Development of fault zones along the Median Tectonic Line, Mie Prefecture, south-west Japan: implication for weakening in the fault core

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The Median Tectonic Line (hereafter referred to as the MTL), which is the largest-scale tectonic line in Japan, extends from eastern Kyushu to the Kanto mountains, north-west of Tokyo, over 800 km throughout south-western Japan. Although the structural development of the MTL is complex, the proto-MTL was originally formed as a granitic mylonite belt in the Ryoke belt of the inner belt of south-west Japan in the latest Cretaceous (Kashio phase). This was later developed into the boundary normal fault between the Sambagawa high P/T-type metamorphic rocks of the outer belt, and Ryoke low P/T-type metamorphic rocks and granitoids, when the former were exhumed and juxtaposed against the latter at 63-58 Ma (Ichinokawa phase, e.g. Kubota and Takeshita, 2008).
We have investigated the MTL in this area to elucidate structural development and weakening processes in a large-scale fault zone, and found the following facts. (1) The upper plate of the MTL consists of c. 70 m thick cataclasite (i.e. fault core) originated from granitic mylonite and protomylonite, overlain by weakly fractured mylonite and protomylonite (fault damage zone). It should be noted however that thin anastomosing cataclasite zones are also developed in the weakly fractured mylonite and protomylonite. (2) Cataclasite was developed into foliated cataclasite with increasing degree of fracturing, and the foliated cataclasite developed along the MTL contains clasts of ultramylonite (Jefferies et al., 2006). (3) Both Y-maximum and type-I cross-girdles with rhomb-maxima (i.e. rhomb plane parallel to the foliation) quartz c-axis fabrics are developed in deformed and recrystallized quartz constituting the mylonite and protomylonite in the fault damage zone (cf. Sakakibara, 1995; Shimada et al., 1998). On the other hand, the quartz c-axis fabrics in mylonite to ultramylonite from the fault core are very heterogeneous, and vary between Y-maximum, type-I cross-girdle with rhomb-maxima, Z-maximum, and random patterns even in a thin section (Czertowicz et al., this session, cf. Okudaira and Shigematsu, 2012). (4) Some areas of mylonite and protomylonite in the fault damage zone suffered overprinting deformation at higher stresses indicated by bulging recrystallization with an average recrystallized quartz grain size of 10 mm in contrast to that of 70 mm associated with the development of the Y-maximum quartz fabric pattern (Bui et al., this session).
As the mylonite and protomylonite formed along the proto-MTL were elevated and cooled, the ductile deformation could have become localized into the fault core, where the differential stresses were built up to form ultramylonite, which is shown by the clast of ultramylonite contained in the cataclasite zone. This strain localization of ductile deformation is evidenced by the development of type-I crossed girdles with rhomb-maxima in the ultramylonite, whereas a Y-maximum c-axis fabric is dominant in quartz from the protomylonite, which are inferred to have been formed at low (300 to 400 $^{\circ}$C) and intermediate (400 to 500 $^{\circ}$C) temperature conditions, respectively (e.g. Takeshita and Wenk, 1988). Note that this strain localization occurred very heterogeneously, shown by the very heterogeneous development of quartz c-axis fabrics in the fault core. However, once cataclasite was formed by faulting, fluids migrated into the MTL fault core zone, resulting in the formation of mica and clay minerals, which weakened the MTL by not only lowering the coefficient of internal friction in rocks, but also enhancing the operation of pressure

solution creep shown by the development of foliated cataclasite. When the fault core consisting of cataclasite was weakened, the stress buildup no longer occurred there, which could have resulted in stress concentration in the surrounding rocks, leading to the low-temperature deformation overprint in the protomylonite shown by bulging recrystallization in quartz.

Keywords: Median Tectonic Line, Mylonite, Cataclasite, Quartz c-axis fabric, Pressure solution