

**Final Report**

**MUNSIST Sesimic Source Test #2 - Flatbay, NL.**

**Exploration License #10-101-01-RS**

Dr. C. Hurich, Dr. S. Deemer & MUN Seismic Team  
Earth Sciences Dept.  
Memorial University  
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## Summary

In June 2010 Memorial University carried out a second production test of the MUNSIST seismic source. The test was aimed at assessing and verifying system modifications that arose from the first test (Five Mile Road, 2009) and to test the effectiveness of the MUNSIST seismic source for high resolution seismic acquisition in a distinctly different geological environment with different imaging requirements. In addition, conventional Vibroseis data and some well data were made available by Vulcan Minerals for comparison and correlation purposes. Both the 2009 and 2010 tests were funded through the Petroleum Exploration Enhancement Program of the Government of Newfoundland and Labrador.

The specific geologic target of the Flatbay test was the potential oil reservoir associated with the Fishells Brook conglomerate. The Fischells Brook is overlain by a series of halites, anhydrites, gypsums and carbonates with high internal reflection coefficients which tends to trap seismic energy and makes the Fischells Brook a somewhat difficult seismic target. The Fischells Brook has proven hydrocarbon content but typically low porosity/permeability so the target of the seismic imaging was to identify small faults that may be the center for enhanced fracture related porosity and permeability. The test was carried out in collaboration with Vulcan Minerals that holds the minerals lease on the property.

The test demonstrated that the modifications made to the MUNSIST baseplate have resulted in a broader bandwidth source but there is still some room for improvement. We were able to provide as good or better quality data at the target level as a conventional Vibroseis profile with considerably lower source effort. In particular, the shallowest reflections are considerably better imaged in the MUNSIST data and faulting that may be associated with enhanced production potential are clearly mappable in the MUNSIST data (see Figure 2).

## Introduction

The MUNSIST source consists of a commercially available (mid-range) hydraulic rock breaker that is combined with a custom designed control valve and control software. The rock breaker is conventionally mounted on a back-hoe or excavator but there is significant potential for development of a wide-tracked low impact carrier that would allow off road and rough terrain operations. The MUNSIST source operates by applying a sweep of multiple impacts to the ground in which the rate of impact increases throughout the duration of the sweep. A shot point consists of the summation of multiple sweeps, each of which have different bump rate ranges (sweep frequencies). In typical operation the final shot point would consist of 200-250 impacts on the ground surface. The recorded signal is then collapsed or decoded either by cross correlation or a shift and sum process and the resulting shot records summed to produce the final shot record for a specific shot point. The result of the decoding process is an impulsive signal which takes advantage of the multiple impacts to increase the S/N by increasing total energy input into the ground and by cancellation of random noise. Unlike Vibroseis, the frequency spectrum of the source is dictated by the impact of the hammer on the ground (not the bump rate of the extended signal) so the MUNSIST system does not require continuous ground compliance.

Tests on hard ground have demonstrated frequencies up to 200 Hz but high end frequencies of 80-120 Hz with peak frequencies of 50-80 Hz are more common.

### **Flatbay Field Test**

The major technical objectives of the Flatbay test were an assessment of the effectiveness of baseplate modifications and control electronics and software adjustments and their affect on production rates.

### **Acquisition Parameters**

#### Source Parameters

- shot point (SP) spacing - 20 m
- 5 sweeps per SP      2-3 Hz   2-5 Hz   2-7 Hz   2-9 Hz   2-11 Hz
- sweep length - 10 s

#### Receiver Parameters

- receiver spacing - 10 m
- geophones - single 14 Hz geophones
- # of channels - 180 - split spread 1-60 X 61-180
- near offset - 20 m
- far offset - 1210 m

#### Recording Parameters

- recording system - ARAM Aries
- sample rate - 2 ms
- record length - 13 s reduced to 3 s after correlation
- data channels - 1-180
- aux. channels - 181 - predicted time break
- 182 - baseplate accelerometer/switch
- 183 - field time break

### **Processing stream for final stack**

#### Pre Vertical Stacking

- Pilot Trace: Bandpass 10/20-150/220 hz
- Pilot Trace: Spike Deconvolution
- Data Traces: Bandpass 10/20-150/220
- Notch Filter: 62 hz
- AGC - (3000 ms)
- SIST Correlation

#### Vertical Stack

- Selected Trace Exclusion and Kills

Vertical Stack  
Geometry Application  
Constant Velocity Stack Analysis

Pre-CMP stack

AGC: (100 ms)  
FKFilter (steep dipping events in shot gathers)

CMP Stack

AGC: (200 ms)  
Normal Moveout Correction (70% stretch mute)  
First Breaks Trim Statics  
CMP Stack

Post Stack Display

Bandpass Filter (10/20-60/75)  
Trace Mix (1,2,3,2,1)  
Kirchhoff Migration  
Trace Mix (1,1,1)

Figure 1. Location map - small numbers = station, large numbers = CDP

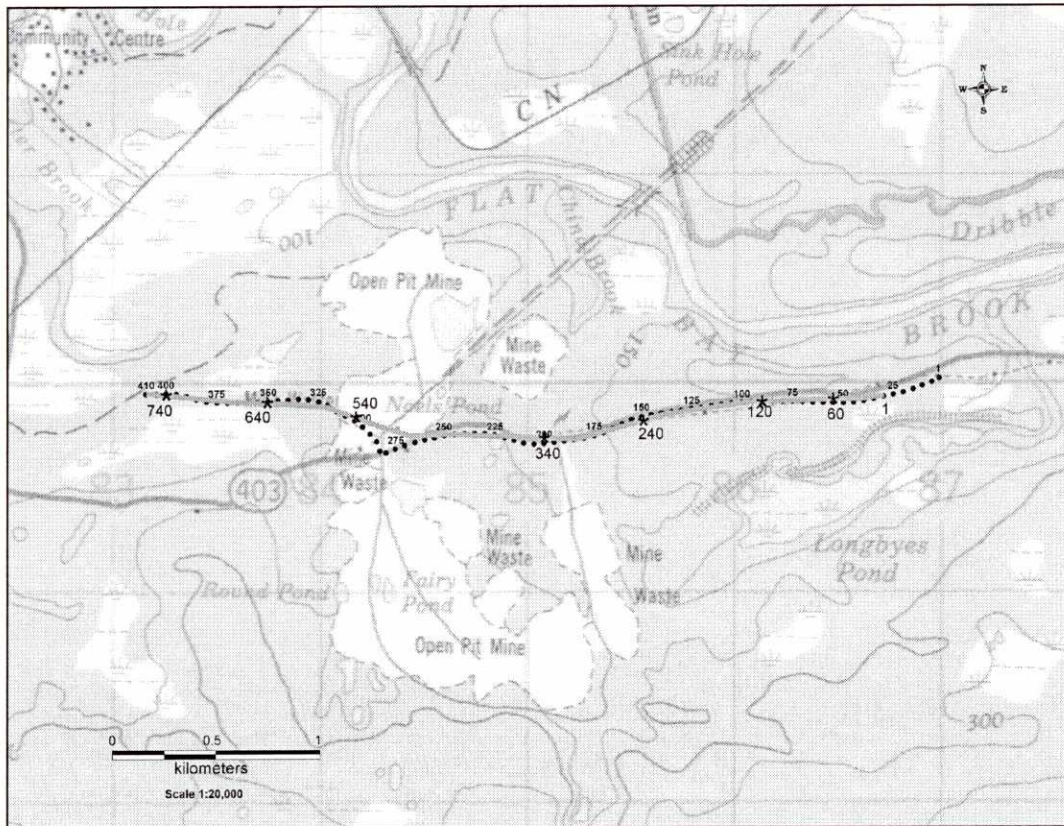
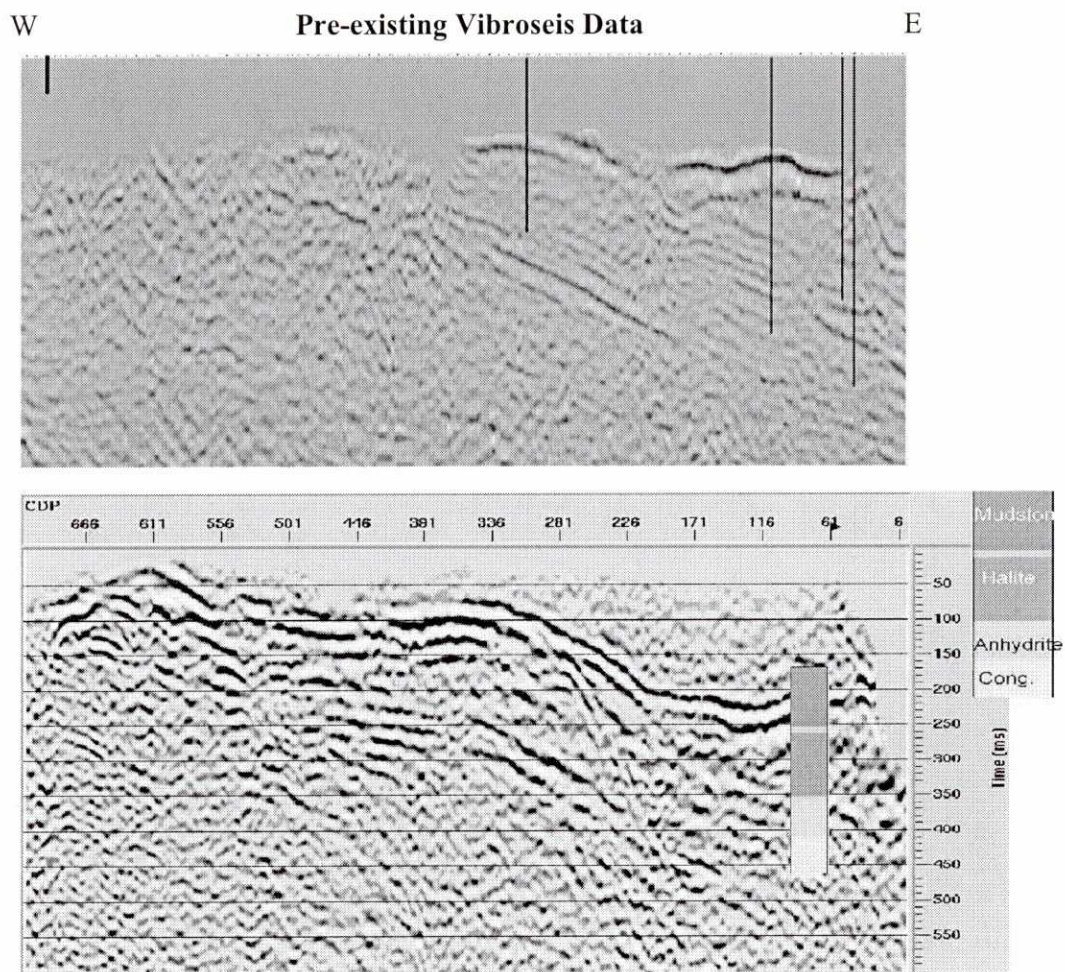


Figure 2. Data Comparison



MUNSIST seismic data (unmigrated)

Vibroseis Acquisition Parameters

- 2 vibrators, 10 sweeps, 14 s sweep, sweeps non-linear 10–120 Hz
- source interval: 40 m - group interval: 10 m
- Nominal Fold: 62

MUNSIST Acquisition Parameters

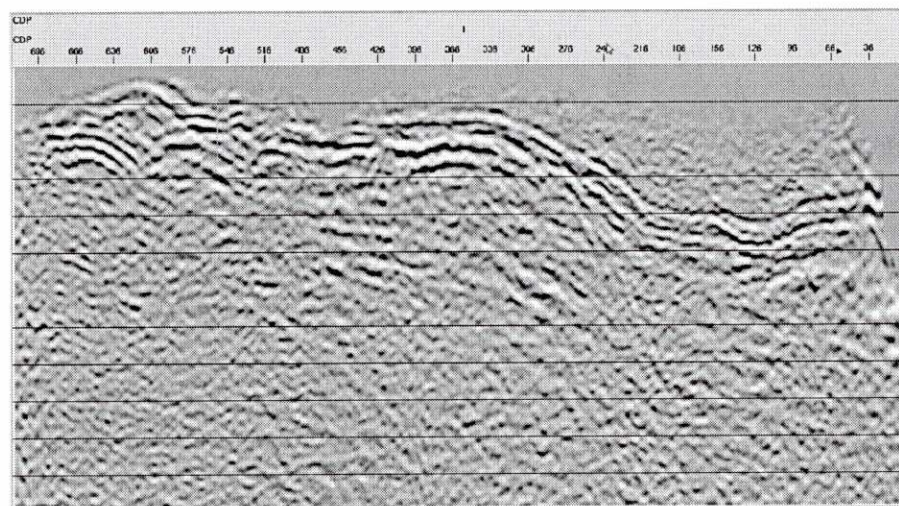
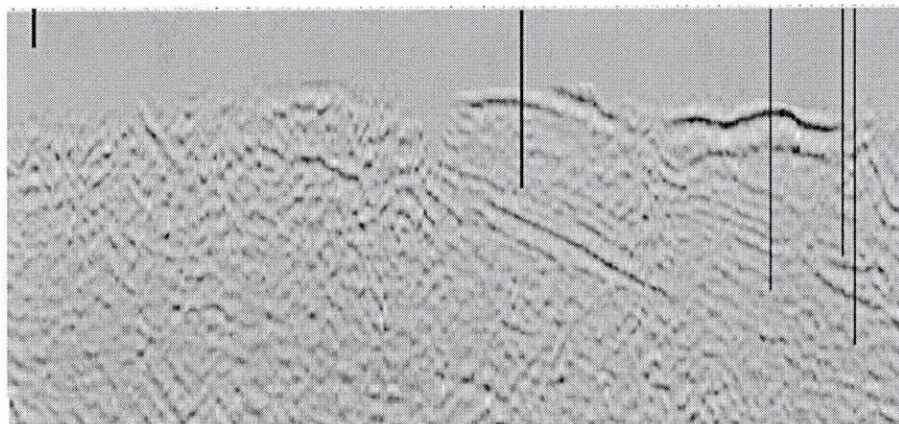
- 1 MUNSIST, 5 sweeps, 10 s sweep
- source interval: 20 m - group interval: 10 m
- Nominal Fold: 45

Major observations:

- A difference in the reference datum of the two data sets is obvious. The datum in the MUNSIST profile more closely matches the geology based on the borehole and preserves the shallow geology much better than the Vibroseis data.
- In the western half of the MUNSIST data, there is considerably more information but the two data sets are pretty much comparable in the eastern half. With the filter chosen for the final display the MUNSIST data are of somewhat lower frequency. However, the filter choice is based on suppression of steep dipping, high frequency scattered waves that are most likely generated in the 10-20 m zone of glacial till at the surface. See Figure 2 for the broader band version of the MUNSIST data.
- The total source effort for the MUNSIST data is considerably less than the Vibroseis data which is adequate for the shallow targets. Although not shown in the data comparison, the Vibroseis data clearly resulted in deeper imaging.

**Figure 3. Comparison between broad band version of the MUNSIST data and the Vibroseis data**

**Vibroseis (Bandpass 8/12-50/70)**



**MUNSIST (unmigrated, bandpass 10/20-90/150)**

Observations:

- This version of the MUNSIST data demonstrates that frequencies up to 100Hz are present in the strong reflections that mark the transition between the mudstone unit and the salt/carbonate sequence. In particular, the fine scale stratigraphy of that transition is better delineated and the structure of the western end of the profile is more interpretable. However, the continuity of deeper even is decreased due to high frequency scattered waves generated in the till at the surface.



## **Analysis**

### MUNSIST

Improvements in the MUNSIST system resulted in considerably higher production rates at Flatbay than the first test at Five Mile Road. As with the Five Mile test, the data quality in the shallow part of the section is as good or better than the Vibroseis data. In both cases the Vibroseis data showed deeper signal penetration but this is not surprising given the difference in the source effort between the two sources. We encountered continued issues with the robustness of the system that records the pilot sweep for the source and the mechanical suspension of the baseplate. Despite these issues we very successfully applied the MUNSIST system for a month long program of both surface and borehole seismic acquisition at the Voisey's Bay mine site in Labrador (Aug. - Sept. , 2010). We are continuing to increase the robustness of the system and to investigate further baseplate modifications to increase the source bandwidth.

### The Geologic Target

The stratigraphy of the Fischells Brook is not well delineated by either data set. However, the MUNSIST data show considerably better delineation of the shallow fault system. If faulting does indeed lead to enhanced porosity and permeability, the mapping of these faults could be critical to the location of productive wells.

### Future Development

A single MUNSIST source provides high quality seismic data for targets less than 1.5 km deep but does not provide enough energy for deeper targets. There is significant potential for combining multiple, larger sources to provide more energy and deeper penetration. We are investigating several alternative carriers for the MUNSIST source that would make it more portable (potentially heli-portable) in difficult terrain.

## **Acknowledgments**

Funding for this test was provided through the Petroleum Exploration Enhancement Program operated by the Government of Newfoundland and Labrador. We wish to thank Ian Atkinson (NALCOR) and David McCallum (formerly Energy Branch) and Laurie Cook (Energy Branch) for support during the funding process and during application for the exploration license. We also thank Phonse Fagan and Vulcan Minerals for the Vibroseis data set and borehole information. The data were acquired by Memorial University through the Land and Seabed Imaging Facility with the support of Chris Byrne (Seismic Manager) and Dan Blackmore (Project Engineer). Dr. Sharon Deemer processed the data in Memorial University's Computing, Visualization and Simulation Laboratory with software provided by Landmark Graphics.

**Appendix** (on DVD)

- correlated shot records (segy)
- stack (segy)
- migration (segy)



## Exploration Survey Cost Summary

*(Estimate where necessary)*

<b>Mobilization:</b>	
<b>Drilling<sup>(1)</sup>:</b>	0
<b>Salaries: Residents:</b>	11000
<b>Non-Residents:</b>	
<b>Accommodations:</b>	6300
<b>Surveying:</b>	
<b>Equipment Rental:</b>	6000
<b>Helicopter Time:</b>	0
<b>Dynamite:</b>	0
<b>Food:</b>	3150
<b>Fuel:</b>	2500
<b>Recording<sup>1</sup>:</b>	5000
<b>Processing:</b>	1500
<b>Miscellaneous:</b>	
<b>Other:</b>	6000
<b>Total Cost of Program:</b> (not including overhead)	41.450

I Charles Humeck of Assoc. Professors Memorial Univ.  
(Name and Position) (Company)  
Name)

do hereby certify that the information contained herewithin is, to the best of my knowledge, accurate.

Charles Humeck  
(Signature of Company Representative)

\_\_\_\_\_  
(Witness Name and Position)

\_\_\_\_\_  
(Witness Signature)

**Exploration Licence #:** 10-101-01-RS

**Date:** 03/08/11

<sup>10</sup> State contract rate per day or per km, where applicable.



## Exploration Survey Equipment Inventory

Description	Newfoundland Based	Other
Vibrators:		
Drills:		
Rental cars / pickups:	4	
Semi-trailors:		
Bombardiers:		
ATVs:		
Snowmobiles:		
Tractors:	1	
Cables:	30	
Geophones:	200	
Helicopters:		
Snowplows:		
Survey Instruments:	1	
Recording Trucks:	1	
Gravity Meters:		
Magnetometers:		
Other:		

Prepared by: Charles Huneault Assoc. Prof.  
(Name and Position)

Charles Huneault  
(Signature)

Exploration Licence #: 10-101-01-R5

Date: 03/08/11



## Exploration Survey Employment Summary

Occupation	Number of Employees		Person Days		Total Person Days
	Residents	Non-residents	Residents	Non-residents	
Project Supervisor:	1		12		12
Line Cutters:					
Surveyors:					
Surveyor's Helpers:					
Drillers:					
Driller's Helpers:					
Juggies:	3		10		30
Line-truck Drivers:					
Cat Operators:	1		8		8
Pilots:					
Mechanics:					
Security Guards:					
Blasters:					
Observers:	2		12		24
Jr. Observors:					
Other:					
<b>TOTAL:</b>	7		42		74

Prepared by: Charles Humech Assoc. Prof

(Name and Position)

Charles Humech

(Signature)

Exploration Licence #: 10-101-01-R5

Date: 03/08/11



## Weekly Report - Geophysical Exploration

Exploration Licence #: 10-101-01-RS Report Period: whole project  
 Licensee: Memoriae Union Contractor: Memoriae Union  
 Area: FLATBAY NL

	TO DATE	REMAINING
Number of km: Cut		
Chained		
Surveyed	4	
Drilled		
Layed Out	4	
Recorded	4	
Reclaimed		
CURRENT EMPLOYMENT	RESIDENTS	OTHER
Party Manager	1	
Observers	2	
Junior Observers		
Line Cutters		
Surveyors		
Surveyors Helpers		
Drilling Supervisors		
Drillers		
Driller's Helpers		
Cat Operators	1	
Pilots		
Juggies	3	
Security Guards		
Blasters		
Mechanics		
Other:		

EQUIPMENT IN USE	NEWFOUNDLAND BASED	OTHER
Vibrator Trucks		
Rental Cars/Trucks	4	
Semi-Trailers		
Snowmobiles		
ATVs		
Drills		
Bull Dozers	1	
Helicopters		
Cables	30	
Geophones	200	
Survey Instruments	1	
Gravimeters		
Magnetometers		
Other:		

COMMENTS:

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Report Prepared by: Charles Hurcut 709-864-2394  
(Print Name) (Telephone) (Fax)

Assoc. Prof. Memorial Univ.  
(Position & Company)

Charles Hurcut  
(Signature)

03/08/11  
(Date)

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