Ocean Bottom Seismograph Experiment Planning and Execution for Landlubbers

Douglas Wiens
Washington University in St. Louis
My introduction to OBS work

1994 LABATTS deployment
Washington University & SIO
Extension of 1993-1995 land deployment
30 OBSs – 3 months
Largest passive OBS deployment to date
Resulted in 10 publications (1994-2011)

Since that time:
Been involved with 4 OBS projects
All combined OBS & land BB sensors
Outline

• Planning: proposal writing stage
• Planning: after funding
• Deployment cruise
• Recovery Cruise
• Post-cruise: data analysis; archiving
Proposal Stage

- Good planning during proposal preparation is a key to success
- Array planning: Need to carefully evaluate the scientific issues, the analysis techniques to be used, and the configuration and # of OBSs needed
- Fill out request forms for the OBS facility and the UNOLS ship facility and include in the proposal
Array Planning

- Array planning for passive OBSs is similar to land experiment planning, but several differences.
- **Cost:** is a factor and limits the size of the arrays. The largest experiments are generally around 50 OBSs. Approx $12K/BB inst.
- **Ship time:** is expensive and ships travel slowly (~12 knts).
- **Water Depth:** Standard OBSs can be deployed from 1-5 km. Shallow (<1 km) and deep (5-6 km) necessitate particular equipment. Currently cannot deploy at depths greater than 6 km.
- **Duration:** Some OBSs may technically be able to operate for 18 months, but reliability and timing accuracy goes down with duration. The normal limit is 12 months.
Additional Considerations

- There may not be any data return from a given OBS. Generally data return from recent experiments is about 90%, but can be < 50%.
- The experiment must be designed so the complete failure of 10-20% OBSs does not undermined the objectives.
- Longer duration deployments, with a equipment swap after one year, are possible but NSF may be reluctant to commit to a series of cruises in a remote area.
- OBSs can now record at high enough sample rates (~ 100 sps) or change sample rate during the experiment so joint active-source/passive recording experiments are possible.
- Two high-density lines for detailed 2D body wave tomography
- 2D active source array along the Eastern Lau Spreading Center
- Embedded in 2D array for lower resolution 3D tomography, surface waves, EQs
- Surrounded by land BB seismographs
- Also included “add-on” Japanese OBEM experiment
A ship track and cruise timetable is required.

D. Lizarralde’s map and spreadsheet – Mariana Trench experiment
Need to specify:
- Number & type of instruments (ie short period, broadband)
- Number of deployments (active source)
- Duration of deployment
- Probable ports and duration of cruises
- Water depths
This is an informational budget provided to prospective users of instruments in the U.S. National Ocean Bottom Seismic Instrumentation Pool. The institutional instrument contributors (IICs) to the National Pool will provide complete engineering and technical support for OBS operations at sea. The cost of providing this support (e.g., instrument charges, personnel support, shipping and travel) will be funded directly through the Pool; these costs do not need to be included in individual science proposals. NSF does, however, require PIs to provide an informational budget estimating these costs in any proposal requesting OBSIP instruments. For more information on OBSIP, see http://www.obsip.org.

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**Project title:** Mantle serpentinization and water cycling through the Mariana trench and forearc

**Principal Investigator(s):** Douglas Wiens, Dan Lizarralde

**Funding Agency:** NSF-OCE

**Submission deadline:** July 1, 2008

**Instruments:**
- 65 SP OBS 4-component
- 20 BBOBS 4-component
- 85 deployments of 85 instruments

**Date of prop. experiment:** May 2010-May 2011

**Logistics:**
- Leg one, 44 days (R/V Langseth)
- Leg two, 14 days (medium R/V)

**Ports:** Guam-Saipan, Saipan-Saipan

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The following is an estimate of the cost of supporting the OBS operations requested in this proposal. These costs are subject to change depending on the scheduling of this project, the length and ports of the deployment and recovery legs, and the OBSIP institution that supports this project. A final budget for OBS support operations for this project will be negotiated as part of the annual cooperative agreement between NSF and the Pool IICs.

**OBS Instrument drop charge:** $4,342 per instrument*
(include batteries, deployment and, if applicable, redeployment costs)

**OBS engineering and technical support cost:** $396,432
(on shore and at sea)

**Shipping:** $53,920

**Travel:** $33,830

**Estimated total:** $853,259

* Varies from proposal to proposal based on the mix of instrument types and deployment lengths

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John Collins
Chair, OBSIP Management Committee
February 5, 2008
Need to fill out ship request form and attach to your proposal as a supporting document

Information needed:
Size of ship (global, intermediate, etc)
Number of science days needed, based on:
  # of OBSs
  depth of water (formulas in OBSIP docs)
  acoustic survey?
  transit times between sites
  contingency time (for weather, failures)
Likely ports and transit days to/from area
Special equipment needed:
  multibeam bathymetry
  MCS equipment
  airguns
Pre-cruise planning

• Amount of pre-cruise planning depends on whether you are chief scientist of the cruise

• Assuming you are Chief Scientist, you will need to submit a cruise plan to the ship operator (SIO, WHOI, etc) that:
  – Details all the objectives of the cruise (including how to spend “contingency time”)
  – Gives a cruise track, with waypoints (need exact coordinates for OBS drops)
  – Provides a timeline for cruise operations
  – Lists the scientific party (including the names of OBSIP techs)

• You may also need to have conference calls or meetings with the ship operator regarding the details of the cruise

• As chief scientist you are responsible for organizing the scientific party, and all the scientific decisions on ship operations
OBS drop coordinates

- You need to chose the exact OBS drop site coordinates
- For broadband OBSs, if good bathymetry is available:
  - Need to find relatively flat sites
  - Far from hazards such as mudslides, volcanoes
- If bathymetry is not available, bathymetry should be checked during the deployment cruise
  - OBSs may drift as much as 500 m during descent
  - Exact position on the seafloor needs to be determined by acoustic ranging or airguns

Example of siting OBS on seamount
If you are chief scientist you will be responsible for representing the science party and OBSIP in cruise decision making. For example, if weather causes changes in the cruise plan.

OBSIP provides essential technicians but normally several additional people are required in support roles (i.e., grad students, etc).

The OBSIP technicians normally take responsibility for planning the layout of equipment on the deck and planning deck operations.

Communication for deck operations generally goes through the “research technician” provided by the ship operator to the bridge.

Assuming things go well, you may need to decide how to use “contingency” time. Activities may include bathymetric surveying, magnetic/gravity data logging, dredging/sampling.
Typical shipboard duties of the Science Party

- monitoring ship operations/data logging during transits
- monitoring bathymetry at drop sites
- logging instrument drop coordinates (backup)
- assisting with instrument preparation
- manning tag lines during deployment/recoveries
- helping with deck operations, tying down equipment
Cruise tasks

- Tag lining
- Logging data in the lab
- Recovering the magnetometer

Logarithmic data in the lab
Recovery Cruise

• Recovery cruise tasks are fairly similar to deployment cruise
• Need to allocate time based on the depth and rise rate of the OBSs
• Need contingency time to allow for delays in releasing from the bottom
• Science party should assist in locating the OBS once it reaches the surface, as well as tagging, etc
The OBSIP is responsible for organizing the data, time correcting, and basic Q/C

OBSIP will usually provide you with a “raw” dataset in miniseed (or SEGY?) format when leaving the ship.

OBSIP will submit the data to the IRIS-DMS 1-12 months later and provide you with the final Q/C’ed dataset.

I like to keep my own spreadsheet with OBS locations and known problems as a backup.

There is no better Q/C than doing research with the data. The science group should also track problems and communicate with OBSIP if problems are discovered.
Questions?