Geophysical Research Abstracts,
Vol. 11, EGU2009-2772, 2009
EGU General Assembly 2009

Vertical structural variation of the dikes exposed in the Miyakejima 2000 caldera

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Measurements of the vertical structures of dikes provide crucial information for understanding the mechanics of dike emplacement and fissure eruptions. The Miyakejima 2000 caldera exhibits a cross section through a part of a stratovolcano in which numerous basaltic dikes can be studied. We studied more than 100 dikes in the caldera wall, some which can be traced vertically for more than 300 meters. The typical thickness of these dikes is less than 2 meters although dikes locally exceed 7 meters. The host rocks of these dikes consist mainly of piles of poorly-consolidated pyroclastics and thin aa lava flows. Using image analysis of the dikes, we estimated the vertical variation in the thickness of many dikes.

The dikes exposed in the caldera wall belong to two groups; feeder-dikes and non-feeders. All the non-feeders terminate at their tips (upper end), indicating that they did not reach to the surface. More than 90% of dikes in the caldera wall are non-feeders. In the uppermost 20-40 m below their tips, the thickness of non-feeders increases but tends to decrease again below this depth. This thickness variation is partly because in the uppermost 20-40 m the host rock is poorly-consolidated pyroclastics with low Young's module. Below this depth the thickness decrease rate is, typically, around or less than 0.5 meter per 100 meters, and is presumably related to higher Young's modules, and lower magmatic overpressure, with depth.

The feeder-dikes connect directly to spatter cones, indicating that the dikes the ground surface and fed fissure eruptions. Feeder-dike thicknesses are greatest at the vent and decrease with the depth within the 20 – 40 meters below the vent. For example, the feeder dike of the 1535 AD eruption fissure has a maximum thickness of 3.5 meters at the base of its spatter cone and gradually decreases to a thickness of 1.0 meter at a depth of 30 meters. This rapid increase of the feeder-dike thickness closed to the surface is partly due to low-stiffness host rocks at that depth and partly to the free-surface effects which tend to increase fracture apertures. Below the depth of 30 meters, the feeder-dike thickness is almost constant, suggesting that, at the end of the eruption, the dike magmatic pressure reached a stress equilibrium with the host rock.