Porosity variation of fault rocks accompanied the Median Tectonic Line in Shikoku, southwestern Japan

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Petrophysical properties of fault rocks are important information to understand evolution processes of fault rocks. Among their properties, hydraulic properties of fault rocks are closely related to fault dynamics and potential of reservoirs of fluid or gas. In this research, we focused on distribution of porosities through fault rocks of the Median Tectonic Line in Shikoku.

The Median Tecotnic Line (MTL) is the longest geological terrane boundary fault. The northern and southern parts from the MTL are Ryoke Belt composed of low P/T metamorphic rocks, granitic rocks and sedimentary rocks and Sanbagawa metamorphic rocks consisted of high P/T metamorphic rocks, respectively. We drilled a bore hole to obtain a geological core sample penetrating the MTL. The total core length is 250 m-long. The fault plane of the MTL is within 37.45 m-depth. The hanging wall and foot wall zones are Izumi Group in Ryoke Belt and Sanbagawa metamorphic rocks, respectively.

The fault rocks in Izumi Group are composed of three zones, fault breccia zone (ca.4– ca.12.5 m-depth), transition zone (ca.12.5–ca.31.6 m-depth) and fault gouge zone (ca.31.6–ca.37.2 m-depth), based on geological observation. On the other hand, the fault rocks of the Sanbagawa metamorphic rocks are cataclasite just below the MTL fault plane (37.45–ca.47 m-depth) and intact rocks in the deeper parts of the core (ca.47–250.0 m-depth).

We measured 49 samples (24 samples in Izumi Group and 20 samples in Sanbagawa metramorphic rocks) from the core. In addition to them, 5 samples from outcrops of Izumi Group were measured to get porosities of intact rocks of Izumi Group, because all parts of Izumi Group in the core are damaged.

The porosities of the hanging wall (Izumi Group) range between 4.54% and 20.35%, whereas those of the foot wall (Sanbagawa metamorphic rocks) are lower (2.06%–11.4%) than those of the hanging wall. Additionally, the porosities of the outcrop samples of Izumi Group show quite low (0.97%–1.75%), corresponding to those of intact rocks of Izumi Group, whereas those of the intact rocks of Sanbagwa metamorphic rocks are estimated to be ca.2%–ca.3%. These porosities are measured for samples in the deep zone (ca.75–ca.200 m-depth) of the core, which are quite far from the fault plane. The porosities of the three zones of fault rocks in the hanging wall are 5.19%–15.27% for the fault breccia zone, 4.54–15.30% for the transition zone and 11.02–20.35% for the gouge zone. It should be noted that the porosities are corrected on the basis of CT values. As the fault rocks of Izumi Group are composed of matrix and clasts, we measured the porosities of both matrix and clasts (or blocks) for each sample. Then, we calculated the correction porosities based on the ratio of matrix and clasts of CT values.
The porosities in the hanging wall (Izumi Group) widely vary depending on characteristics of fault damage, however those gradually increase toward the fault plane. In addition, the porosities are quite higher than those of intact rocks. On the other hand, the high porosity zone in the foot wall (Sanbagawa metamorphic rocks) is limited in a narrow zone (37.45–ca.50 m-depth). These facts suggest that the hanging wall (Izumi Group) are strongly damaged compared to the foot wall (Sanbagawa metamorphic rocks). This is an intriguing characteristics for understanding petrophysical properties of fault rocks.

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