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Rhyolitic dome growth in shallow sea during Showa Iwo-jima eruption in 1934-35

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[Introduction]

Showa Iwo-jima, one of central dome in Kikai caldera, south of Kyusyu Japan, was formed by submarine eruption during the years 1934-1935. This eruption should give us important information on the rhyolitic volcanism in shallow sea because there are little recent examples of direct observation. The process of lava dome growth is strongly influenced by the surrounding condition. This indicates that the analysis of dome morphology should yield us the information on the emplacement mechanism for both submarine cases (Pichler, 1965; Yamagishi, 1991) and subaerial cases (Huppert et al., 1982; Blake, 1990). Despite the large number of studies on the dome emplacement, few studies have been performed on the case as like in Showa-Iwojima in shallow sea. We will present the geological study of Showa Iwo-jima dome to understand the growth process of rhyolitic lava dome in shallow sea.

[Eruptive sequences]

The eruption is divided into two stages based on literatures (Tanakadate, 1935; 1936); the early stage (from December in 1934 to January in 1935) characterized by phreato-magmatic explosion with cock's tale jets and cone-formation, and the later stage characterized by effusive lava dome growth (from January to March in 1935).

[Internal and surface structure of dome]

The flow formed a lava dome of about 150 m wide, 350 m long and higher than 20m above sea level. The dome has onion-like structure with folded lava on the margin. The central crater with 50m diameters is filled with lava developing multiple folding on its surface. The dome is covered with pumiceous clinker, and shows the lava wrinkles circularly on the surface from the vent to the isle end. On the marginal front, i.e., isle end, clinkers are embedded by folded lava. Furthermore, oxidized clinker and dense lava distributes alternately in dome interior. In the west, the marginal front with clinker and dense parts is folded over the main dome against the flow direction. In the southeast, the constituent material above sea level to a few tens of meters height is characterized by glassy blocks and oxidized welded breccias surrounded by dense lava on the folded margin. The glass transition temperature (Tg) of the glassy blocks determined by DSC measurement is 90 C higher than that of other marginal lava. This indicates that the glassy blocks resulted with a high cooling rate compared to the others part because whole rock compositions, water contents for glass matrix and the procedure for measurement were identical for all samples.

[Dome growth process]

The viscosity and temperature of lava was estimated to be 10^9 Pas and 800 C respectively based on the equation by Fink and Fletcher (1978) using the shape of lava wrinkle. The shape of lava dome related to the estimated effusion rate, 10^5 m3/day based on the literatures, was not in harmony with the growth model by Fink and Griffiths (1990, 1998).The model assumes the Newtonian or Bingham behavior, using the dimensionless parameter,psi, which is the ratio of time taken for solid crust to form on an element of lava issuing from vent to a characteristic time scale for horizontal advection of the lava.

These results suggested the following dome growth process. (1) hot rhyolitic lava effused from the submarine vent filled with seawater. The lava surface was covered by hyaloclastic carapace. (2) dome was strongly compacted at the marginal part before viscosity enough increased, (3) the rock faces, which characterized by hyaloclastite with glassy blocks and oxidized welded breccias, surrounded by dense lava appeared on the folded margin over the sea. One of the reasons for the discrepancy between the real and the model may depend on the fact that subaqueous volcanic deposits formed by phreato-magmatic explosion in the early stage prevented the dome growth on the margin. The process of dome growth in a shallow sea should be reflected in these evidences.