Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SVC48-P34 Room:Convention Hall Time:May 19 18:15-19:30

Possible application of stroboscopic muography to monitoring periodic eruptions

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Many of the muon radiography observations have been applied to static objects, but some dynamic studies have so far been performed (e.g. imaging before and after the 2009 Asama eruption; Tanaka et al., 2009). One of the reasons which makes it difficult for us to perform real time or rapid time sequence radiography is the relatively low intensity of the cosmic ray muon flux that leads to long integration times to reach an adequate contrast in radiographic images. However, such low cosmic ray muon flux can be compensated for by averaging a large number of short acquisition frames, as in the case of periodic processes. If we assume a vent, with a radius of 10 m to detect it through 400-mwe-thick rock, the horizontal penetrating muon flux will be $5x10^{?5}$ $sr^{?1}cm^{?2}s^{?1}$ and $7x10^{?5}$ $sr^{?1}cm^{?2}s^{?1}$ for the filled and vacant vent respectively. A detector with an active area of 4 m^2 and the required angular resolution of 100 mrad, located at a distance of 200 m from the vent, can therefore collect 0.02 and $0.03^{?1}$ for each condition, and 2500 eruption events can distinguish these conditions in 1 s at a 3 sigma confidence level. 2500 eruption events are not unrealistic if we consider that 110 eruptions were observed in Stromboli between 14 and 17 October 2007 (Goto et al., 2008). In this work, we evaluated this idea by utilizing a comprehensive model system that consists of a muon detector with an active area of 0.16 m^2 and an electric furnace with a diameter of 15 m as a periodic test target. The variations in the density contrast were clearly observed in the furnace with a period of 12 hours by averaging 17 frames. The result infers a possible application of stroboscopic muography to monitoring periodic eruptions.

Keywords: muon, radiography, stroboscope