

Temporal change in fault-zone permeability derived from injection-induced seismicity at the Nojima fault, Japan

Keiichi Tadokoro (Nagoya University, Japan)

Kin'ya Nishigami (Disaster Prevention Research Institute, Kyoto University, Japan)

Abstract

A scientific drilling was carried out at the Nojima fault zone that ruptured during the 1995 Hyogo-ken Nanbu (Kobe) earthquake, Japan. Water-injection experiments have been repeatedly performed several times from 1997, two years after the mainshock. Injected water was pressurized at 3-4.5 MPa and injected into the 1800-m-deep borehole and supplied to the fault zone. The main purpose of the water injection experiments is to monitor temporal changes in fault-zone permeability.

We installed a temporary seismic network, with a span of about 2 km around the injection hole to monitor changes in seismic activity accompanying the water injections. We picked up ultramicro earthquakes from continuous recordings, and investigated seismicity change before and after the injection experiments.

In the 1997 experiment, induced earthquakes started to occur 4-5 days after the beginnings of injection. The induced earthquakes in 1997 have the characteristics as follows: the magnitude ranges from -2 to 1; focal region is located about 3 km from the injection point; the focal depths are between 2 to 4 km. We estimated the fault-zone permeability, assuming the diffusion of injected water on the two dimensional fault-zone. Permeability of the fault-zone has been estimated at $10E-14$ - $10E-13$ m² from the time dependency of the induced seismicity [Tadokoro *et al.*, 2000]. The values suggest that the Nojima fault was more permeable than many other regions without active faults.

In the 2000 experiment, the beginning of the induced seismicity was observed at the same region of 1997 activity. Also the other characteristics are same as those of 1997 induced activity. The induced activity started 6-7 days after the beginnings of injection. The time delay of two days implies decrease in permeability in the fault-zone by 20-30 % during the three years due to fault.

Our temporary seismic network detected some groups of earthquake with similar waveform, indicating earthquake clusters. The earthquake clusters are found among both induced and natural earthquakes. In addition, the clusters are observed at the same region for the natural and induced earthquakes. The activity of earthquake cluster reflects inhomogeneity in the crust, that is, the regions of earthquake clusters have low strength.

References

Tadokoro, K., M. Ando, and K. Nishigami, Induced earthquakes accompanying the water injection experiment at the Nojima fault zone, Japan: Seismicity and its migration, *J. Geophys. Res.*, 105, 6089-6104, 2000.