On the inner structure and formation process of Komezuka scoria cone, Aso volcano

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Explosive basaltic eruptions often produce pyroclastic cones. The manner of clast emission and accumulation rate can be inferred from residual morphologies of the cone. Head and Wilson (1989) discussed the local landing temperature and accumulation rate of the clasts in relation to the style of an eruption. They qualitatively argued that the degree of welding of the deposited clasts at a given distance from the vent can be predicted from gas content and volume flux of the magma. On the basis of this argument, some field studies have been done by means of observations of outcrops to infer the formation process of specific pyroclastic cones (e.g. Yamamoto, 2003). Although geological observation is the most effective approach, there are practically many cases in which the inner structure is not visible. In this study we discuss the inner structure of a scoria cone by using some geophysical exploration methods.

Komezuka is one of the basaltic cinder cones located in the northwestern part of the Central Cones of Aso volcano. Stratigraphic age of Komezuka is younger than 1,700 BP (Ono and Watanabe, 1985). The scoria cone has the basal diameter and relative height of about 400 and 80 m, respectively, accompanied by a significant volume of lava flow toward northwest. This monogenic cone is also one of the scenic resources of this area and thus any trench observation of the inner structure is not possible. However, it is easy to perform some geophysical explorations on it since its surface is a grass field, permitting an easy access. In this study we inferred the inner structure and formation process of Komezuka by the 2D DC-electrical survey and magnetic anomaly mapping.

The resistivity cross section shows that the superficial part of the summit crater is covered with a low resistivity layer of several tens to hundreds Ohm-m. A markedly resistive body of an inverted circular cone shape is resolved below it, implying either a dense material (strongly welded spatter) or a highly porous material without water (scoria fall-back or substantial volume of void space due to drainage of lava). Meanwhile, the general feature of the magnetic anomaly can be reproduced by a topography with a uniform magnetization of 10 A/m. The residual magnetic anomaly suggests a subsurface structure below the summit. Strong anomalies are also seen around two outlets of lava flow at the western and northeastern foots but they do not seem to be connected with the central anomaly. We here investigated some simple forward calculations with an ax-symmetrical model. The observed anomaly is well explained by the model with a relatively small magnetization for the summit low resistivity layer and a large magnetization for the high resistivity body below it. Summarizing the results above we infer the inner structure and formation process of Komezuka as follows.

(1) The resistive body below the summit has a high magnetization, suggesting welded spatter.

(2) The surrounding material has a moderate resistivity and magnetization, suggesting porous scoria deposits. Gradual decrease of the resistivity with depth implies the permeating ground water toward the base of the cone.

(3) The superficial part of the summit is less resistive and weakly magnetized. This is probably due to the post-eruption erosion and soil layer.

(4) Size and shape of the welded part suggests the eruption of Strombolian type.

(5) The basal lava outlets do not seem to be connected with the central vent at least in the shallow part.