MWH Geo-Surveys, Inc.

9229-C144-1E

Logistical Summary
Gravity Survey; Colville Hills, NWT

for Canadian Natural Resources Limited

MWH Geo-Surveys Ltd.
February – March 2001

INTRODUCTION:

From February 6 to March 28, 2001, MWH Geo-Surveys Ltd. carried out a regional gravity survey in the Colville Hills region of the Northwest Territories at the request of Canadian Natural Resources Limited. The gravity survey crew was mobilized from our Vernon, B.C. office. The positional survey associated with this project was carried out by a differential post-processed GPS survey. All gravity stations were accessed by snowmobile.

PROJECT SCHEDULE:

The following is the project timeline.

- First Aid & Snowmobile safety courses; February 6, 7
- Mobilization to Norman Wells: February 8
- Start of Production: February 10
- Completion of Colville Hills survey: March 4
- Demobilization: March 5

A total of 380 unique stations and 66 repeats were occupied during 23 crew days.

FIELD OPERATIONS:

Survey Personnel: The personnel involved on this project were:

• Dan Pickett	Gravity Operator / GPS Surveyor
• Kevin MacNabb	GPS & Gravity data processing

Instrumentation: The gravity meters used on this project were Lacoste & Romberg # 332 & #371. The positional survey was conducted using Ashtech Z Surveyor GPS receivers.

Field Procedures, Gravity: All gravity readings were taken within closed loops to allow for correction of instrument drift. A temporary gravity base station was established in the survey area and tied to the IGSN reference station in Norman Wells. The reference site in Norman Wells is at the Fire Hall with an absolute gravity value of 982,229.01.

Approximately 17 per cent of the gravity stations (66 stations) were repeated on this survey with a standard deviation of the repeats .018 milligals.

Field Procedures, GPS Surveying: Gravity stations were positioned by a differentially corrected GPS survey. The GPS survey technique was short static rover observations from two static base stations. The base station receivers were mounted on tripods and the rover

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gps receiver was carried by backpack. Our gps survey was tied to the ongoing seismic survey control at the following points:

Control Point #	Easting NAD83	Northing NAD83	Elevation MSL
CB01	602170.394	7429290.206	241.70
CB02	606020.398	7418654.798	245.24
CB03	609968.532	7404057.006	244.23
CB04	600898.575	7400009.282	326.01

Survey control was provided by Mercedes Surveys. All UTM coordinates are zone 9. To improve our survey production and eliminate survey redundancy we used the positional information from Mercedes for all gravity stations located on the current year seismic lines.

DATA REDUCTION and INTEGRITY:

Gravity: The data from the Lacoste & Romberg meter was corrected to milligals using the appropriate meter constants and then corrected for the tide effect. Additional corrections were made for the drift between base ties and an adjustment to the IGSN base value. The results from these calculations are listed as Observed Gravity. The Observed Gravity values were corrected to Bouguer Gravity using the following formula:

$$g_B = g_{obs} - \gamma + (.30845\,\Delta h) - (.04193\,\rho\,\Delta h) + dg_T$$

where:

g_B = Bouguer Gravity

g_{obs} = Observed Gravity

γ = Theoretical Gravity

dg_T = Terrain correction

h = Station elevation metres

ρ = Density gm/cc

There are several theoretical gravity formulae available. We have used the most recently published formula (1998) from The United States National Imagery and Mapping Agency (NIMA). According to this new formula, the theoretical gravity (γ) obtained from the gravity field of the WGS84 reference ellipsoid is

$$\gamma = (978032.53359)\left(\frac{1 + 0.00193185265241 \sin^2(\phi)}{\sqrt{1 - 0.00669437999014 \sin^2(\phi)}}\right) \text{ milligals}$$

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where (is the geodetic latitude. Using this formula requires a small Atmospheric Gravity Correction (because the WGS84 Earth's gravitational constant includes the mass of the atmosphere. This correction is given by

$$= 0.87e^{-0.118\left[\left(\frac{h}{1000}\right)^{1.047}\right]}$$

where h is the elevation with respect to sea level.

Bouguer gravity data was calculated using densities of 1.8, 2.0 and 2.2 gm/cc. A data listing is included as Appendix I.

Terrain Corrections: The terrain observations are made by the operator in the field using an optical inclinometer. Slope measurements are made in four sectors of Hammer Zone B (2.0 - 16.5 metres), six sectors of Zone C (16.5 - 53.3 metres) and six sectors of Zone D (53.3 - 170.0 metres). The measured slope is used with the sector midpoint distance to compute a vertical difference. Then using the standard formula for the gravitational attraction of a vertical hollow cylinder:

$$g = 2\pi[R_2 - R_1 + \sqrt{R_1^2 + h^2} - \sqrt{R_2^2 + h^2}]$$

where:
g = terrain correction in milligals
= gravitational constant
= density
R_1 = inner zone radius
R_2 = outer zone radius
h = height of cylinder

correction in milligals is calculated for each zone sector.

The listed terrain corrections are computed using a density of 2.0 gm/cc. During bouguer calculations, the terrain correction density is scaled to match the bouguer density.

GPS Surveying: Our GPS data was downloaded into Ashtech's Office Suite for Survey (AOSS) version 2.11 processing software. All data was recorded at 5-second data intervals with an elevation mask angle of 10 degrees. Rover positions were calculated relative to both of the two base receivers. A least squares adjustment was performed to test the integrity of the computed positions and adjust the final positions. The NGSD91 geoid model was used in calculating orthometric elevations from the processed geoid heights. All positions were converted to NAD27 using the Tralaine software package using the NADCON overlay.

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SUMMARY:

There were no technical or logistical problems during the course of this survey. The high accuracy of the gravity measurements and surveyed positions will yield a reliable data set from which geophysical decisions may be based.

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CANADIAN NATURAL RESOURCES LTD

Report on Seismic Survey Conducted on EL 400

Colville Hills Area, NWT

Covering the Program Conducted Between

January 2001-March 2001

Submitted to the National Energy Board

Calgary, Alberta

September, 2001

By:

Jim D Archibald, P.Geoph

Area Geophysicist

NEB Autorization #9229-C144-1E

Sahtu Land and Waterboard Land Use Permit #500B-001

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2) Lines CVH01 to 06 (Migrated) and LYNX-8624 (structure stack) interpreted

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4) Seismic base map with topography and culture 1:100,000

5) Seismic shotpoint maps 1:100,000

6) Interpreted Maps:

- Proterozoic time structure
- Saline marker subsea
- Saline marker to Proterozoic Isopach
- Proterozoic "Pseudo Depth" (subsea)

II) INTRODUCTION

A 204 km Vibroseis 2D seismic survey was conducted, covering most of EL 400, from January to March 2001 (see index map). The program was designed to image Proterozoic structures, with gas trapped in the overlying Cambrian Mount Clark Sandstones. The offsetting well in 0-35/66-40/ 126-15 has established gas reserves, and is used for velocity control and reflection identification. The final map is a rough depth converted Proterozoic subsea, that shows significant structural closure on EL 400.

IV) TECHNICAL DISCUSSION AND INTERPRETATION

1)Data Quality and Parameter Selection

The data shot previously in the area varied in quality from very good to very noisy. To give the most flexability in parameter selection, as well as to be consistent with the best of the previously shot data, it was decided to use Vibroseis. A number of combinations of sweep, sweep lengths, and drag length were tested at both a good and bad record locations. The final parameters decided on were:

- 3 vibrators over 20 meters, with 20m drag
- 8 6second sweeps
- 10-90 Hz sweep, with 6db/octave boost
- 20m Group interval
- 60m Source interval
- 1600-20x20-1600m split spread

These parameters resulted in excellent data quality over 80% of the program. But there were still areas of high noise, with little or no coherent refection information.

2) Processing

A Standard 2D land processing sequence was applied by GEO-X Systems. A post stack F-X noise attenuation was applied, followed by Finite Difference Migration.

3)Reflection Indentification and Velocity Control

The new lines were tied back to O-35, through line 8624 (reproduced from a previous NEB report). Two reflections were consistent enough to map:

a) Saline marker- a high velocity anhydrite unit, within the Saline River evaporites.
b) Proterozoic unconformity- the top of the Proterozoic in the area is an angular unconformity that is easily identified, where the high angle metasediments of the Proterozoic are overlain by the relatively horizontal Cambrian sediments.

With only one close well tie in in the area, a single velocity function from 0-35 was used to estimate depths and isopachs.

a) Suface to Saline marker 5554 m/s to a datum of 305m. All of the new lines were bulk shifted to tie line 8624.

b) Saline marker to Proterozoic 3824m/s

4) INTERPRETATION

The target reservoir in the area is the Cambrian Mt Clark Sandstones, directly overlying the Proterozoic unconformity. The Proterozoic reflector was converted to depth by adding a depth converted Saline marker to a calculated isopach from the Saline marker to Proterzoic. The resulting map is labeled " Proterozoic Pseudo Depth", and shows structural closures of up to 200 meters, that are interpreted to trap gas.

V) OPERATIONS REPORT

The following " Operations Final Report" was prepared by Trace Exploration Ltd.

EXCLUSIVE 2D SEISMIC REFLECTION SURVEY

N.E.B. Authorization # 9229-C144-1E
Sahtu Land & Water Board Land Use Permit # S00B-001

Report Date: June 30th, 2001

Work Period: January 10th, 2001 to March 7th, 2001

OPERATIONS

FINAL REPORT
For
COLVILLE AREA
Block EL – 400 & Off Interests
Northwest Territories

LOCATION:
Latitude: 66° 25' to 67° 05' Longitude: 126° 15' to 127° 30'

Block Operator:
Canadian Natural Resources Limited

Project Operator:
Canadian Natural Resources Ltd.
2500, 855 – 2nd Street S.W.
Calgary, AB
T2P 4Z5

Acquisition Contractor:
Trace Explorations Ltd.

Project Supervisors:
Canadian Natural Resources Limited and
Trace Explorations Ltd.

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Introduction

This is a final report on our seismic acquisition program performed in the winter of 2000/2001 only. By no means is our intent to terminate our permits or authorizations issued on this project prior to their expiry dates.

This Colville area project site is known 'in-house' at Canadian Natural Resources Limited (CNRL) as Colville Hills 00-A. This program is located in the southwest of the community of Colville Lake, Northwest Territories, west of Lac Belot, north of Hare Indian River. Colville Lake is approximately 1950 kilometers north-northwest of Calgary, Alberta.

The Colville Hills Seismic program was conducted in the winter of 2001. Trace Explorations Ltd. handled the compilation of Sahtu Land and Water Board and NEB applications and Northern EnviroSearch conducted and completed the environmental study portion. Trace Explorations Ltd. conducted the vibroseis geophysical field acquisition. All the parties were working on behalf of CNRL. CNRL acted as the operator and the geophysical survey was for the exclusive use of CNRL.

The work period was from January 10th, 2001 to March 7th, 2001. There were generally between 65 and 85 people involved in all phases of the operation. Advance camp consisted of 20 to 35 people and Recording camp up to 50 people.

Bill Busby, of Trace Explorations Ltd., was the Base Manager. He was situated in Trace's base camp in Norman Wells. Terry Newman, of Mercedes Surveys, handled the GPS units on the bulldozers prior to directing the establishment of line locations and line clearing/cleaning operations. Willie Bevan, surveyed lines and assisted in monitoring slashing operations. Brent Noseworthy, of Trace Explorations Ltd., was the Party Manager, who coordinated the vibroseis recording operations. Both Mr. Newman and Mr. Noseworthy were situated on-site in the Advance Camp and Recording Camp respectively.

This project was submitted for Land Use approval to the Sahtu Land and Water Board on November 21, 2000 and approval was granted on January 10, 2001. Application to the National Energy Board was submitted on November 20, 2001 and granted on January 19, 2001.

Final Plan Statistics

The final plan map details are provided by Mercedes Surveys. Details are as follows:

LINES #	CVH-00-01	CVH-00-02	CVH-00-03	CVH-00-04	CVH-00-05	CVH-00-06	CAMPS	ACCESS	TOTAL
BOL	355	101	71	98	191	101	-	-	-
EOL	2101	953	2363	2330	2021	1361	-	-	-
KM LAKE	3.74	1.6	4.44	7.52	4.18	3.64	-	-	25.12
WIDTH	1	1	1	1	1	1	-	-	-
HA	0.37	0.16	0.44	0.75	0.42	0.36	-	-	2.5
KM NEWCUT	30.66	15.02	38.96	36.76	31.66	19.78	2.90	3.20	178.94
WIDTH	7.36	7.01	7.95	7.67	7.82	6.98	20	7.47	-
HA	22.57	10.53	30.97	28.19	24.76	13.81	5.80	2.39	139.02
KM HANDCUT	0.52	0.42	2.44	0.36	0.76	1.78	-	-	6.28
WIDTH	1	1	1	1	1	1	-	-	-
HA	0.05	0.04	0.24	0.04	0.08	0.18	-	-	0.63
KM EXISTING	-	-	-	-	-	-	-	69.8	69.8
WIDTH	-	-	-	-	-	-	-	7.0	-
HA	-	-	-	-	-	-	-	48.86	48.86
DETOUR	4.84	1.98	6.74	8.24	6.42	7.5	-	-	35.72
WIDTH	7.4	7.4	7.4	7.4	7.4	7.4	-	-	-
HA	3.58	1.47	4.99	6.1	4.75	5.55	-	-	26.44
TOTAL KM	34.92	17.04	45.84	44.64	36.60	25.2	-	-	204.24

Weather & Terrain

Weather conditions for this program were in the temperature range of –42° to +5° Celsius throughout the course of the operations. Most of the working conditions were from –30° to around –10°. Delays were encountered in January waiting for the Hare Indian River crossing to freeze to a thickness sufficient for heavy equipment to cross. The weather in this period was unusually mild. Great care was taken near all water bodies, as the warm weather and unusually deep early season snow did not allow the small water bodies to freeze to their usual thickness.

This project area was primarily small spruce timber and fairly flat terrain. Line CVH 00-01 was cut 6.4km short to avoid a steep hill and CVH 00-05 was cut short on the eastern end (near Lac Belot) as sinkholes were encountered.

Logistics & Summary

The Base Staff in Norman Wells arranged personnel movements, purchased fuel, foods and other essential supplies to ensure ongoing operations of the field crews. Personnel in transit through Norman Wells stayed primarily at the Trace Base Camp facilities in Norman Wells – if no room was available local hotels were utilized.

Canadian North Airlines was used to transport personnel, equipment and supplies from the south.

Local fixed wing support, for chartering local personnel and handling of emergencies (if required), was primarily provided by North-Wright Airways Ltd. of Norman Wells. Aircraft utilized were a Cessna 172 and a DeHavilland Twin Otter.

Norman Wells Claimant Corporation Ltd. in partnership with Canadian Helicopters and Sahtu Helicopters both provided rotary wing support for scouting, personnel transfer, critical supplies, possible medical evacuations (if required) and general operations. Helicopters utilized on this program were a Bell 206, a Bell 206 long ranger and a Bell 212.

All snow machines were sourced and rented from the local community. This was arranged through the Behdzi Ahda First Nation. They provided up to 15 machines to the Trace Explorations operations. Behdzi Ahda First Nation also provided slashing and environmental monitoring services. This directly employed 6 community members.

Some personnel came from the south (i.e. Calgary – point of hire). However, the local component of Northwest Territory's residents comprised of approximately 64% of worker days. Times off periods were determined by self-requests given that replacement personnel were available.

Daily fuel consumption averaged approximately 2836 litres of diesel and 158 litres of gasoline over the 57 days of this operation. Fuel and lubricants were purchased from a supplier in Norman Wells. Aviation fuel was purchased in barrels and supplied by Island Lake Esso, the Norman Wells Claimant Corporation Ltd., and Sahtu Helicopters.

Upon completion of the CNRL operations all equipment was released and moved to a Paramount Resources Ltd. seismic program in the vicinity.

Safety, Health & Environment

Environmental concerns were addressed in a report provided by Northern EnviroSearch Ltd. Environmental monitoring was onsite once the camp moved onto the access road north of the Hare Indian River. Environmental Monitoring Reports were submitted daily and distributed to the Project Manager and then forwarded to Trace's Calgary office. Reports were reviewed with the monitors and corrective actions were taken when required.

All new cut lines were cat cut 7 to 8 meters wide. All necessary First Aid supplies plus a field radio, satellite telephone and/or mobile radio-telephone were available to communicate with the crew and outside. Radio check-in is required on a regular basis. Each camp had a snow machine and body sleigh with jump pack and oxygen available 24 hours a day for any difficult field emergency. Airstrips were built at strategic locations to facilitate medivacs (if required). Advance Camp had a medic on site. Recording Camp had a Paramedic on site. The medics were in communication together and were usually within 1-hour ground transport of each other, if assistance was required.

Field operations were inspected by Mr. Rick Turner, of the National Energy Board based in Calgary, and several times by Mr. Steve Deschene, Resource Management Officer III, of Indian and Northern Affairs Canada based in Norman Wells. Their concerns were addressed in a timely manner and assisted Trace in the running of a lost time free program.

Copies of safety meetings, audits, etc. were forwarded to the National Energy Board and Trace Explorations Ltd.'s Calgary office.

Line Clearing Operations

Bulldozers did all the line clearing. Mr. Terry Newman, of Mercedes Surveys, was the cat push handling the day-to-day field operations of establishing the line locations physically in the field.

The program largely consisted of new cut line. The entire cat cut was windrowed to either side of the lines with breaks to allow wildlife access and to eliminate a continuous fire fuse. The debris was bucked and slashed.

All slashers had snow machines to facilitate transport to and from camp. In poor weather situations access to crew cab Nodwells was available. Radio check-ins were conducted on a regular basis.

Creek crossings were constructed of man-made snow fills. All crossings were removed before the crew left the area.

Surveying Operations

Mr. Lorne Kelly, of Mercedes Surveys located in Alberta, was the Survey Manager provided quality control and supplied equipment to the crew on this project. Mr. Willie Bevan, of Mercedes Surveys, was the head surveyor in the field responsible for the line locations and survey. Mr. Kellie Shilka, of Mercedes Surveys, was the surveyor responsible for the chaining and GPS survey on the prospect.

A chaining crew placed flagging at the geophone station intervals and identified the vibrator points. Chaining notes were prepared every evening for the field operations and a final copy forwarded to survey audit company and seismic data processor at the completion of the project.

A survey crew recorded the point locations by GPS. A Novatel GPS system was used to establish the control and survey the locations of lines and access. Control was based upon Geodetic Survey of Canada benchmarks.

All survey work was performed in the metric system.

Recording Operations

Instruments		I/O System II
Number of Traces		160 channels
Geophone Type		Mark L210
Geophone Frequency		10 Hz
Geophone Array		6 geophones over 20 meters (spacing)
Sample Rate		2 milliseconds
Record Length		3 seconds
Anti-Alias Filter (high cut)		¾ Nyquist Min
Low Cut Filter		3 Hz/12 dB
Receiver Interval (group interval)		20 meters
Source Interval (vibrator shot point)		60 meters
Extra Source Points		Nil
Fold		2400%
Spread		160 channels
Roll in		80 channels
Source		Vibroseis
Source Array		3 vibe drag over 20m
Number of Sweeps		8 sweeps
Length of Sweeps		6 seconds

The recording crew removed all flagging, lath and survey markers upon completion of their operations on the project.

Recording personnel were based in a sleigh camp situated on the prospect. Recording camp was moved to position the crew close to the area of work.

DATES OF OPERATIONS

Advance Camp Mobilized		January 10th, 2001
Advance Camp Released		February 28th, 2001
Line Clearing Commenced		January 28th, 2001
Line Clearing Demobilized		February 23rd, 2001
Surveying Commenced		February 1st, 2001
Surveying Demobilized		February 28th, 2001
Recording Camp Mobilized		January 28th, 2001
Recording Camp Released		March 7th, 2001
Recording Commenced		February 5th, 2001
Recording Demobilized		March 7th, 2001

Recording Production Summary

Total Kilometers Surveyed		204.24
Number of Vibrator Shot points		3357
Number of Stations		10218
Number of Recording Days		31 days
Kilometers Recorded per Day		6.58
Days Mobilized / Demobilized		12.5 days
Days Lost Due to Weather		5 days for river crossing to freeze
Days Lost to Equipment Failure		2 days (included in recording days)
Down Time per Day		Average 1 hr/day over the program

PERSONNEL

Recording Camp	1	Party Manager
	1	Observer
	1	Jr. Observer
	2	Cable Repair/Battery Manager
	2	Trouble Shooters
	15	Line Crew Helpers
	3	Mechanics
Source Crew	2	Vibrator Mechanics
	4	Vibrator Operators
Recording Camp	1	Cook
	1	Cook's Helper
	2	Camp Staff
	1	Delta III Water Hauler
	1	Delta III Supply / Fuel Hauler
	1	Paramedic
	5	Recording Camp Cat Operators
	1	Client Rep
Surveying	1	Advance Manager/Cat push
	2	Surveyors
	2	Chainers
	3	Survey/Chainer Helpers
Line Clearing	1	Cat Foreman
	5	Cat Operators
Slashing	5	Hand Cutters
Advance Camp	1	Cook
	1	Cook's Helper / Camp Staff
	1	Camp Water Hauler/Camp Mechanic
	1	Medic
	1	Delta III Supply / Fuel Hauler
	1	Mechanic
	1	Monitor
	3	Ice Checkers/Helpers
	1	Cat Operator trainee
Base Camp Norman Wells	1	Base Manager
	1	Clerk
	1	Expediter / Technical Support
	1	Supply Driver
	1	Cook
	1	Camp Staff
TOTAL PERSONNEL	80	Average Day This Level Varies Slightly

EQUIPMENT

Recording	1	FN 110 Recorder Unit
	4	FN 110 Cable Line Truck Units
	2	Trouble Shooters Snow Machines
Source Crew	4	Vibrators
	1	FN 110 Vibrator Technician Unit
Recording Camp	5	Recording Camp Cats
	1	FN 110 Mechanic Unit
	1	FN 110 Nodwell Water Truck
	1	FN 60 Manager/Client Nodwell Unit
	1	Delta III Water Unit
	1	Delta III Supply / Fuel Unit
	1	Party Manager Snow Machine
	1	Paramedic Snow Machine
	1	Paramedic Body Sleigh
Surveying/Catpush	3	FN 60 Nodwell Units
	6	Snow Machines
Line Clearing	5	Cats
	1	Delta II Supply / Fuel Unit
Slashing/Monitor	6	Snow Machines
Advance Camp	1	FN 110 Nodwell Water Truck
	1	Medic Snow Machine
	1	Medic Body Sleigh
Base Camp Norman Wells	2	1 – 4X4 Pickup
	2	4X4 1- ton truck