Temperature and pressure estimates of vein-forming fluids in the footwall rocks of the Nobeoka thrust, Kyushu, Japan.

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A number of quartz and carbonate veins occur in pelitic rocks of the Paleogene Huga Group, the footwall rock of the Nobeoka out-of-sequence thrust (e.g., Kusaba et al., 2008). Quartz in the veins and neighboring host rocks were collected from 1-27 m away from the thrust for temperature and pressure estimates of the vein-forming fluids.

Microthermometry measurements of two-phase fluid inclusions in the vein quartz show their homogenization temperatures of about 180°C with NaCl eq. salinities of about 4 wt. %. The temperatures and salinities do not vary with distance from the thrust.

Modal reflectances in air (Ra) of carbonaceous matters (CMs) in the pelitic rocks close to the veins are around 0.10 being equivalent with those in oil (Ro in %) as 1.59. They also do not vary with the distance from the thrust and are almost the same as those in the rocks away from the veins. The spreadsheet of the easy % Ro (Sweeney and Burnham, 1990) has been modified to enable it to simulate thermal maturations of CMs for constant temperature durations (Okamoto, 2016), and is used in the present study to estimate diagenetic T-t paths of the host pelitic rocks of which diagenetic duration is taken as 49 myr. The resultant highest temperature for a parabolic T-t path is 174°C, while that for a trapezoidal path is 166°C. Since the difference in the two temperatures is small, we will take the former path for the following estimations.

The maximum depth of the diagenetic process of the rocks could be estimated as 6.0 km when we assume the geothermal gradient of 25°C/km. The hydrostatic pressure at the depth has been calculated by accumulation of water columns downwards with water densities at given P-T conditions provided by NIST as 57 MPa. Hence, fluid temperatures can be estimated from an isochore depicted from the homogenization temperatures of above fluid inclusions as 214°C.

Since the fluids in fissures now occupied by the veins did not affect maturations of CMs close to the veins, the fluid might percolate adiabatically (rapidly). Therefore, it can be concluded that when the veins were formed by filling under the hydrostatic condition at the maximum depth (6.0 km), the fluids might migrate from deeper than 7.6 km (214°C). In the same manner, the fluids infiltrated from deeper than 6.9 km (197 °C), when the veins were formed at 3.0 km during the late diagenetic (ascending) process.

Numerical simulations of the above isothermal decompressions revealed that quartz precipitate 0.0003 mole/kg-water in the former, while 0.0007 in the latter.

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