Continuous observations of crustal movements at an 800 m borehole on Awaji Island

Kunio Fujimori[1], Atsushi Mukai[2]

[1] Earth and Planetary Sci., Kyoto Univ., [2] Faculty of Law, Nara Sangyo Univ.

Under a scientific program, the Nojima Fault Probe, an 800 m borehole was drilled into the Nojima Fault zone at Toshima in Awaji Island. An Ishii-type multicomponent instrument was installed at the borehole bottom. The continuous observations of crustal strains and tilts have been done since May, 1996. The underground water of about 500cc/hour flows out from the borehole in the opening state of the top, and the gushing out of the water is suppressed in the sealing state of the top. The groundwater pressure in the borehole under the sealing state is about 0.08 M pa higher than that in the opening state. We consider that the pressure surrounding the instrument is a pore pressure of the original state (borehole drilling former). For the first stage of the observations, sealing state was kept, and at the end on December, 1996, the top was opened to measure the discharge amount. The top was sealed up again on August 3, 2000, and the pressure observation has been continued. We consider that pore pressure produces a great influence on the crustal movements, and that keeping an original state of the pore pressure is necessary for crustal movement observations. We report on the crustal movements and the underground water change observed at the 800 m borehole.

The strain trends show a extensional step when the top was opened at the end on 1996, the trend change between before and after the opening is uncertain because the influence of the installation remains still greatly. However, the trends were changed by the sealing in August, 2000. The sealing generated a contractile step in the trends, the strain rates after the step is small, and the strain in the N21W direction changed from an extension into a contraction. That is, after the sealing, contraction strains was caused though strains in all direction under the opening state showed extensions. the strain changes after the sealing harmonizes with the tendency to the strain field obtained from GPS observations and the crustal stress measured in the 1800 m borehole which is for near. It is thought that the recovery to the original state in the pore pressure at the 800m borehole produced the strain changes reflecting strain (stress) state in the large area.

The strain trends show remarkable contractions from the spring of 2001. The underground temperature also began rising from the same, and the rate is about 0.3 degree/year. The cause of this temperature rise is uncertain. It is necessary to watch the change in the future.

The amplitudes and phases of the earth tide strains between the sealing and opening states are different. the difference in the diurnal tides is larger than that in the semidiurnal tides. Moreover, the earth tides under the sealing state are smaller in the amplitude of the dilatation strain than those under the opening one, and larger in the amplitude of the shear strain.

After the sealing of the top, strain changes (sudden strain change) following the groundwater pressure changes (sudden pressure change) were observed prior to the 2000 Tottori-ken Seibu Earthquake (M7.3, D160km), the earthquake in the northern part of Hyogo Prefecture northern part on January 12, 2001 (M5.4, D110km), and the 2001 Geiyo Earthquakes (M6.7, D220km) which occurred in Kinki or the Chugoku districts. Moreover, sudden pressure changes were observed 2 days before the Tottori-ken Seibu Earthquake and 1 day before the Geiyo Earthquakes. As the generation of these phenomena relates to the earth tides, we think that the sudden pressure and strain changes are precursors.

After the Geiyo Earthquake, there was no active seismic activity in the region near from this observation station, and 2 remarkable sudden strain changes were observed. In order to verify the relation among sudden pressure changes, sudden strain changes, and earthquake occurrences, it is necessary to wait for a remarkable earthquake occurrence in the near region.