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Vertical Deformation Detected by Precise Leveling around Tono Research Institute of Earthquake Science, Gifuin 2004-2012

Fumiaki Kimata[1*], Toshiyuki Tanaka[1], Rikio MIYAJIMA[1], Yasuhiro Asai[1], Ryo Honda[1], Hiroshi Ishii[1]

[1]Tono Research Institute of Earthquake Science, ADEP

Introduction

Precise leveling network was established in the west part of Mizunami in March 2004, as a part of projects of Tono Research Institute of Earthquake Science (TRIES), to research the underground water flow, strain accumulation, ground deformation and gravities changes and their relations in shallow crust. Around TRIES, Japan Atomic Energy Agency (JAEA) has started the 1,000m shaft excavation project in April 2004. Precise levelings are carrying out once or twice every year until October 2012. Leveling route is about 10 km length with 10 benchmarks in 2004 and 50 in 2012. Closer errors of leveling are less than about 1 mm.

Vertical deformation

During the survey period of 8 years and 8 months from February 2004 to October 2012, subsidence is distinguished, and the maximum reached about 2 cm in October 2012. Generally, benchmarks detected 1-2 cm subsidences are locating close to the shaft excavation site and on its south side area. As it is referred a 2km away benchmark, the subsidence of 2 cm supports ground tilt of 10 micro-radian. It is suggested that it is not the slant quantity of influence upon the building now.

Groundwater level

Groundwater levels are monitored in observation wells of TRIES and JAEA, located at 100 m or 300 m south from the shaft excavation site. Drawdown of water head amounting to 70 m was detected in December 2010. When shaft reached at 120m depth, the groundwater inflow due to the shaft excavation suddenly increased to 300 ton/day. The groundwater level decreased approximately by 30m at the same time. The groundwater level was almost recovered to its level of before the shaft excavation when drainage was temporarily stopped in June 2005, but it decreased by resume of drainage again. After the shaft reached at 500m depth, the quantity of groundwater inflow is ranging around 700 ton/day. The groundwater risings due to the occurrences of the earthquake are observed. 13 m and 3 m rises were observed by 2011 M 9.0 Tohoku earthquake and in M 5.7 Mizunami earthquake on December 14, 2011.The groundwater level is descending after the earthquakes slowly.

Subsidence and ground water drawdown

The groundwater level decreased with rates of 10-30 m/year for the period in June 2005 to June 2007, and subsidence with rates up to 2-5 mm/yr was observed at the benchmarks locating close to the shaft excavation site and on its south side area. On the other hand, the observed subsidence is relaxed, when a groundwater drawdown is decreasing to less than 10 m/yr. After the co-seismic groundwater rises observed in March and December 2011, additionally, slight uplifts were observed in February 2012. The maximum subsidence was observed at the benchmarks in the south side of the shaft excavation site, not at the benchmarks close to the shaft excavation site.

On the south side of the shaft excavation site, 160,000m^3 of soil was cut and covered according to the construction of a park in 2004. Therefor it is considered that the influence of the construction is included in observed ground deformation in a part. The deformation by the construction should be discussed precisely in the next subjects.

Distribution and mechanism of subsidence

Distribution of subsidence is the important information to consider its mechanism. However, it is not able to clarify its spatial distribution of the subsidence yet, because benchmarks are limited to the shaft excavation point neighborhood. Authors set up benchmarks to the neighboring area newly in 2012 to clarify distribution of the subsidence more precisely.

Keywords: vertical deformation, precise leveling, groundwater level