Permeability structure and shear failure properties around an ancient exhumed subduction-zone fault (II)

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We conducted permeability measurements and shear fracture experiments on rocks sampled from an exhumed ancient subduction zone fault in the Cretaceous Shimanto accretionary complex of Japan. The permeability and shear failure properties under seismogenic environment conditions show a heterogeneous structure across the fault zone. A combination of permeability contrast between these two zones and fluid pressure source, including tectonically driven burial and dehydration, could result in a concentration of pore fluids along the fault, which causes Deep Seismic Reflections during underplating stage as delineated in seismic reflection studies. Following a rise of temperature up to 250C, the permeability of all the sampled rock types became smaller than at room temperature, and also gradually decreased with increasing hold time.

Shear fracture experiments showed that peak shear strength of highly sheared zone is lowest, and black shale in melange also has weak strength. In contrast, sandstone in turbidite sequence shows the hugest values of the peak shear strength. It is also found that maximum slip-weakening rate of highly sheared zone and black shale in melange shows the smallest values across the fault zone. This result indicates that the shear failure process of highly sheared zone and black shale in melange develops more stably than other rock types.

Hemipelagic sediments, mainly composed of black shale with low strength and high stability of shear failure, are sandwiched between sandstone in coherent unit and oceanic basement. Based on the present experimental results and geological evidences, we propose the idea that the underthrusting process coincides with the aseismic-seismic transition regime.