

Remote monitoring of island volcanic activities using an autonomous vehicle of the Wave Glider

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Nishinoshima is a volcanic island approximately 1000 km south from Tokyo. The island erupted above sea level in November 2013 for the first in the 40 years. Until November 2015 the island grew up to nine times as large in area as a result of numerous lava flows. Eruptive activity stopped in November 2015, and no additional activity was observed during 2016. Re-eruption began in April 2017, and continued until the middle of August 2017. Information comes mainly from monthly reports provided by the Japan Meteorological Agency and reports and photographs taken by the Japan Coast Guard. And satellites also provide valuable information from image and thermal data. These periodic reports, however, have a limitation in the continuous monitoring to reflect forecasting of volcanic activities.

We have developed a monitoring system of remote island volcanic activities using an unmanned sea surface vehicle of the Wave Glider (Liquid Robotics Inc.). The Wave Glider is designed to propel using only wave and solar energy without fuel and is equipped with the Iridium satellite communication modem to transmit navigation data to land stations. In the monitoring system, the Wave Glider performs a multi-parametric observatory platform at sea surface on which we mounted two microphones to hear infrasound with surface volcanic eruptions, hydrophone to sense acoustic and seismic waves with internal volcanic activities, wave gauges to detect heave displacements with volcano collapse, and four time-lapse cameras for telescope. The recorded data except for the images on cameras can be sent to the land server via the Thuraya satellite.

We had an observation of the Nishinoshima using the Wave Glider monitoring system in December 2017. The system was launched from an 8.5-ton fishing boat of the Shingen-maru near the Bonin island 130 km east from the Nishinoshima on the 1st of December and went to reach at a waypoint on the circle course with a radius of 5 km from the center of the Nishinoshima on the 4th. After five rounds traveling clockwise, the system left on the 8th and returned near the Bonin Island on the 10th to be recovered on the 13th. The data from the microphones and the hydrophone were almost successfully obtained in real-time via the Thuraya satellite. On the 4th during the vicinity of observation, steam emission from the volcano were surely recognized on pictures taken by the four visible cameras. The higher coherent waves between two microphones were observed in this active period, which may suggest infrasound signals from the steam emission, but which should be carefully considered. Based on the practical result, the system has been almost accomplished to promote a forward-looking observation of island volcanic activities.

Keywords: island volcanic activity, Nishinoshima, Japan, remote monitoring