Extensive faulting in the biotite zone during exhumation of the Sambagawa metamorphic rocks in central Shikoku, Japan

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Our research group has been conducting researches on exhumation tectonics of the Sambagawa metamorphic rocks since 1990. It had been said that the deformation stages during exhumation can be divided into D1, D2 and D3 (e.g. Hara et al., 1977; Faure, 1983; Wallis, 1990), and that there are no major discontinuities (faults) which greatly displace the metamorphic zone boundaries, although the large-scale recumbent fold which overturns the peak-metamorphic thermal structure forms during the main exhumation stage, D1 (e.g. Wallis et al., 1992). On the other hand, Takeshita and coworkers have pointed out that faulting at low temperatures during the exhumation stages was distinct and pervasive in the biotite zone, based on the facts that the P-T paths inferred from the compositional zoning of amphibole greatly changes in the small distance (Yagi and Takeshita, 2002, JMG), and that there are discontinuities in the spatial distribution of recrystallized grain size of quartz, which was deformed and recrystallized, and frozen-in at temperature conditions between 300-450 degrees (Takeshita and Yagi, 2004, Geol. Soc., London, Special Pub., 227). In fact, distinct and pervasive faulting has been recognized in the oligoclase-biotite zone along the Asemi-River (Shiraga and Ryuo logging roads, Takeshita and Yagi, 2004), and at the boundary between the biotite and garnet zones along the Kamio and Saruta Rivers (Takeshita and Yagi, 2003, Earth Monthly). Furthermore, we have recently documented that faulting pervasively occurred in the biotite zone along the lower reaches of the Kokuryo River, Niihama city (El-Fakharani and Takeshita, 2004, abst. GSJ; Takeshita, 2005a, abst. Joint Meeting; Takeshita, 2005b, abst. GSJ). In this area, folds of the wavelength less than 100 m with the axis trending WNW-ESE, plunging W at 30 degrees penetratively develop. The folds, which sometimes accompany crenulation cleavages, are inferred to be D3-stage folds. Stereographic plots indicate that poles to the faults, which are oblique to the foliation at low angles (Group A, mentioned below), lie on the same great circle, on which poles to the foliation planes lie, suggesting that the faults themselves are also D3-folded together with the foliation planes. Restoring the fault orientations to those before the D-3 folding, we have found that one dominant fault system strikes ENE-WSW and dip northwest (Group A), and another system strikes N-S to NNW-SSE and dips east (Group B). Slicken-fibre of quartz often develops on the fault plane, trending NW-SE. Therefore, the first dominant set of faults (Group A) is normal fault with a sinistral strike-slip component. Both sets of the faults seem to be conjugate. These conjugate faults extensively develop, particularly in the oligoclase-biotite zone, traced to the Oriu Area (Elouai and Takeshita, 2003, Earth Monthly) and Asemi River area (Shiraga and Ryuo logging roads) mentioned above, which are located 15 km and 25 km far from the Nihama area toward the ESE direction parallel to the strike of foliation. Although how much displacement occurred along the fault zone cannot be estimated for the moment, it could be inferred that the oligoclase-biotite zone was a large-scale detachment normal fault zone during exhumation of the Sambagawa metamorphic rocks.