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Time dependent changes of pore pressure before and after the 2011 Tohoku earthquake

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Changes in well water level, streamflow and chemical composition changes of ground water accompanied by earthquakes have been widely observed. Groundwater monitoring is especially important for understanding of mechanism of earthquake-related change.

We are monitoring continuous pore pressure and atmospheric pressure with a recording interval of 1 second at the Kamioka mine, Gifu Prefecture, central Japan. Pore pressure decreased after the 2011 Tohoku earthquake (M 9.1) on 11 March. In general, causes of the pore pressure changes include meteorological effects, Earth tide and crustal deformation. Here, we focused on the Earth tide response before and after the earthquake. The observed data during the period from April 2005 to December 2011 were divided into time windows of one month (744 hour). The tidal analysis program, BAYTAP-G (Tamura, 1995) is used to extract tidal responses of pore pressure from the divided data. Amplitudes of M_2 and O_1 components decreased after the Tohoku earthquake, which can possibily be due to: (1) the increase of the permeability (2) the elastic coefficient change of the rocks. We estimated the hydraulic diffusivity supposing that the cause of the tidal amplitude change is the increase of the permeability. This yields an increase of the diffusivity from 0.03m^2/s to 0.09 m^2/s. Increase of the hydraulic diffusivity is consistent with pore pressure reduction. But in actually, the effects of the elastic coefficient changes of the rocks cannot be excluded. We analyzed the data before and after the 2007 Noto Hanto Earthquake (M6.9) and apparent amplitude changes cannot be detected. These results imply that only large deformations caused by very large earthquakes, such as the Tohoku earthquake, cause changes of the hydraulic diffusivity and the elastic coefficient.

Keywords: pore pressure, hydraulic diffusivity, Tohoku earthquake, Earth tide