Regional vertical deformation around Aira caldera from GNSS data

*Kazuho Nakai[1], Masato Iguchi[2], Takahiro Ohkura[3]

1. Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, 2. Sakurajima Volcano Research Center, Disaster Prevention Research Institute, Kyoto University, 3. Aso Volcanological Laboratory, Institute for Geothermal Sciences, Graduate School of Science, Kyoto University

We investigated regional ground deformation around Aira caldera by analyzing vertical displacement observed by GNSS.

We used daily coordinate data from F3 solutions of GEONET stations in Kyusyu for periods from 1998 to 1999 and 2015 to 2016 when the ground uplift rate was larger than 18 mm/yr at 960719 station (North of Sakurajima). In order to increase number of stations, we analyzed RINEX data around Aira caldera and Sakurajima observed by Kyoto University and obtained daily coordinate data calculated based on the coordinates of the F3 solution of the GEONET stations closest to each observation point by using RTKLIB Ver. 2.4.2. The vertical displacement rate was estimated by removing the coseismic or antenna change steps and the annual and semiannual components. The ground deformation close to Kirishima volcano was affected by the pressure source located about 9 km beneath the Karakuni-dake (Nakao et al. 2013). We removed these effects causing inflation of the pressure source.

The ground within a radius of 20 km from the center of Aira caldera was uplifted in the both periods. The amount of uplift near the center of Aira caldera is larger than that in distant region and the largest uplift of station (25 mm/yr in 1998-1999 and 20 mm/yr in 2015-2016) was obtained at northern part of Sakurajima. In contrast, the ground subsidence was detected at distances from 20 to 30 km away from the center of the caldera during the period in 1998-1999 and from 30 to 40 km during the period in 2015-2016. The amounts of subsidence were about 3 mm/yr in the both periods.

We applied a model of dual source of Mogi-type (Mogi, 1958) to the ground deformation. In the period of 1998-1999, an inflation source was obtained at a depth of 10 km and a deflation source at a depth of 14 km beneath the Aira caldera. The amounts of volume change were estimated at about $+1.8\times10^7$ m^3 and -1.5×10^7 m^3, respectively. Similarly, in the period of 2015-2016, an inflation source was obtained at a depth of 10 km and a deflation source at a depth of 30 km. The amounts of volume change were estimated at about $+1.5\times10^7$ m^3 and -3.3×10^7 m^3, respectively. The order of volume change of the inflation source is almost same as the deflation source in the both periods.

The spatial distribution of the vertical displacement rate can be explained by the shallow inflation source and the deep deflation source. The shallow inflation source coincide with A-source beneath the Aira caldera (Hotta et al. 2016) corresponding to magma reservoir. Considering similarity of the volume changes, magma seems to move from to the shallow magma reservoir around 10 km deep from a deeper part.

Keywords: Aira caldera, Global Navigation Satellite System, vertical deformation