8 January 2009
10:00 am Tank View Conference Room

MBARI Project 900907 Meeting
High Resolution Near-Surface Seismic Refraction Tomography

Attending: David Caress, Rich Henthorn, Mark Chaffey, Paul McGill, Bill Kirkwood

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Some Introductory Notes….

Project Abstract:

We propose a two-year development project to develop a high-resolution seismic refraction capability to image the shallow structure of the seafloor subsurface. The technique will include a swept-frequency (chirp) acoustic source mounted on an ROV and multiple ocean bottom hydrophones (OBHs). To conduct an experiment, we will use the ROV to deploy the OBHs in a desired configuration, run profile lines along the seafloor while pinging the source, and then recover the OBHs. The OBH data will be match filtered ("dechirped") using the source signal to yield seismic refraction record sections. Once refracted arrivals are identified and travel times are picked, tomographic inversion can be used to yield 2D or 3D models of the subsurface compressional seismic velocity structure. By using a 1-6 kHz sweep, we expect to observe refracted arrivals to ranges in excess of 1 km, depending on the material and the subsurface velocity gradients, allowing penetration and imaging of structure to depths of as much as 200 m.

During year 1 we will purchase the source and two OBHs, integrate the source with ROV Ventana, develop the necessary software, and conduct three one-day test experiments to refine the technique. In the course of the testing, we will investigate the shallow seismic velocity structure of the flat shelf and of the axis of upper Monterey Canyon. The canyon refraction experiment will measure the thickness of the sands moving down axis, an observation important to our developing understanding of sediment transport processes in submarine canyons. During year 2 we will purchase additional OBHs and conduct a major field experiment at one of two methane hydrate deposits that have been previously investigated by MBARI using ROVs and the Mapping AUV (Barkley Canyon and Santa Monica Basin). Imaging the subsurface structure of actively forming hydrate deposits will provide new constraints on models for the formation and evolution of these features.

Project Team:

David Caress (PI, Lead Scientist, Project Manager)
Rich Henthorn (Lead Engineer)
Mark Chaffey (EE – acoustic source)
Paul McGill (EE – OBH receivers)

Bill Kirkwood (ME)

Year 1 Milestones

1. Preliminary Design and Purchases
    a. Define requirements
    b. Identify components to purchase
    c. Order equipment
    d. PDR – after purchases – February or March?
2. Build System
    a. Acoustic source
    b. Receivers
    c. Software
3. Test System in Tank
    a. 1st week in April?
        i. Need ozone off in tank a week before testing…
4. Test System at Sea
    a. 3 days on R/V Point Lobos & ROV Ventana
        i. Thursday April 9
        ii. Wednesday May 27
        iii. Monday June 8
5. Products
    a. Proposal for Year 2
    b. Publish technique and initial results

Functional Requirements (or a start on it anyway…):

Overall System

- Acoustic system combining on-bottom sources and receivers capable of propagating sound through the seafloor to lateral ranges of more than 100 meters.
- Data must allow reliable identification of refracted arrivals allowing resolution of subsurface sound speed structure.

Acoustic Source

- Integrated with ROV Ventana
    - Exportable for use on ROV ROPOS and ROV Jason
    - Depth rating of 3000 meters required, 6000 m desirable.
- User-defined, repeatable, calibrated source wavelet.
- Source timing and navigation recorded

Acoustic Receivers

- Deployable from ROV
- Record full bandwidth of source wavelets
- Record continuously for at least 10 hours (24 hours desired).
- Timing must be accurate to uncertainty of arrival picks.
    - A 2000 m/s sound speed in sediment translates to 2 m per msec

- 3 kHz wavelength => 0.33 msec period
- Shoot for 1 msec or better