

Paleostress transition estimated from small-scale deformation structures of the Sanbagawa metamorphic rocks in the Nagatoro area, Saitama Prefecture, central Japan

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Low-grade metamorphic rocks of the Sanbagawa belt are well exposed in the Nagatoro area, Saitama Prefecture, where deformation structures such as folds, kink bands, faults, and mineral veins are well developed. Uemura and Kanesaki (1989) described deformed small structures in detail in the Nagatoro area, and reported that deformation stages (D1~D5) can be divided by cutting relationship. In low-ductility phase, contractional kink bands (D4 stage) were formed prior to extensional kink bands, small faults, and mineral veins (D5 stage). However, few studies have focused on the paleostress fields of D4 and D5 stages forming these structures. This study aims to determine the paleostress fields and to study its detailed deformation history of the Sanbagawa metamorphic rocks of in the Nagatoro area using paleostress analytical methods after Yamaji et al. (2006), and Yamaji and Sato (2011). We measured the attitudes (and slip directions) of 27 kink bands, 17 small faults, and 202 white mineral (quartz and/or calcite) veins to determine the paleostress fields. By using the Hough transform method (Yamaji et al., 2006), contractional kink bands (D4 stage) are indicated to have been subjected to Stress D4 (σ_1 : 216°/18°, σ_3 : 54°/71°), while the extensional kink bands and small faults (D5 stage) to the two different stresses; Stress D5-1 (σ_1 : 180°/79°, σ_3 : 47°/8°), and Stress D5-2 (σ_1 : 33°/32°, σ_3 : 211°/58°). These results are also consistent with those of paleostress analysis using the quartz veins (D5 stage). Furthermore, the stress analysis using calcite twins in the veins indicates that deformation structures in D5 stage were subjected to Stress D5-1 prior to Stress D5-2. These results imply that the Sanbagawa metamorphic rocks in the Nagatoro area have experienced the transition of three paleostress fields from D4 through D5-1 to D5-2 stages. Considering the mean ductility of each small structure and the deformation temperature (around 200 °C: Burkhard, 1993) estimated from the geometrical characteristics of calcite deformation twin, these small structures are sequentially formed at the time of exhumation of the Sanbagawa metamorphic rocks.

Keywords: Sanbagawa metamorphic belt, kink band, mineral vein, fault, paleostress analysis