

Variation of oceanic sediment entering the Japan Trench and its implication for a co-seismic slip reaching the trench axis

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Earthquake, geodetic and tsunami data show the large co-seismic fault slip reaching the trench during the 2011 Tohoku-oki earthquake. Structures and compositions of a shallow portion of the source fault of the Tohoku-oki earthquake are successfully drilled by IODP Expedition 343 (JFAST). A significant result from JFAST is that a plate boundary fault is developed along a thin localized deformation zone composed of pelagic clay. This observation suggests that the pelagic clay may be a critical geological factor controlling a large shallow co-seismic slip. The pelagic clay layer observed at JFAST site correlates with similar pelagic clay cored at DSDP site 436, which is located at the Pacific plate entering the Japan Trench. Backtracking of the site 436 and other ocean drilling sites along the plate motion of the Pacific plate demonstrate that the pelagic clay layer is likely distributed on a broader region of the northwestern Pacific except for seamounts. However, the co-seismic slip distribution of the Tohoku-oki earthquake showed huge slip in a compact region in the central part but did not extend to the northern and southern parts of the Japan Trench. The observed co-seismic slip does not seem to be consistent with the predicted distribution of the clay layer. To examine an effect of the clay layer entering the Japan-Kuril Trenches on the seismic slip, we map a precise distribution of the clay layer using on seismic reflection sections seaward of the trenches. A result shows that most of the area along the profiles is covered by the ~500 m thick sedimentary layer, which is characterized by well-stratified mud/mudstone underlain seismically scattered Cretaceous chert layer. Although the seismic section does not resolve the thin pelagic clay layer, integration of the seismic data and the core sample indicates that the thin pelagic clay layer is interbedded between the well-stratified mud/mudstone and the seismically scattered Cretaceous chert layer. The sediment distribution map shows very thin sediment patches, which are interpreted to be attributed by the Petite-spot magmatism, in the outer-rise region and the trench axis. The seismic characters in those patches imply a break of continuation of the thin pelagic clay layer. We propose from those observations that petite-spot can be a factor controlling propagation a shallow co-seismic slip. This idea seems to explain a heterogeneous distribution of the co-seismic slip around 39° N where the petite-spot is mapped.

Keywords: Subduction zone, Oceanic plate, Japan Trench