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# Evolution of aperture distribution and permeability change during fracture sealing by silica minerals

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Fractures are dominant fluid pathways in the upper crusts. Ubiquitous occurrences of quartz veins suggest that precipitation of quartz provides significant effects on the hydrological and mechanical properties of crustal environments. For example, a model has been proposed that fracture sealing processes control the change of pore fluid pressure and thus earthquake cycle. Previous studies on quartz veins have focused on the P-T conditions, stress and strain fields and fluid compositions; however, details of dynamics of fluid flow and how fractures are sealed during vein formation are still unclear. In this study, we carried out the hydrothermal experiments to synthesis quartz veins, and observed the aperture structures by using X-ray CT. The purpose of this study is to clarify how aperture structures evolve by quartz precipitation in fractures and to understand the behavior of permeability evolution during vein formation.

We conducted the hydrothermal flow-through experiments for quartz precipitation from Si-supersaturated solutions at 430C and 30 MPa (supercritical region). The experimental apparatus consists of two vessels for preparation of the Si-supersaturated solution and for precipitation, respectively. The precipitation vessel has double-structure: the main flow path was the inner alumina tube, and the outer SUS tube was filled with static solutions connected with the flow path. A granite core (Westerly granite, diameter=3.6mm, length=50mm) with a slit of 300 micro-meter width was placed in the alumina tube. Inner and outer pressure of the inner tube was almost same (31MPa). Precipitation occurred preferentially within the alumina tube (mainly in the slit of granite), and alumina tube was broken when fracture was sealed and upstream fluid pressure was raised toward ˜35 MPa. The fluid pressure was recorded by the second to calculate the change of the permeability during run. The advantage of this system is that we can take out the non-destructive sample. We observed the aperture sizes of fractures before and after of run by computer tomography.

The mineralogy and aperture structures changes systematically along the fluid flow path. Near the inlet of the precipitation vessel, only amorphous silica precipitated predominantly. From the inlet to 35mm of fracture, nucleation and growth of quartz predominantly occurred, regardless of vein wall minerals. In this region, precipitation of quartz occurred preferentially on top wall rather than bottom wall, indicating the effects of the gravity on the density fluctuation of supercritical water. From 35mm to outlet of fracture, silica precipitates occurred as epitaxial overgrowth from quartz crystal. The wavelength of aperture structures is controlled by distribution and grain size of quartz of the host granite. Accordingly, fractures are not sealed homogeneously, but complex 3D flow pathways are evolved during vein formation.

Keywords: Hydrothermal experiments, Quartz vein, aperture