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2011 年新燃岳噴火の準プリニー式噴火，ブルカノ式噴火，溶岩流出に伴う傾斜変動
Tilt motions associated with sub-Plinian, Vulcanian eruptions, and an effusive stage in the 2011 Shinmoe-dake eruption

前原 祐樹 [1], 武尾 実 [1*], 大湊 隆雄 [1], 市原 美恵 [1], 及川 純 [1]
MAEHARA, Yuki[1], TAKEO, Minoru[1*], OHMINATO, Takao[1], ICHIHARA, Mie[1], OIKAWA, Jun[1]

[1] 東京大学　地震研究所
[1]Earthquake Research Institute, University of Tokyo

Numerical simulations and experimental studies suggest that bubble formation and fragmentation in magma ascending through a conduit play an important role in an explosive eruption. These phenomena should cause some kind of ground deformations, and such observations have been reported in several volcanoes [*e.g.*, Iguchi *et al.*, 2008]. In this paper, to reveal a behavior of magma associated with an eruption, we investigate tilt motions near a summit crater during the 2011 eruption of Shinmoe-dake, Kirishima volcano. As a broadband seismometer is capable of measuring a ground tilt motion [*e.g.*, Graizer, 2006; Aoyama & Oshima, 2008], we obtained tilt motions from a broadband seismometer (SMN) installed at 1 km northward and a tilt-meter (KISH) at 1.5 km NEN-ward from the crater by elimination of tidal trends and daily noises. A comparison of tilt motions obtained from the broadband seismometer with those from tilt-meter reveals us that the broadband seismometer is available to measure tilt motions with a period up to a few thousand seconds.

Tilt motions indicating summit-up inclines about a few thousand seconds before eruptions preceded most of explosive eruptions, including sub-Plinian eruptions in 26^{th} and 27^{th} January and Vulcanian eruptions between 1^{st} and 7^{th} February. Any clear distinctions, such as in precursor times and in sizes of tilt motions, have been recognized between the tilt motions preceding the sub-Plinian eruptions and the Vulcanian eruptions up to this time. However, we found systematic changes of the tilt ratio between these two stations: the tilt ratio of the far station (KISH) to the near station (SMN) gradually increased from around 0.3 to 0.4 as the eruptions closed in, not only the sub-Plinian but also the Vulcanian eruptions. In the effusive stage, we observed periodic summit-up and summit-down tilt motions with a period of about 1 hour; some parts of these periodic motions correlated with volcanic tremors.

There are several speculative interpretations about the temporal change of the tilt ratio. If we assume the location of source in the conduit and fixed source mechanism, the ratio change could be explained by the change of source depth. On the other hand, assuming the fixed source depth in the conduit, it could be explained by the change of source mechanism. We don′t have enough data to bring to an end, so hereafter we tentatively interpret these observations based on the assumption of fixed source mechanism. Employing an isotropic pressure source (Mogi model) as the source, the ratio change corresponds to the deepening of source from 420 m to 140 m above sea level. The absolute values of tilt change preceding the first sub-Plinian eruption on 26^{th} January can be explained by pressure increase of around 10 MPa assuming the source volume of $10^6 m^3$. This pressure decreased rapidly just after a small eruption which occurred about 30 min before the start of the sub-Plinian eruption. This depressurization in the conduit might have triggered the fragmentation of magma in the shallow part of the conduit.

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