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Fault zone structure in pelagic sedimentary rocks: an example from the thrust fault in the Jurassic accretionary complex

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The Integrated Ocean Drilling Program (IODP) Expeditions 343 revealed that the plate-boundary faulting including the shallow coseismic slip during the 2011 Tohoku-Oki earthquake was highly localized along the smectite-rich pelagic clay of less than 5 m thick. This suggests a stratigraphic control on long-term evolution of plate-boundary faults and coseismic slip in shallow portions of subduction zones. However, little is known about deep portions of subduction zones. Here, we examined how the fault zone structure develops in pelagic sedimentary rocks based on detailed structural analysis of the thrust fault in the coherent chert-clastic sequence of the Jurassic accretionary complex in central Japan. The studied thrust is thought to branch from the plate-boundary fault, which separates the early Middle Triassic cherts and carbonaceous claystone above from the Middle Jurassic siliceous mudstone below. The stratigraphy at the base of the hanging wall (i.e., carbonaceous claystone and black chert in the base, gray chert, and red chert in ascending order) represents the mid-Triassic recovery from the deep-sea anoxic event that occurred across the Permo-Triassic boundary, with its total carbon content increasing from 0 to 8.5 wt% toward the base. The fault zone is ~20 m in thickness, and the footwall siliceous mudstone is widely damaged forming foliated cataclasite. In contrast, only ~1 m-thick chert is fractured and brecciated in the hanging wall. In particular, the faulting is concentrated into the 5 cm-thick cataclasite defined by the fragments of black chert in the carbonaceous clay matrix. Notably, a few millimeters-thick dark layer sharply cuts the cataclasite. On microscopic scale, this dark layer shows the appearance of fault and injection veins, rounded and embayed vein boundaries, and the presence of muscovite microlites in amorphous matrix, which are the characteristics of pseudotachylytes. Our results indicate the faulting including seismic slip is highly localized along the carbonaceous claystone and black chert. This suggests that a stratigraphic control on fault localization also occurred in deep portions of the subduction zone, which appears to be related to deposition of carbonaceous material during deep-sea anoxia.

Keywords: pelagic sedimentary rocks, carbonaceous material, deep-sea anoxic event, pseudotachylyte, chert-clastic sequence