Normal-faulting Paleostress around the Up-dip Limit of Seismogenic Zone Recorded in an Onland Accretionary Complex

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Mechanical condition of plate boundary thrusts is one of the most essential problems in subduction zones. Their weakness owing to elevated pore fluid pressure is expected since Hubbert and Rubey (1959). The critical taper model of accretionary wedge with macroscopic topographic data (Davis et al., 1983) also supports that although it was based on the assumption of mechanical equilibrium in static state. Recently, decoupling of stress and strain at decollements has been confirmed by direct observations of the Ocean Drilling Programs (e.g., Moore et al., 1998). To shift to dynamic or seismogenic processes, the San Andreas Fault has been intensively studied and turned out to be a weak strike-slip fault without frictional heating. What confirmed that was the stress field with sigma-1 (maximum compressional) axis at large angles (60 - 85 degrees) to the fault plane inferred from focal mechanisms of earthquakes, in situ stress measurements and geologic structures (e.g., Mount and Suppe, 1987; Zoback et al., 1987). The cause of weakness was guessed to be superhydrostatic fluid pressure and dynamic thermal pressurization (Hickman et al., 1991, 1995; Chester et al., 1993).

Similarly, do the decollements in subduction zones also have such low strength? For the purpose of elucidating mechanical conditions there, meso-scale faults in a tectonic melange of the ancient Shimanto accretionary prism were analyzed using a stress inversion technique. The studied Mugi melange is comprised of terrigenous and oceanic materials and is thought to have underplated with forming duplex structure at the depth of the up-dip limit of the seismogenic zone. Systematically striated shale cleavages represent melange-forming ubiquitous shear deformation. According to cross-cutting relationship, the meso-scale faulting occurred before or during the duplex underplating process.

The multi-inverse method (Yamaji, 2000b), which is an extended version of classical stress inversion (Angelier, 1979), was applied to fault-slip data obtained in each duplex unit. Most of the resultant sigma-1 axes are arranged normal to the shale cleavages. Although the cleavages slightly vary their orientations according to later rotations, sigma-1 axis changes together with them. This cleavage-controlled paleostresses have low stress ratios, that is, axial compressional ones. In the restored orientation the meso-scale faults appear to have been formed as normal ones due to overburden. The duplex structure is thought to be formed at the moment of underplating and be caused by stepdown of the décollement (e.g., Platt, 1985; Sample & Fisher, 1986; Moore & Silver, 1987). Assuming the horizontal compressional stress field in the accreted body, the normal-faulting under the decollement requires the decoupling of stress field at the plate boundary. Consequently, a weak decollement is inferred at least around the up-dip limit of the seismogenic zone.