

Secular change of permeability estimated by using the variations of groundwater discharge

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Secular change of permeability causes the variation of the atmospheric pressure admittance of groundwater discharge. We estimated the permeability of the surrounding crust by using the groundwater discharge observed at Rokko-Takao station during 12 years from 2001 to 2012. The estimated secular change of permeability contained the short term variations for about a year as well as the gradual decrease. It is considered that the gradual decrease of permeability was caused by the closure of the cracks, which were opened in the 1995 Hyogoken Nanbu earthquake, due to the accumulation of mud and the crustal stress. On the other hand, the short term variations of permeability suggest the temporary re-open of the cracks due to the earthquake ground motions.

The Rokko-Takao station is located in Kobe, the southern Hyogo prefecture, and passes through the fracture zone of Manpukuji fault. At this station, the significant increase of groundwater discharge was observed just after the 1995 Hyogoken Nanbu earthquake (Fujimori et al., 1995). This suggested that the many cracks were opened in the fracture zone around the station by the ground motion of the earthquake. Mukai and Otsuka (2009) estimated the elastic properties by using the tidal strains observed at the station and reported that the Young's modulus of the surrounding crust showed the secular increase. This suggested that a part of cracks were closed by the crustal stress and the accumulation of mud and the strength of the fracture zone had been recovering.

Mukai and Otsuka (2013) estimated the variations of permeability due to the 2011 Tohoku earthquake by using the atmospheric pressure admittances of the groundwater discharge observed at the station under the assumption of one-dimensional model about groundwater migration. The permeability just after the earthquake increased by about 1.9 times just before the earthquake and decreased to the level about 1.3 times just before the earthquake in 10 months. This suggested that even the small ground motions due to the teleseismic waves could cause the outflow of the mud and the temporary re-open of the cracks in the fracture zone.

In this study, we estimated the secular change of permeability around the station during 12 years from 2001 to 2012 by using the procedure of Mukai and Otsuka (2013). The permeability estimated by using the atmospheric pressure admittances of the groundwater discharge showed the secular decrease by about 50% in 12 years. This result agrees to the secular increase of Young's modulus estimated by using the tidal strain and is considered that the gradual decrease of permeability was caused by the recovering of the fracture zone, in which the cracks were opened in the 1995 Hyogoken Nanbu earthquake.

Keywords: fracture zone, permeability, groundwater discharge, strain change