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Dike thickness controlled by the layering of the host rock

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Mechanical layering of the host rock has strong effects on dike emplacement. Young stratovolcanic edifice consists of layers of lava and unconsolidated pyroclastic materials and the emplacement of dikes in the volcanic edifice will be strongly affected by the mechanical properties of the host rock. To clarify the effect of the mechanical layering on the dike structure, we investigate the relationship between the variation in dike thickness and the host-rock properties of several feeder and non-feeder dikes exposed in the caldera wall of Miyakejima Volcano, Japan. In this presentation, we describe the field occurrence of the dike in the layered host rock and present a preliminary modeling for the dike growth in the layered media.

Many basaltic dikes, both feeder dikes and non-feeder dikes, are exposed on the caldera wall of the Miyakejima Volcano. These dikes dissect a pile of scoriaceous pyroclastic rocks interbedded with several massive lava flows. Overall, the vertical cross sections of the non-feeder dikes have a elliptical shape, with a maximum thickness at around the center and tapering away toward the upper and lower tips. The tips themselves, however, are rarely exposed. The feeder dikes connect directly to the base of the associated lava flow or cinder cone.

The dike thickness is locally narrower in the massive lava flows than that in the adjacent poorly-consolidated pyroclastic layers, reflecting the mechanical contrast between the layers. Dike thickness decrease up to 50% at the center of the massive lava flows in comparison with the thicknesses in the adjacent pyroclastic layers. The effect of massive lava flows in reducing dike thickness is most noticeable in lava flows thicker than 2 meters. This dike-thickness distribution reflects the contrast of Young's moduli within the host rock: Young's modulus of the massive lava flows is much higher (that is, they are stiffer) than that of the poorly-consolidated pyroclastic layers. Preliminary finite-element (FEM) numerical simulation also shows decrease of dike thickness in stiff layers. In the case of a 10-meter thick lava flow with a Young's modulus of 10 GPa with adjacent soft pyroclastic layers a Young's modulus of 1 GPa, the dike thickness in the center of the lava flow is only 2/3 of its thickness in the adjacent pyrolcastic layers.