Magma transport process from deep source - Twin pressure source model for Mt. Usu (1910 and 2000) and Campi Flegrei (1982-85)

Jun Okada[1]

[1] Institute of Seismology and Volcanology, Hokkaido Univ

Ground deformation associated with the 2000 eruption of Mt. Usu was characterized new cryptodome (The 2000-Shinzan) formation which was huge amount of local upheaval at western flank and edifice wide areal deformation which was centered at the western part of the summit crater at the same time. Latter one was one order smaller (several m upheaval at the summit) but the deformation was extended to several ten's km from the center of deformation. Edifice-scale deformation excluding localized upheaval of new cryptodome at the western flank showed sharp decrease of displacement (at around 4-6 km), uplift-to-subsidence reversal (at around 6 km), and a small subsidence and contraction at further distances (at 7-40 km). This systematic deformation pattern can be modeled by the simple combined Mogi's pressure source model with shallow inflation (2 km) and deep deflation (10 km). Nearly equivalent volumes but opposite sign of twin source (10^8 m^3 in order) were estimated. This model indicates magma transport from the depth to the shallow part of the summit (Okada, 2007).

Similar magmatic intrusion process can be applicable for the past eruptions of Mt. Usu such as 1910, 1943-45, and 1977-82. Each leveling data could be explained also by the application of Mogi's twin pressure source model with shallow inflation (2 km) and deep deflation (10 km). Nearly equivalent volumes were estimated at both deep and shallow depths for the models of 1910 and 2000. Common physical process of dacitic magmatic intrusion exists between 1910 and 2000. Both deformation activities were characterized by the 10^8 m^3 orders of dacitic magma intrusion from the depth (10 km) and its significant part remains at shallow depth beneath the summit (2 km). This result is especially implicative in considering the similarities of precursory earthquakes, eruption activities and subsurface cryptodome formation between 1910 and 2000.

Twin source model with shallow inflation and deep deflation was applied to the various types of volcanic deformations in the world. Deformation associated with the 1924 eruption of Kilauea volcano in Hawaii Island showed all ground subsidence over wide area. Wide areal vertical displacement data was well explained by single Mogi's deflation source. This deformation pattern is essentially different from twin source model of Mt. Usu. However, the deep magmatic process was quite similar between Mt. Usu and Kilauea. On the contrary to this, deformation data obtained in the 1982-85 volcanic episode of Campi Flegrei Caldera showed all uplift. Vertical displacement data rapidly decreases at 5-6 km from the center of deformation. This is quite similar ground deformation pattern with the 2000 eruption of Mt. Usu. It was well explained by the Mogi's twin pressure source model; shallow inflation (3 km) and deep deflation (10 km) with equivalent volumes. Combination use of precise leveling survey and widely designed precise GPS measurement is very important for estimating of deeper source process. The model similarities and also differences among Mt. Usu (1910 and 2000), Kilauea (1924), and Campi Flegrei (1982-84), indicate the different magmatic processes: basaltic effusive magma outflow of Kilauea, dacitic or silicic cryptodome formation of Mt. Usu and Campi Flegrei.

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