Self-potential surveys and monitoring on Satsuma-Iwojima Volcano, Japan

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Satsuma-Iwojima is a volcanic island in South Kyushu region, Japan, located on northwestern margin of the Kikai caldera that was formed by eruptive activities about 6,300 years ago. Eruptions were not recorded in the historic time except a submarine eruption in 1934 at 3km east of the island. An intense fumarolic activity has been known for at least 1,000 years from the summit crater and flank of Iwodake, a post-caldera dome of rhyolite. In 1990, a high temperature fumarolic vent was recognized inside the summit crater of Iwodake and has gradually grown to a diameter of about 200m since then. Earthquake swarm has repeatedly occurred just beneath the crater with occasional ash ejections since 1998. A wideband seismometer installed in the summit area often observed a pulse-like earthquake that is characteristic phenomenon to Satsuma-Iwojima Volcano and is considered to be associated with the gas emission.

A self-potential (SP) anomaly of about a few hundreds to more than a thousand millivolts was observed on many active volcanoes. Electrokinetic effect associated with subsurface fluid upflows is considered to be the most probable cause of such a large anomaly, so that the SP data are often used as an indicator of the hydrothermal activity of volcanoes. We have conducted SP surveys at active volcanoes in South Kyushu region in order to reveal the hydrothermal system beneath the volcanoes for better understanding of volcanic activities. The SP surveys on Satsuma-Iwojima were conducted four times since 1999. A positive anomaly of 200-250 mV peak-to-peak was detected on the Iwodake edifice, although the survey area was limited because of the steep topography and existence of high temperature fumaroles. The anomaly seems to be centered on the summit area of Iwodake and can roughly be explained by a pair of conduction current source and sink located around the sea level beneath the crater (Kanda and Mori, 2002). Depth of the current source may indicate the upper end of a liquid-phase water upflow zone, where the water vaporizes due to heat and depressurization.

In order to detect the time variation of the SP distribution associated with the volcanic activity, a part of measurement was repeatedly conducted along the same traverse to the summit from the SW coast of Iwodake. Results show that almost the same SP profile was obtained in the upper part of the edifice, while a slight but significant change was found below 200 m in elevation when the seismic activity was in low level. It may be interpreted that the hydrothermal system was affected by a change in volcanic activity, probably in the depth of magma as a heat source. In July 2002, we also started the continuous measurements of self-potential at three sites in the summit area in order to detect change in a fluid flow pattern associated with expansion of the crater or change with the pulse-like earthquake. Two orthogonal dipoles with 50 m span were installed at each site and four electrodes were additionally installed along the southern rim of the crater. Although significant voltage anomaly has not been found yet, we will report the latest result in the presentation.