

Factors controlling annual changes in groundwater migration in the fault fracture zone of Manpukuji fault

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Rokko-Takao station in the southern area of Hyogo prefecture crosses Manpukuji fault, and the groundwater discharge can be observed all the time about the fault fracture zone. The groundwater discharge and pore pressure observed at the station usually contain annual changes which have the minimum value in spring and the maximum one in autumn. However, the scale of the annual changes depends on year. In 2017, we could not see any definite annual changes in the groundwater discharge and pore pressure. In this study, we investigated some factors controlling the annual changes in groundwater migration and report about the effects of regional crustal movements, precipitation and seismic motions on them.

We have been performing the continuous observation of groundwater migration nearby the fault fracture zone with the groundwater discharge meter and the pore pressure meters, as well as crustal movements with strainmeters, extensometers and water-tube tiltmeters. We calculated the tidal amplitudes and phases in the groundwater discharge and pore pressure by applying the tidal analysis program 'BAYTAP-G' to the observational data, and compared them with the theoretical ones obtained by 'GOTIC2'; the program for computation of oceanic tidal loading effect. The observed phases in major constituents O1 and M2 almost agreed with the theoretical ones for every observed groundwater migrations. This shows that the groundwater discharge and pore pressure changes at the station have similar response to tidal stress.

The groundwater discharge and pore pressure changes in 2017 showed just slight annual changes, the amplitudes of which were at least 10% of the annual averages, while the amplitudes of the annual changes were a few 10% or more of the annual averages in other years from 2015. When we investigated the observational data of groundwater discharge that started to be observed before 2000, the annual changes were diminished definitely in 2005 and 2012 as well. It was considered that the variations in the amplitudes of annual changes might be caused by regional crustal movements, precipitation, seismic motions and so on.

We calculated the dilatation changes as regional crustal movements by using GSI's GEONET data. The dilatation showed significant annual changes even in 2005, 2012 and 2017, so that the diminished annual changes were considered not to be caused by the regional crustal movements. Second, we investigated the effect of annual precipitation. The annual precipitation were unusually small just before 2005, 2012 and 2017, so that it seems that small precipitation might cause decreasing of groundwater and small annual changes in groundwater migrations. However, this idea does not agree with the observed result that the pore pressure had kept to be high level all through 2017.

Permeability in the fracture zone of Manpukuji fault was observed to be reduced over one year after 2011 Tohoku Earthquake (Mukai and Otsuka, 2014). Similar permeability changes occurred just after 2016 Kumamoto Earthquake and 2016 Central Tottori Earthquake as well (Mukai et al., 2017). The diminishment of annual changes in groundwater migrations were observed just after such large earthquakes. This might suggest that temporal decrease of permeability due to the large earthquakes

prevented groundwater migration and propagation of pore pressure, and resulted in the small annual changes.

Keywords: fault fracture zone, groundwater migration, annual change