

Continuous Observation of Groundwater and Crustal Deformation for Forecasting Tonankai and Nankai Earthquakes in Japan

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Abstract

Fluid in the crust is highly sensitive to crust strain and solid deformation can lead to groundwater level changes in a well within confined aquifer, even if the deformation in the crust is small. Previous studies detected groundwater level changes related to the Tonankai and Nankai earthquakes. The results of this study indicate that it should be possible to identify pre-seismic alterations associated with pre-slip through ongoing monitoring of groundwater levels and crustal deformation in the vicinity of the anticipated epicenter of the Tonankai and Nankai earthquakes. Since 2006, the Geological Survey of Japan (AIST) constructed a new observation network of 12 stations for researching the Tonankai and Nankai earthquakes, to clarify the mechanisms of past pre-seismic groundwater changes and crustal deformation. It stands as one of the world's most advanced groundwater observation networks dedicated to earthquake prediction research. Tidal components and the effect of atmospheric loading on the strain, groundwater level and pressure are removed by BAYTAP-G, a Bayesian-based modeling approach for analyzing time series data that contain tidal and other variations. The groundwater monitoring in the Tokai area for earthquake prediction has been done since the 1970s. The M 7.9 1944 Tonankai earthquake was preceded by pre-seismic crustal deformation and followed by co-seismic and post-seismic changes in groundwater levels. The M 8.0 1946 Nankai earthquake, followed 11 pre-seismic drops in groundwater levels. The analysis carried on the first two new stations, HGM and ICU, where strain changes due to slow-slip events were detected. However, the related changes in groundwater levels were not clearly recognized.

Keywords: Groundwater, Strain, Tremor, Slow-slip event, Nankai earthquake, Tonankai earthquake

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Abstract—In 2006, we started construction of an observation network of 12 stations in and around Shikoku and the Kii Peninsula to conduct research for forecasting Tonankai and Nankai earthquakes. The purpose of the network is to clarify the mechanism of past preseismic groundwater changes and crustal deformation related to Tonankai and Nankai earthquakes. Construction of the network of 12 stations was completed in January 2009. Work on two stations, Hongu-Mikoshi (HGM) and Ichiura (ICU), was finished earlier and they began observations in 2007. These two stations detected strain changes caused by the slow-slip events on the plate boundary in June 2008, although related changes in groundwater levels were not clearly recognized.

Key words: Groundwater, strain, tremor, slow-slip event, Nankai earthquake, Tonankai earthquake.

slow slip, in and around the focal region, expected to start a few days before the main shock. These groundwater data can be accessed from http://riodb02.ibase.aist.go.jp/gxwell/GSJ_E/index.shtml.

We have been monitoring groundwater in the Tokai area for earthquake prediction since the 1970s. However, the possibility of the occurrence of Tonankai and Nankai earthquakes, which have occurred in the Nankai Trough next to the Suruga Trough at intervals of 100–200 years, has been increasing recently. In addition, hydrological anomalies related to past Nankai earthquakes were often reported in