

Increasing the Access to and the Relevance of Marine Seismic Data

December 11-13, 2014 – San Francisco, CA

Convener: James A. Austin, Jr., University of Texas at Austin, Institute for Geophysics (UTIG)
Steering Committee (alphabetical order): David Arctur, University of Texas at Austin (designated EarthCube liaison); Nathan Bangs, UTIG; Suzanne Carbotte, Lamont-Doherty Earth Observatory (L-DEO); Jon Childs, U.S. Geological Survey (USGS); Adrian McGrail (ION); John Snedden (UTIG)

Executive Summary

Introduction

This NSF-supported workshop brought together knowledgeable U.S. and international representatives of the marine geology and geophysics academic community, along with selected members of the offshore hydrocarbon business, representing both key industry data users and seismic data vendors. During the workshop, these participants, both in plenary sessions and in successive breakout configurations of smaller groups, considered the following primary objectives and related relevant topics:

- Review of some successful examples of academic use of preexisting industry marine seismic data.
- Discussion of strategies for developing joint industry-government-academic acquisition of new data, which are consistent with commercial/academic imperatives and data restrictions.
- Discussion of the potential for a revised model for research vessel *Marcus G. Langseth* operations.
- Link to (new NSF initiative) EarthCube: Identifying current limitations to the conduct of marine seismic research in terms of data management, processing, analysis and visualization. Envisioning the future of the science and identifying scientific challenges and data/cyberinfrastructure for the next decade.
- Exploration of more efficient use of U.S. and non-U.S. national seismic databases. How can international academic communities work together to optimize seismic data resources and related cyberinfrastructure? Identification of seismic data resources unfamiliar to the academic community.
- Codification of industry sources of 2D/3D seismic data for future U.S. academic community use, *e.g.*, in support of scientific ocean drilling efforts in areas where both academia and industry will benefit from such drilling.
- Construction of a roadmap to augment existing models of seismic data access for the U.S. and international academic communities.

Of the 51 participants, 39 were from academia; we targeted various levels of seniority. In addition, 12 were either from industry (petroleum regulation, petroleum exploration, engineering, software) or from U.S. government agencies (USGS, Bureau of Ocean Energy Management [BOEM], National Oceanic and Atmospheric Administration [NOAA]). Four program managers attended from the National Science Foundation (NSF); active participation by these managers in the ongoing discussions contributed to the workshop's success. Finally, 4 participants came from outside the U.S. (Norway, Germany [2], Japan). (For a complete list of participants and their affiliations, see Appendix 1.)

The workshop took place over ~2.5 days just prior to the 2014 Fall Meeting of the American Geophysical Union. The originally envisioned Agenda is included as Appendix 2. Presentations given at the workshop are the property of the presenter; some data shown were proprietary. These may be requested by contacting the presenter (see e-mail addresses with participants list, Appendix 1). However, a city-wide power failure associated with an intense storm during virtually all of Day 1 forced a complete re-thinking of the original agenda. As a result, break-out discussions in several groups took place during that day, and most presentations in plenary sessions scheduled for Day 1 took place instead during days 2 and 3. Fortunately, all participants rose to the challenge, and very effective communication occurred (see summaries below).

Break-out group discussion topics and summary action items:

- **Strategies for developing joint industry-academic acquisition of new data, based upon known successful case studies, which are consistent with commercial and academic imperatives and data restrictions**

Discussion leaders: Childs (USGS) and McGrail (ION)

- **Construction of roadmap to augment existing models of seismic data access for the U.S. and international communities**

Discussion leaders: Childs (USGS) and Damm (BGR)

(For a summary of the notes from these two break-out sessions, see Appendix 3.)

Action items:

1. Develop a roadmap outlining a Joint Industry Project (JIP) to analyze shallow geomorphology using “non-sensitive” (i.e., upper 1 second of seismic data record) of industry 2D/3D seismic in the Mississippi Canyon, Gulf of Mexico (GoM): Torry, Prather, Reece, Sager. Timeline: Q1, 2015. (For a more complete summary of this item prepared by Prather, see Appendix 4.) First meeting held in February, 2015, in Houston; follow-up meeting proposed for 2Q 2015. Prather to lead.
2. Schedule EarthCube presentations at selected professional society meetings (AAPG, SEPM, AGU, OTC): Ransom. Timeline: calendar 2015.
3. Develop increased interoperability between both public-domain and industry databases (e.g., NGDC, AGI, NAMSS) through Web services: Childs, Carbotte, Jencks. Timeline: calendar 2015.

- *Discussion of a revised model for research vessel Langseth operations*

Discussion leaders: Sawyer (Rice) and Bangs (UTIG)

(For a summary of the notes from this breakout session, which spanned days 1 and 2, see Appendix 5.)

Action Items:

1. MLSOC and the operator at L-DEO could develop a web-based roadmap for countries that need support for planning and executing a cruise on *Langseth*; the ship and scientists needed for analysis and interpretation (from the U.S.?) could be pitched as a “package”. Timeline: calendar 2015.

2. Solicit periodic “Letters of Intent” from the U.S. academic community. A committee (membership TBD, by MLSOC) would vet these letters; set up multi-year *Langseth* future general directions that follow a regional model of cruise planning. Encourage a separate NSF panel for judging *Langseth* proposals relative to each other (with MLSOC?) Timeline: calendar 2015.
3. MLSOC prepares to be able to provide science consulting (e.g., a workshop for new users, as has already been initiated by MLSOC annually at the AGU Fall Meeting); some members of the community seek *Langseth* knowledge from colleagues, but others (i.e., new users) do not know who to talk to about preparing proposals to use the vessel. Timeline: calendar 2015.
4. MLSOC should update the 2010 Incline Village workshop “flashy document.” (*Marine Seismic Imaging: Illuminating Earth’s Structure, Climate, Ocean and Hazards*). Timeline: calendar 2015.
5. MLSOC could poll the relevant community to find out which *Langseth* “tools” are most important. Timeline: calendar 2015.
6. Improve advertising of *Langseth* and the data she collects, and improve the educational footprint; MLSOC with the L-DEO science operator could develop a website for these purposes. Timeline: calendar 2015.
7. Endorse “training cruises”; reserve bunks for early career scientists (*being done*).

○ **Discussion of strategies for developing joint industry-academic acquisition of new data, which are consistent with commercial and academic imperatives and data restrictions.**

Discussion leaders: Snedden (UTIG) and McGrail (ION)

(For a summary of the notes from this breakout session, ref. also Appendix 3, see Appendices 7 and 8.)

Action Items:

1. Expand/make more dense (i.e., reduce receiver spacing) long-offset OBS seismic refraction collection; eventual formation of a JIP?
2. Independent testing of seismic source arrays to evaluate marine wildlife impact.
3. Consider bringing students onboard industry seismic vessels, for training purposes.
4. Formation of a committee to develop a road map or actual JIP to make use of shallow sea bed seismic images to understand deep-water processes (see more detailed action item description on this above).

○ **Links to EarthCube: Science Drivers and Challenges** (*Note: This breakout group focused on science drivers and challenges, with less emphasis on actionable items. The relationship of seismic imaging within the NSF EarthCube initiative will be explored with a follow-up effort to fund a Research Coordination Network (RCN) to advance the interests of the seismic imaging end-user community within the currently evolving EarthCube framework.*)

Discussion leader: Arctur (UT/Austin)

While the petroleum exploration industry is primarily interested in marine seismic surveys to understand where oil and gas may be found along the Earth's continental margins, the academic community wishes to study broader issues of stratigraphic and structural evolution, including rifting and thermal subsidence, long-term sea-level history, magmatism and geochemistry, geomorphology and earthquakes. The industry participants at the workshop expressed strong philosophical support of academic science research, but issues of substantive collaboration and funding remain.

Important science drivers and challenges: Participants identified several high-priority science questions that will focus interdisciplinary efforts during the next 5-15 years:

- A. *Digital Earth: get enough data with sufficient resolution and history of change, from which to understand/forecast/predict:*
 - Major subsidence events/earthquakes/volcanic eruptions/hazards;
 - Dynamics of sea level rise; likely shoreline changes over next 100 years;
 - Combinations of factors that control the modes of slip on fault zones;
 - Combinations of factors that control the modes of rifting in continental crust, especially to break-up and seafloor spreading; this includes the architecture of magmatic systems and dynamics of magma transport and associated eruptions;
 - Sedimentary evolution of continental margins from Greenhouse to Icehouse (warm climates to cold climates);
 - Visualization of Earth systems, from the scale of tectonic plate geodynamics to reservoir simulations.

- B. *Improved monitoring systems, long-term and real-time, with advanced simulation:*
 - Monitor crustal displacement and microseismicity; monitoring with active source time-lapse (4D) studies;
 - Anticipate major seismic events;
 - Develop and maintain a fleet of small autonomous seismic sources and seismic detectors that could be monitored with intelligent drones to acquire seismic field data safely without harming the environment.

- C. *Understanding impacts to marine life, esp. endangered species (i.e., settle the ongoing environmental debate):*
 - Marine mammals, etc.;
 - Are chemosynthetic seafloor communities (e.g., those adjacent to fluid seeps in basins like the GoM) affected by seismic surveys?

Current challenges to high-impact, interdisciplinary science: Several themes emerged as consistent challenges faced within/across the involved discipline(s):

- A. *Should we seek development of a national academic data computation capability for processing field data?*
 - Strengthening academic HPC could do this, but it's controversial; industry tends to do this better due to extensive familiarity with ground-truth; e.g., noise correction is highly variable & requires expert geologic knowledge of target areas. It's not just about "having HPC."
 - Alternatively, we (EarthCube) could work to develop licensing schemes for commercial tools, data and use in academic centers, but this is institutionally difficult for industry.
 - One area of development would be to strengthen industry/academic relationships (outreach: share lessons learned, contractual experiences, institutional best practices).

- Some from industry suggested academia could bring valuable software engineering skills to bear on processing techniques to use HPC wisely, and work with industry to incorporate domain expert knowledge.
- Academia could help focus on visualization tools to look for patterns in imagery, relationships with other variables, map layers, etc.

B. Discovering sources of relevant, accessible data:

- We are building the ability to do federated search of catalogs of marine seismic data resources, via GeoMapApp and GEOSS. Also need access to academic, government agency and international data resources.
- GEOSS (geoportal.org) provides a single point of search to dozens of community catalogs for Earth science, such as NASA GCMD, Pangaea.de
- Could register additional major catalogs in GEOSS
- Look into Microsoft LayerScape

C. Data preservation, long-term archiving and access:

- UTIG/L-DEO/NGDC have systems and practices in place - collecting all possible (data) sources for long term redundant storage.
 - L-DEO: field data
 - UTIG: processed data
 - NGDC: long-term archive for L-DEO and UTIG data
- USGS/BOEM has a similar approach with NAMSS.
- Needs access to PIs and their students before grants end, to archive field data and products (education/outreach/incentives).

Technical information/issues/challenges:

A. Desired tools, databases, etc. needed for pursuing key science questions:

- Continuing access to seismic data acquisition of some kind (see earlier action items).
- Continued integration of existing (and perhaps new) databases.