Improving the Monitoring, Verification, and Accounting of CO2 Sequestrated in Geologic Systems with Multicomponent Seismic Technology and Rock Physics Modeling

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Carbon Storage R&D Project Review Meeting
Developing the Technologies and Building the Infrastructure for CO_2 Storage
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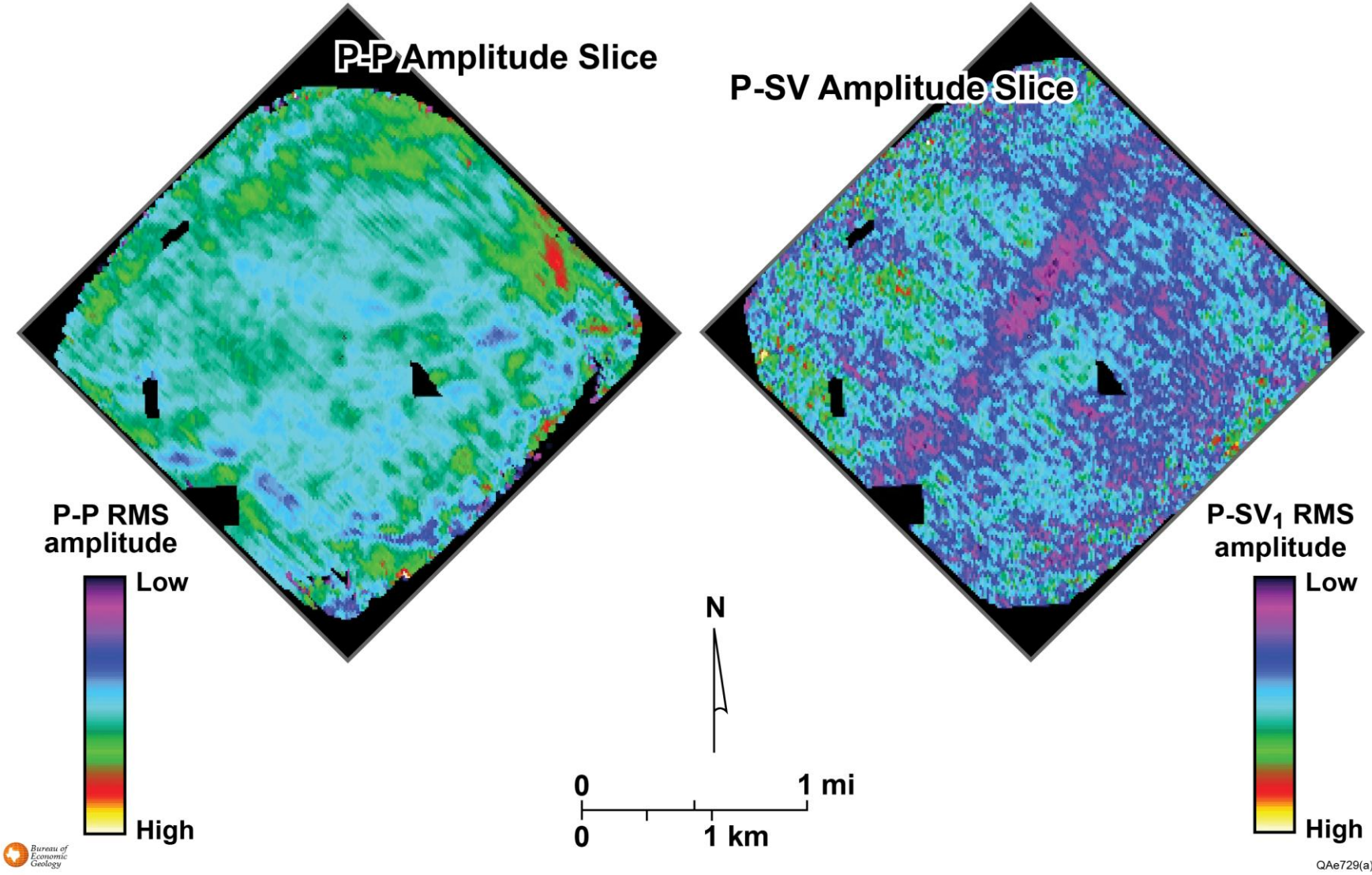
Benefit to the Program

- **Program Goals**
  - **Develop technology to predict CO_2 storage capacity of a targeted formation to an accuracy of ± 30 percent.**
  - **Develop technology that defines amount of CO_2 that remains in injection zones.**
- **Project Benefits**
  - **Defines intra-reservoir anomalies not seen with P-wave seismic data.**
  - **Better definition of subtle faults.**
  - **Improved resolution of stratigraphic layering.**

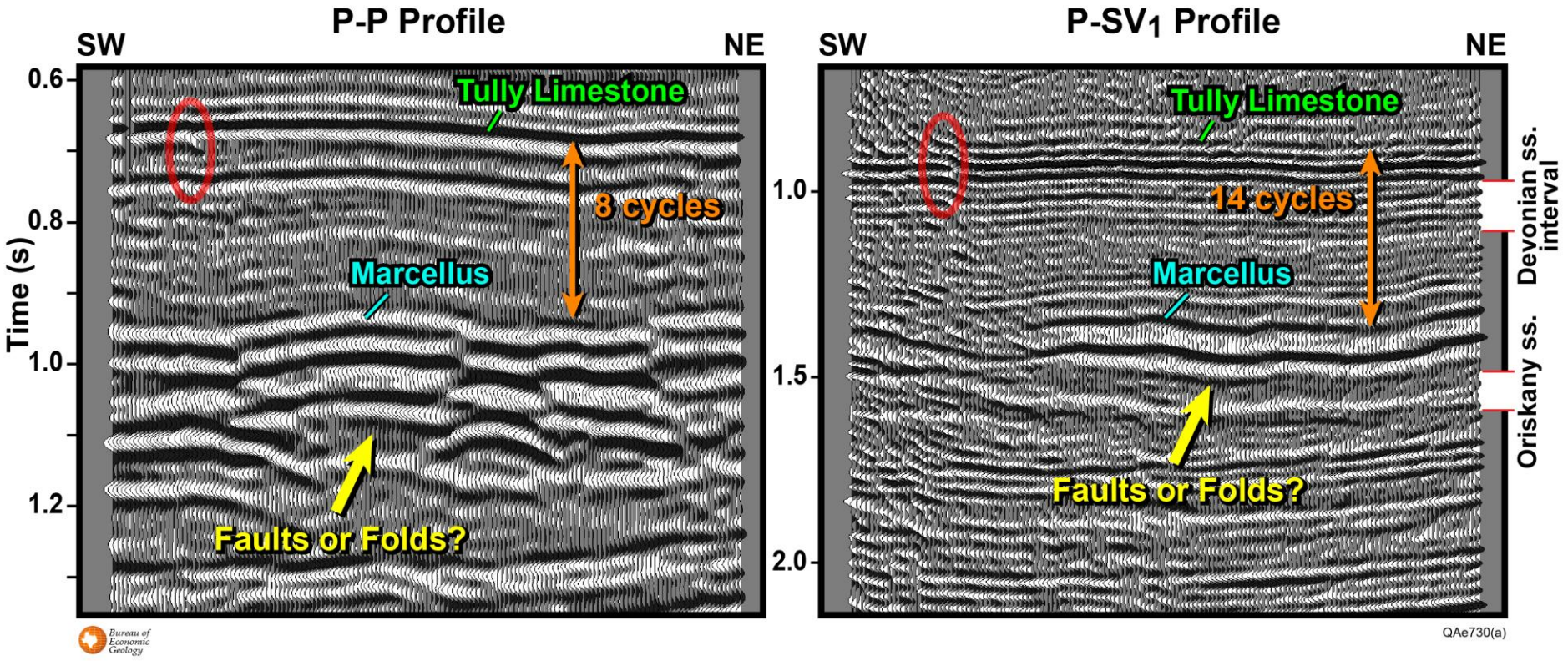
Project Overview

- **Goals and Objectives**
  - **Improve fault detection and stratigraphic resolution.**
  - **Detect intra-reservoir anomalies that affect fluid flow.**
  - **Demonstrate vertical-force seismic sources generate direct-S modes.**
- **Success Criteria**
  - **Produce real data examples that provide visual proof that each of these objectives is achieved.**

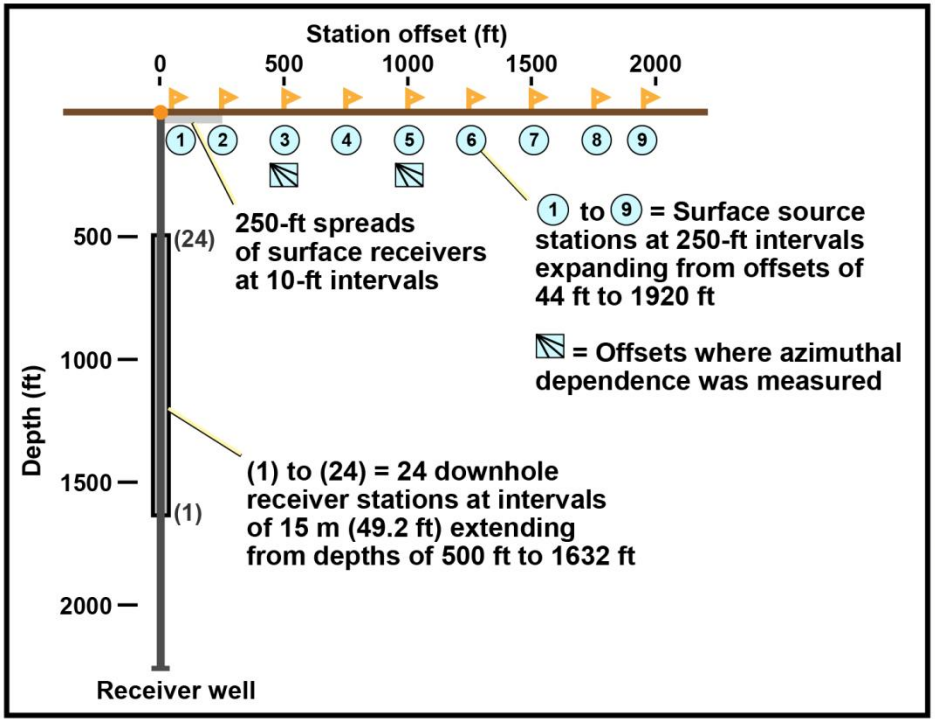
INTRA-RESERVOIR ANOMALY: MIDDLE DEVONIAN SANDSTONE INTERVAL

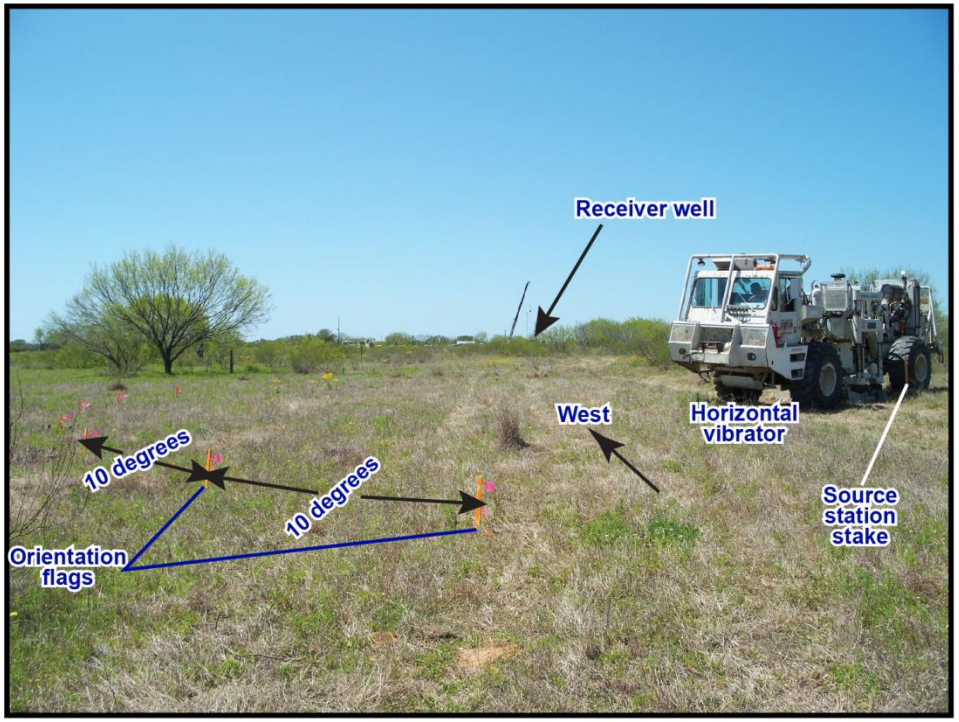


FAULTS, FOLDS, AND SPATIAL RESOLUTION



FIELD TESTS: ANALYZING DIRECT-S MODES





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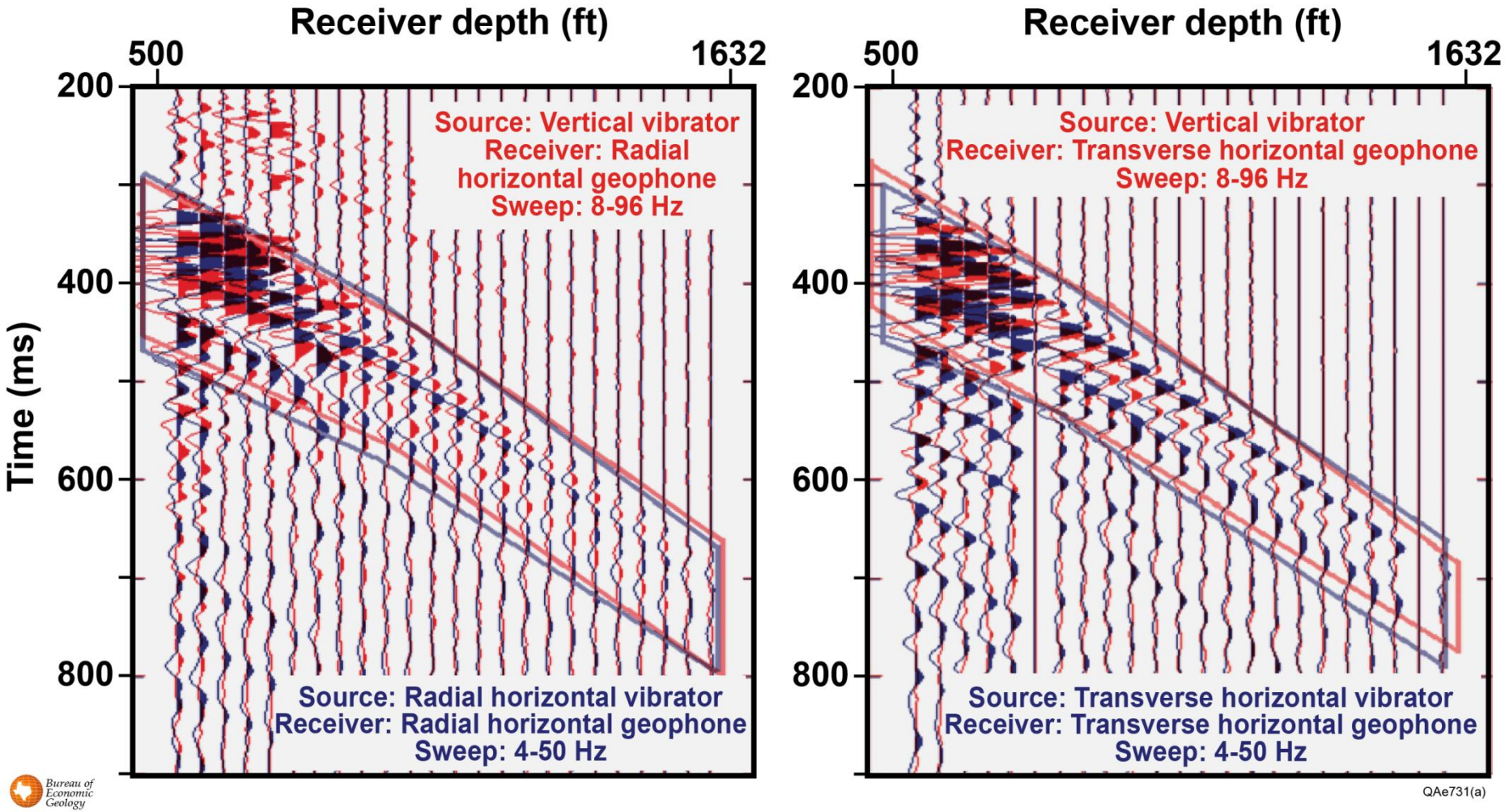
DIRECT-S FROM HORIZONTAL AND VERTICAL VIBRATORS



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Accomplishments to Date

- **Documented value of P-SV seismic data.**
- **Collected and analyzed test data comparing direct-S modes produced by horizontal-force and vertical-force seismic sources.**

Summary

- **Key Finding and Carry-Away Message**
  - **Multicompoment seismic technology is essential for optimal MVA of sequestered CO_2!!**

- **Future Plans**
  - **Demonstrate value of direct-S mode produced by vertical-force sources.**
  - **Demonstrate value of SV-P seismic mode (the inverse of the P-SV mode used in the study.**

Appendix 1: Project Team

Research Team

Bureau of Economic Geology
(Exploration Geophysics Laboratory)

Industry Cost Share

- Geokinetics (3C3D seismic data)
- Geophysical Pursuit, Inc. (3C3D seismic data)
- Chesapeake Energy (VSP and well log data)
- Dawson Geophysical (Field tests)
- Halliburton (Field tests)
- Sercel (Field tests)
- Mitcham Industries (Field tests)
- Seismic Source (Field tests)
- iSeis (Field tests)
- United Service Alliance (Field tests)

Appendix 2: Gantt Chart

WORK TASKS

Task	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Project management, planning, and reporting												
2. Technology transfer												
3. Select study sites				M1								
4. Build calibration database							M2					
5. Acquire multicomponent seismic data							M3					
6. Build geological model												
7. Build rock-physics model									M4			
8. Seismic data processing										M5		
9. Seismic interpretation												M6
10. Construct maps of geologic properties												M7
11. Postmortem and documentation												

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M1–M7 = Milestones

Delay of 3 months;
Loss of 3 research staff

Appendix 3: Bibliography

Publications

Thesis:

- **Alkan, E., (Dec. 2012?), PhD Thesis, The University of Texas at Austin**

Journal:

- **Alkan, E., and B. Hardage, 2013, Comparison of direct-S modes produced by horizontal vibrators and vertical vibrators: The Leading Edge, Society of Exploration Geologists.**

New Journal for Case Histories:

- **INTERPRETATION. A new journal published by Society of Exploration Geologists to be launched in 2013. Case history paper being prepared. Need other case histories about CO_2 Sequestration.**