In-situ visualization of fluid flow image by X-ray CT

Tetsuro Hirono[1], Manabu Takahashi[2], Satoru Nakashima[3]

[1] Interactive Research Center for Sci., TIT, [2] GSJ, [3] Interactive Research Center, Tokyo Inst. Technol.

X-ray CT image has been successful applied to this study of fluid advection in laboratory permeameter. High-resolution, three-dimensional fluid flow distribution was measured for fault-related rocks. The fault zone of independent particulate flow mechanism play a role as conduit to fluid flow while cataclastic fault zones act as barriers. In sheared rock including some cracks, the only connected cracks can function as fluid conduits. The localized permeabilities along permeable fault zones and fractures, calculated by fluid front rates, are two-orders higher than averaged bulk permeability derived from the pressure or volume difference between inflow and outflow in permeameter.

Many laboratory-based permeability measurements have been performed on reconstituted fault derived from crystalline rocks. However, the previous experiments treat averaged bulk permeability values derived from the pressure or volume difference between inflow and outflow at any methods (e.g., constant head, flow pump and transient pulse methods). The heterogeneity within samples was, that is, out of consideration on the studies. The aims of this research was specified as follows:

1) To visualize the advecting fluid image during permeability testing.

2) To elucidate the relationship between fluid flow property within fault related rocks and their deformation mechanism.

In order to achieve these aims it was necessary to develop apparatus with the capability of not only measuring permeability but also visualization of fluid advection. The X-ray computerized tomography (CT) medical scanner was used as a tool to noninvasively image three-dimensional flow patterns during permeability testing. Experiments were carried out using the permeameter machine made from acrylic plastics, which was sit in X-ray CT. KI solution was used as a contrast medium, because it has much advantage of high X-ray attenuation and innocuousness for human.

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