Ocean Crust and Mantle

(interpreted broadly to include the science that requires that we get our feet wet)

First a summary of the science themes and needs, followed by a summary of instrumentation and facilities needed to address those theme.

1) **Formation, distribution, migration and focusing of melt from mantle to crust:**

- How much melt is in the asthenosphere?
- How does melt migrate and what controls where it ends up?
- Why is there intraplate volcanism?
- Ocean is the best place to understand first principles of this process because the crust is relatively simple.

Needs:

- Broadband and short period OBS array experiments along plate boundaries and within the plates.
- Active source imaging using OBSs and the new capabilities (to the academic community) of the R/V Langseth.

(note: scale this down to study gas formation, migration and and focusing in sediments, with applications to gas hydrates and CO2 sequestration.)

2) Seafloor deformation and marine geohazards (submarine earthquakes and landslide, tsunamis):

- Understand seafloor deformation on a continuum of spatial and temporal scales.
- Value of offshore seismometers for early warning - precious seconds when a large earthquake occurs.
- Impact of subducted plate roughness on earthquake process.
- Impact of upper plate structures on tsunamigensis.
- Impact of minerology along the plate boundary on fluid pressure,
- 4D imaging of fluids on the megathrust.
- Potential for gas hydrate destabilization in response to tectonics and environmental change.

Needs:

- Long-term **real-time** measurements in the ocean,
- Short-term imaging experiments on a continuum of scales.
- Instruments for rapid response.
- Submarine geodesy.

3) Cycling of fluids and volatiles in the oceanic crust and sediment:

- Subduction factory starts in the ocean.
- Most spreading centers also in the ocean.
- Fluid input to the subducting plate occurs in the ocean (serpentinization and other hydration reactions affect chemistry and rheology).
- Fluid leaks out of the subducted plate from the deformation front to the arc and beyond, with impacts on…
  - Forearc fluid flow, gas hydrate formation and slope stability.
  - Faulting processes - slip rate, distribution, etc.
  - Arc magmatism.
  - Fluid transported deep into the mantle.
  - Possible role in driving plate tectonics.

Needs:

- Offshore instrumentation so extend boundaries of high resolution images so that they encompas the whole system.

4) Structure of the mantle and core and baseline definition of global seismic activity:

- Although the need for 20 GSN stations in the oceans to complete the GSN at 2000 km station spacing was identified 2 decades ago, that goal has not been met and remains important.

5) Development of human resources:

- At present, demand by industry exceeds supply of students.
- Need to recognize growing and changing societal needs for subsurface imaging and adopt an academic framework that emphasizes the scalability of many seisological techniques.

Summary of needs:

1) Cheaper, effective instrument design and coordination between EAR and OCE to allow completion of the GSN/OSN.

- Utilize existing boreholes (e.g. Ninety-East Ridge, Mid-Atlantic Ridge, central Pacific)
- Implement OOI plans
- Take advantage of other opportunities to piggyback on mid-ocean data acquisition systems.
- Explore new ideas (e.g. autonomous drifting sensors with GPS, hydrophones and telemetry)
- Expand hydroacoustic capabilities to increase frequency range of observations.

2) Continued support and expansion of broadband ocean bottom seismometers for temporay deployments:

- Targeted projects by individual PIs.
- Structured deployment plan in USArray-like framework.
- ROV deployment to simply instrument package and improve coupling.
- Burial or hydrodynamic shielding.

Summary of needs (cont.):

3) Continued support for the R/V Langseth.

- First results are spectacular
  - (Lasik surgery on our eyes into the Earth – John Mutter).
- Need to maintain and enhance capabilities.
- Need adequate support for 3 and 4D acquisition and processing.

4) Develop seafloor geodetic capabilities.

- Recent recognition of a variety of slow-slip phenomena has blurred line between seismology and geodesy.
- Need analogous tools to measure deformation along plate boundaries beneath the ocean.