Permeability heterogeneous structure nearby a fracture zone estimated by observed groundwater migration

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Permeability structure in a fault fracture zone might change due to seismic motion. However we have not realized the spatial scale of the change definitely. In this study, we observed pore pressure changes due to seismic motions at three sites in Rokko-Takao station which was established in a tunnel penetrating the fracture zone of Manpukuji fault, and estimated local changes in permeability structure nearby the fault fracture zone.
Groundwater migration is considered to mainly occur in a fracture zone, because permeability in that area is higher than the surrounding crust. Therefore, a fault fracture zone is approximately assumed to be one board with homogeneous permeability. Mukai et al.(2015) made a one-dimensional groundwater migration model and derived the method to estimate change in permeability by using changes in groundwater discharge and pore pressure. When we applied this model to the data obtained at Rokko-Takao station, we found that permeability in the fault fracture zone had been reduced during a few months just after the 2011 off the Pacific coast of Tohoku Earthquake. This result shows that a strong seismic motion propagated from a long distance could affect permeability structure in a fault fracture zone even though the fault was not an earthquake source fault.
To investigate the spatial distribution of groundwater migration, we newly installed two pore pressure meters in addition to the existing instruments in 2016. When we estimated permeability changes by using the observational data of pore pressure and groundwater discharge, we found that the permeability structure had changed just after the 2016 Kumamoto earthquake and the 2016 central Tottori earthquake as well. However the permeability changes depended on the location to observe the pore pressure, or the distance from the fault. For instance, just after the 2016 Kumamoto earthquake, permeability close to the fault rose by about 7%, while one in dozens of meters distance reduced by about 22%. This discrepancy might be caused by the outflow of mud due to the seismic motion. In the undeveloped fracture zone apart from the fault, the mud could be blocked and the permeability might be reduced, while the mud could flow out in the completely developed fracture zone nearby the fault.

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