Magma intrusion and discharge process at the initial stage of the 2000 Miyakejima activity inferred from tilt and GPS data

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The eruptive activity of Miyakejima volcano started at 18h30m (JST) on June 26, 2000, with large crustal deformation and earthquake swarm, which suggested magma intrusion into the shallow part of the volcano. The activity changed into caldera formation due to subsurface magma discharge in July and August, and large gas emission from the caldera has continued since September 2000. This activity is far different from the typical recent eruptions, that is, fissure eruptions of basaltic lava on the flank of the volcano. The magma movement at the initial stage is probably a key to understanding of the activity. As the crustal deformation was clearly observed by tiltmeter and GPS operated by NIED, ERI, JHD, and GSI, we estimate the magma movement with high spatiotemporal resolution in the period from 18h30m on June 26 to 6h on June 27.

We constructed a source model with a genetic algorism to interpret the crustal deformation. The source model consists of three dilatating dikes and one contracting dike. They correspond to magma intrusion and discharge amounting to about 0.04km3 and 0.03km3, respectively. The result shows that there existed two phases of magma movement; a small intrusion at a depth range of 1-3km beneath the southwestern flank of the island from 18h30m to 21h on June 26, a large intrusion beneath the west coast, and a large magma discharge of a dike-shaped magma chamber beneath the small intrusion, both of which started simultaneously at about 21h on June 26. The depth ranges of the large intrusion and discharge are from 1km to 10km and 3km to 5km, respectively.

We can infer the magma migration process at the initial stage from the model as follows. The magma ascended from the dike-shaped chamber to the southwestern part of the island at 18h30m first, and then large amount of magma intruded beneath the west coast and discharged from the chamber after 21h on June 26. However, the magma probably did not directly migrate from the chamber to the west because the intrusion was more rapid than the discharge. The dike-shaped magma chamber had been suggested by crustal deformation observed before the activity (Murakami et al., 2001; Kimata, 2001). The crustal deformation also suggests a deep-seated magma chamber beneath the dike-shaped chamber at a depth of about 7 km. Therefore, the magma probably intruded from the deep chamber to the west, and the magma in the shallow chamber passively descended to the deep chamber. The discharge of large amount of magma from the shallow chamber probably terminated the first intrusion. Then the magma migration toward the northwest from the island and subsurface magma discharge started and continued in July and August (Nishimura et al., 2001).