Pore geometry and elastic moduli of fault rocks accompanied by the Median Tectonic Line in Shikoku, southwestern Japan

*Michiharu Ikeda[1], Kakda Kret[2], Takeshi Tsuji[3], Tatsunori Ikeda[3], Tomohiro Tsuji[4], Kozo Onishi[5], Naoki Nishizaka[5]

1. Department of Civil Engineering, Shikoku Research Institute Incorporated, 2. Institute of Technology of Cambodia, 3. Kyushu University, 4. Yamaguchi University, 5. Shikoku Electoric Power Co. Inc.

Textures or fabrics of fault rocks are basic geological information to estimate maturity and evolution processes of faults. The textures or fabrics are composed of various components: shear planes, matrix, clasts, pores etc. Especially, pores play an important role in evolution processes of fault rocks, because pores strongly control behavior of fluid which promotes alteration of fault rocks and trigger mechanical instability of faults. Pores in fault rocks are mainly composed of intergranular pore, crack pore and clay pore. Fabrics or geometry of pores in mature faults have been subjected to significant modification for a long time. Therefore, the shape of pores in fault rocks can be a good indicator for deformation intensity, evolution stages, and categorization of fault rocks. In this study, we focused on variation of characteristics of pores through fault rocks of the Median Tectonic Line in Shikoku.
The Median Tecotnic Line (hereinafter MTL) is the longest geological terrane boundary fault. The northern and southern parts from the MTL are the Ryoke Belt composed of low P/T metamorphic rocks, granitic rocks and sedimentary rocks and the 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 the Izumi Group in Ryoke Belt and Sanbagawa metamorphic rocks, respectively.
The fault rocks in the Izumi Group can be classified into three zones, Fractured zone (ca.4–12.5 m-depth), Transition zone (ca.12.5–31.6 m-depth) and Gouge zone (ca.31.6–37.2 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 (ca.37.5–47 m-depth) and intact rocks in the deeper parts of the core (ca.47–250 m-depth).
We measured seismic velocities and porosities of 53 samples; 24 samples in the Izumi Group and 24 samples in Sanbagawa metramorphic rocks from the core. Because all core samples of the Izumi Group are damaged, 5 samples from outcrops (intact rocks) of the Izumi Group were measured. We estimated the dominant pore aspect ratio (short axes/long axes) and grain elastic moduli from observed velocity-porosity relationships of these samples via the grid-search inversion (Kakda et al., 2018).
Overall, aspect ratios a of pores of intact rocks of the Izumi Group (a=0.005) are distinctly small in comparison to those of damaged rocks of the Izumi Group (a=0.06–0.30). The gouge samples show the largest values of the aspect ratios in the damaged rocks. The aspect ratios of the transition rock samples are slightly higher than those of the fractured rock samples. And then, elastic moduli of intact rocks are remarkably large in comparison to those of damage rocks. The bulk and shear moduli of intact rocks are ca.100 and 60 GPa, respectively, whereas ca.3–5 GPa for both elastic moduli in damage rocks. The gouge samples show largest values of the elastic moduli in the damaged rocks. The elastic moduli of the fractured rock samples are higher than those of the transition rock samples.
The results indicate that destruction of an original rock structure in intact rocks must affect both pore aspect ratios and grain elastic moduli. And then, the variation of the aspect ratios of pores in damaged rocks should depend on combination of the three type pores with each characteristic. On the other hand, the elastic moduli in damaged rocks might be controlled by mixing materials which have different stiffness. The variation of pore aspect ratios and grain elastic moduli along the MTL contribute to

understand evolution processes of fault zone and evaluate petrophysical properties (e.g., permeability or strength) of fault zone.

Keywords: pore geometry, elastic moduli, MedianTectonic Line