seismic Data Processing Sequence

The data acquired from the Mt. Flett area was processed by Kelman Seismic Processing. To all three lines in the survey, the following sequence was applied:

Demultiplex:

Process sample rate:	2.0 ms
Process record length:	4.0 sec

Amplitude Recovery:

Exponential gain curve	K[T]PWR[N][EXP[AT]] K=1 A=0 N=2

Trace editing

Phase compensation

Type:	Instrument and geophone

FK Filter

Transparent:	For calculation of deconvolution operators only

Deconvolution

Type:	Surface consistent spiking
Operator Length:	80 ms
Prewhitening:	1%
Design gate:	700 - 2500 ms at 25m offset 1600 - 2900 ms at 3500m offset
Offset range:	25 - 3500 m

Partial Spectral Balancing:

Frequency	8 - 120 Hz

Equalization:

Design gate	Same window as decon.

Statics (Refraction)

Method	GLI
Frequency spacing	Every shot
Datum elevation	500 m
Weathering velocity	762 m/sec
Replacement Velocity	4000 m/sec

Sort:
To common depth point

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual):

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum Shift:	+/- 32 ms
Correlations per trace	15
Number of iterations	2

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual): Second Pass

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum shift:	+/- 16 ms
Correlations per trace	15
Number of iterations	2

Pre-Stk Mig. Vel. Analysis:

Type	Constant percentage moveout

Mute Pattern:

Distance	250 450 1800 5000 m
Time	-500 200 700 1600 ms

Equalization:

Design window	500 ms AGC

Full Pre-Stack Time Migration:

Type	Kirchoff summation

Datum referenced, to plotted weathering replaced surface, separately at shot and receiver

Stack:

Spike Suppression	3:1 threshold
Fold	50

Filter:

Frequency	8/13 - 50/58 Hz

Equalization:
Design window 600 ms AGC

Display Parameters

Film Display: Horizontal: 48 Traces/Inch
Vertical: 5 Inches/second

V OPERATIONS REPORT FOR LINES NAC-002, 7, 8
(SHOT IN JULY 1996)

1. Introduction

NEB Authorization #9229-BO-59-004E on EL 362 & 363.

In July 1996 a seismic survey for Ranger Oil Limited was undertaken by Geco-Prakla (Party 1267) in the Fort Liard area of the Northwest Territories. This section covers pertinent operational information from the survey, as required by the Canada Oil and Gas Geophysical Operations Regulations.

The survey consisted of three 2D dip lines of approximately 8.0 kilometers each for a total of 25.02 kms, over the Eastern slopes of the Liard range with some alpine, mostly treed and heavy underbrush topography. The lines, labeled NAC-002, NAC-007, NAC-008, appear on the accompanying location map.

Weather conditions were fairly agreeable for heliportable operations. High winds and rain shut down the advance crew for half a day and the recording crew for approximately 29.5 hours.

The main staging area was km 91 on the McKenzie Highway north of Fort Liard.

The main recording camp was near the Pointed Mountain gas field.

Food, fuel and supplies came generally from Fort Liard and Fort Nelson and were transported to the camp location via barge, river boat and air.

All data acquired during this survey was processed in Calgary by Kelman Seismic Processing.

2. Statistical Data

1.0 Personnel

Recording Crew Personnel

1	Supervisor
1	Party Manager
1	Drill Push
1	Head Surveyor
1	Surveyor
2	Field Administrators
1	Instrument Technician
2	Observers
2	Shooters
1	Cable Repair
1	Supplyman
14	Total in Recording Crew

Survey Personnel
Survey was conducted by All Terain Surveys Ltd
with a total of 4 Personnel

4	Total in Survey Crew

Line Clearing

Supplied by Destiny Resources and Beaver Enterprises Ltd.

Destiny	1	Supervisor
	8	Handcutters
Beaver	13	Handcutters

Both companies were handcutting with power saws and helicopter support.

Nineteen northern residents were employed.

Drilling

Destiny	1	Foreman
	1	Coordinator
	6	Drillers

Additional Employment

E&D Catering Employed 5 northern residents.

Total Personnel

14	Recording Crew Personnel
4	Survey Personnel
22	Line Clearing
8	Drilling
5	Additional Employment
53	Total Personnel

2.0 Equipment

Recording Equipment

1 Heliportable INPUT/OUTPUT SYSTEM TWO digital telemetry system, comprising:

167	MRX's with solar batteries
250	Spare battery modules
1	Battery Management System
4	ALX's (Advance Line Taps)
2	LTU's (Line Tap Units)
1	LIM's (Line Input Module)
1	SCM (System Control Module)
1	SIM (System Interface Module)
1	TTM (Tape Transport Module)
1	OCM (Operator Control Module)
3	HHT's (Hand Held Terminal)
2	RANDOM ASCII terminals
1	Printer

1000 Strings of GS20AX 10 Hz geophones (12 phones/string spaced over 15m)

167 Tescorp RSC interconnect cables (9 takeouts @ 35m)

3 I/O SSS-301 Digital Decoder (blaster)

2 I/O SSS-301 Digital Encoder

40 Heli-bags

2 Portable Shooter's equipment

1 Mechanic Unit - F250 4x4

1 Party Manager Unit - F250 4x4

1 F250 Fuel Unit

2 4x4 GMC Suburban personnel units

Survey Equipment

The survey was done using conventional methods, theodolites and EDM (electric distance measures). No vehicles were used.

The survey crew had 7.5 shifts with one shift lost due to weather.

Drilling Equipment

Destiny Resources Inc.

7 - Heliportable air hammer drills
1 - Shop Trailer
1 - 12 Passneger Van
1 - Mechanic's Unit

Communication/Office Equipment

8 VHF handheld radio transceivers

16 VHF mobile radio transceivers fitted to vehicles

1 Facsimile machine

1 Photocopier

1 Portable computer

2 IBM Compatible P.C.'s for automated OB logs, administration and cost control

1 RX/TX Communication Repeater

Camp

1 80 man camp consisting of sleeping accommodations, offices, kitchens, dining and recreation facilities, heated workshops, first aid station, washroom facilities and generators.

3.0 Significant Dates

June 4	Party Manager arrives at Fort Liard
June 12	Slashing commenced
June 23	Drilling commenced.
July 2	Recording commenced.
July 6	Recording completed.

4.0 Production Statistics

	Fort Liard
Profiles Shot	225
Days Worked	13
Kms Recorded	25.02
Weather Days	1
Total Days	13
Total Hours	158.5
Total Holes Drilled	281
Total Meters Drilled	5,568
Total No. Shifts	6
Total Shifts Lost (weather)	2.5

3. Field Procedures

1.0 Conditions

Weather in the Fort Liard area during the survey was good except for 1.5 days of rain. Temperatures ranged from five degrees Celsius at night, to plus fifteen during the day. In all, 2.5 shifts were lost due to rainy conditions.

2.0 Topography

The terrain of the area is mountainous. Steep cliff sections are present along the lines shown on the topography map provided. Due to the slope of the terrain, there was some danger of falling rocks. The topography of the region did not have any significant effect on the operation.

3.0 Survey

The survey was done by conventional methods, using theodolite, EDM and chainage.

4.0 Camp

One 68 man side by side enclosed with 2 separate 5 room sleepers & 3 separate sleepers with 13 rooms. The camp also consisted of offices, kitchen, dining & recreational facilities, first aid station, washrooms and generators. The camp was located at Pointed Mountain access from Fort Liard was by jet boat and truck. The cutting crews, survey crews, and recording crew stayed at the camp throughout the program.

5.0 Data Acquisition

5.1 Energy source parameters

No. of Groups Active	600
Group Spacing	15
Phones/Group	6 over 15m
No. Receiver Points	1636
No. Source Points	275
No. of Holes	1
Hole Spacing	90 m
Hole Depth	20 m
Charge Size	20 kg/tamped, double capped

5.2 Recording system parameters

Instrument Type	INPUT/OUTPUT SYSTEM TWO digital telemetry system
Filters Low Cut Hz/Db	3/12
Filters High Cut Hz/Db	75/12
Record Length	16 sec
Notch Filters	out
Pre Amp Gain	36 dB
Sample Rate	2 ms

5.3 Spread Parameters

No. of Traces	600
Source Interval	90 m
C.D.P. Size	7.5 m
Group Interval	15 m
Geophone/Group	12
Type	OYO 20 DX, 10Hz
Fold	50

5.4 Spread Configuration

TRACES: 1-300-x-301-600 TRACE 1 N.E.
4507.5-22.5-x-22.5-4507.5 m

4. Data Processing

1.0 Seismic Data Processing Sequence

The data acquired from the Mt. Flett area was processed by Kelman Seismic Processing.
To all three lines in the survey, the following sequence was applied:

Demultiplex:

Process sample rate:	2.0 ms
Process record length:	4.0 sec

Amplitude Recovery:

Exponential gain curve	K[T]PWR[N][EXP[AT]] K=1 A=0 N=2

Trace editing

Phase compensation

Type:	Instrument and geophone

FK Filter

Transparent:	For calculation of deconvolution operators only

Deconvolution

Type:	Surface consistent spiking
Operator Length:	80 ms
Prewhitening:	1%
Design gate:	700 - 2500 ms at 25m offset 1600 - 2900 ms at 3500m offset
Offset range:	25 - 3500 m

Partial Spectral Balancing:

Frequency	8 - 120 Hz

Equalization:

Design gate	Same window as decon.

Statics (Refraction)

Method	GLI
Frequency spacing	Every shot
Datum elevation	500 m
Weathering velocity	762 m/sec
Replacement Velocity	4000 m/sec

Sort:
To common depth point

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual):

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum Shift:	+/- 32 ms
Correlations per trace	15
Number of iterations	2

Velocity Analysis:

Type:	Constant percentage moveout

Statics (Residual): Second Pass

Type:	Automatic surface consistent
Correlation Window:	400 - 2200 ms
Maximum shift:	+/- 16 ms
Correlations per trace	15
Number of iterations	2

Pre-Stk Mig. Vel. Analysis:

Type	Constant percentage moveout

Mute Pattern:

Distance	250 450 1800 5000 m
Time	-500 200 700 1600 ms

Equalization:

Design window	500 ms AGC

Full Pre-Stack Time Migration:

Type	Kirchoff summation

Datum referenced, to plotted weathering replaced surface, separately at shot and receiver

Stack:

Spike Suppression	3:1 threshold
Fold	50

Filter:

Frequency	8/13 - 50/58 Hz

Equalization:

Design window	600 ms AGC

Display Parameters

Film Display:	Horizontal: 48 Traces/Inch Vertical: 5 Inches/second

VI TECHNICAL DISCUSSION and INTERPRETATION

1. Data Quality

The key parameters that led to improved data quality in the heliportable surveys were (in order of priority):

IN ACQUISITION

- high fold/short group interval >50 FOLD, 15m GI
- deep charges - 20kg @ 20m (double tamped holes)
- marsh phones - pushed by pole through the moss
- a I/O digital telemetry system - 24 bit recording

IN PROCESSING

- careful analysis of migration panels to maximize the quality of the pre-stack time migration
- careful muting
- careful velocity work on the depth migration

The character of the Nahanni formation, i.e., one narrow trough followed by a wide doublet trough could be recognized throughout the area on the newer data.

Reprocessing of the older Purcell (Northcor) data (lines NAD - 2E, 2W, 3, 5, 7, 8, 9, 10, 831) improved the quality and character tremendously but it still was much poorer quality than the new Ranger data even though it was 48 fold. The reprocessing of the older six fold Amoco data (lines NAJ - 001, 004) improved the quality noticeably but the data was almost unuseable.

2. Reflection Identification

Well ties were a problem since there were only 4 wells in the area:

E-54: did not reach the Nahanni target and only a partial poor quality sonic is available

D-29: is missing most of the sonic log and the velocities below 2500m look unreliable

F-25/25A: together they provide a fair tie to the reflections on line NAD-831 but the well is near the end of the line so the migration is not as good as most of the area

N-19: no sonic log is available for this well but using approximately velocities the tie to the Nahanni on line NAB-004 at 580m is fair.

Regionally the ties were carried from NAB-003 to the east.

3. Velocity Control

Velocity control in the area is poor, since the velocities of the four seismic tie wells were unreliable, six other wells with better sonics were used for velocity control:

b-21-K/94-0-14
c-51-B/94-0-14
MURPHY NETLA M-31
AMOCO E. FLETT H-13
ARROWHEAD N-02
IMPERIAL NETLA C-07

(see enclosed copies of synthetics used in this report)

4. Interpretation

The Liard Plateau is an area where pre-Laramide normal faulting (see line NAB-003 & NAC-002) is overprinted with several vintages of Laramide thrusting.

Using the combined lines NAB-003 & 004 as an example you can see several of the structural features of the area. Working from east to west on the section: the East Liard thrust which outcrops just east of the Liard River extends at a very low angle and rides up and over the main Flett Anticline as well as plunging down and forming the Liard structure at the Nahanni level. The Liard thrust and the two surface thrusts just west of it merge into a decollement surface which rides over the Flett Anticline. This is probably an out-of-sequence thrust. The main thrust that forms the Flett Anticline can be seen to break into a series of en-echelon faults that join up with the upper detachment fault. This forms a small 'triangle zone' out in front of the Nahanni thrust. It is this 'triangle zone' that is eroded and forms the core of Besa River outcrop that is present at the valley west of the Liard River.

Note also the pre-Laramide normal faulting that exists at SP 2760 and SP 3096 on line NAB-003.

The character of the Nahanni can be seen to be recognizable on most of the lines - see especially line NAC-003 where it is a clear peak-trough-peak followed by a wide doublet trough.

The character of the Nahanni Carbonate unit below this is a dull zone of 300-400m followed by a distinctive zone of 3-5 strong, ringing reflectors indicating the Pre-Devonian or Cambrian section.

The Basement or Pre-Cambrian section is largely devoid of reflections except for strong discontinuous burst of high amplitudes believed to be injected sills. The Pre-Cambrian structure can be seen to dip regionally to the west in this area.

The Besa River section is hard to correlate in areas partly because it is predominately shale and therefore is highly fractured and squeezed, and partly because the lime stringers within the shale that contribute to the reflections probably do not extend for great distances. The Flett section near the surface is a high frequency, ringing zone that correlates quite well with the surface geology.

An important indication of the Nahanni that serves to confirm the interpretation above is the fact that the 6000m/sec carbonate interval velocity can be easily picked out while performing the interactive pre-stack time migration velocity analysis.

It is interesting to speculate on the possible connection of the Pointed Mountain structure to the newly mapped Liard structure. The gas/water contact of Pointed Mountain at -3230m could be leaking updip into the Liard structure which I have estimated a most likely (P_{50}) case of -2800m G/W or as low as -3000m for a P_{90} maximum case.

VII CONCLUSIONS

- The reflection data acquired was considered very good quality considering the rugged topography and near surface alluvial channels.

- Therefore high-fold, (i.e., 50+ fold) is needed in this rugged area to acquire good data.

- A time structure map was prepared on the Nahanni Carbonate which indicated two major thrusts, one which elevates the 'Liard Sheet' approximately 900m to a crest of -2300m and one that thrust the 'Flett Sheet' approximately 2500m to -600m.

- Velocity control derived from sonic logs from nearby wells gave a rough estimate of velocities but closer values were derived from the interactive workstation at Kelman Processing.

- The resultant depth structure map on the Nahanni shows a drillable feature cresting on line NAC-003 at SP 415 which is on EL 363.

- Porosity in the Nahanni was not directly mapped but numerous small faults near the crest of the structure should indicate fracturing of the reservoir.

- A 'triangle zone' is formed directly in front of the Nahanni thrust as seen on lines NAC 2, 3, 4, 5, 7, 8. This could create new drillable targets if a reservoir in the Besa River was encountered.

VIII LIST OF ENCLOSURES

1. TIME STRUCTURE MAP - NAHANNI 'LIARD SHEET' 1:50,000
2. DEPTH STRUCTURE MAP - NAHANNI 'LIARD SHEET' 1:50,000
3. TIME STRUCTURE MAP - NAHANNI 'FLETT SHEET' 1:50,000
4. DEPTH STRUCTURE MAP - NAHANNI 'FLETT SHEET' 1:50,000
5. SHOT POINT LOCATION MAP 1:50,000
6. SYNTHETIC SEISMOGRAMS