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Estimated pressure source and vertical deformation in Tatun volcano ,Taiwan, detected by precise leveling in 2006-2011

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Tatun volcano group (TVG) including more than 20 volcanoes such as Chihsing, Siaoguanyin, and Huangzuei volcanos is located in the 15 km northeastward from Taipei, Taiwan. Although TVG has a hydrothermal activity characterized by some strenuous fumarolic activities and hot springs, it was evaluated that there is no resent eruptive activity and the nuclear power stations were constructed on the mountainside. Seismological network installed in 2003 detects a micro-seismic activity such as the volcano-tectonic earthquakes, tremors, monochromatic events and long-period earthquakes in and around Chihsing volcano (Lin et al., 2005; Konstantinou et al., 2007).

Based on the recent stratigraphy research, it makes clear that the magmatic eruption of 13,000-23,000 years ago and the phreatic eruption of about 6,000 years ago occurred at TVG and Chihsing volcano respectively. As results, the government established the volcano observatory in TVG to monitor the volcano activity in 2011.

Since those volcano-seismic swarm occur just around some fumaroles, it strongly suggests that the micro-seismic activity and the hydrothermal activity are closely related. Basically, the swarm activity around volcano is often accompanied by the deformation (e.g.: Kimata et al., 2004; Daita et al., 2009). Since these deformations are sometimes localized to a small region and few mm scale, a precise leveling survey is the most efficient survey to detect the deformation successfully.

Therefore, we established a 10km leveling route crossing the Chihsing volcano from south to north to detect the vertical deformation in June 2006. The leveling route is consisting with 30 benchmarks, and the defference of height is 300m. Our leveling surveys were re-conducted five times of June 2006, March 2007, August 2007, March 2009, and March 2011. Additionally, the leveling route was extended to the fumarolic area in the east part of the Chihsing volcano in August 2007.

We detected the subsidence of 5 mm in the east part of the Chihsing volcano for 9 months from June 2006 to March 2007. The subsidence was observed in the period of March-August 2007, and it became 10 mm in total for 14 months from June 2006 to August 2007.

After the leveling route extension, we detected the significant deformations in two areas. One is the subsidence of 5 mm in the mountainside, and another is the uplift in the fumarolic area for 19 months from August 2007 to March 2009. The similar deformation pattern to the preceding observation was observed in March 2011. However, the subsidence in the mountainside was relatively larger than the uplift close to the fumarolic area.

Based on the observed deformation in the period between August 2007 and March 2011, we estimate the volume changes and the locations of two spherical sources on that condition by employing a genetic algorithm (GA).

As a result, shallow pressure sources are estimated. One pressure source is estimated with -1.7∗10ˆ5 mˆ3 at 3 km depth beneath the northeast foot of the Chihsing volcano, and another source is estimated with 0.3∗10ˆ5 mˆ3 at 0.7 km depth in the fumarolic area.

It suggested that the estimated pressure sources are related to the hydrothermal activity. In the study period, the subsidence in the mountainside was detected to be caused by a major deeper deformation in TVG. The hydrothermal fluid supplied to the shallow sources in TVG may not be significant in this period.

Keywords: Tatun volcano, Taiwan, leveling, pressure source, vertical deformation