Fluid/Mass/Heat Migration during the Caldera Formation of Miyake-jima Volcano in 2000 As Inferred from EM Observations

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(1) The total intensity observation revealed a paired anomalous change, i.e. increase by 10 nT at OYM and decrease by 5 nT at TRK in the central and southern area of the volcano for the period from mid-1996 to mid-1998. The variation declined after 1998, but still continued untill 2000. It can be explained as uprising of a demagnetized cylinder from a depth of 600 m bsl toward 200 m asl beneath around the southern rim of the summit caldera. The horizontal position of the cylinder was specified not only by the magnetic data but also by a newly emerged psitive anomaly of SP between 1995 and 2000. The origin of magnetic and SP sources is reasonably assumed as hydrothermal fluids dispatched from magma: We detected the formation of a new vent.

(2) The vent, or a cylinder filled with hydrothermal fluids, seems to have reached the hydrothermal acquifer already existed in the summit caldera floor, most probably at the initial stage of the 2000 activity. The bottom of the reservoir was destroyed and fluids escaped away down to the depth, which was clearly detected by the controlled source resistivity measurements. A possibility is that connection of a new vent and the hydrothermal reservoir resulted in decrease in the hydrostatic pressure within the shallow magma reservoir, which triggerred vesiculation of volatiles to magma intrusion on June 26, 2000.

(3) At least 2 days prior to the summit explosion on July 8, a cylindrical space with weak magnetization was formed from a depth of 2 km bsl up to 0.9 km bsl: It extended toward the depth of 0.2 km bsl, just before the summit collapse. The vacant space should have been sustained by some stiff pillars, which was suggested by non-zero magnetization of the cylinder.

(4) Total intensity data indicated that the initial sinkhole was formed within 4 minutes at the time of the steam explosion on July 8. At the same time a vacant cylindrical space, 300 m in radius and 200 m in height, at a depth of 2 km was filled with magnetized material with 3 A/m: This is quite coincident with the ource for the Lamb pulse, which generated a long-period seismic waves at the time of explosion. Model analyses of these magnetic changes indicate that the volcano edifice is rather strongly magnetized toward a depth of 2 km bsl. This gives a constraint to the size of the shallow magma reservoir, of which depth was estimated as 2.9 km by geodetic observations: Its radius must be at most 1 km.

(5) Since July 8, the total intensity showed a large amount of changes at several stations. These variations became flat after the largest eruption on August 18. The model estimate by approximating the hole as a demagnetized circular cone cannot fully explain the observations: Thermal demagnetization just below the bottom of the new caldera down to a depth of 900 m proceeded until August 18. The demagnetization was estimated as only - 1 A/m or so which can be attained by temperature rise up to 100 degree C. Such effective thermal diffusion should have been achieved by hydrothermal circulation within the collapsed caldera floor. However, such a large-scale hydrothermal system was destroyed by the Aug. 18 eruption, as inferred from changes in SP during the eruption.

(6) In the 1983 eruption, a thermally-demagnetized area emerged at a depth of 3 km beneath the summit. Repeat surveys and continuous measurements of total intensity from 1983 to 2000 revealed that enlargement of cooling of this demagnetized area did not take place. It is thus inferred that some portion of magma remained at this depth and that it reactivated at the initial stage of the 2000 activity of Miyake-jima volcano.