A Comprehensive magma source model to explain all available crustal deformation data for 1986 Izu-Oshima eruption

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We present a comprehensive magma source model to explain all available crustal deformation data(1 borehole strainmeter, 3 borehole tiltmeters and leveling surveys on the island, and 3 borehole strainmeters outside of the island) for 1986 Izu-Oshima event, along the context of Linde et.al.(2016)Journal of Volcanology and Geothermal Research vol.311, p.72-78. Borehole strainmeters data used in this study are calibrated by using long period seismic wave response.
Here we discuss the whole event in two phases, phase 1(Nov.15-20, from the start of summit eruption to quiescence just before the start of fissure eruption) and phase 2(Nov.21-30, after the estimated dike intrusion to fissure eruption).
Phase 1
The eruption started from the south wall of the nested caldera at 17:25(JST) on Nov. 15, 1986. Before the eruption, no significant change in seismicity and short-term crustal deformation was observed, indicating no new conduit formation. After the start of the summit eruption, synchronized changes were observed not only by 1 borehole strainmeter and 3 tiltmeters on the island, but also 2 borehole strainmeters on Izu peninsula facing to the island, until they cease at around the midnight on 20th. To explain all these changes, pressure decrease of spheroidal source, centered at NW part inside of the caldera at 4km depth, with 2.25km long major axis dipping 70 degrees in a vertical plane perpendicular to the maximum tension direction due to the bending of Philippine Sea Plate, and aspect ratio of 1:0.3, was estimated as an optimal magma source model. The extension of the major axis intersects the surface close to the eruption point. Pressure increase of the source of this shape can also explain the relative subsidence of the crater relative to the caldera rim revealed by repeatedly conducted short line leveling surveys before the eruption.
In phase 1, erupted magma volume was precisely estimated from the observed magma top level in the crater with known topography. This was a very rare case in which the erupted magma volume to the surface was quantitatively compared with the magma source volume change estimated independently from crustal deformation observation. The former was larger than the latter, and it can be interpreted as a simultaneous recharge of magma to the pressure source probably from a deeper reservoir.
In recent years, long-term island inflation overlaid by short-term relative deflation and inflation has been observed by borehole strainmeter, GNSS and laser ranging on the island. Spherical sources which are located near the above mentioned spheroidal source for respective changes are estimated by Meteorological Research Institute. We expect a progress of their research as for their relation.
Phase 2
After 1.5 days of quiescence at the end of phase 1, eruption resumed with a fissure eruption inside of caldera at 16:15 on Nov. 21, and it extended to a flank fissure eruption in about one hour. About two hours before the first fissure eruption, borehole strainmeter on the island started to show a large change, and significant seismic activity extending NW-SE across the island started. The strain change started with contraction, and turned to expansion in ten minutes. Expansion continued until the end of the day when it turned its polarity again, and the total expansion was over 100 micro strains. Synchronized significant strain changes were also recorded at 3 borehole strainmeters outside of the island. To explain all these crustal deformations, fissure trend on the surface, hypocenters distribution and leveling survey results (including the effect of phase 1) conducted before and just after the eruption, opening of main two dikes

trending NW-SE direction, slightly offset, and pressure decrease of oblate spheroid centered at 10km depth under the caldera was estimated. In this model, the conservation of magma mass is considered.

Keywords: 1986 Izu-Oshima eruption, Crustal Deformation, Magma source model