Restart of magma accumulation after the 2010 eruption at Merapi Volcano, Indonesia detected by GPS observation

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Merapi Volcano in Central Java, Indonesia is one of the most active volcanoes in the world. This volcano has erupted intermittently since 16th century based on historical records and often caused pyroclastic flows due to collapse of lava domes called "Merapi-type".

In October 2010, an explosive eruption occurred at the summit and destroyed the old lava dome formed in the eruptive activity of 2006 and a new crater was opened at the summit. And pyroclastic flows continuously occurred through the summit crater during the period of November 3 - 5.

In this paper, we report a ground deformation detected by GPS observation which we deployed after the eruptive activity of 2010 at Merapi volcano as an activity of a project "Multi-disciplinary Hazard Reduction from Earthquakes and Volcanoes in Indonesia" under SATREPS supported by JST, JICA, RISTEK and LIPI.

We have started GPS observation in December 2010 around Merapi volcano. We installed 3 stations around the summit, which are 2-5km apart from each other and these stations are located 27-32 km north from the base station, BPPTK (former Merapi Volcano Observatory located in Yogyakarta city). Each station around the summit is equipped with a dual-frequency GPS receiver (Leica GR10). Continuous observation with a sampling rate of 1second is performed at all stations. We also installed a Wireless LAN system between each station and BPPTK where other type of GPS receiver (Leica GRX1200) was installed for the reference. We applied a PPP (precise point positioning) using GPS analysis software, GIPSY-OASIS II ver. 6.1.2. In the analysis, JPL precise ephemeris is used, and dairy coordinates are calculated with single receiver ambiguity resolution.

As a result of this analysis, extensions were detected in the baseline between BPPTK and the stations located at the northern foot of the volcano with a rate of 1cm per year. And a contraction was detected between BPPTK and the southern station of the volcano with a rate of 1cm per year. The baselines among the summit stations showed expansion with a rate of 1-2 cm per year. These results suggest an expansion of volcanic edifice.

Assuming a Mogi source beneath the summit, the depth and the volume change of the source were determined with a grid search method using baseline change between March and December 2011. The obtained depth is 3-3.5km below sea level with an inflation volume of 5-8x$10^5$$m^3$.

This depth almost coincides the lower limit of the volcanic (VTA) earthquakes during 1991 obtained by Ratdomopurbo et al. (2000, JVGR). And obtained inflation rate (about 1x$10^6$$m^3$) is almost same as the magma production rate during 1890-1992(Siswowidjoyo, et al. 1995, Bul. Volc.). We can conclude that it is highly possible that magma accumulation has already started for the next eruption.