Relative locations between plate interface estimated from seismic survey and deep low-frequency tremor in western Shikoku

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Deep low-frequency tremor found in plate subduction zone, is intensively studied in these years, because it occurs in the vicinity of asperities of great earthquakes and would be relevant to generation system of great earthquake. To understand the tremor mechanism, the information of the location, particularly relative location to plate interface, is important, which needs improvements of the accuracies of tremor hypocenter and plate interface location. Since the plate location depends on models based on hypocenter distribution or converted wave analysis, it is therefore difficult to attain accuracy within 1 km. Then we identified the plate interface using data of seismic survey performed in March 2008. We moreover clarified the precise relative locations between the plate interface and the tremor using a common velocity model.

The seismic survey line ran through above a cluster where tremors concentrate and had a length of 75 km. Two hundred seismometers aligned with an average interval of 400 m recorded four explosive shots on the line. We applied a series of conventional seismic processing to the retrieved data, and finally obtained a seismic depth section. The assumed velocity model was in combination with a refraction analysis result above 5 km in depth and seismic tomography result below 5 km.

The depth section shows a lot of strong reflection layers, particularly a north-dipping and very strong reflection layer which locates at depths of 25 - 37 km. Another reflection layer was identified 8km below the strong one and paralleled it. Taking account of the depth, the continuity and the dip angle of the reflect layers, we interpreted the upper strong layer as the plate interface, the lower layer as the oceanic Moho-discontinuity, respectively. In comparison with previous studies, the plate interface became up to 2 km shallower, and the Moho-discontinuity at north end of the line became 3 km deeper.

Next, we relocated tremor hypocenters using the common velocity model. The relocated hypocenter distribution indicated 2 - 3 % smaller in standard deviation and 0.1 km larger in centroid depth than the initial, it consequently did not significantly change. The tremor centroid matches with the estimated plate interface, insisting that the tremor occurs on the plate interface.

Around tremor area, we recognized very strong reflectors in down-dip direction of the slab and close to the tremor, where tremor does not almost occur. We interpreted it as serpentinized mantle wedge. The reasons are that receiver analysis shows the existence of island Moho around 30 km and that tomography analysis shows high Vp/Vs ratio there. The existence of serpentinized mantle wedge cannot charge stress enough to induce brittle rupture due to its low viscosity, so that tremor does not occur. As a result, it suggests that tremor occurs only where oceanic and island-arc crust contact.