

Intermittent inflations recorded by broadband seismometers prior to caldera formation at Miyake-jima volcano in 2000

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Preface: Miyake-jima island, which is about 200 km south of Tokyo, is one of the most active volcanoes in Japan. In most historical events of this volcano, basaltic magma have erupted mainly from part of the flank in a more or less constant time interval, but the 2000 eruption took place in a quite different way. One of the main phases of the 2000 activity was a formation of caldera as had happened 2500 years ago. Interesting seismic signals that have a pulse width of about 20 s on velocity seismograms, called very-long-period (VLP) seismic pulse events hereafter, are recorded by broadband seismometers deployed in the island. The VLP events were observed frequently 1-2 days prior to the first summit subsidence producing the caldera. The seismic events were hardly recognized after the subsidence began. Considering this temporal sequence in relation to the summit subsidence event, the VLP signals likely took place in the preparatory process of the caldera formation. In this presentation, we will report the analysis results for the VLP signals.

Data analysis: From the displacement records, we clearly find that the VLP signals have smoothed step-like changes. The vertical seismograms display significant uplifts for all the stations. The particle orbits of the VLP signals show that all the stations have elliptical or rectilinear particle orbits, the major axes of which point to a region at the depth of a few km beneath the south 1-2 km of the summit. Each initial motion is oriented outwardly from the region that the particle orbits point to. This evidence strongly suggests that the VLP event was excited by a volumetric expansion. The waveform inversion we conducted shows that the source time histories have step-like shapes with a rise time of 20 s. Prominent step-like increases of the diagonal components indicate a significant dilatational variation of the source. A candidate for the source mechanism is the inflation of an elliptical cylinder with axis tilted 20-30 degrees from vertical and major axis of the elliptical cross section oriented northeast-southwest.

Speculation: We may interpret that the 20 s-VLP events were produced by falling mass injection into a magma reservoir associated with the caldera formation, whose idea was proposed by Kumagai et al (2001) to explain a reproducible nature that repeated with almost same duration times synchronously with successive caldera growth. We assume here that the falling mass events already started in the period when 20 s-VLP events were recognized prior to the caldera collapse on the surface. Applying the model for the 50 s-VLP events, we estimate injection of mass having the piston length of 560 m from the duration of 20 s for the 20 s-VLP events with the other parameter values fixed. We speculate that the repeated occurrences of the rock collapses resultantly lead to the caldera formation due to the gravitational instability in the crust.