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Initiation and development of slickenlined surfaces in clay-rich material of the Nankai Trough accretionary prism

Ana Crespo-Blanc (1), Anja Schleicher (2), and the IODP Expedition 348 Scientific Team

(1) Departamento de Geodinámica - IACT, Universidad de Granada - CSIC, Granada, Spain (acrespo@ugr.es), (2) Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum, Potsdam, Germany (aschleic@umich.edu), (3) Chikyu D/V, offshore Kii Peninsula

During the International Ocean Discovery Program (IODP) Expedition 348, which is part of the Nankai Trough Seismogenic Zone Experiment (stage 3), the drilling vessel Chikyu advanced the deep riser hole at Site C0002, located 80 km offshore of the Kii Peninsula (Japan), from a depth of 860 meters below sea floor (mbsf) to 3058.5 mbsf. Underlying the Kumano Basin sediments, the Nankai accretionary prism appears, below 975.5 mbsf. It accreted during Upper Miocene to Pliocene times and is formed mainly by turbiditic silty claystone with rarely observed sandstone intercalations.
Cuttings from both the 1–4 mm and >4 mm size fractions were investigated, showing slickenlined surfaces and deformation bands together with carbonate veins throughout the entire section from 1045.5 until 3058.5 mbsf. A scaly fabric is increasingly observed below approximately 2400 mbsf. Clay-rich cuttings were selected at different depth for specific SEM-EDS analysis, in order to investigate the initiation and development of the slickenlined surfaces, from both a structural and mineralogical point of view.
Two end-members of the slickenlined surface types were observed: a) isolated smooth and uniform planes, between 20 and 50 μm long, formed by single grains of smectite with marked lineations and frequently jagged boundaries and b) microfaults (longer than 100 μm) with sharp boundaries to the undeformed rock, formed by aggregates of illite and smectite and with a well-developed lineation. In transition between these two end-member types, planes that are apparently unconnected draw a single plane and show subparallel lineations. Concerning the orientation of the slickenlines, it seems to be coherent with that observed in an array of conjugated faults, i.e. all the slickenlines belong to the same plane, in turn sub-perpendicular to the intersection of conjugated planes.
These observations suggest that the slickenlined surfaces initiated along single grains of smectite and that with increasing deformation, the planes coherently oriented connected all together until the formation of a mature slickenline surface (microfault). It must be stressed that the described geometry was observed at any depth and the same process of formation seem to be valid for the whole drilled section of the Nankai accretionary prism.

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