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Three-dimensional P-and S-wave velocity structures in the southwestern Ryukyu arc, and its relationship to repeating slo

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The three-dimensional crustal structure in the southwestern Ryukyu arc was computed to show the relation among the crustal structure, distribution of micro-earthquakes, and occurrence of slow slip events. The biannually repeating slow slip events occur in the southwestern Ryukyu arc. The average magnitude of the slow slip events is Mw 6.6. The slow slip events occur at the depth of 20-40 km on the upper interface of the subducted Philippine Sea plate.

A tomographic inversion was used to determine P and S wave structures in the southwestern Ryukyu region (Iriomote Island) for comparison with the locations of slow slip events. The double-difference tomography (Zhang and Thurber, 2003) was employed. The P- and S- wave arrival time data picked manually by Japan Meteorological Agency are used. The 5733 earthquakes from January 2000 to July 2011, which were observed at the seismic stations of the Japan Meteorological Agency, were used. The used events are distributed from 23.8N to 24.7N, from 123.0E to 124.5E, and from 0 km to 100 km in depth. The numbers of arrival time data analyzed are 32277 for the P-wave and 31193 for the S-wave as absolute travel times. The intervals of horizontal and vertical grid-nodes are set to 10?20 km. The distance between earthquake pairs was limited to 10 km. A total number of 13 seismic stations are used.

The result shows that the depths of the faults are 20 km shallower than those of the hypocenters in the slab. This is consistent with the analysis of S-wave reflectors. The depth of plate interface, which was estimated from travel time of S-to-S reflection at the plate interface, is 23?40 km at the 123.6E and 24.3N. This is about 20 km shallower than the depths of the earthquakes cluster in the slab (depth range of 50?60 km).

The fault-planes of the repeating slow slip events (Heki and Kataoka, 2008) are located in the low Vp zone. This zone is between the overlying high Vp/Vs zone and underlying low Vp/Vs zone. Assuming that the difference between high Vp/Vs and low Vp/Vs originates to the fluid contents, this may suggest that the fluids from the subducted oceanic crust cannot be transported upward and is trapped at the plate interface. The observed strong S-wave reflector in the upper interface of the subducted plate also supports the idea.

The tops of the faults of the repeating slow slip events connect to the cluster of micro-earthquakes in the lower crust. This suggests that the trapped fluids are transported upward along the faults, accumulates in the lower crust, and induce the swarm of micro-earthquakes in the lower crust.

Keywords: crustal structure, Philippine Sea plate, subduction, Ryukyu Trench, seismic tomography