Leapfogging Array Working Group

What are the most important scientific questions in earth structure and mantle dynamics that leap-frogging arrays could address over a decade?

Thermal Structure and Dynamics of Oceanic Lithosphere/Asthenosphere

What controls variation in subsidence of oceanic lithosphere?
What is the distribution and form of small-scale convection?
What mechanisms underlie inter-ocean variability?
What is the relationship of large-scale upwellings to ridges?
What is the relationship between variations in anisotropy and large-scale convection?
What is the origin of the unique anisotropy of Pacific?
What is the layering in the oceanic upper mantle and how does it relate to the dynamics? What is the nature of the lithosphere/asthenosphere boundary? Is the asthenosphere wet?
What is the deep structure of the Pacific superswell?
How deep are the roots of hotspots in the Pacific, Indian, and South Atlantic oceans?

Structure and Dynamics of Mantle Transition Zone

What are the intermediate-scale variations in the topography of the 410 and 670 km discontinuities?
How anisotropic is the Transition Zone? What is the origin of the anisotropy?
Is there a 520 km discontinuity? What is its geographical variation?
What is the nature of the coupling between the upper and lower mantle in regions of upwelling?

Structure and Dynamics of Lower Mantle

Are there detectable dead slabs in the deep mantle?
What is the connection between slabs and the "slab graveyard" in the lowermost mantle?
What is the distribution and nature of scatterers in the deep mantle?
What is the nature and what are length-scales of D'' heterogeneity?
How sharp are the boundaries of superplume roots?
What is the extent of and cause of anisotropy near the core-mantle boundary?

What is the distribution and nature of ULVZs?
What are the scale-lengths and heights of CMB topography?

Structure of the Core
Are there sediments at the core-mantle boundary?
What is the cause of the complexity of core-phase data (e.g. hemispherical variations in PKP travel times).
Is there an innermost inner core?

Where should the arrays be placed and in what order? How long should each array be in place? How many instruments? How many arrays?
Goal: Fill in gaps in global seismic coverage to attain intermediate-scale resolution (few hundred km) for study of inner core to uppermost mantle.
Two arrays of 25 instruments each.
Deployment durations of 1 year.
Array aperture ~ 1000 km x 1000 km
Highest scientific priority is the Southern Ocean and the gap in the central equatorial Pacific. Also, the Artic Ocean for inner-core anisotropy. For logistical reasons recommend initial deployments in the central North Atlantic and the equatorial Pacific. Efforts should be made to encourage international cooperation.

What are the technical requirements for instruments?
Minimum bandwidth is 100 s to 10 Hz.
To acquire useable horizontal-component data at intermediate and long periods seismometers must be buried wherever feasible.
Orientations can be determined to ~ +/- 5° using recorded waveforms from either natural sources or airguns.
Clock drifts of ~1 ms/day before correction.
Other sensors needed are Differential Pressure Gages, hydrophones and current-meters.
Possibility of adding MT instruments at some sites.
If power budget permits, consider sampling at 100 Hz (see Rhett Butler)

What instrument development is needed?

Development of a second-generation, gravity-driven burial system is under way.

Need to consider ways to bury seismometers in areas of hard bottom (ROV?).

Seismometer equivalent to an STS-2 (performance and power) is needed.

For gravity-driven emplacement, seismometer should have small cross-sectional area.

Servicing of arrays and redeployment

Arrays can be refurbished and redeployed if total cruise duration is <= ~40 days.

Need ~5 spares/cruise.

Management of Project

Science steering committee will decide on deployment priorities.

Arrays will be managed as a facility.

Each deployment will have 1-2 P.I.s who will be responsible for deployment/recovery and basic data quality-control, such as seismometer orientation, ensuring data are clock-corrected etc. P.I. may have some flexibility in station distribution (perhaps up to 20% of sites).

Cruise Durations

Deployment

25 OBS x 12 hours = 12.5 days

1000 km x 1000 km => 6000 km total transit from station to station
13.5 days @ 10 knots

Recovery

25 OBS x 6 hours = 6 days

1000 km x 1000 km => 6000 km total transit from station to station
13.5 days @ 10 knots

Data Management

Data will be available immediately to the community.

Data will be archived by the facility at the DMC following standard QC.

Opportunity for additional QC and product preparation (travel time picks, event locations, moment-tensor inversions, etc). This could be the long-term responsibility of selected expert groups.