Deformation and fluid flow related to the Nobeoka Thrust in the Shimanto Belt, eastern Kyushu

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Nobeoka Thrust is a major geologic boundary between the Northern and the Southern Belts of the Shimanto accretionary complex in Kyushu, Southwest Japan. It strikes roughly NE-SW direction and dips gently to the North. The Nobeoka Thrust is a fossilized out-of-sequence thrust (OST) which was active at the depth of seismogenic zone. And there is no evidence for the reactivation during and after its exhumation to the surface. Therefore, it is expected that seimogenic-related geological phenomena are recorded within and around the Nobeoka Thrust. The hanging-wall and the footwall of the thrust are the Kitagawa and the Hyuga Groups, respectively. Although both of them are shale-dominant accretionary complex, their deformation regimes are quite different. The hanging-wall Kitagawa Group exhibits penetrative plastic deformation, and the footwall Hyuga Group is characterized by brittle melange fabrics. Vitrinite reflectance analysis reveals ca. 70 C of thermal gap across the Nobeoka Thrust, which corresponds to 8-10 km of fault displacement assuming 35-40 C/km of geothermal gradient. The estimated displacement is unusually large for OST in modern subduction zone, with an exception of the splay fault in the modern Nankai Trough.

The obtained sense of shear for the Nobeoka Thrust is the top-to-the south thrusting. All structural elements in the hanging-wall and footwall are consistent with that those in the fault core zone.

Damage zone of Nobeoka Thrust is asymmetrically distributed with regard to the thrust. The fault-related brittle deformation in the hanging-wall side can be recognized only within two meter thick from the fault core. However, in contrast, it can be traced down to 100 m in the footwall side. This feature is quite different from the previous understanding of the damage zone; i.e. the hanging-wall side is more damaged than the footwall side in case of thrust type fault (Ramsay, 1990).

Veins of several different origins are developed in the fault core and the footwall rocks. The latter is a tension crack filling vein, opened perpendicular to the P-surface of the melange fabric. Heating and cooling experiments of the fluid inclusions in these veins have yielded 148-175 C, 128-148 MPa for fault core vein, and 148-260 C, 144-218 MPa for tension crack vein for their trapped temperature-pressure (P-T) conditions. Interestingly, the latter yielded higher temperature. In the footwall rocks, distribution of high temperature fluid has a positive correlation with the concentration of micro shear zone. Paleo P-T conditions of these vein fluid are not in equilibrium with the surrounding rocks. This infers the fluid derived from deeper part of the subduction zone infiltrated upwards in association with the movement of the Nobeoka Thrust.