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Application of Tensile Crack Model to the Ground Deformation at Sakurajima Volcano

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Sakurajima volcano is an active volcano located at southern edge of Aira caldera. The vertical ground deformation around the volcano associate with its activity after summit eruption activity started at 1955 has been mainly revealed by the results of precious leveling and GPS observation, and the spatial distribution of the ground deformation have been explained by 2 spherical pressure sources at the center of the Aira caldera (about 10km depth) and at beneath the summit crater (about 3km depth) have been assumed (e.g. Eto and Nakamura, 1986).

Hidayati et al. (2007) explained the VT earthquakes occurred during 2003-2004 at SW off the volcano by assuming tensile crack opened by intrusion of magma toward the volcano from the pressure source assumed to be located at the center of the Aira caldera, and also indicated that the depression around Sakurajima volcano during 1978-1980 can be explained with the model with spherical pressure source and additional tensile crack.

In this research, we intended to apply tensile crack to the ground deformation around Sakurajima volcano at expansive period which Hidayati et al. (2007) assumed by the seismic activity at expansive period.

For this purpose, GPS data observed by SVO (Sakurajima Volcano Observatory) (9 stations) and GEONET data (16 stations) during 2000-2004 were analyzed. In analysis, we used GIPSY OASIS II software. Grid search method was applied to decide the location etc. of pressure sources, and we decided the parameters by least-square method using the observed horizontal displacements and calculated ones reffered to GEONET station 0491.

At first, we presumed one spherical pressure source. Expanding pressure source was located at about 11 km depth at NE off the volcano. Its change rate of volume was $9.2*10^6 m^3$/year. The previous study estimated the change of volume during 1995-2007 $8.0*10^7 m^3$ (Iguchi et al., 2008), so average change rate of volume we obtained is a little large from the previous work.

The ground deformation during 2000-2004 at western stations around Sakurajima volcano seems to have a large horizontal displacement toward west direction. So we added vertical tensile crack from the pressure source toward summit crater. The location and change of volume of the spherical pressure source obtained at the first calculation was fixed. We also fixed the depth and dip of tensile crack 6-9km and 90 degrees respectively, referred to Hidayati et al. (2007), and length and opening of tensile crack were changed. Then, vertical tensile crack with 2.1km length opening about 146cm was located between the spherical pressure source and summit crater.

Although the fitting of large horizontal displacement toward west direction at the western stations were a little improved by adding the tensile crack, there were some stations which have a large difference between observed displacements and calculated ones. The difference may caused by the fragile modeling (we may need to change the parameters of the pressure source in applying tensile crack. And also the direction of tensile crack need to be investigated), or the proper ground deformation at some stations. Also, the stations locate at northern Osumi peninsula should be added to analysis.

Finally, we would like to thank the Geospatial Information Authority of Japan for providing the GEONET data.

Keywords: GPS, ground deformation, Sakurajima volcano, Aira caldera, tensile crack