3rd International Forum on High Energy Geophysics:
Muon and Neutrino Radiography
(March 9, 2010 Tokyo, Japan)

Imaging density distribution of a big object by muography and its application to the analysis of gas-liquid two-phase flow in a conduit during volcanic eruption

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This paper reviews the principle of cosmic-ray muon radiography (muography) and its application to the analysis of gas-liquid two-phase flow in a conduit during volcanic eruption. Muography is a useful technique for imaging internal density distribution of a big object (e.g., a volcano, a blast furnace, etc.). By measuring muon path lengths and absorption along different paths through the object, one can deduce average density along the path inside the object. According to numerical modeling of gas-liquid two-phase flow in the volcanic conduit during a dome-forming eruption, magma porosity (i.e., density) inside the conduit largely changes depending on magma flux even if the porosity at the surface is kept low. The increase in the porosity inside the conduit may induce the transition to explosive eruption. This implies that high-resolution measurement of the porosity distribution inside the conduit is essential for predicting the transition of eruption styles. Recent progress in a muon detector system enables us to perform this measurement, such as in Mt. Iwodake of Satsuma-Iwojima Volcano, Japan. Spatial resolution of muography is adequate for detecting the variation of the porosity inside the conduit. Applications to industrial plant monitoring are also discussed. This meeting was supported by the Earthquake Research Institute cooperative research program.