VII. International Activities

1. Collaboration Study on Volcanic Activity between Indonesia and Japan

Geophysics

In l993, the Disaster Prevention Research Institute (DPRI), Kyoto University and the Directorate General Geology and Mineral Resources, Ministry of Mines and Energy, Indonesia reached an arrangement for the joint research program in the field of volcanic activity to migrate volcanic hazards in Indonesia and in relation to IDNDR. Kyoto University has made survey and observations at Indonesian volcanoes in cooperation with Volcanological Survey of Indonesia (reorganized to Directorate of Volcanology and Geological Hazard Mitigation in 2002). In 1998, the arrangement of cooperation was extended until 2003 and the arrangement will be extended 5 years more until 2008.

1) Guntur Volcano

Guntur volcano repeated eruptions with lava flows, ejection of volcanic bomb and pyroclastic flows until the middle of 19th century. After the last eruption in 1843, no eruption has occurred, however, several tens volcanic earthquakes had been observed per month. Kyoto University and DVGHM have continued seismic observation. In May l997, seismic activity at Guntur Volcano suddenly increased and the seismicity was concentrated beneath the summit, especially at depths of 2-4 km, and the hypocenters were aligned from NW to SE, that is, direction of alignment of craters and domes in the summit area (Suantika and Iguchi, 2000). When the volcanic earthquakes successively occurred, reverse fault type earthquakes were dominant. Upward tilt toward the summit crater was observed by a tiltmeter installed 2 km south of the summit crater associated with the seismicity increase from May l997. The tilt change suggests inflation of the ground around the summit crater. The inflation around the summit crater was detected by precise leveling along bench marks on the southeastern and south flanks of the volcano (Hendrasto *et al*., 2000). Referred to benchmark at southeastern flank, the benchmark closed to the summit was elevated 5 mm during the period from August 1996 to November 1997. The vertical deformation was inverted to deflation in 1998 when seismicity declined. On May 6, 1999, two felt earthquakes (M = 2.7 and 2.8) occurred at Guntur volcano and 60 after-shocks were observed. The hypocenters were concentrated beneath Gandapura caldera NW of the summit crater area at depths of 4 km. Focal mechanism of the earthquakes is reverse fault type. Associated with increase in the seismicity, inflation around the summit area was detected by precise leveling again. The benchmark closed to the summit was elevated by 5mm during the period from August 1998 to May 1999. Similar relations between increase in seismicity and uplift of the ground around the summit crater were also found in August 2000 (Hendrasto *et al*., 2000) and December 2002 (Fig. 1).

2) Merapi Volcano

Merapi volcano has repeated growth of lava domes and their collapse generating pyroclastic flow. During the period from 1990-1991, volcano tectonic earthquakes originated beneath the summit. After the seismicity, lava dome growth and collapse were repeated in time interval of a year. Inflations associated with the dome growth were observed by tiltmeters around the summit prior to generation of pyroclastic flows (Voight *et al.*, 2000). Pyroclastic flows in July 1998 entered in rivers the southwestern flank. Koike *et al* (2002) estimated the area and the volume of the pyroclastic deposites to be 10 km^2 and 9 x 10^6 m^3, respectively, by using SAR data. Merapi volcano became dormant for two years after the pyroclastic flow. In August 2000, the seismicity of volcano tectonic earthquakes resumed beneath the summit and continued to January 2001 when frequent rock-fall started from the lava dome. During the activity, pyroclastic flow on February 10, 2001

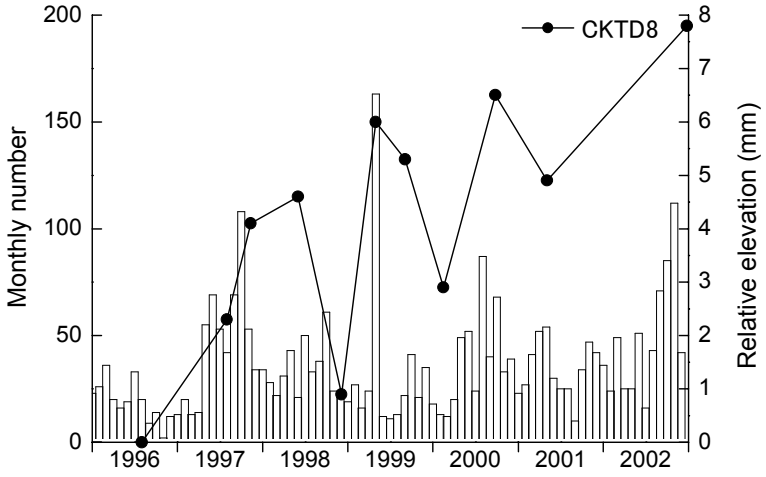

Fig. 1. Relation of relative elevation and monthly number of volcanic earthquakes at Guntur volcano, West Java, Indonesia. The benchmark CKTD8 is located on the southeastern flank of the volcano.

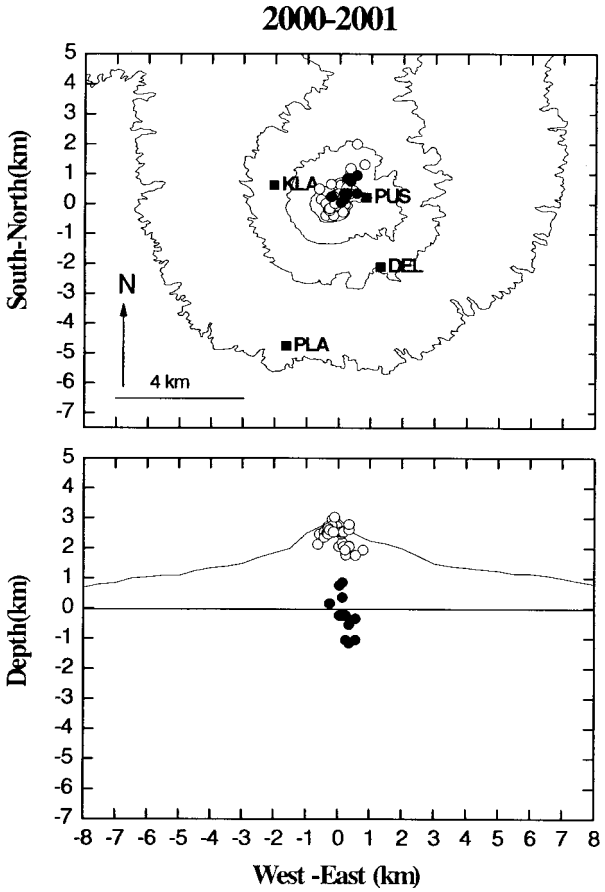

Fig. 2. Hypocentral distribution of volcano tectonic earthquakes at Merapi volcano. Closed and open circles denote VTA and VTB type events. Aseismic zone is recognized between the types of the events. Top: epicenter. Bottom: vertical cross-section in EW direction.

is the biggest, and the front of the pyroclastic flow reached 7 km from the summit. Hidayati (2003) determined the hypocenters and focal mechanisms of the volcano tectonic earthquakes. Deep volcano tectonic earthquakes are located at depth 2-4 km beneath the summit, and the mechanism is normal fault type. Shallow volcano tectonic earthquakes have shallower hypocenter of less than 1 km and reverse-type mechanism (Fig. 2).

3) Other Volcanoes

Anak Krakatau volcano in Sunda Straight resumed Strombolian activity in February 1999. Kristianto *et al.* (2000) observed air-shocks caused by the eruptions and compared the characteristics with Suwanosejima volcano. Iguchi *et al.* (2001) applied tensile shear crack model to monochromatic events at Papandayan volcano where mud eruptions have repeated and magmatic eruption occurred in November 2002. Monochromatic events may be related with shallow hydrothermal system of the volcano.

Geology

Kagoshima University started to collaborate with DVGHM on chronology of Tangkubanparahu volcano, West Java. The volcano is situated north of Bandung. The chronology of 100 ka has been made clear (Kartadinata *et al.*, 2002) and started study on eruption in Sunda Caldera Period. They studied on chronology and formation mechanism of Batur caldera, Bali, Indonesia. Batur caldera has double rim and central stratovolcano and many maars are distributed inside the caldera. The chronology of the caldera was made clear from radiocarbon dating of burned woods in several layers (Sutawidjaja *et al.*, 2003).

"Research Cooperation Project on the Exploration of Small-scale Geothermal Resources in the Eastern Part of Indonesia" was jointly conducted by Volcanological Survey of Indonesia, and Geological Survey of Japan, and NEDO during 1997- 2002. Mataloko area, Flores island was selected as a project site. Based on geological mapping, and geophysical explorations, two holes were drilled. Steam production test confirmed the geothermal reservoir under the site.

In order to evaluate the time-space relationship of large volume eruptions in comparison with Japanese calderas, the cooperation project on geological study for caldera forming eruption in Indonesia has started between Volcanology and Geological Hazard Mitigation and Geological Survey of Japan in 2002. The geology of Rinjani volcano, Lombok island was studied in 2002.

(Masato Iguchi)

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