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プレート沈み込み帯分岐断層の岩石物性と岩相・構造 ―延岡衝上断層掘削におけるコア・物理検層統合解析―
Core-log integration of a subduction zone megasplay fault -Example from the Nobeoka Thrust Drilling-

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Subduction zone megasplays are known to act as tsunami-seismogenic faults and have been the focus of numerous geological and geophysical research. Reflectance surveys and wave tomography reveal clear outlines of the megasplay in the Nankai Trough, indicating low velocity zone along the thrust and the contrast in physical property and structure between the hanging wall and footwall. Megasplay has been the target of Integrated Ocean Drilling Program (NanTroSEIZE), but the deep portion of the megasplay has not been reached yet. Thus the nature and evolution of megasplay remain to be poorly constrained. On the other hand, however, the fossilized megasplay fault now exhumed on-land, enables to directly observe and study the lithology and structures from the outcrop. The Nobeoka Thrust in Shimanto belt, Kyushu Island, has been studied to be a fossilized megasplay fault, and present well preserved structures of fault zones from the seismogenic regime. To obtain geologic and geophysical datasets to correlate with ocean drilling program, the Nobeoka Thrust Drilling Project was conducted in 2011. 255m of continuous coring and geophysical logging was held, and the main fault core between the hanging wall and footwall was found at 41m depth.

The purpose of this study is to present the results of core-log integration, focusing on the relation among lithology, structure, and physical property along the Nobeoka Thrust, emphasizing the clear contrast between the hanging wall and footwall.

Hanging wall (0-41.3m) is composed of the Kitagawa Group of phyllite of alternating beds of sandstone and shale, while the footwall (41.3~255m) is composed of the Hyuga Group of foliated cataclasite consisted with scaly shale, tuffacious shale, sandstone, and acidic tuff. The main fault core between the hanging wall and footwall is random fabric cataclasite of ~50cm thickness, and above and below, the damage zone close to the fault core is characteristic in the hanging wall and footwall. The hanging wall damage zone (32.4-41.3m) is sandstone-rich, with boudinaged and fragmented structures, while the footwall damage zone (41.3-53m) is clay-rich cataclasite with abundant fragments and less mineral veins. 5 lithologic units are classified in the footwall, mainly by the variety of sandstone, silt, and tuff and its structures. Other than the main fault core, several macroscopic fault zones are seen throughout depth in the hanging wall and footwall, which are included in each unit and partly influence the change in lithology and structure there. Tuffacious silt becomes abundant especially from Unit 3, across the fault zone at 112-118m.

Geophysical logging data correlates well with the lithology and structure observed above, and the contrast between the hanging wall and footwall is particularly clear around the main fault core. Footwall presents higher values of neutron porosity (~7.6%) compared to hanging wall (~4.8%), while porosity is lowest (~3.6%) towards/just above fault core. Resistivity is higher at hanging wall (LN~507, SN~453, GD~400 ohm-m), followed by drop near fault core (329,268,315) and stably lower footwall (308,232,310). P-wave velocity is slightly higher at hanging wall and fault core(~4.3km/sec) compared to footwall (~4.2km/sec). Temporary drop in natural gamma ray (~108API) and spontaneous potential (~39mV) are characteristic towards and just above fault core, while values are nearly constant at hanging wall (~123API, ~55mV) and footwall (~122API, ~57mV). Density does not vary much throughout depth (~2.7g/cc).

Curve fitting of number distribution of logging data for each unit, and statistically significant values are obtained from normalized distribution. To understand and estimate the physical property of megasplay fault from logging data, I recalculate values using elastic theory of open cracks assuming the effective pressure to be 55 MPa representing those at in situ values of the Nobeoka Thrust when it was active at depth.

キーワード: 分岐断層, 付加体, 南海トラフ, 岩石物性
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