Head and tail of massive earthquakes: Mechanism arresting growth of interplate earthquakes

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The behavior of the shallow part of the plate boundary fault, which is deeply involved in the growth of megathrust earthquakes, shows remarkable variations along the Japan Trench. New paleoseismological evidences acquired from the deep seafloor sediment cores revealed that massive seismic slip events like the 2011 Tohoku-Oki Earthquake (M9.0), repeatedly occurred with an interval of ~ 600 years only in the central part of the margin. In the southern part, where no clear evidences of the large coseismic slip near the trench axis, evident post-2011 slip is still taking places. Lack of evidences for the past large-scaled shallow slips suggests that aseismic slip mostly consumes the relative motion across the subduction megathrust. Compared to the southern region, postseismic deformation in long-term average was much smaller in the northern part of the Japan Trench, where occurrence of large coseismic slip during the 2011 mainshock has not proved conclusively. In the area, recent careful reanalysis of seafloor geodetic data suggested that an aseismic slow slip event happened in 2015 near the trench. We hypothesize that slow slip events have occurred periodically to release significant portion of the accumulated slip deficit. Anomalous tsunami earthquakes, like that occurred in 1896, considered as moderately slow failure of the shallow plate boundary can also another type of major process to release the slip deficit. Existence of these processes may explain why we do not have clear records of massive shallow slip in the region. In 2019, we started a comprehensive marine geophysical/geological research activity to explore 1) slip history of past tsunami earthquakes based on the sedimentary core study, 2) spatial extent of the periodic slow slip by seismological and geodetic monitoring, and 3) a realistic model to explain coexistence of massive earthquakes and various kinds of slow slip as observed and recorded.

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