# *Terms of reference ( c ) Marine seismic assets*
# *Marine Seismic Assets sub-committee*

Active source: Warren Wood, Beatrice Magnani, others
OBS: Del Bohnenstiehl, others

**From the MSROC Terms of Reference**

(c) Regularly review the technical capabilities of existing marine seismic assets to ensure they meet the needs of the scientific community, and advocate for upgrades when compelling needs for new capabilities are identified.

The MSROC will provide high-level input on scientific needs and guidance on prioritization for implementation of upgrades and deployment of new marine seismic capability. It is expected that the OBSIP liaison on the MSROC will serve as the conduit for information to/from the OBSIP advisory committee. Additional ad hoc groups will be formed as needed to address other marine seismic technical and operational issues.

# *How exactly do we do this?*

# *OBS Instrument Pool: 3 main types*

3 types: **broadband**, **short-period, active** and **short-period, long-deployment**

Identify **Science Targets**, and **Existing Functional Specs** for each

# *Active Source Seismic Instrument Pool?*

types:

**Multi-channel:**

- **Large seismic gun array**
- **Small seismic gun array**

**Single-channel:**

- **P-Cable**
- **Hull-mounted acoustic (fathometer)**
- **towed (chirp, boomer, mini-sparker**

Identify **Science Targets**, and **Existing Functional Specs** for each

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OBSIP

OCEAN BOTTOM SEISMOGRAPH INSTRUMENT POOL

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# 2017 OBS Symposium

**September 18-19, 2017 Portland, Maine**

The 2017 OBS Symposium will be held September 18-19 in Portland, Maine. Registration is now open. Details on hotel bookings, travel, and speakers will be announced via the OBSIPtec mailing list and made available on this website.

## *Current OBSIP Fleet*

**~90 Short Period**

Three-axis 4.5 Hz seismometers (+ hydrophone) used for active source experiments and long duration passive micro-earthquake studies.

**~157 Broadband**

Three-component broadband sensor (Trillium compact, T240, other), with Differential Pressure Gauge (DPG), hydrophone or Absolute Pressure Gauge (APG).

# *Current OBSIP Fleet*

| Instrument Centers | LDEO | SIO | WHOI |
|---|---|---|---|
| Broadband OBS | 30 | 39 | 30 |
| Short Period OBS | | 60 | 30 |
| Cascadia BB OBS | 10 | 15 | 14 |
| Cascadia Trawl Res.OBS | 19 | | |
| Total OBSIP Inst. | 59 | 114 | 74 |

https://www.nsf.gov/pubs/2017/nsf17080/nsf17080.jsp

**NSF 17-080**

## Dear Colleague Letter: Management and Operation of a National Ocean Bottom Seismometer Instrument Pool

May 1, 2017

Dear Colleagues:

The Division of Ocean Sciences in the Geosciences Directorate of the National Science Foundation (NSF/OCE) intends to issue a solicitation to establish, manage and operate a National Ocean Bottom Seismometer Instrument Pool (NOBSIP) through a competitive, merit-based external peer-review process. This initiative is expected to result in the award of a five to ten-year Cooperative Agreement (CA) for this activity.

This letter provides general information regarding the upcoming competition to potential proposing organizations and other interested parties as to the material and information needed for responsive proposal preparation.

- ✓ Unclear how number and type of instrumentation might be impacted by change in operator.

## Functional Specifications:

The OBSIP Oversight Committee has developed (with community input) “functional specifications” intended to guide OBS development in order to best meet current and future science needs.

The functional specifications are (short-to-intermediate term) forward looking and are not fully realized in the current generation of OBSIP instrumentation.

The functional specifications are divided into three instrument types - **broadband**, **short period active** **and** **short period long duration**.

# Science Targets for Broadband OBS

Lithospheric and asthenospheric structure; mantle dynamics; deep earth structure; earthquake studies; source physics; slow slip; noise studies; infragravity waves; tsunamis.

Science targets defined by community input require improved consistency in delivering low noise on horizontal channels, accurate timing, and on-scale (not clipped) recording.

- ✓ Quality of horizontal component data at teleseismic periods, limits studies of Love waves, receiver functions, teleseismic shear wave splitting.
- ✓ Mid-magnitude earthquakes located near instruments were clipped on broadband sensors during the Cascadia experiment

# Functional Specs for Broadband OBS

| Specification | Requirement | Justification/Notes |
|---|---|---|
| 1. Fleet Size | a. 150 instruments | a. Allows for 1 large operating experiment (75 inst)<br>b. Allows for simultaneous instrument refurbishment of 1 large experiment (75 inst) |
| 2. Shielding | b. 75 unshielded instruments should be available and remotely deployable for normal deepwater experiments | a. Direct burial not required until cost effective installation and retrieval method developed |
| | c. 75 shielded instruments should be available and remotely deployable for experiments requiring low noise horizontals | b. Comparison of shielding options and at sea capability remains a priority study for the OBSIP facility |
| 3. Trawl resistance | a. 25 (of 75 current shielded instruments) should provide trawl resistant shielding for operational depths of up to 500 meters | Shallow water depth capability needed for near-shore studies |
| 4. Clock accuracy | a. Correctable accuracy to 0.1ms for the length of the deployment | Accurate timing is essential for earthquake source and tomography experiments |
| 5. Clock operation duration | a. 24 months or greater | |
| 6. Recovery | a. Acoustically commanded release<br>b. Steel anchor left on seafloor is standard operating method<br>c. Pop up buoy capable<br>d. Fresh water release capable | a. Some specialized deployments may require that nothing be left on the seafloor, and PI/IIC/OBSIP communication and advanced planning on instrument modifications for those rare experiments could accommodate these instances |

# Functional Specs for Broadband OBS

| | | |
|---|---|---|
| 7. Recording duration | a. 18 months at 100 sps<br>b. Extendable to 24 months with extended battery supply | 24 months for slow slip studies, repeating earthquakes, etc. |
| 8. Depth | a. Min 200 meters standard<br>b. Min 50 meters - 25 instruments (trawl resistant instruments)<br>c. Max 6000 meters standard<br>d. Max 9000 meters - 10 instruments | Shallow depths for near-shore studies, continental shelf, margins<br>Subduction zones 50 m – 5000 m.<br>6000m useful for much of ocean basin.<br>9000m for trenches in subduction zones |
| 9. Broadband Seismometer | a. Required in all instruments<br>b. Passband: flat to velocity from [240 or 120?] seconds to [35 or 50?] Hz.<br>c. Self-noise: below NLNM 100 s to 10 Hz.<br>d. Bandwidth: -3dB points at 240 s and 200 Hz<br>e. Clip level: 26mm/s from 0.1Hz to 10Hz. Able to capture a M 5.5 earthquake at 50 km on-scale. High dynamic range needed. | |
| 10. Strong Motion Sensor | e. No clipping on M8+ earthquakes at local distances<br>f. Include on a subset (30-50%) of the instruments | a. Important in areas of high seismicity rates and aftershock sequences of large to great earthquakes |
| 11. Absolute Pressure Sensor | a. Required in 50 instruments<br>b. 0-10000 psia<br>c. Passband: flat response between 1 Hz and DC. | a. For geodesy, tsunami studies, and surface wave corrections (DPG can be used for surface wave corrections, but APG needed for geodesy)<br>b. Needs to be on a mix of shielded, unshielded, and trawl resistant instruments |
| 12. Differential Pressure Gauge | a. Required in 50 instruments<br>b. Standard OBSIP DPG or better | a. Cheaper solution that is quieter at some frequencies, but of limited usefulness without calibration |
| 13. Hydrophone | a. Required in all instruments<br>b. High Tech HTI-90-U or better | |

# Functional Specs for Broadband OBS

| | |
|---|---|
| 14. Datalogger | a. 4 channels minimum:<br>  a. 3 Channels: Broadband seismometer: vertical and horizontals (Accelerometer capable)<br>  b. 1 Channel: APG or DPG<br>b. Expandable to 9 channels:<br>  a. 3 Channels: Accelerometer (co-located with Broadband Sensor)<br>  b. 1 Channel: APG or DPG<br>  c. 1 Channel: Hydrophone<br>c. Frequency response: DC to 80 Hz @ 200 sps.<br>d. Anti-aliasing FIR filter. Double Precision FIR Filter Causal/Acausal; >140 dB attenuation at output Nyquist<br>e. Sampling rates: 1, 10, 20, 40, 50, 100, 200, 250, 500, 1000 sps<br>f. Sampling rates configurable by channel<br>g. Datalogger dynamic range and noise floor do not limit sensor performance<br>h. Acquisition modes: continuous, triggered, time windows<br>i. Extendable time synch to other dataloggers/systems |

## Science Targets for Short Period Active OBS

Active source experiments, crustal imaging, gas hydrates studies

Current research is limited by physical size of the instruments now in use.

- ✓ limits number on ship
- ✓ deployment and recovery is slower for larger instruments => greater costs
- ✓ instruments much larger than industry equivalent.

# Functional Specs for SP Active Source OBS

| Specification | Requirement |
|---|---|
| 1. Fleet Size | a. 200+ instruments |
| 2. Shielding | a. None |
| 3. Trawl resistance | a. None |
| 4. Clock accuracy | a. Correctable accuracy to 0.1ms for the length of the deployment |
| 5. Clock operation duration | a. 3-4 months or greater |
| 6. Recovery | a. Acoustically commanded release<br>b. Steel anchor left on seafloor is standard operating method<br>c. 45 meters/minute rise rate |
| 7. Recording duration | a. 2 months at 500 sps or higher |
| 8. Depth | a. Max 6000 meters standard |

# Functional Specs for SP Active Source OBS

| | |
|---|---|
| 9. Short period Seismometer | a. Required in all instruments<br>b. Three-component seismometer, self gimballing<br>c. Passband: flat to 4.5 Hz natural frequency.<br>d. Self-noise: below NLNM to 100 Hz.<br>e. Bandwidth: ?<br>f. Clip level: ? |
| 10. Strong Motion Sensor | a. None |
| 11. Absolute Pressure Sensor | a. None |
| 12. Differential Pressure Gauge | a. None |
| 13. Hydrophone | a. Required in all instruments<br>b. High Tech HTI-90-U or better |
| 14. Datalogger | a. 4 channels minimum:<br>i. 3 Channels: seismometer: vertical and horizontals<br>ii. 1 Channel: Hydrophone<br>b. Frequency response: ?<br>c. Anti-aliasing FIR filter<br>d. Sampling rates: 100, 200, 250, 500, 1000 sps<br>e. 24 Bit A/D<br>f. Sampling rates configurable by channel<br>g. Datalogger dynamic range and noise floor do not limit sensor performance<br>h. Acquisition modes: preprogrammed time windows, programmable/changeable sampling rates<br>i. Extendable time synch to other dataloggers/systems |

## Science Targets for Long-Deployment Passive Short Period OBS

Seismotectonics of plate boundaries, earthquakes, microseismicity experiments: hydrothermal processes, magmatic processes, mid-crustal activity, subduction zones. Seafloor and lake-bed volcano activity. Local earthquake studies.

- ✓ Perhaps a long-term OBS with module sensor (BB or SP) configuration could fulfill the needs for this class.

# Functional Specs for Passive Short-Period OBS

| Specification | Requirement | Justification/Notes |
|---|---|---|
| 1. Fleet Size | a. 200 instruments | a. close station spacing needed for accurate hypocenter determination |
| 2. Shielding | a. | a. |
| 3. Trawl resistance | a. on 25% of instruments | a. Shallow deployments required for studies of megathrust tectonics, continental shelf seismic hazard studies |
| 4. Clock accuracy | a. Correctable accuracy to 0.1ms for the length of the deployment | a. Accurate timing is essential for hypocenter determination, earthquake source, and tomography experiments |
| 5. Clock operation duration | a. 24 months or greater | a. Ensure final clock lock at end of experiment |
| 6. Recovery | a. Acoustically commanded release<br>b. Steel anchor left on seafloor is standard operating method | a. |
| 7. Recording duration | a. 24 months at 100 sps | a. |
| 8. Depth | a. Max 6000 meters standard | a. |
| 9. Short period Seismometer | a. Required in all instruments<br>b. Three-component seismometer, self gimballing<br>c. Passband: flat 5 s – 200 Hz (2 Hz natural frequency).<br>d. Self-noise: below NLNM 1 to 100 Hz.<br>e. Bandwidth: ?<br>f. Clip level: no clipping for M3-4 event at 0-10km distance | a. |

# Functional Specs for Passive Short-Period OBS

| | |
|---|---|
| 13. Hydrophone | a. Required in all instruments<br>b. High Tech HTI-90-U or better |
| 14. Datalogger | a. 4 channels minimum:<br>a. 3 Channels: Broadband seismometer: vertical and horizontals (Accelerometer capable)<br>b. 1 Channel: APG or DPG<br>b. Expandable to 9 channels:<br>a. 3 Channels: Accelerometer (co-located with Broadband Sensor)<br>b. 1 Channel: APG or DPG<br>c. 1 Channel: Hydrophone<br>c. Frequency response: DC to 80 Hz @ 200 sps.<br>d. Anti-aliasing FIR filter. Double Precision FIR Filter Causal/Acausal; >140 dB attenuation at output Nyquist<br>e. Sampling rates: 1, 10, 20, 40, 50, 100, 200, 250, 500, 1000 sps<br>f. Sampling rates configurable by channel<br>g. Datalogger dynamic range and noise floor do not limit sensor performance<br>h. Acquisition modes: continuous, triggered, time windows<br>i. Extendable time synch to other dataloggers/systems |
| 15. Data delivery requirement: | a. DMC: SEED for all experiments, SEG-Y for active source |

# *Active Source Seismic Instrument Pool?*

types:

**Multi-channel:**

- **Large seismic gun array**
- **Small seismic gun array**

**Single-channel:**

- **P-Cable**
- **Hull-mounted acoustic (fathometer)**
- **towed (chirp, boomer, mini-sparker**

Identify **Science Targets**, and **Existing Functional Specs** for each

# *Active Source Seismic Instrument Pool?*

types:

**Multi-channel:**

- ~~**Large seismic gun array**~~ **(Hire out? Let Germans lead?)**
- **Small seismic gun array**

**Single-channel:**

- **P-Cable**
- **Hull-mounted acoustic (fathometer)**
- **towed (chirp, boomer, mini-sparker**

Identify **Science Targets**, and **Existing Functional Specs** for each

# *Active Source Seismic Instrument Pool?*

Questions to keep in mind:

Does the scientific community want a

1) “push button – get banana” capability

Or

2) A cutting edge educational capability?

Should this committee lead the community, or follow it?