

Implosion earthquakes at very shallow level beneath lava dome, Unzen Volcano, Japan

*Tasuku Hashimoto¹, Koki Aizawa², Takeshi Matsushima², Yuto Hayashida¹, Kaori Tsukamoto³, Yuto Yamamoto¹, Yuhei Yuasa¹, Kanta Miyano¹, Naoto Maesako¹, Yuta Kawamura¹, Hiroshi Shimizu², Satoshi Matsumoto², Megumi Kamizono⁴, Ayaho Mitsuoka¹

1. Department of Earth and Planetary Sciences, Graduate School of Science, Kyushu University, 2. Institute of Seismology and Volcanology, Faculty of Science, Kyushu University, 3. Fukuoka Regional Headquarters, JMA, 4. DIA CONSULTANTS CO., LSD.

Unzen Volcano is a stratovolcano located in central part of the Shimabara peninsula of Kyushu Island, Japan. During the eruption periods 1991-1995, the seismicity was vigorous at shallow level beneath the Heisein-Shinzan lava dome (Shimizu et al., 1992; Umakoshi et al., 2001), then the number of shallow earthquakes decreased significantly after the eruptions. However, since 2010, the number of shallow earthquakes have been increasing steadily beneath Mt. Fugen and Heiseishinzan lava dome (Japan Meteorological Agency (JMA)). The most of the hypocenters were estimated 1~2 km below sea level, while importantly, several earthquakes were located above sea level since February 2017. The P-wave arrivals of the earthquakes above sea level show the downward motion at all stations of JMA, MLIT, and Kyushu university. The coda, which shows relatively longer period oscillation, continues approximately 20 to 40 seconds. According to Japan Meteorological Agency (JMA), very shallow earthquakes above sea level were reported 6 times in 2018 and 4 times in 2019.

In order to explore the shallow earthquake activity beneath Unzen volcano, we established 12 seismic stations around Mt. Fugen and Heisei-Shinzan lava dome in August, 2018 (plus 2 stations at Heisei-Shinzen lava dome since April, 2019). In addition, broad-band magnetotelluric (MT) observation was conducted in October and November, 2018 to investigate the contribution of fluids to the earthquakes. From these observations, we found (1) the hypocenters of very shallow earthquakes are relocated 200m depth, which correspond to the boundary between Mt. Fugen and Heisei-Shinzan lava dome and also correspond to the conduits of the 1991-1995 eruptions, (2) very shallow earthquakes not only shows downward P-wave arrivals but shows upward P-wave arrivals at a few seismic stations, (3) very shallow earthquakes sometimes occur repeatedly within 20 seconds, (4) Tensile axes of very shallow earthquakes shows various directions, (5) the zone below very shallow earthquakes shows significantly high resistivity. We conclude that the very shallow earthquakes were generated by the collapse of small voids filled with gas and air at the boundary between Mt. Fugen and Heisei-Shinzan lava dome. We speculate that the recent deflation around the volcanic conduits may generate the voids for the very shallow earthquakes.

Keywords: Unzen Volcano, implosion earthquake, volcanic earthquake, resistivity structure, closing crack, lava dome