Innovation in Exploration Seismology
Seismic sources and acquisition geometries

C. Hurich
Memorial University
Earth Sciences Department

2012 PEEP Seminar
Project Objectives

Development of alternative seismic source for application onshore

- Relatively few roads for vibrator access – no local crews
- Costs and environmental issues with drilling and explosives
- Focus on High Resolution (Broad Bandwidth)

Enhance the onshore seismic capability and expertise at MUN

- MUN operates a commercial grade seismic recording system
- The PEEP projects are linked to a major project funded by ACOA, NSERC & Vale aimed at development of novel seismic imaging methodologies
The Seismic Source

Design Characteristics

- Modest environmental and physical footprint
- Operable in difficult terrain
- Cost effective

Major trade-off

- Source power output vs. footprint

Swept Impact Seismic Technique (SIST)

- Reasonably well known technology with lots flexibility for development
SIST

SIST is basically a cross between Vibroseis (chirp) and Impact type sources

**Vibroseis Sweep (1-10 Hz)**

**SIST Sweep (1-10 Hz)**

*VIBROSEIS* – Bandwidth = **sweep** - requires constant ground compliance

*SIST* – **Bandwidth function of impact** not the sweep frequency
- instantaneous ground compliance
  - Significant potential for broader bandwidth
Custom control software and valve linked with a hydraulic rock breaker

Includes – Calibration and QC modules
Testing on Western Newfoundland Targets

Five Mile Road 2009 – First Production Test
1 MUNSIST vs 4 Vibrators
W-verging thrust stack

Shelf Sequence
~ 2 km depth

1 MUNISIST
unmigrated stacked

4 Vibrators
migrated stacked
Value Added in the Thrust Stack
Spectral Issues - soft surface
Testing on Western Newfoundland Targets

Flat Bay 2010 – Shallow Reservoir – Thanks to Vulcan Minerals

2 Vibes – 10 sweeps – 14s

1 MUNSISt – 5 sweeps -10s
**Additional Operations**

**2010 & 2011** – MUNSIST used for two seismic programs at Voisey’s Bay
- Surface seismic
- Walk-away Vertical Seismic Profiles
- Narrow cut lines
Further Field Trials – Voisey’s Bay - 2010

Surface Profile

Borehole Profile

Voisey’s Bay

Reid Brook Zone

60°

Borehole

VSP Shots

Troctolite Dike

VSP Source Line

2D CMP binning profile

Overburden

Troctolite

Orthogneiss

Sulphide Mineralization Exposed and Projected
Seismic Interferometry and Virtual Source Profiling

Virtual Source Profile – Voisey’s Bay
PS Depth Migration

Synthetic Virtual Source Profile
PS Depth Migration

Dominated by sub-vertical features
Interpretation of the Combined Images

Potential for delineation of bends and thickness changes in the dike that focus massive sulfide accumulations.

Demonstrates the potential for continued development of the technique.
Development of MUNSIST and the enabled seismic technologies

- Opens possibilities for conventional and unconventional O&G exploration in the NL onshore as well as minerals exploration

- We have done a rigorous ‘first round’ of R&D and testing on the system

- There is a need for a ‘second round’ of development to broaden the system and we are presently seeking partners
Moving Forward

- Adapt to a carrier with a lower center of gravity – potentially heli-portable
- Move to a wireless control system
- Vibration analysis on the base plate to tune for higher frequency
- Multiple hammer system – increased power output