

Seismic activity related to solidified magma beneath Hachijo Island

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Seismic activity around Hachijo Island, one of volcanoes on the Izu-ogasawara arc, was studied from Jan. 2003 to Dec. 2008 using Izu-Islands volcanic observation system installed by the Tokyo metropolitan government. The activity is usually much lower than other volcanoes such as Miyakejima and Oshima but earthquakes are occurring at a rate of once or twice a month. We detected 323 events for 13 stations, magnitude range M0.0-3.4, in and around Hachijo Island. The events in the island are almost characterized as being low-frequency (1-2 Hz) occurred at 10-15 km depth, locating at the south-west rim of Mt. Hachijo-Fuji. We determined a velocity structure model beneath the island adopting the tomographic inversion method (Zhang and Thurber, 2003) to the P- and S-travel times. Two high velocity zones at about 15km depth are imaged beneath Hachijo-Fuji and Hachijo-Miharayama, which are considered solidified magma bodies. Most of the earthquakes distribute at 11-13 km depth on the upper edge of one high velocity zone beneath Hachijo-Fuji. These results provide that water derived from the cold magma results in seismic activity.

On 13th August, 2002, an earthquake swarm began to occur beneath Mt. Hachijo-Fuji in association with the ground deformation. A dike intrusion model has been proposed from GPS measurements (Kimata et al., 2004). Resonance of a magmatic dike has been inferred from very-long-period seismic signals (Kumagai et al., 2003). However accurate hypocenter distribution has not been obtained because of the problems of time delay and station allocation. We determined the hypocenters of the 2002 swarm using the Double-Difference tomography method adopting the new velocity model to the phase data of the Earthquake Research Institute. Re-calculated 505 earthquakes began to occur at the east coast of Mt. Hachijo-Fuji at 10-14 km depth and extended toward the south-west, producing concentrated aligned seismicity perpendicular to the direction of movement. Then the activity migrated from the east to the north offshore after several days. These events including low-frequency ones locate the narrow regions between the lower high velocity zones estimating solidified magma and upper low velocity zones. The swarm location is apart from the dike. The swarm at 10-14 km depth is deeper than that estimated dike at 3-7 km depth. These results suggest that the dike intruded silently not accompanying earthquakes but an increase in stress from the dike intrusion and fluid derived from solidified magma resulted in the 2002 seismic swarm. The spatial and temporal alignments of earthquake distribution also suggest the complex crack system produced.

Recent earthquakes is occurring from the west coast of Mt. Hachijo-Fuji to the most southern region of the 2002 swarm. Most of them are low-frequency ones as compared with the 2002 swarm, so that there are no concentrated activities producing cracks. In both cases, it is suggested that fluids derived from solidified magma play an important role in the generation of the seismic activities.