



Innovation in Exploration Seismology

Seismic sources and acquisition geometries

2012 PEEP Seminar

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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

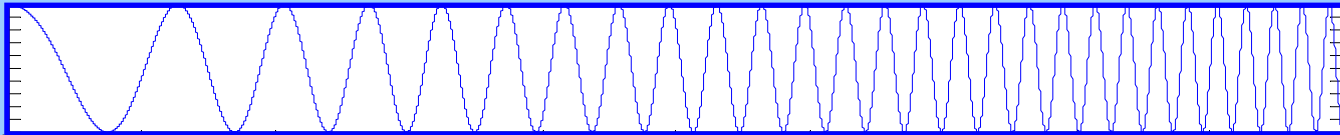
- Source power output vs. footprint

Swept Impact Seismic Technique (SIST)

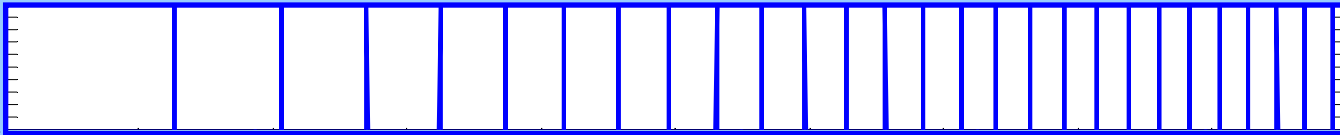
- Reasonably well known technology with lots flexibility for development

SIST

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



Vibroseis Sweep (1-10 Hz)



SIST Sweep (1-10 Hz)

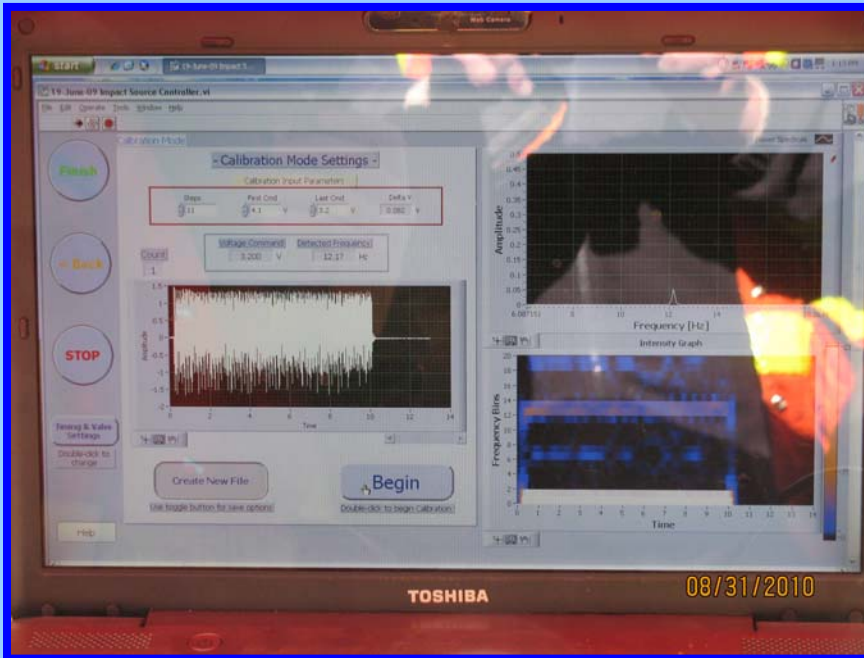
***VIBROSEIS* – Bandwidth = sweep** - requires constant ground compliance

***SIST* – Bandwidth function of impact** not the sweep frequency

- instantaneous ground compliance

- **Significant potential for broader bandwidth**

MUNSIST



Custom control software and valve linked with a hydraulic rock breaker

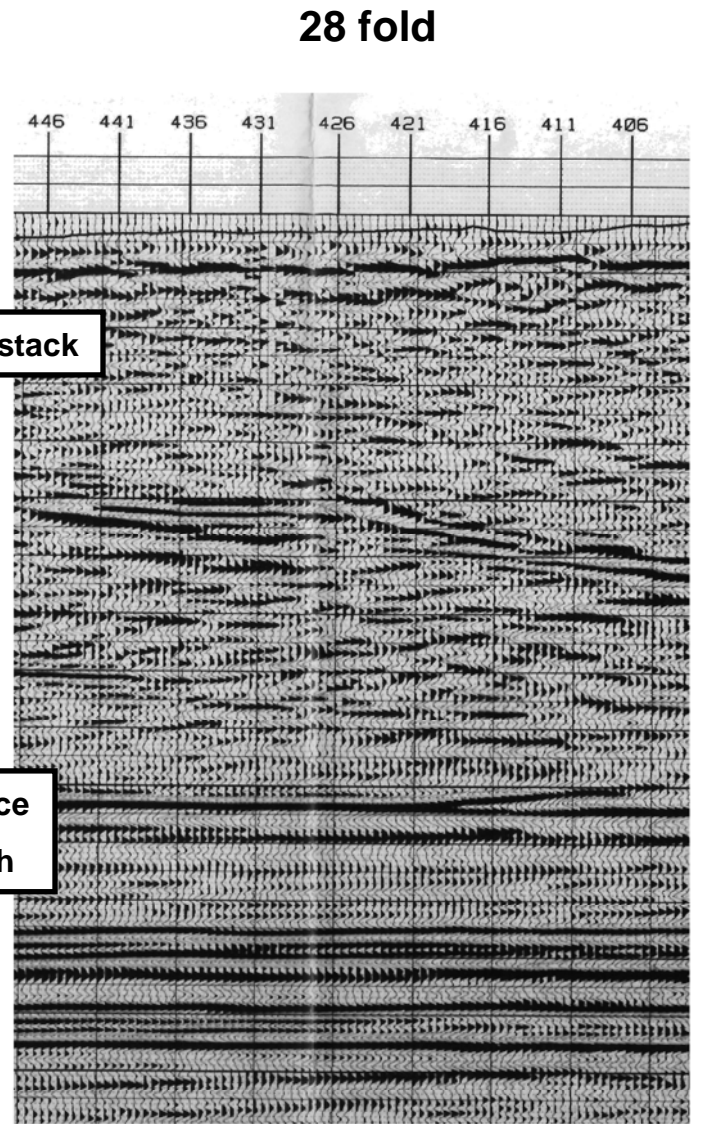
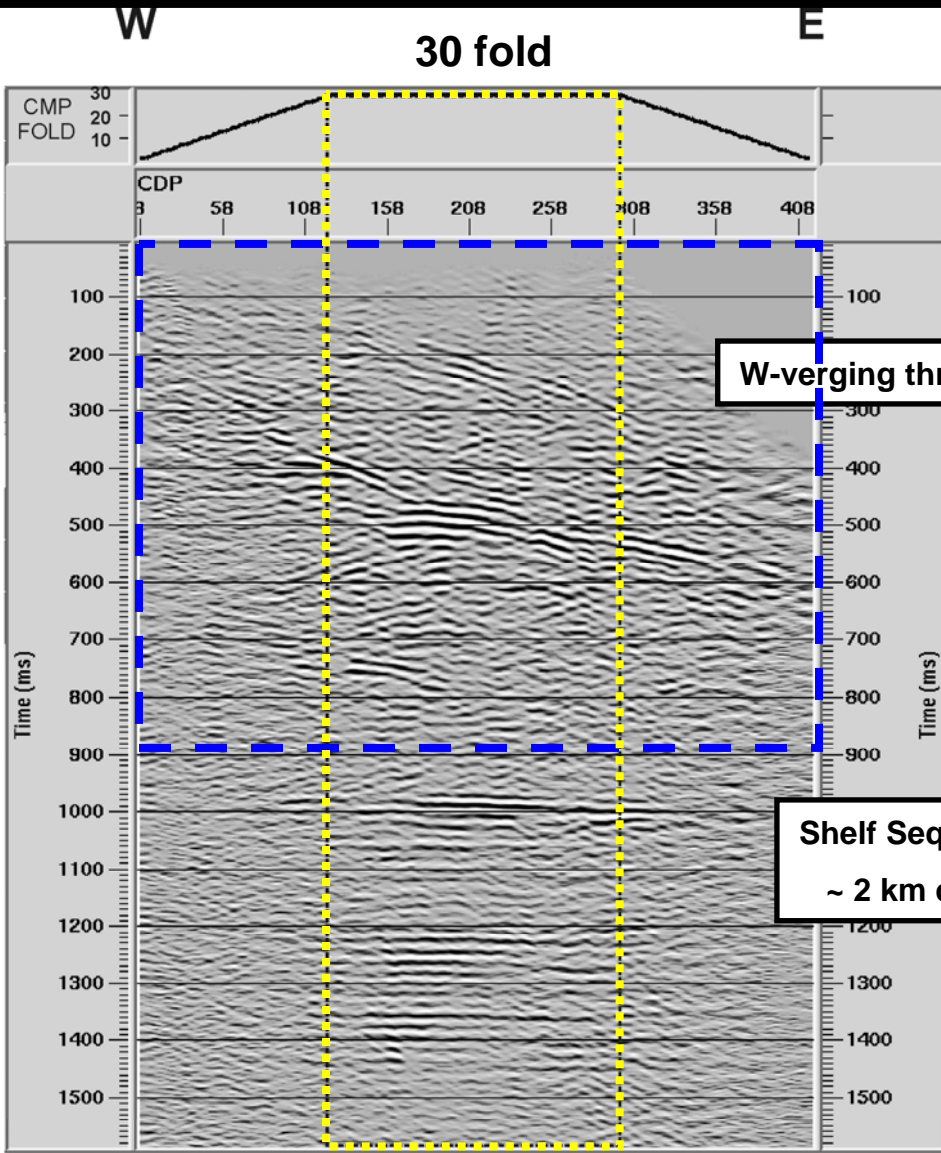
Includes – Calibration and QC modules

Testing on Western Newfoundland Targets

Five Mile Road 2009 – First Production Test

1 MUNSIST vs 4 Vibrators

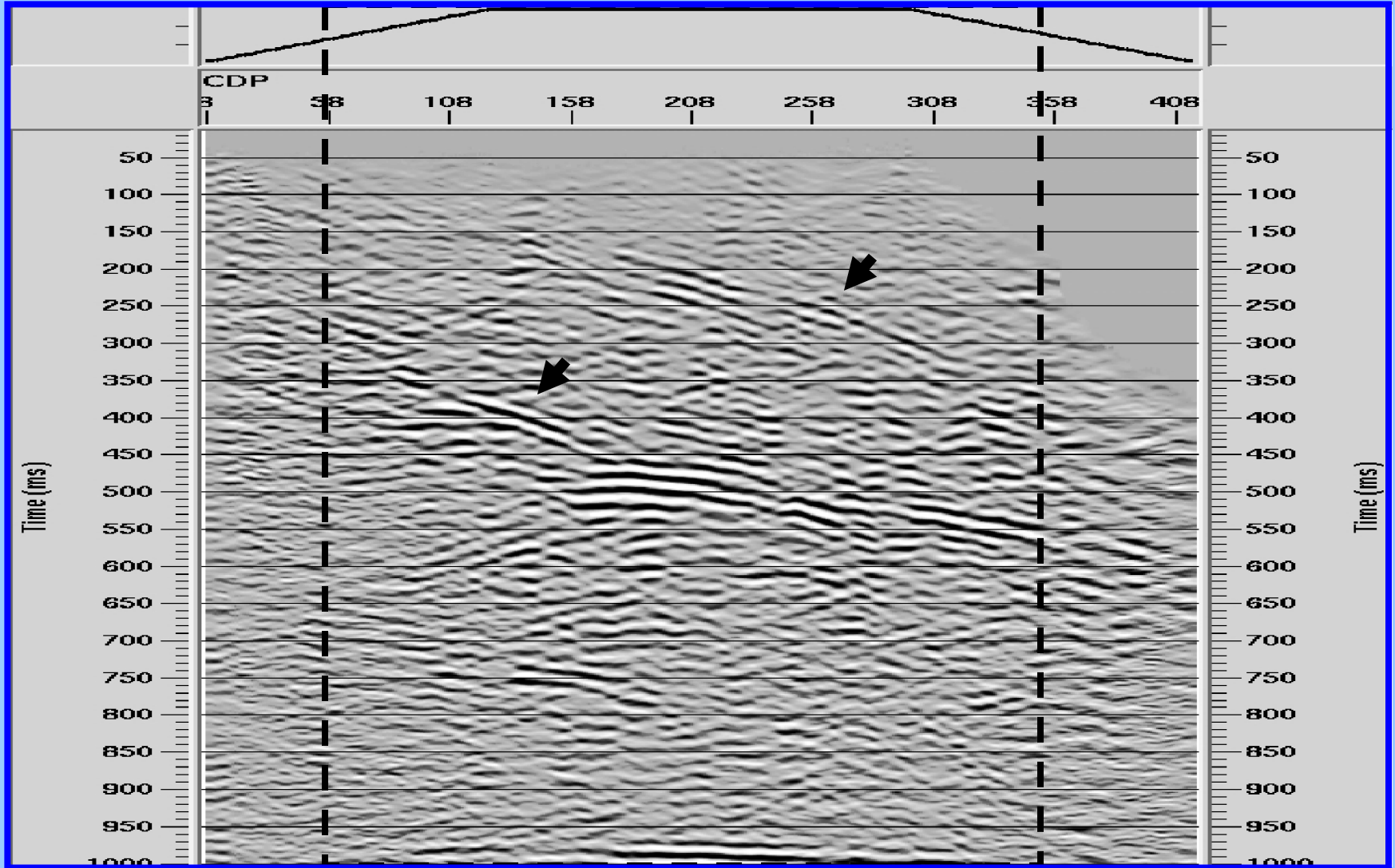




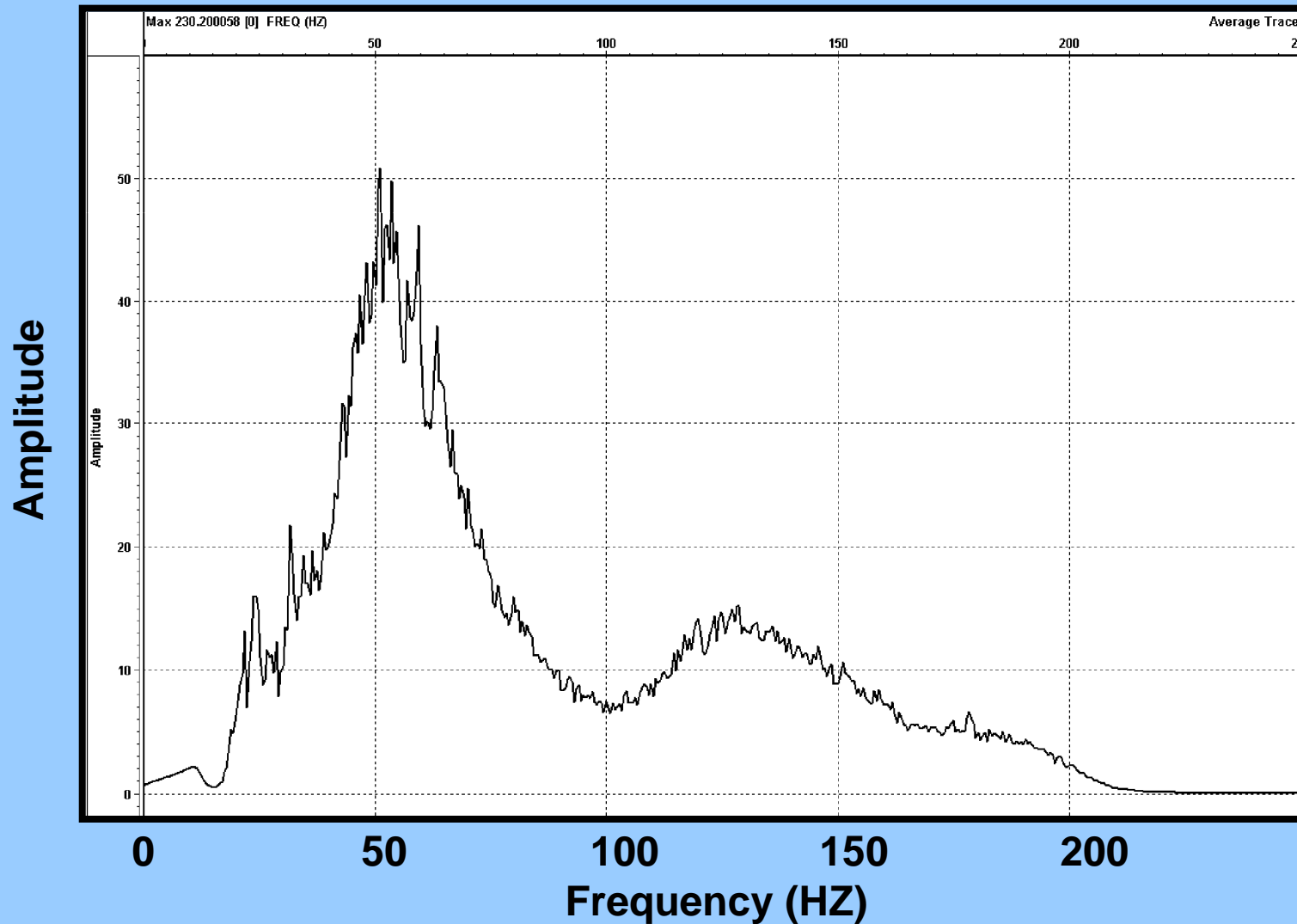
1 MUNSIST
unmigrated stacked

4 Vibrators
migrated stacked

Value Added in the Thrust Stack



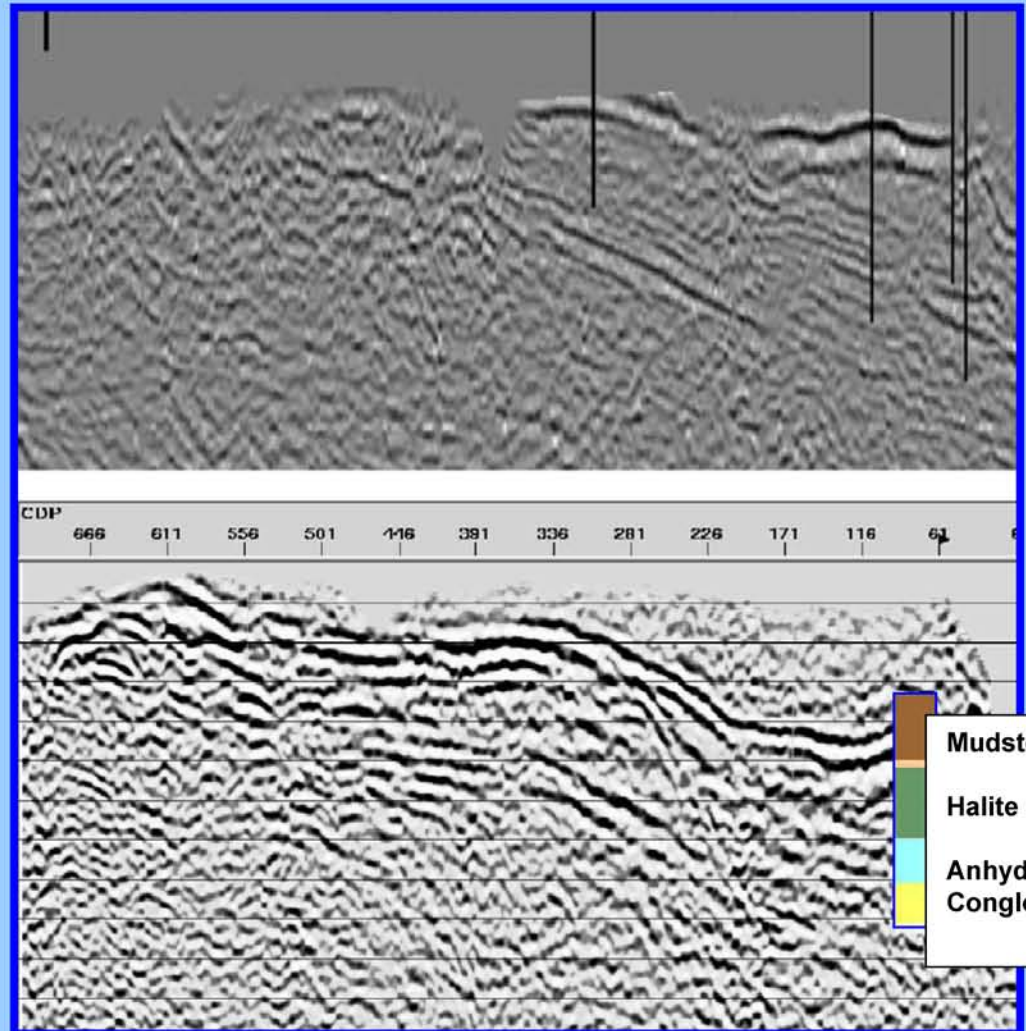
Spectral Issues - soft surface



Testing on Western Newfoundland Targets

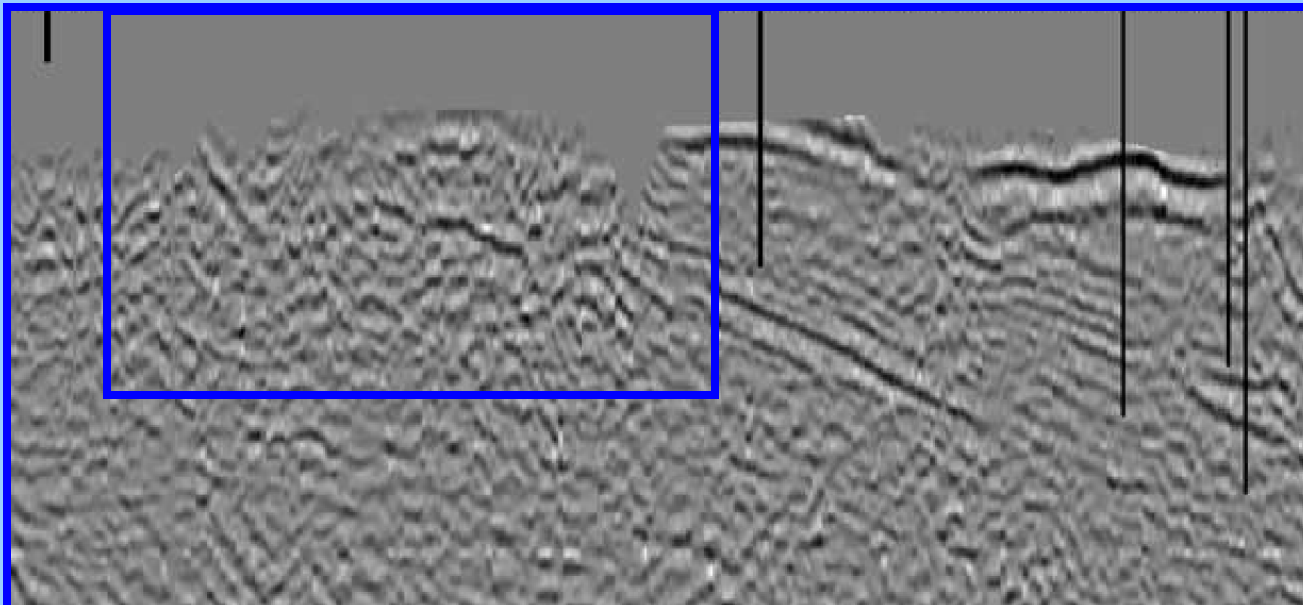
Flat Bay 2010 – Shallow Reservoir – Thanks to Vulcan Minerals

2 Vibes – 10 sweeps – 14s

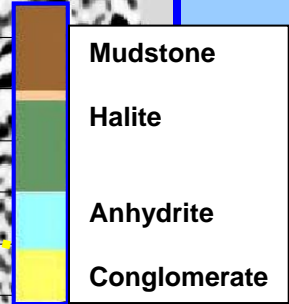
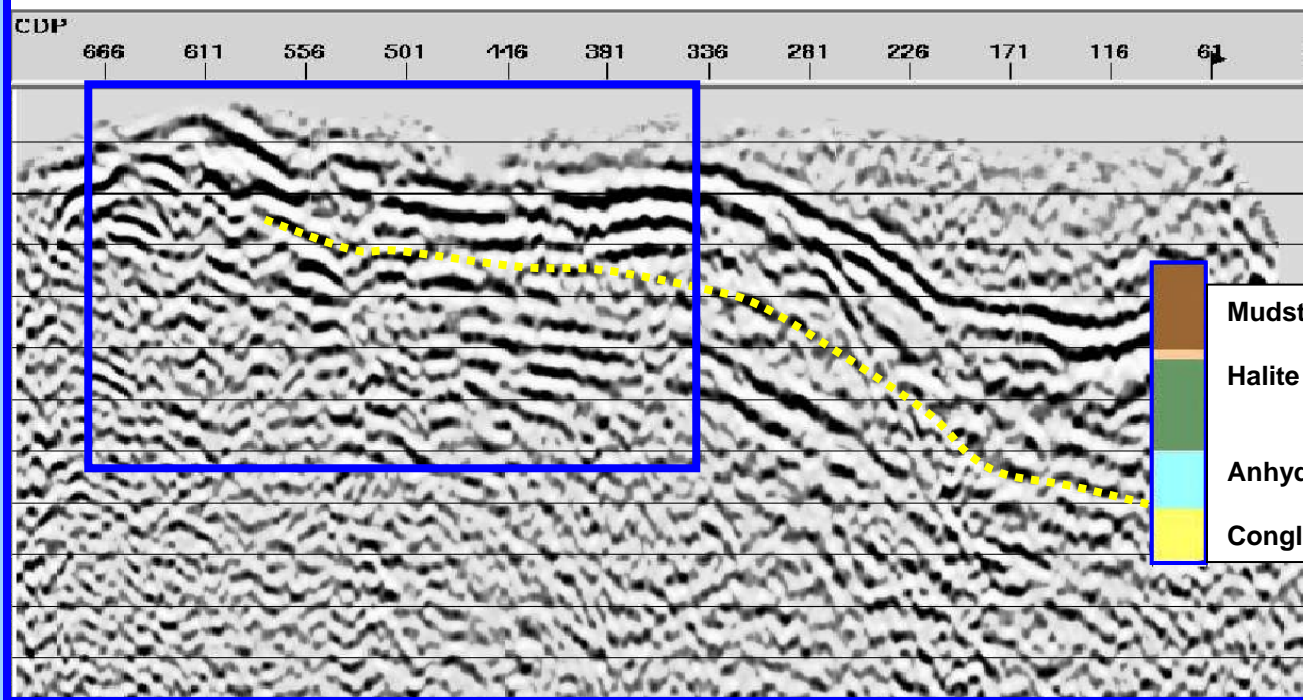


1 MUNSIST – 5 sweeps -10s

2 Vibes



1 MUNSIST

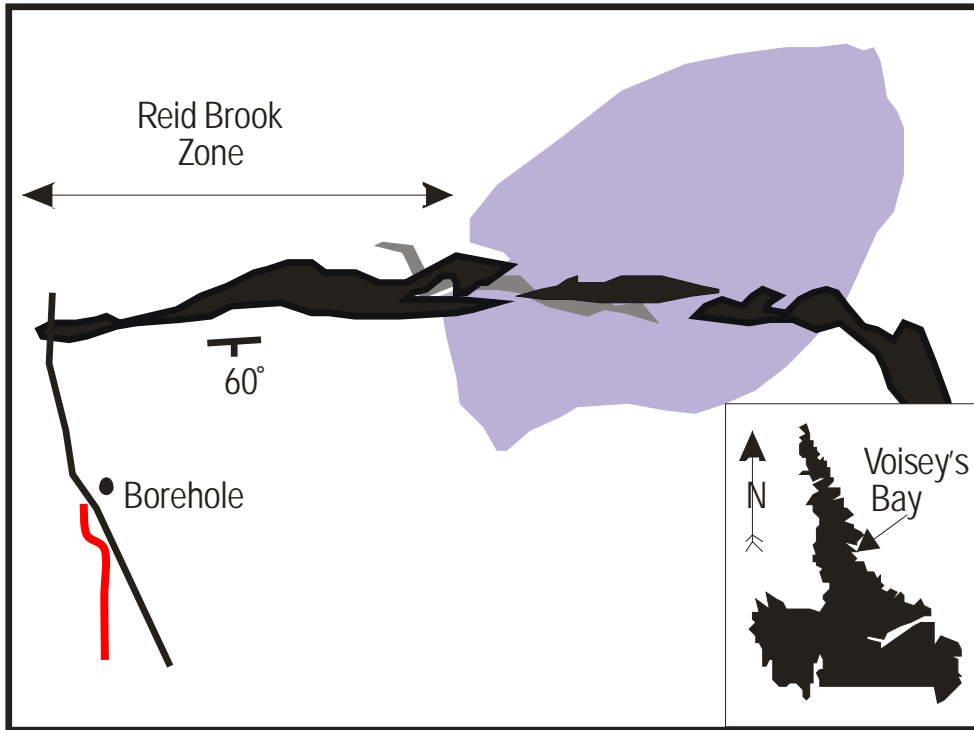


Additional Operations

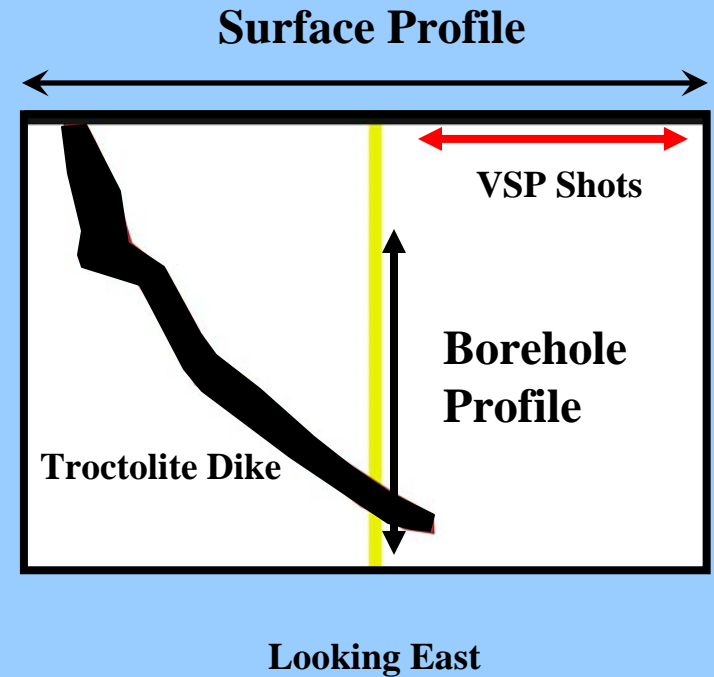
- **2010 & 2011** – MUNSIST used for two seismic programs at Voisey's Bay
 - Surface seismic
 - Walk-away Vertical Seismic Profiles
 - Narrow cut lines



Further Field Trials – Voisey’s Bay - 2010



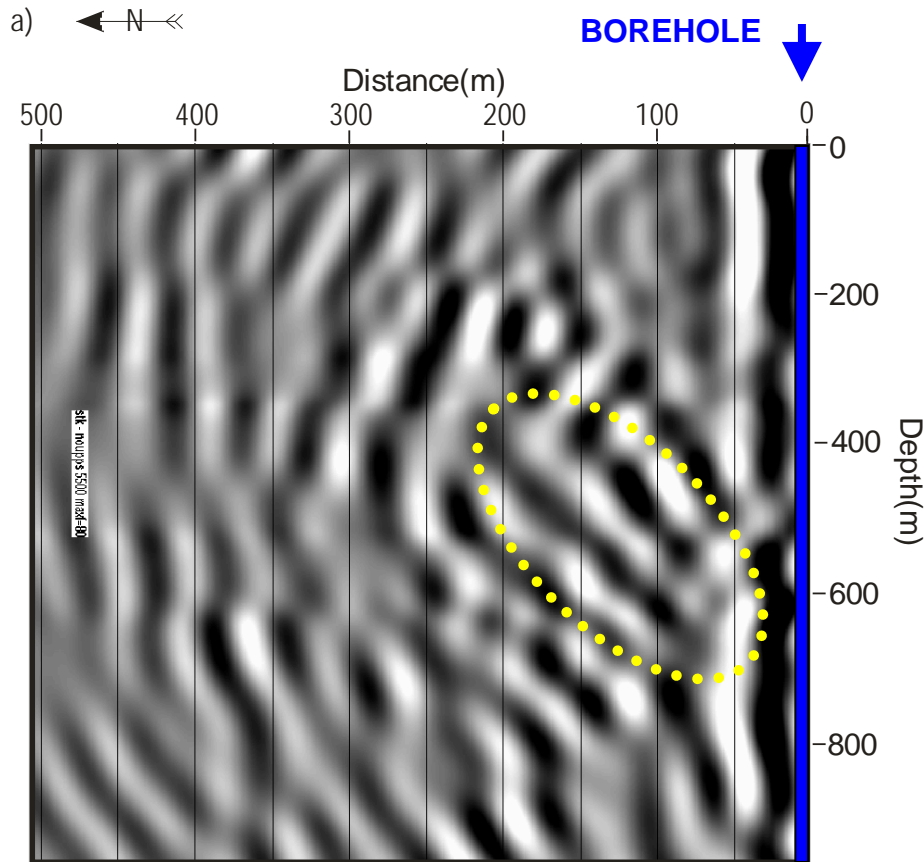
- VSP Source Line
- 2D CMP binning profile
- Overburden
- Troctolite
- Orthogneiss
- Sulphide Mineralization Exposed and Projected



Seismic Interferometry and Virtual Source Profiling

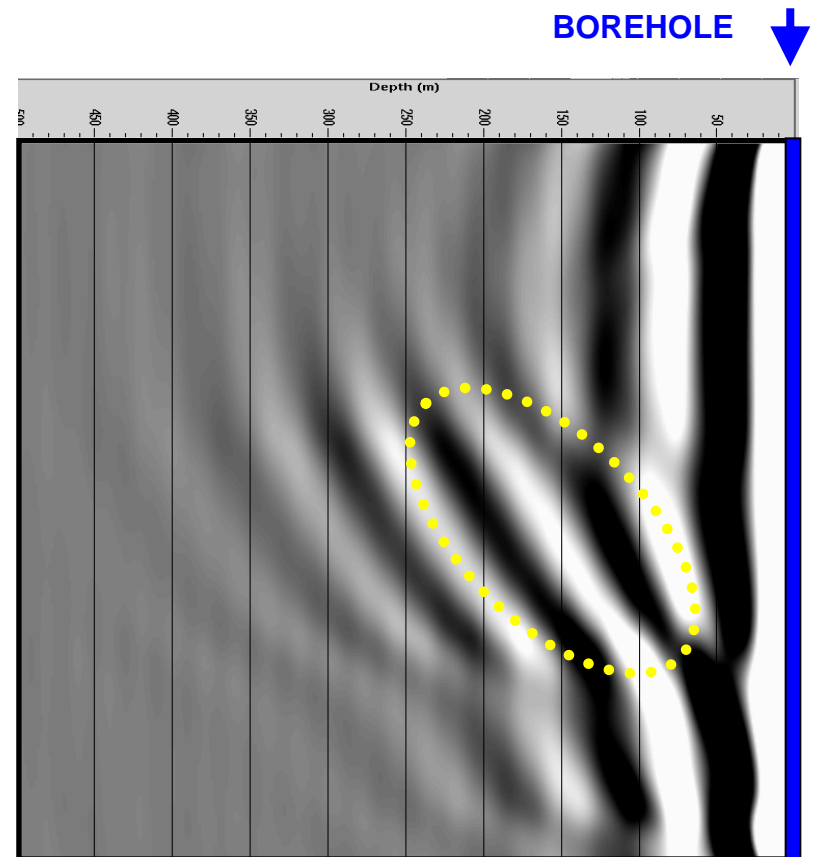
Virtual Source Profile – Voisey’s Bay

PS Depth Migration

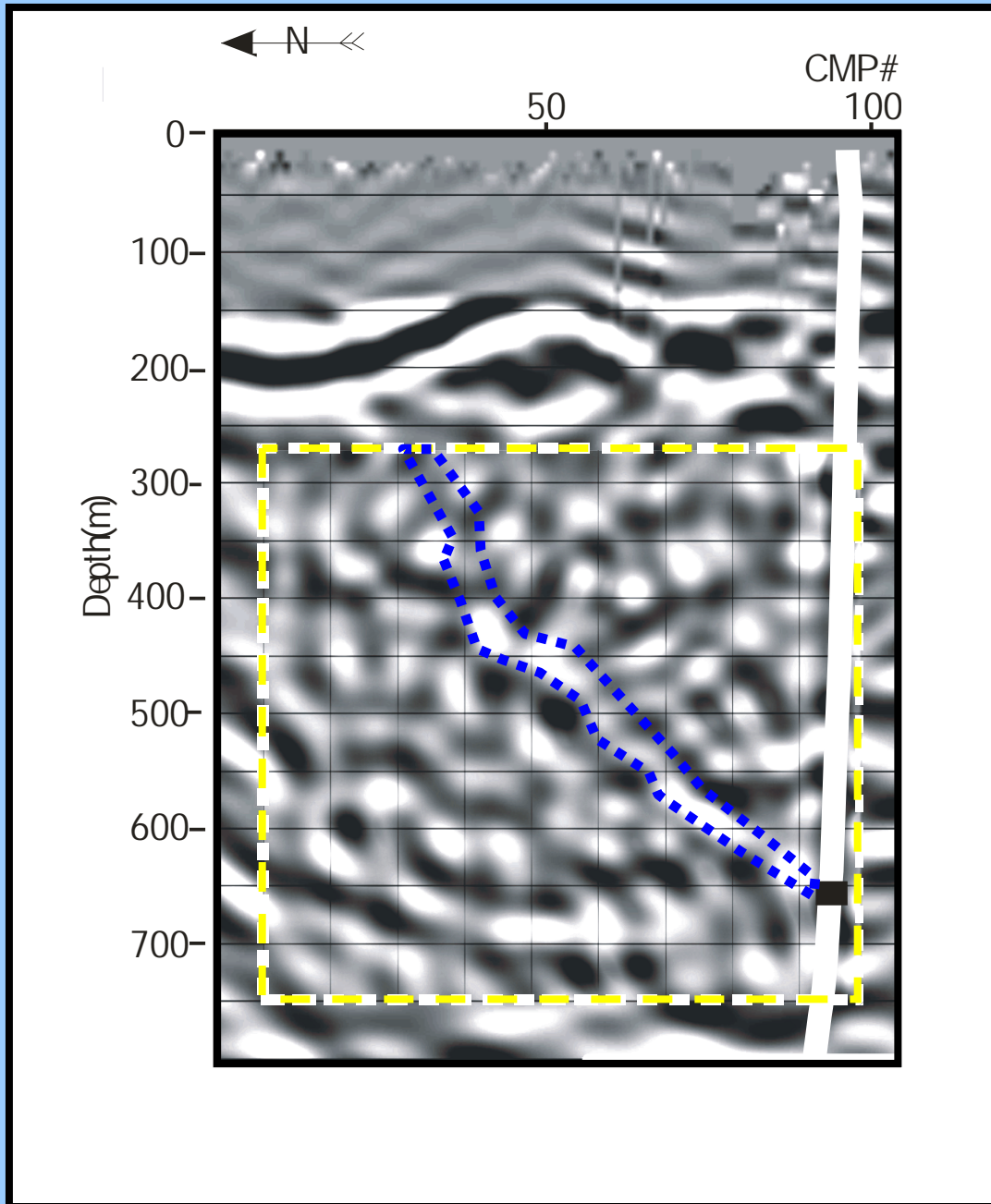


Synthetic Virtual Source Profile

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.

Summary

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**