Ground deformation around Ontake earthquake swarm area detected by leveling and GPS measurements in 1999-2003

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Earthquake swarm is observed at the eastern part of Ontake volcano, western Nakano-ken, in August 1976, and the activity is continued for about 30 years now. After the occurrence of earthquake swarm, Ontake volcano located within 10 km from the earthquake swarm was erupted in October 1979. The western Nagano-ken Earthquake of M 6.8 was also occurred in the swarm area in September 1984.

Although the Ontake earthquake swarm continues for a long time period over 30 years, the earthquake of M4 class occurs only several times per year. The seismic moment of the earthquake swarm at Ontake is clearly small-scale as compared with the seismic moment of the earthquake swarm at Ito. However the depths of the earthquake hypocenters are very shallower and lower part of hypocenters are located in 5 km depth.

National Research Institute for Disaster Prevention carries a dense seismic network of about 50 points was carried out in this region. From the seismic observation, a 100-300 m fractured zone was presumed near the earthquake fault of the Naganoken-Seibu earthquake and small strike-slip earthquakes are observed in a fracture zone, which is the same focal mechanism of the Naganoken-Seibu earthquake [Horiuchi et al,2003].

Kasaya et al.[2002] and Iio et al.[2000] show clearly that a portion with high electrical conductivity and a low portion exist by contrast bordering on the earthquake fault region from electrical conductivity inquiry. Moreover, Takahata et al.[2003] reports that the gas of the mantle origin is contained in the ground gas contained all over the location of a hot spring in the uplift region. In the Mt. Ontake swarm earthquakes region, the crust activity relevant to the volcanic activity of Mt. Ontake is presumed.

We repeated the precise leveling and GPS measurements at Ontake earthquake swarm area to make clear the earthquake swarm mechanism from the ground deformation every year since 1999[Kimata et al.2002]. The leveling route was set on 15km from Makio-Dam toward swarm along Otaki River, and we extent the leveling route of 7 km toward northwest from Mitake village in 2002. As a result, uplift ground deformation of 6 mm was detected along the extended leveling route toward northeast in the period of 2002-2003[Kimata et al.,2003]. As an uplift ground deformation is detected within a leveling route of 4 km, a point source is estimated in a shallow area in a depth of 2.5 km with inflation volume of 0.6 x 106m3/yr.

As mentioned above, lower part of earthquake hypocenters at Ontake earthquake swarm are determined in a depth of 5-10 km generally and they are located very shallow. The domain where upheaval was observed is located in shallowest hypocenter distribution. A low resistively zone is estimated in the same area [Kasaya et al., 2002]. Furthermore, mantle origin gas is also observed in the Shirakawa ground pond located neighborhood of a uplift area[Takahata et al.,2003]. From these observations of uplift ground deformation, shallow hypocenters, low resistively and mantle origin gas, it is suggested that so0me hydrothermal activity is high and controls the deformation, earthquakes, and ground gas.

We install the GPS observation network consisting of 20 points in the range of 20 x 20 km centering on the swarm earthquakes source region in 2001, and we repeat GPS observations for 1-2 days every year. The original target is comparatively wide area ground deformation, and the distances between observation points amount to several km. The vertical deformation detected by precise leveling at the bench marks in the period of 2002-2003 estimates the horizontal displacements of few mm/yr at GPS stations. Therefore, detection of significant horizontal displacements is in the difficult situation from the repetition of GPS observation for 1-2 days.