Long period seismic noise in deep ocean boreholes

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From the observations in ocean borehole seismometers in the Japan Trench and NW Pacific, it is clarified that the effect of the infragravity wave can be reduced by several orders of magnitude for horizontal components if we install the seismometer in the basement. This is because the sediment is subject to a deformation under a shear stress by the loading of the infragravity waves, which results in a significant tilting of the seismometer.

We installed two borehole seismic observatories near the Japan Trench during ODP Leg186 in 1999. The seismometers were placed about 1.1 km beneath the sea floor suspended by pipes near at the bottom of the boreholes. In order to avoid a disturbance by the fluid flow near the seismometer, which was suggested to be a potential noise source, we injected grout through the pipes and cemented the instruments in the borehole to eliminate seawater nearby the instruments. We successfully began observation in early September 1999. Initial 8-hour data was recovered from one of the sites. In 2000, another installation of broadband seismometer in ocean borehole has been successfully made by ODP Leg191 in the North Western Pacific Basin.

Comparison of the JT borehole seismic noise spectra with those at nearby seafloor stations clearly showed the advantage of the deep burial. In most of the observational frequency between 1 mHz and 20 Hz, the borehole station was quieter than the sea floor stations. As well as vertical component, the borehole noise spectra showed excellent noise levels for horizontal components such as -175 dB (m**2/s**4/Hz) at 70mHz and -160 dB at 2mHz for example.

As the seafloor turbulence noise disappears, an infragravity wave becomes conspicuous noise source in the JT borehole records that is apparent between 3mHz and 200mHz for both horizontal and vertical components. The infragravity wave in the sea gives a load on the underlying sediment and the crust, resulting in a deformation observed as the seismic noise. It is clarified that the effect of the infragravity wave can be reduced by several orders of magnitude for horizontal components if we install the seismometer in the basement. This is because the sediment is subject to a deformation under a shear stress by the loading of the infragravity waves, which results in a significant tilting of the seismometer.