

Orientation of eruption fissures controlled by shallow magma plumbing system; example of the fissure pattern in Miyakejima

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Orientation of the eruption fissures and composition of the lavas of the Miyakejima volcano indicate the competitive processes of the regional tectonic stress and the local stress generated by the activity of a magma plumbing system beneath the volcano. We investigated the distributions and magmatic compositions of the recent 23 fissures that formed within the last 2800 years, based on a field survey. Some fissures are also confirmed their eruption date by new datasets of ¹⁴C ages. The result highlights the tectonic influence of shallow magma chamber on the development of feeder dikes in a composite volcano.

As previously known, the dominant orientation of the eruption fissures in the central portion of the Miyakejima volcano was NE-SW during the last centuries, which is perpendicular to the direction of regional maximum horizontal compressive stress (σ_{Hmax}) indicated by the regional seismicity. Our field survey reveals that the magmas that show evidence of mixing between basaltic and andesitic compositions erupted mainly from the eruption fissures with a higher offset angle from the regional σ_{Hmax} direction.

The dike pattern perpendicular to the direction of maximum compression σ_{Hmax} is an unusual and uncommon feature in volcanoes. The distribution and magmatic compositions of the eruption fissures in Miyakejima volcano can be explained by the tectonic influence of shallow magma chamber on the development of feeder dikes in a composite volcano. The presence of a shallow dike-shaped magma chamber controls the eccentric distribution of the eruption fissures perpendicular to the present direction of σ_{Hmax} . Injection of basaltic magma into the shallow andesitic magma chamber caused the temporal rise of internal magmatic pressure in the shallow magma chamber which elongates in NE-SW direction. Dikes extending from the andesitic magma chamber intrude along the local stress field which is generated by the internal excess pressure of the andesitic magma chamber. As the result, the eruption fissures trend parallel to the elongation direction of the shallow magma chamber. The dikes propagated from the andesitic magma chamber provide the evidences for magma mixing between the stored andesitic and injected basaltic magmas. Some basaltic dikes from the deep-seated magma chamber reach the ground surface without intersection with the andesitic magma chamber. These basaltic dikes develop parallel to the regional compressive stress in NW-SE direction. The patterns of the eruption fissures can be modified in the future as was observed in the case of the destruction of the shallow magma chamber during the 2000 AD eruption.

Keywords: eruption, eruption fissure, magma chamber, dike, Miyakejima