Ductile Shear Zone in the Setogawa Slate belt along Itoigawa-Shizuoka Tectonic Line

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The Itoigawa-Shizuoka Tectonic Line (ISTL) is a major fault that divides SW Japan from NE Japan and Fossa Magna. Although the recent activities of ISTL attract the attentions of many geoscientists from the geohazardous points of view, its deformation history and mechanism have not received little attentions. We present here the results of detailed structural analyses a ductile show zone in the Paleogene-Lower Miocene Setogawa Group along ISTL in a well-exposed outcrop, about 1 km in N-S length and 150 m in E-W width, along the Hayakawa River in the Akaishi Mountains. The Setogawa Group on the west of N-S trending ISTL around this outcrop is mainly composed of mudstone layers which intercalate sandstone and tuff layers of several cm to 2 m thick. In the mudstone, strong slaty cleavages develop nearly parallel to the N-S trending and steeply dipping bedding surfaces forming a regional-scale slate belt. The slaty cleavages are considered to have been formed by coaxial layer-normal flattening under a metamorphic condition of greenschist facies.

In this outcrop, the Setogawa Group has abundant meso- and microscopic ductile deformation structures such as slaty cleavages, composite planar fabrics, and asymmetric folds. Asymmetrical composite planar fabrics including S-C like structures and rhomboidal boudins, made by lensoidal clasts of sandstone and 'fish' of sigma structures of disrupted quartz veins, clearly indicate that they were formed by left-lateral layer-parallel shear with stretching component. Many quartz veins, about 10 cm thick in maximum, develop nearly parallel to the slaty cleavages. The opposite-z-shaped asymmetric folds, less than a few tens of cm in wavelength and tight to closed in shape, are also often found in the slate that includes many quartz veins and sandstones layers. These folds have NNE-SSW trending axial planes with sub-vertically plunging axes. The veins in the longer limbs of them are trend to be thicker and those in the shorter limbs to be thinner. These asymmetrical shapes show left-lateral layer parallel shear with shortening component. Formation temperature of the veins is estimated at about 330 degrees Celsius by micro-thermometry of fluid inclusions. This temperature agrees with the ductile deformation features of quartz grains in the veins, which show grain boundary migrations and undulose extinctions in thin sections. Some of these folds cut and dislocate the composite planar fabrics, suggesting that the composite planar fabrics were formed earlier than the asymmetric folds.

This study concludes that the ductile deformation structures in the Setogawa slate belt were formed under a condition of greenschist facies metamorphism in association with the left-lateral shear of ISTL after the development of slaty cleavages by coaxial layer-normal flattening. Stress fields change from elongation into contraction in this study area during the left-lateral shear. This strike-slip motion was related to the northward bending of the easternmost SW Japan due to the collision of the Izu-Bonin Arc during the Early-Middle Miocene.