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Deep sea borehole seismic observatory

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Abstract

More than half of the Earth's surface is covered by ocean, where little permanent seismic observation has been performed. The lack of the long-term seismic observation limits our understanding of the Earth's interior structure. I would proposed (a) to install broadband seismographs in the boreholes as many as possible as proposed by ION in order to achieve a uniform coverage of a permanent broadband global seismic network (including land stations) and (b) to deploy array of the borehole stations in the focused area with focused target, e.g., an evolution of lithosphere, an origin of hot spots and mantle plumes. The topic may be related to WG6.1 (Observatories) and WG6.2 (Subseafloor laboratories and experiments).

Deep sea borehole seismic observatory

The international scientific community recognizes the importance of deploying long-term deep sea borehole seismic observatories, which should be multi-disciplinary and have multi-purposes. The International Ocean Network (ION) defines a three-phase approach to installing deep sea observatories. The first phase, pilot experiments to solve technical issues, were completed successfully and we are now the end of the phase 2 (installation of a small number of prototype observatories). The deep sea borehole seismic observation has been technically feasible and has been operated at a few sites in the globe (e.g., Suyehiro et al., 2006) and it is a time (phase 3) that the number and coverage of the deep sea borehole observatories should be improved. The following types of stations are desirable.

(1) A part of global seismic network

The ION proposed potential deep sea observatories which fill gaps of land-based stations, of which only a few stations have been realized. We should go forward to deploy more deep sea observatories. Considering difficult logistics required to operate and maintain deep sea observatories (power, vessel, etc.), we should start with sites

where such logistics are more available: a seafloor in Pacific Ocean more than 1000 km away from Japan and the United States. Then proceed to more remote sites, such as Ninetyeast Ridge in Indian Ocean and French Polynesian region in South Pacific.

(2) Array observatories

Besides the ION-proposed sites, we should consider an array type of deployment to derive more information from seismograms. The array observation enables various measurements such as slowness measurements and enhancement of weak but important seismic signals, which are impossible with single isolated station. The array should be designed to observe seismic waves for focused target. A recent research on lithosphere-asthenosphere boundary in the Pacific Ocean, which utilized the deep sea borehole observatory WP-1 in the Philippine Sea and WP2 in the northwestern Pacific Ocean is a good example (Kawakatsu et al., 2009). Other potential targets are the origin of hot spots and mantle plumes; seismic structure of LIPs; core structure that unsampled by land-based stations. Potential sites are northwestern Pacific for lithosphere structure, the French Polynesian region for the hot spot study, and Philippine Sea for the core study.

The borehole observatories should be installed on basement rock beneath sedimentary layers. Required vessels are JOIDES Resolution or Chikyu.

References

Kawakatsu, H. et al., Seismic Evidence for Sharp Lithosphere-Asthenosphere Boundaries of Oceanic Plates, *Science*, 324, 499-502, April 24, 2009.

Suyehiro, K., et al., Ocean seismic observatories, Oceanography, 19, 144-149, 2006.