

Purpose and Experiment of Seismic Exploration by Using Active Sources at Kuchierabujima Volcano, Southwest Japan

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Kuchierabujima volcano is an andesitic island volcano located south of Kyushu Island. Major historic eruptions with magmato-phreatic or phreatic type occurred at a summit crater of Shindake or a fissure east of the summit crater in 1841, 1933-34, 1945, 1966 and 1980. The eruptions in 1841 and 1933-34 were hazardous and many people were killed or injured by the eruptions. Although no eruptions have not occurred after the 1980 eruption, increase in seismicity has been detected by continuous seismic observation at a station (0.4km west of the summit crater), installed by Disaster Prevention Research Institute, Kyoto University in 1991. In dormant period of seismicity, monthly number of volcanic earthquakes is less than 20, the monthly number exceeded 80, during March-June, 1996 and August 1999 – February 2000. Recently, seismicity reached at peaks and 227 volcanic earthquakes were recorded in February 2004 and 340 in January 2005. Most of volcanic earthquakes at Kuchierabujima volcano are high-frequency types and a temporal observation revealed that the hypocenters are concentrated at depths of 100-500m in the summit crater and west and south crater rim. Repeated GPS surveys show inflation of the ground around the summit crater, with radial horizontal movements of 2cm during the period from 1995/96 to 2000. It is estimated that the inflation was caused by expansion of a small crack at a depth of 1.5km, east of the summit crater. Airborne survey of magnetic intensity detected an anomalous area of the magnetization of volcanic body at a similar area to the inflation source. From the facts, it is inferred that a hydrothermal reservoir is located at 1-2 km east of the Shindake crater, and the hydrothermal reservoir is connected to the fumarolic zone at west and south of the crater by a fracture zone. When the hydrothermal reservoir inflates, hydrothermal water is injected to the fracture zone and seismicity of high-frequency earthquakes increases at the fracture zone. Associated with a gradual increase in seismicity since April 2001, remarkable change of total force of magnetic intensity has been observed showing demagnetization of rock beneath the crater due to increase in temperature.

Under the 7th national project of volcanic eruption prediction, a seismic exploration by using active sources was conducted at Kuchierabujima volcano in order to reveal the structure of the hydrothermal system, revealed by the geophysical observations. The experiment was conducted by Kyoto University, Hokkaido University, Akita University, Tohoku University, Tokyo Institute of Technology, University of Tokyo, Nagoya University, Kyushu University, Kagoshima University and Japan Meteorological Agency. We exploded 19 shots at west and east capes, and flank and summit of Shindake with charge of 15-120kg, and observe seismic waveforms at 165 stations (79 three-component stations). Apparent P-wave velocity near the shots at northern part (geologically old part) of the volcano ranges 2.8 km/s to 3.3km/s. They are 2.3km/s to 2.7km/s at flank of Shindake and they correspond to new material of recent eruptions. Apparent velocity of 5.0km/s appeared at stations around 2.5km from the shot points. 97 seismic stations were operated for a day to observe volcanic high-frequency earthquakes and tectonic earthquakes. The tectonic earthquakes near Tanegashima and Nakanoshima Islands show P-wave apparent velocity of 6.1km/s.