Integrated research of volcano dynamics with an ultra-low noise large muon detector array

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The mechanism of transport and eruption of magma from volcanoes is not well known. For example, linear, sheet-like bodies of magma which are intruded deep underground eventually transform into cylindrical shapes as they approach to near the surface. The magma may emerge as either explosive or effusive eruptions. Our detailed understanding about these phenomena would help us to better predict the eruption sequence of volcanoes, however the information that conventional geophysical surveys, such as seismic tomography or geodetic measurements, can provide is limited. Therefore, we need a more direct diagnosis method to explore the internal structure of a volcano. A new imaging technique called "muography" utilizes muons, elementary particles originated from cosmic rays, and has the capability to highly resolve the internal density profile of a gigantic object. For example, bubbly magma indicating magma convection was successfully imaged in the 2008 Satasuma-iwojima volcano observation campaign. In 2013, magma ascents and descents were successfully captured during an eruption of the same volcano. However, conventional muography provides only a 2-dimensional projection of the volcano and the time resolution is limited to 3 days. This present proposal envisages the idea of producing ultra-high-spatio-temporal resolution 3-dimensional images of a volcano by arraying an ultra-low-noise-high-positional-resolution muographic observation systems. By establishing these advanced muography technologies, advances in the imaging of underground structures, planetary geological explorations, and non-invasive inspections of historical heritages are expected. Also, we anticipate benefits to the social safety and security when these advanced muographic technologies are applied to industrial plants, such as nuclear reactors, blast and electric furnaces, and civil engineering structures.

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