論 文 の 内 容 の 要 旨

論文題目　巨大分岐断層上盤を構成する付加体の発達史解明：
南海トラフ深部掘削と延岡衝上断層を例として
（Evolutional processes of accretionary wedges constituting the hanging walls of megasplay faults: examples from the Nankai Trough deep drilling and the Nobeoka Thrust）

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Geologic evolutionary processes of accretionary wedges developing at the hanging wall of plate boundary faults of subduction zones provide basic information for linking earthquake to accretionary tectonics. To understand evolutionary processes of modern and ancient megasplay fault, I performed geothermometry, age dating and mineral analysis to drilled samples retrieved from IODP Site C0002 in the Nankai Trough and the Nobeoka Thrust in the Shimanto Belt.

Integrated Ocean Drilling Program (IODP) Site C0002 is located within the Kumano forearc basin. Multiple drilling operations have been performed to reach the megasplay fault (~5200 m below sea floor (mbsf)), and samples down to 3058.5 mbsf have been recovered so far. For tectonic reconstruction of megasplay fault and/or decolllement depth which are seismogenic zone of inner accretionary wedge in the Site C0002, I performed vitrinite reflectance analysis and zircon U-Pb dating for clarifying sediment provenance and depositional age using cuttings collected every 100 m between 870.5 and 3058.5 mbsf. Although Ro values of vitrinite reflectance tend to increase with depth, a reversal exists at 2400–2600 mbsf, suggesting the existence of a thrust fault with a vertical offset of ~700 m. The youngest detrital zircon U-Pb age of the cuttings from 2600.0 mbsf is ~7.41 Ma, which is obviously younger than shipboard nannofossil ages (9.56–10.54 Ma) at 2245.5 mbsf. This age reversal between 2245.5 and 2600.0 mbsf strongly supports the existence of a thrust at 2400–2600 mbsf. An estimated paleogeothermal gradient (~120°C/km) is higher than that of present Site C0002, which was caused by heating duration in the vicinity of the trench axis characterized by

high heat flow. Despite similar depositonal age and paleogepthermal gradient, lithofacies in the hanging- and footwall of 2400–2600 mbsf thrust fault are different; volcaniclastic sediments are rare in the footwall. The lack of volcaniclastic sediments corresponding to the Middle Shikoku Basin facies in the footwall of the thrust suggests that sediments below ~2600 mbsf have similar sedimentation background to that of present off-Muroto input site sediments. The evolutional process of the accretionary wedge constrained in this study suggest that Site C0002 sediments were heated in the vicinity of trench axis at ~4 Ma, and transferred from the outer to inner wedge at ~2 Ma.

IODP Site C0002 is dedicated to sample return and in-situ monitoring at the seismogenic zone. Understanding of exposed fossil seismogenic faults is significant for planning a strategy of ultra-deep drilling science. Nobeoka Thrust is a fossilized tectonic boundary thrust in the Shimanto Belt, the Cretaceous-Paleogene Shimanto accretionary complex in southwest Japan. Paleotemperature estimation using illite crystallinity (IC), the full width at half maximum of the illite (001) peak in clay-fraction X-ray diffraction (XRD) presents methodological ambiguity because IC is not only affected by background temperature but also by mechanical, hydrothermal, and surface weathering effects. To clarify the influences of these effects on IC in the fault zone, I analyzed the IC and the illite 001 peak intensity of continuous borehole core samples from the Nobeoka Thrust. I also carried out grinding experiments on borehole core samples and sericite standard samples as starting materials and investigated the effect of mechanical comminution on the IC and illite peak intensity of the experimental products. Paleotemperatures of the hanging- and footwall of the Nobeoka Thrust estimated by IC are 288°C to 299°C and 198°C to 249°C, respectively. The principal slip zone (fault core) of the Nobeoka Thrust does not exhibit IC decrease, suggesting that temperature rise caused by frictional heat and/or hot hydrothermal fluid flow was limited. The correlation of IC and illite peak intensity in the brittle deformation zone of the hanging wall were well reproduced by the grinding experiment, suggesting that the effect of mechanical comminution increases toward the PSZ. Abrupt increase in IC value accompanied by high illite peak intensity observed immediately above the PSZ is explained by hydrothermal alterations including plagioclase breakdown and the formation of white micas, also supported by Na decrease in the PSZ and the footwall detected by XRF two-dimensional mapping. These results indicate that systematic mineralogical changes such as IC across a fault zone has potential for quantifying the effects of thermal, mechanical and chemical effects within a fault zone.

Taking the results produced from the drilled samples of Site C0002 and the Nobeoka Trust into consideration, I estimated the possible materialogical changes across the megasplay fault beneath the Site C0002.

(1) Depositional age of underthrust sediment immediately beneath the décollement at the toe of accretionary wedge is ~4 Ma, whereas the oldest sediments at the Site C0002 is ~11 Ma. Assuming that underthrust sediments continues to the depths, ~7 m.y. age difference across the hanging- and footwall is expected.

(2) Experienced maximum temperatures prior to subduction exceeds modern temperatures at megasplay fault depths beneath the Site C0002 when the thickness of Site C0002 source sediments was thicker than ~1 km. In that case sudden decrease in vitrinite reflectance is expected across the megasplay fault.

(3) Meter-scale mineralogical and chemical anomalies caused by mechanical comminution and hydrothermal alteration are expected to be observed across the PSZ of megasplay fault. Contrasting to millimeter-scale temperature anomalies caused by frictional heat along slip surfaces, they will be detected by illite crystallinity and major element geochemistry of bulk rock samples.

These predictions will be tested when the drilling reaches the megasplay fault and material are recovered.