Sub-surface magma movement inferred from continuous extensometers' and tiltmeters' records during the eruption of Kirishima Shinmoe-dake in 2018

*Koki Yoshinaga[1], Takeshi Matsushima[2], Hiroshi Shimizu[2], Yusuke Yamashita[3], Shintaro Komatsu[3], Ken'ichi Yamazaki[3]

1. Department of Earth and Planetary Sciences, Graduate School of Science, Kyushu University, 2. Institute of Seismology and Volcanology, Faculty of Sciences, Kyushu University, 3. Miyazaki Observatory, Disaster Prevention Research Institute, Kyoto University

Shinmoe-dake is one of the volcanoes constituting the Kirishima volcanic group in southern Kyushu, and it is an active volcano with major eruptions in 2011 and 2018 in recent years. In the 2018 eruption, eruption started on March 1, the amplitude of volcanic tremor and the volume of plumes increased from the night of March 5, and lava was confirmed to be flowing into the crater on March 6. The explosive eruptions started on March 6, and a total of 34 explosive eruptions occurred on March 6 and 7. In this study, we use vault-housed extensometer and tiltmeter data to analyze the ground deformation recorded during the Shinmoe-dake eruption in 2018. The purpose of this study is to clarify what occurred underground during the eruption with high spatial and temporal resolution.

We used the vault-housed extensometer data installed at the Isa Observatory (ISA), Kyoto University. The ISA consists of tunnels in three directions, E1, E2, and E3. Each extensometer made up of 30m lengths of super-invar rods. E1 extends in the direction of the presumed deflation source of the 2018 eruption, and E2 in the direction orthogonal to E1. The tiltmeter data were obtained from six stations: Takachihokawara (KITK) station, Onamiikenansei (KION) station, Karakunidakehokuto (KIKH) station, and Kurinodakenishi (KIKR) station operated by the Japan Meteorological Agency (JMA), Hinamoridai (KRHV) station and Manzen (KRMV) station operated by the National Research Institute for Earth Science and Disaster Resilience (NIED). The extensometers and tiltmeters of JMA recorded data with 1Hz sampling, and tiltmeters of NIED recorded with 20Hz sampling. We resampled the original data at 1 minute by averaging and removed tidal components from the resampled time series using the tidal analysis software BAYTAP-G (Ishiguro *et al.*, 1984). Next, we performed rainfall correction of all data (c.f., Ueda *et al.*, 2010; Kimura *et al.*, 2015), and finally removed linear trend. The optimal solution was obtained by grid search method using the analytical solution (Mogi, 1958) for pressure source estimation.

Strain and tilt changed from 14:00 on March 5 to 12:00 on March 8, which we regarded as the inflation and deflation of the pressure source located in the northwest from Shinmoe-dake. From 14:00 on the 5th to 6:00 on the 6th, the component ratios of the strains and tilt vectors changed among the four time periods, and we classified this period as Phase 1, and from 6:00 on the 6th to 12:00 on the 8th as Phase 2. Assuming a single point source in Phase 1 and 2, a deflation source (source A) was estimated at a depth of 6.8 km, about 11 km to the northwest from Shinmoe-dake. We also estimated a deflation source (source B) at a depth of 6.5 km, about 3.6 km southeast of the source A in Phase2. The volume change of source A in Phase 1 was estimated to be $-3\times10^5 m^3$, and that of source B in Phase 2 was estimated to be $-3.4\times10^6 m^3$. This suggests that the source A deflated in Phase 1, and the source B deflated and supplied magma to the crater in Phase 2.

Keywords: Shinmoe-dake, Extensometers, Tiltmeter, Ground deformation

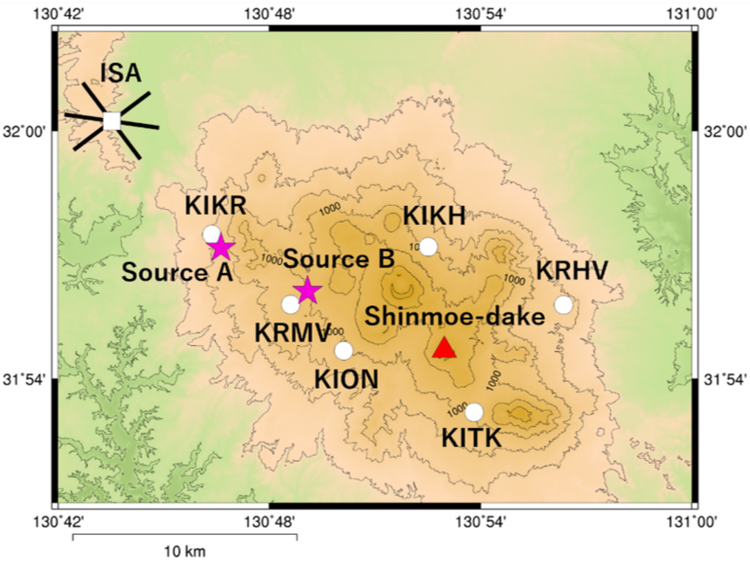

Fig.1 Map showing the location of Shinmoe-dake volcano carter (triangle) and observation sites. The square indicates the extensometers site (ISA), and the circle indicates the tiltmeter sites, respectively. The star represents the source locations inferred from this study.