Continuous relative gravity observation at Sakurajima Volcano: Short-period gravity changes before and after eruptions

*Tsuyoshi Kurihara[1], Takahito Kazama[1], Keigo Yamamoto[2], Masato Iguchi[2]

1.Kyoto University, 2.DPRI, Kyoto University

Mass movement in a volcano leads to minute gravity changes on the ground, along with crustal deformations. Since the amplitude of the gravity changes depends on the density of the mass moving in the volcano, gravity observation is useful to directly understand the mechanism of the crustal deformations, such as melt supply from the deep underground and magma degassing in a magma chamber. In Sakurajima Volcano (Kagoshima Prefecture, Japan), crustal deformations have been observed to discuss preparation processes for eruptions with broadband time periods from seconds to years (e.g., Iguchi et al., 2008; Hotta et al., 2016). Okubo et al. (2013) also collected absolute gravity values at Arimura (2.1 km south-southeast from the Showa crater of Sakurajima Volcano) continuously, and observed the 10-micro-Gal gravity decrease associated with the magma ascent in a volcanic conduit. However, they only focused on the absolute gravity changes with the period of more than a few days, because the short-period absolute gravity values they collected were noisier than the long-period ones. Precise continuous gravity changes should be collected with the high sampling rate, in order to understand broadband activities of Sakurajima Volcano in terms of mass movement.
We were thus motivated to discuss the short-period processes of mass movements in Sakurajima Volcano, using the continuous relative gravity data sampled every one minute. The gravity data were collected by a Scintrex CG-3M relative gravimeter at Arimura Observatory from September 2010 to December 2015. The gravity data was dominated by several disturbances such as the instrumental drift, the long-period tidal effect with periods of more than a day, and the short-period tidal effect with periods of less than a day, which should be corrected from the original gravity data to retrieve gravity signals associated with volcanism. We first corrected the gravity changes due to the instrumental drift and long-period tides, by subtracting synthetic gravity changes expected by a spline function, which was calculated from the two-day average values of the original gravity data. We also corrected the short-period tidal effect by a tidal analysis software, BAYTAP-G (Tamura et al., 1991). Moreover, we reduced the effect of ground vibrations by stacking the two-day-long gravity data, which was cut off from the corrected gravity time series in 2013 and 2014 on the condition that the median time of the two-day window corresponds to the time of an eruption with a volcanic plume of >3000 m altitude. Note that we individually analyze the gravity data during the non-explosive eruption at 10:18 JST, 26 September 2013, because the small ground vibration enabled us to recognize volcanic gravity signals directly.
The stacked gravity data for the 2013 eruptions showed a slow decrease of about -20 micro-Gal since 12 hours ahead of the eruptions. The stacked gravity data for the 2014 eruptions also showed a rapid increase of about +30 micro-Gal in 30 minutes just after the eruptions. In addition, whereas no significant tilt variations were observed during the eruption on 26 September 2013, the simultaneously obtained gravity data showed a slow decrease since about 5 hours before the eruption, and the gravity value returned to the original level just after the eruption. These gravity changes can be explained by the inflation/deflation of a magma chamber below Sakurajima Volcano or the ascent/descent of magma mass in a volcanic conduit. In this presentation, these possibilities will be discussed quantitatively to understand the short-period process of mass movement in Sakurajima Volcano.

Keywords: relative gravity, gravity change, Sakurajima Volcano, magma, short period, density

