Detection of temporal change in permeability of the Nojima fault zone by repeated water injection experiments

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Abstract

The Nojima Fault Zone Probe Project drilled three boreholes with depths of 500, 800 and 1800 m near the southwestern end of the Nojima fault, which is one part of the earthquake source faults of the 1995 Hyogoken-Nanbu earthquake. It is expected that displacement and/or crustal deformation at the earthquake enhanced crack density or porosity of the Nojima fault zone and thereafter the fault zone begins the healing process from the damage by the earthquake. We researched the permeability of the fault zone, since the permeability of rock is closely related to porosity of rock. To measure the permeability of the fault zone of the Nojima fault zone, the Project conducted water injection experiments from the 1800-m borehole in 1997, 2000, 2003, 2004 and 2006. We observed discharge rate or groundwater level at 800-m borehole and detected the changes in discharge rate or groundwater level induced by water injection (Figure 1). Using numerical calculations, the permeability of the fault fracture zone was estimated for each experiment (Figure 2). As a result, the permeability in 2000 was 55% of that in 1997 and the permeability in 2003 was 40% of that in 1997. Since 2003, the permeability does not decrease. It is guessed that the decrease of the permeability shows decrease of porosity, that is to say, the healing of the Nojima fault zone after the 1995 earthquake. It is concluded that macroscopic healing continued 5-8 years after the 1995 earthquake.
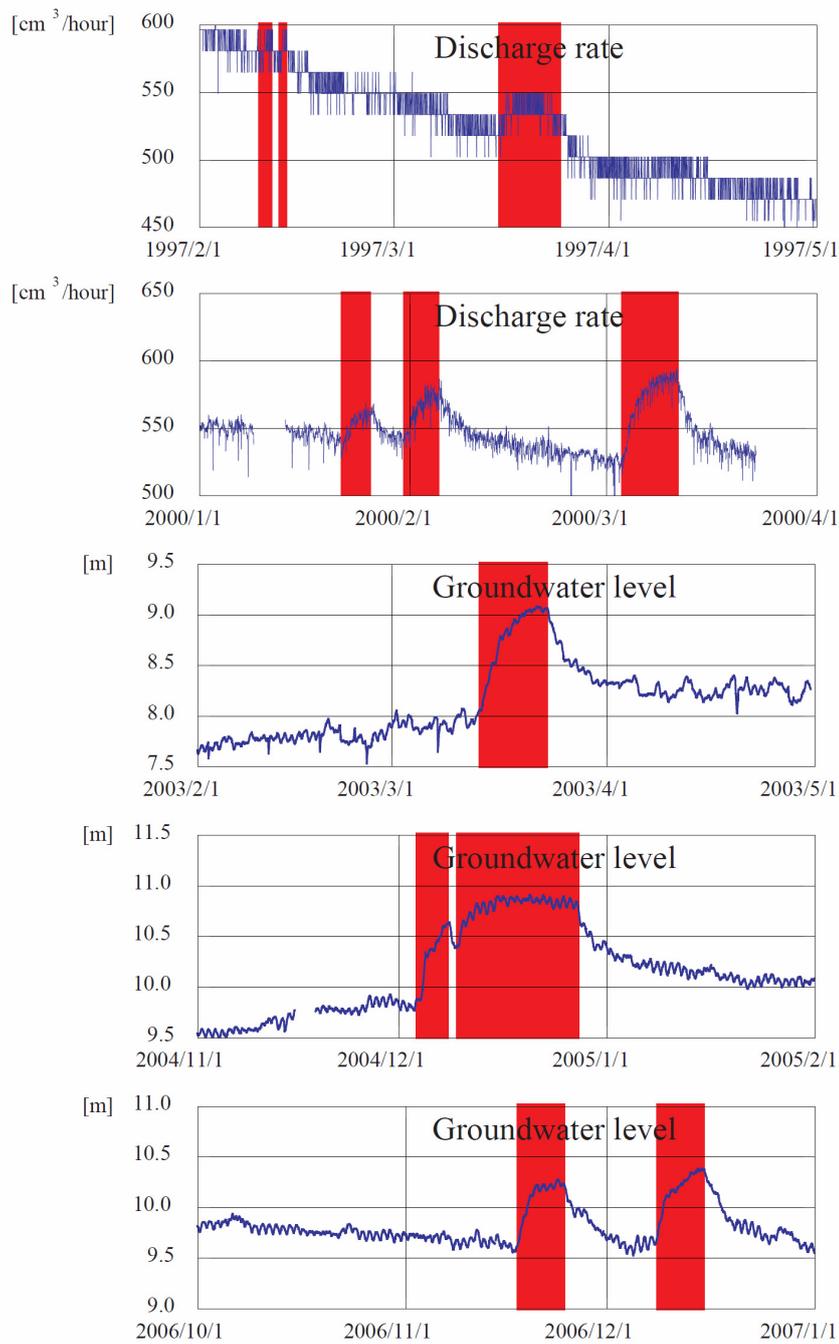
Figure 1. The observation result of the 800-m borehole. Red shaded zones show the period of the water injection experiments at the 1800-m borehole.
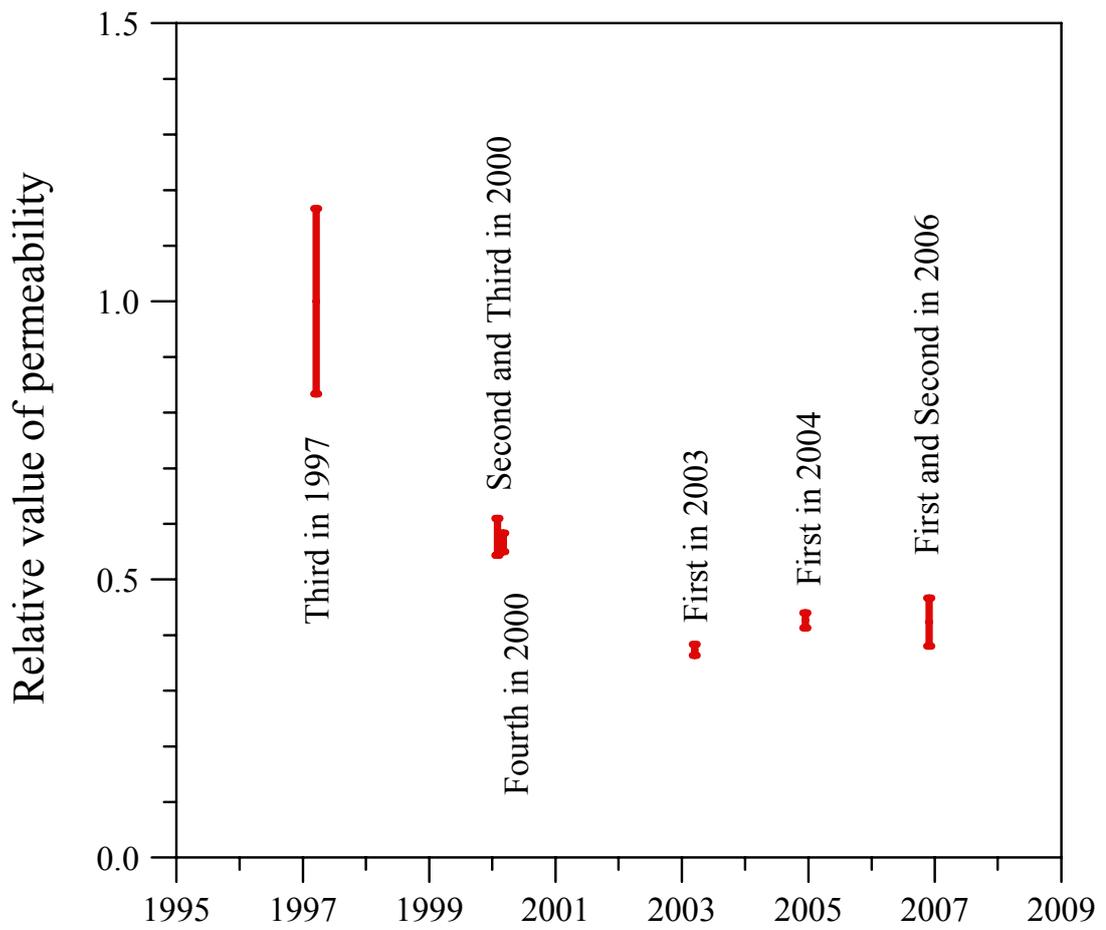
Figure 2. The temporal change in permeability estimated by the experiments. This plot used the relative value for each experiment to median value for third experiment in 1997.