PP-reflection intensity distribution over an aseismic region in the Japan Trench observed in an-OBS-airgun experiment

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The seismic reflection-refraction experiment in the forearc slope of the Japan Trench in 1996 revealed an important relationship between seismicity and characteristics of seismic records, that is, the plate-boundary P-P reflected waves with large amplitude were observed within the aseismic regions (Fujie et al., 2002). To verify this correlation between seismicity and reflection intensity at the plate boundary, we carried out a seismic reflection-refraction experiment over seismic and aseismic regions along the forearc slope of the Japan Trench. We used thirty-nine OBSs and four airguns as controlled sources along seven survey lines parallel to the Japan Trench axis. One of the seven survey lines is nearly identical to a part of the NS-line of the 1996 experiment.

The authors evaluated several causes of amplitude variations in reflected arrivals, such as geometrical spreading of energy, variation in radiated energy among airgun shots, and variation in incident angles to the plate boundary.

Variation in radiated energy can be ascribed to the total chamber size and to the firing depth of the airguns. The amplitude variation was observed by a hydrophone streamer, and each trace was normalized to its averaged amplitude for each profile. The amplitude variation with respect to variation in the incident angle relative to the plate boundary is not so large if we do not include records near the normal incidence.

We also generated Move-out Record Sections in reference to the theoretical travel times for the P-P plate boundary reflections. P-wave velocity structures along the seven lines, determined by referring to the structure along the NS-line of Fujie et al. (2002), were used for computations of theoretical travel-times for the P-P arrivals reflected at the plate boundary.

The arrival times of the observed intense seismic reflection agree well with theoretical travel times. Surface maps of plate-boundary-reflected P-P wave intensities show the same features as ones found by Fujie et al. (2002). These results support the interpretation that the observed intense P-P reflection is from the plate boundary in the aseismic zones.

By comparison of the observed waveforms and the results of synthetic seismograms, the materials existing at the aseismic plate boundary is considered to be some low Vp and Vs materials such as clay, serpentinized rocks and/or high fluid contents rocks. These materials could be a cause of aseimicity due the relation between mechanical strength and seismic velocities.