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Seismic velocity model of the seamount chain on the Weatern Pacific Basin

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On the Western Pacific Basin, many seamounts are scattered and divided into several seamount groups. According to the results from radiogenic isotope studies for dredged samples from the seamounts, they were formed predominantly in the Cretaceous in spite of being in a wide area, without clear age progression. Constructing a formation process of these seamounts is important to understand mantle behavior and its roles in the evolution of oceanic crust. Up to now, many models have been proposed to explain this widespreading non-linear age intraplate volcanism; complicated plate motion with several hotspots, thermal feedback, cracking or bending of lithosphere, upwelling of superswell and etc. From a point of view of seismic studies, velocity structure of the lower crust and the uppermost mantle can be a clue to constrain a formation model of these seamounts.

To reveal the seismic structure of the area characterized by the Cretaceous volcanic activity, Hydrographic and Oceanographic Department, Japan Coast Guard conducted wide-angle and multi-channel seismic experiments on the survey line, named as MTr5, across the Marcus-Wake Seamount chain, one of the seamount groups close to Japan. The length of MTr5 is about 910 km, long enough to clarify the velocity structure of the uppermost mantle. Northern and southern ends of the survey line are set on the Jurassic seafloor, on which magnetic lineation associated with oceanic spreading are recognized. Besides the seamount group model, a typical oceanic crustal structure model, also, can be acquired in this experiment.

We deployed total 180 Ocean Bottom Seismographs (OBS) at a 5 km spacing. Sampling rate and preamp gain of geophone and hydrophone sensor were set to 200 Hz and 40 dB, respectively. As a seismic source, a tuned airgun array composed of 36 guns (total 131.8 liter; 8040 cubic inch) was shot every 200 m firing in the wide-angle seismic experiment and every 50 m firing in the multi-channel seismic reflection experiment to provide high resolution data set.

All OBSs were retrieved and all recorded data are usable for analysis. To construct a shallow structure model, sediment structure acquired by the reflection experiment was incorporated into the initial model and two-dimensional forward modeling based on a graph theory was applied. Two-dimensional tomographic inversion was applied to clarify a velocity structure of lower crust and uppermost mantle, and reflection travel time mapping was applied to estimate locations of reflectors in a model.

The obtained structure of seamount chain shows thicher than 8 km crust thickness and slower than 7.8 km/s P-wave seismic velocity of the uppermost mantle. The deepest Moho depth of 17 km in the model is not located just beneath a seamount, is located beneath the center of seamount cluster. This structure may show that a magma derived from the upper mantle ascends and temporally stays beneath the oceanic crust. Then it rises through weak part of the crust and forms seamount cluster.

The uppermost mantle velocity beneath the Jurassic seafloor to the south of seamount group is 7.9-8.0 km/s and to the north of the group is 8.3-8.4 km/s. The difference between these velocity structures could be due to inhomogeneity of the uppermost mantle or P-wave anisotropic velocity structure in the uppermost mantle, caused by seafloor spreading.

Many OBS data show strong signals at far offset (farther than 250 km). Based on assumption that these signals are reflected waves in the mantle and seismic velocity in the upper mantle (up to 100 km) is 8.0-8.6 km/s, locations of deep reflectors are estimated as 70-90 km in depth beneath the seamount clusters.