

Recent anomalous groundwater temperature and water level changes at the frontier land zone for impending great earthquakes at the Nankai trough

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Earthquakes are generated by the anisotropic principal stress regime in the rock medium. In the preparing process of a large earthquake, the medium would be deformed generating regions of contraction and dilatation around the nucleus of the shearing stresses. According to a hydraulic model, pore fluid flow is driven upward to the ground surface through crack systems serving as flowing pipes by high pressure pumps at a deep spot. The change in the quantity of the upwelling hot water from deep underground causes a change of groundwater temperature (Tsukuda et al., 2005).

We have 16 groundwater observation stations for temperature, and 3 stations for water level in the Tokai and Nankai regions, central and southwest Japan, respectively, where are close to the source regions of the great Nankai-trough earthquakes. High precision quartz thermometers are installed at Otomi (OT) in Yaizu City and Nakajima (NK) in Shizuoka City. At other stations, platinum resistance thermometers are installed. Due to the machine breakdown, the instrument at OT was replaced by a platinum resistance thermometer in 2014. We use semiconductor pressure sensors for water level. At OT (Yaizu) in the Tokai region, the temperature has been monotonously increasing since the measurement started in 2003. The rate of increase has clearly fallen down since the end of 2012. However, since the middle of 2017, an anomalous increasing temperature change has been found at OT. At NK (Shizuoka), 14km northeast of OT, the temperature data presented a precursory change from increasing to decreasing trend, one year before the 2009 Suruga-bay earthquake of M6.5 (Tsukuda, 2012). The decreasing rate after the earthquake became much higher than before and had continued till 2012. The temperature changed to increasing trend in around May, 2013, and started to severely decrease in 2016. At stations HA and WA in Shionomisaki, Nankai region, Wakayama Prefecture. The long-term trend of the water level is rising, corresponding to the ground subsidence found by levelling and GNSS data (Kobayashi, 2013). The trend of temperature is similarly rising, suggesting contraction of the rock medium under Shionomisaki, the southernmost end of Honshu. At KZ (Kozagawa) in the Nankai region, the temperature is monotonously falling since the observation started in 2002. However, the decreasing temperature changed to severely increase in the middle of 2015. In addition to above anomalies, at Awaji Island and Inagawa Town, Hyogo Pref. located at the back regions of the frontier for the Nankai-trough great earthquakes, anomalous changes of water temperature have been observed recently.

As mentioned above, the deformations of the rock medium are accelerated under the regions close to the source regions of the great earthquakes at the Nankai trough. For prediction studies for the impending great earthquakes, we should start to conduct detailed and multidisciplinary observations.

Keywords: earthquake prediction, groundwater temperature, water level, crustal movement