3-D Seismic Reflection Imaging Workshop 2005—Opportunities for IODP Site Survey Collaboration

by Gregory F. Moore and John C. Mutter

The capability of the U.S. academic marine geoscience fleet will be significantly improved with the addition of the research vessel *Marcus G. Langseth* in 2006 (Fig. 1). The *Langseth,* which until recently was collecting commercial quality 3-D seismic data for WesternGeco as the *Western Legend,* will provide seismic acquisition capabilities well beyond those currently available to U.S. scientists by allowing the systematic collection of high-quality, 3-D seismic data in a wide variety of environments around the globe. To date, a small number of 3-D seismic data acquisition cruises have been run in the U.S. academic community using single streamer vessels acquiring 3-D grids by multiple closely spaced lines. This method of acquiring 3-D data is very inefficient, and limitations such as minimal streamer navigation cause data quality to be less than desirable. The *Langseth* will make it possible for the academic community to acquire 3-D seismic data in a time-efficient and cost-effective manner and of comparable quality to industry exploration.

In the commercial sector the introduction of 3-D seismic acquisition is credited as one of the advances in technology that produced the three most significant increments in oil field discovery rate in the last fifty years. Best practices for 3-D seismic data acquisition are now well understood and available in extensive literature, and processing software for 3-D data is now readily available and very stable. Moreover, there is much experience in the exploration industry on the processing and analysis of 3-D data sets. With the acquisition of the *Langseth,* the academic sector is poised to take advantage of these developments and gain a similar major advance in scientific discoveries. At the same time, because of the very limited experience in our community with the 3-D approach, many scientists are not fully apprised of the range of new problems that become accessible to study.

Figure 1. Model of the *Marcus G. Langseth* is a 235 ft, 2578 gross ton research vessel which is owned by the National Science Foundation and operated by Lamont-Doherty Earth Observatory of Columbia University. The *Langseth* replaces the *Maurice Ewing,* which has just ended a distinguished career (picture from http://www.ldeo.columbia.edu/res/fac/oma/langseth/).

Against this background, a group of ninety-one scientists from around the world gathered at the Lamont-Doherty Earth Observatory (LDEO) on 8–10 September 2005 to discuss 3-D Seismic Reflection Imaging. The workshop, funded by the U.S. National Science Foundation (U.S. NSF), emphasized the great breadth of the new and emerging areas of scientific inquiry that can be uniquely tackled using 3-D imaging, including high-resolution approaches, and the participants discussed possible 4-D applications as well. The questions that were explored included those fundamental to mid-ocean ridge studies, continental margins, and Integrated Ocean Drilling Program (IODP) objectives.

A series of presentations by academic and petroleum industry speakers focused on how successes in the petroleum industry might be used as models for academic research. Numerous examples of 3-D images similar to those shown in Fig, 2 were presented to show the level of detail that can be achieved for defining the morphology and evolution of slope, channel, and deep-water sedimentary environments, as well as structurally complex regions (Posamentier, 2003, 2004). State-of-the-art seismic interpretation software was used to demonstrate how quickly and accurately horizons and faults can be interpreted from 3-D seismic cubes. Other industry speakers illustrated the recent advances in 4-D surveys and improvements in marine acquisition that allow better deghosting of source signatures.

Several academic speakers discussed lessons learned from academic 3-D seismic programs in accretionary prisms and spreading centers, and they introduced the use of seismic reflection data in the relatively new field of seismic oceanography (Holbrook et al., 2003). Because academic surveys have recently encountered challenges in obtaining clearances and permits, a summary was presented to make everyone aware of their requirements, lead times required to obtain permits, and other issues. A joint presentation focused on new results relating to seismic sources and their effects on marine mammals. In addition, recommendations and

requirements for 3-D site surveys for the IODP were discussed.

Major goals of this workshop were to inform academic marine scientists of the capabilities of the *Langseth* and to educate them on how to design 3-D surveys on it. Presentations by LDEO marine office personnel and a half-day seismic acquisition clinic achieved these goals by presenting details of the Langseth's acquisition capabilities and how they can be used to acquire fully imaged 3-D data volumes.

A concluding half-day panel discussion focused on new opportunities for 3-D seismic acquisition and ways to make the broader academic community aware of our new capability to acquire 3-D seismic data. Many workshop attendees felt that a new paradigm for 3-D acquisition and interpretation is necessary to ensure the long-term success and growth of the field. The workshop agenda, including a list of participants is online at: http://www.ldeo.columbia.edu/events/workshops/3Dseismic/.

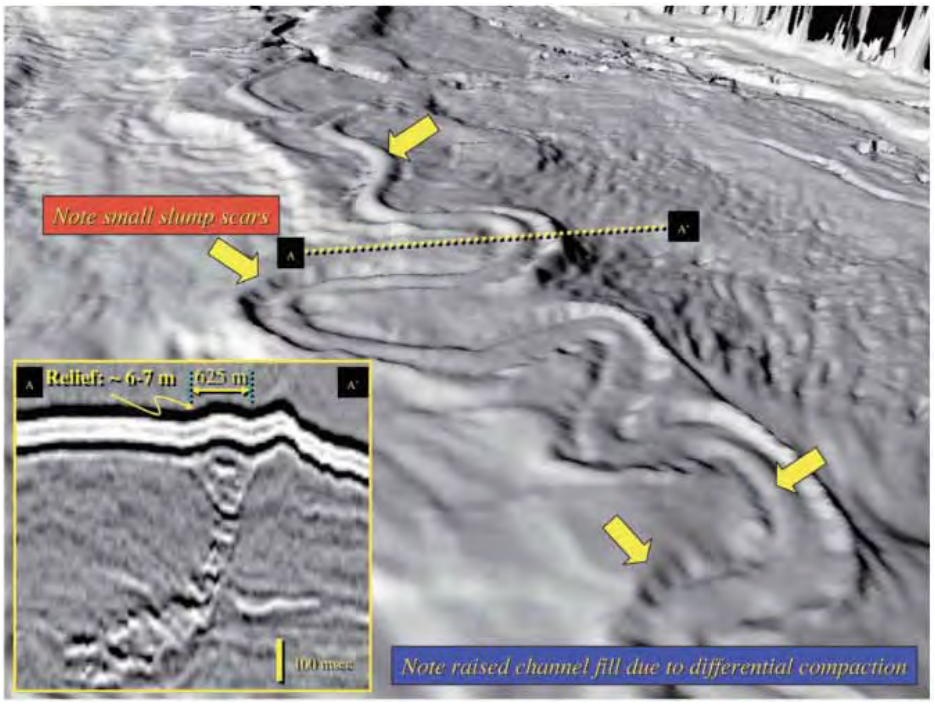

Figure 2. Illuminated and perspective views of the surface acquired by 3-D seismic imaging. The elevated aspect of the channel thalweg with its associated levees becomes quite apparent. The inset depicts a cross-section through the channel showing that the thalweg is associated with high reflection amplitude, indicative of a higher acoustic impedance relative to the surrounding mud and therefore suggesting the presence of sand. After Posamentier (2003) and Posamentier (2004).

As a follow-up to discussions at the workshop, we would like to point out the opportunities for diversifying funding sources and expanding the community through international cooperation. Specifically, the IODP has already seen an increased need for 3-D seismic surveys in support of riser drilling on the new Japanese drilling vessel *Chikyu*. A large commercial 3-D seismic program has been jointly funded between the U.S. NSF and the Japanese ship operator, the Center for Deep Earth Exploration (CDEX) of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). To date, only a single riser drilling proposal has been recommended for scheduling, but many more are either being considered now or will be considered in the future. Each riser hole will likely require 3-D data, and several planned riserless programs will also benefit from 3-D surveys. CDEX hopes to continue jointly funding these 3-D programs. This should be seen as an excellent opportunity for international scientific collaboration.

References

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Authors

Gregory F. Moore, Department of Geology & Geophysics, University of Hawaii, 1680 East-West Road, POST 813, Honolulu, Hawaii 96822, U.S.A., (currently at the Center for Deep Earth Exploraion (CDEX), JAMSTEC, Yokuska, Japan), e-mail: gmoore@jamstec.go.jp

John C. Mutter, Lamont-Doherty Earth Observatory, Marine Geology and Geophysics, 61 Route 9W – P.O. Box 1000, Palisades, N.Y. 10964-8000, U.S.A.

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http://www.ldeo.columbia.edu/events/workshops/3Dseismic/index.html

http://www.ldeo.columbia.edu/res/fac/oma/langseth/