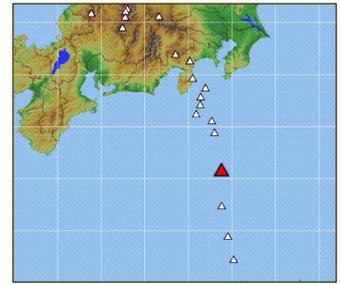


64. Hachijojima

Continuously Monitored by JMA

Latitude: 33°08'13" N, Longitude: 139°45'58" E, Elevation: 854 m
(Nishiyama) (Triangulation Point - Hachijo-Fuji)

Latitude: 33°05'31" N, Longitude: 139°48'44" E, Elevation: 701 m
(Higashiyama) (Triangulation Point - Miharayama)



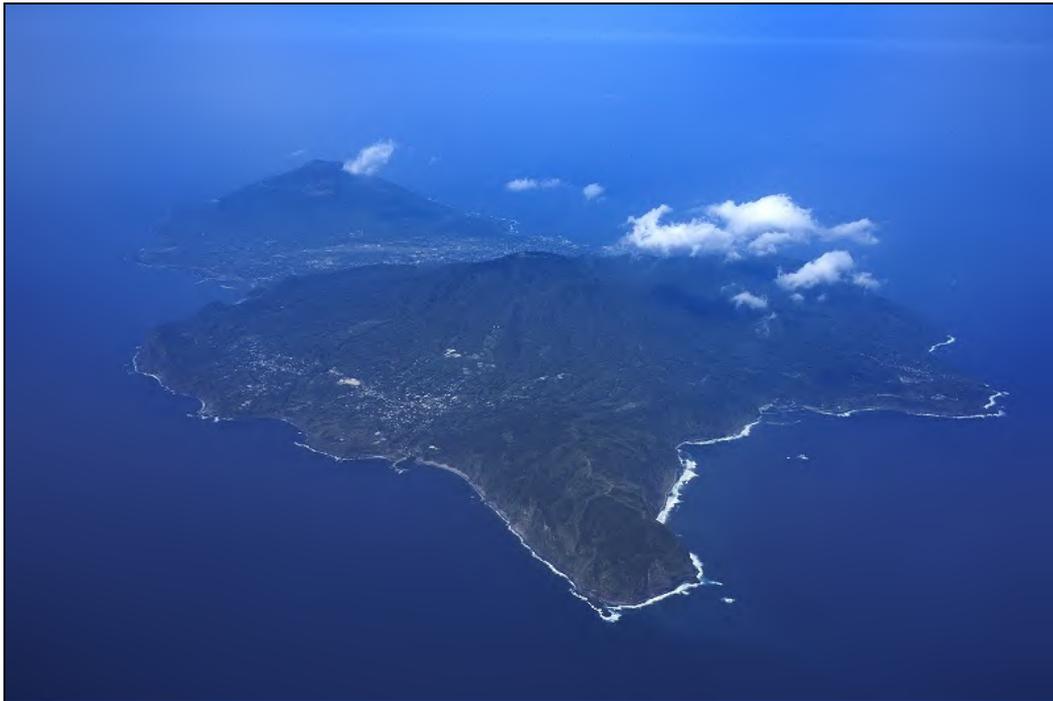
Overview of Hachijojima taken from northwest side on February, 2012. Courtesy of the Tokyo Metropolitan Government Bureau of Port and Harbor.

Summary

Hachijojima is composed of two joined volcanoes, Higashiyama and Nishiyama. It measures 14 km northwest to southeast, and 7.5 km northeast to southwest. Nishiyama (also known as Hachijo-Fuji) and Higashiyama (also known as Miharayama) are both stratovolcanoes, which are composed mainly of basalt. The Higashiyama volcano was active between 100,000 and approximately 3,700 years ago, and formed calderas at least twice. It is mainly composed of basalt, but also contains andesite and a small amount of dacite. No records exist of eruptions within the historical era, and the volcano shows a large amount of erosion. The Nishiyama volcano is a young basalt stratovolcano which became active somewhat over ten thousand years ago. It has a concealed caldera, which appears to have been buried by volcanic rocks at a later date. At the summit there is a crater approximately 500 m in diameter, with a flat lava cone at its center. Over 20 parasitic craters (pyroclastic cones) are located on the southeastern mountain slope, the foot of the volcano, and the lowland where the volcano joins the Higashiyama volcano. Tuff cones (Kandoyama, etc.) were created by phreatomagmatic explosions in the lowlands near the coast. Many crater chains have been identified below sea level in an area centered north of Nishiyama (Ishizuka et al., 2008). The SiO₂ content is between 46.6 and 73.4 wt %.

Records exist of several eruptions before the 17th century, but the eruption locations are unknown. They do not appear to have been large eruptions. Eruptions would be expected to include activity such as scoria and lava flow emissions, and, in areas near the coast, phreatomagmatic explosions are possible.

Photo



Overview of Hachijojima taken from southeast side on February, 2010. Courtesy of the Tokyo Metropolitan Government Bureau of Port and Harbor.

Submarine Topographic Map

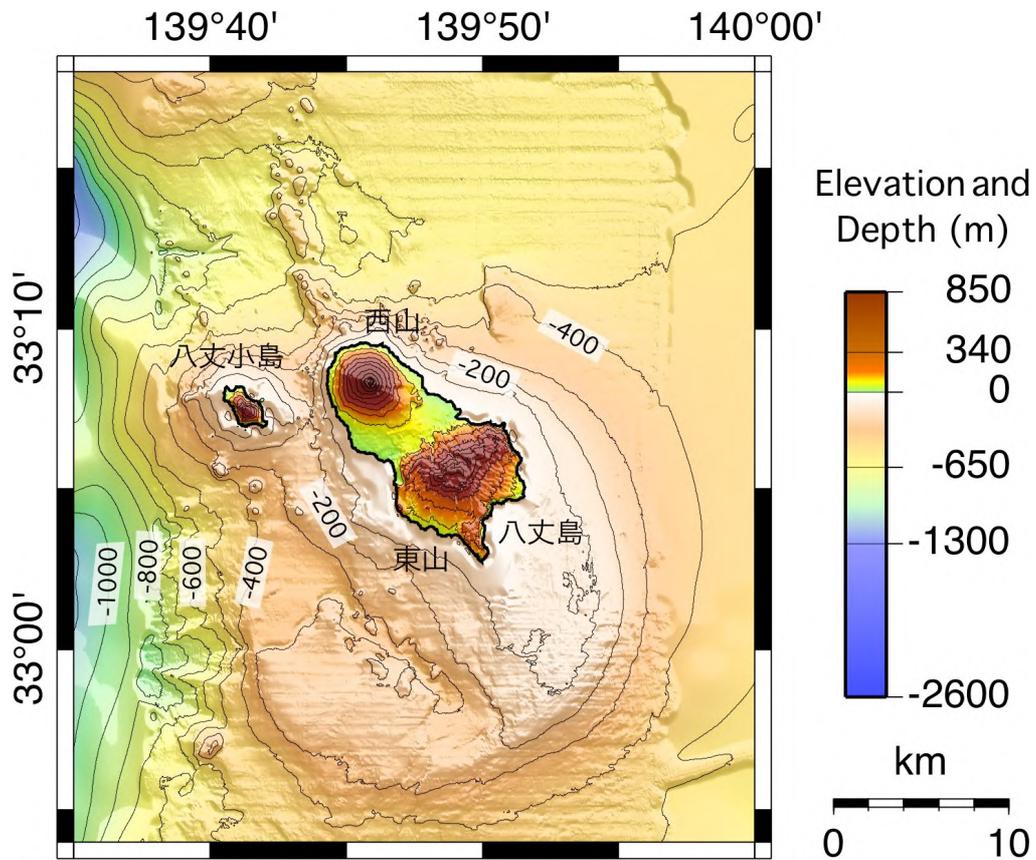


Figure 64-1 Submarine topographic map of the Hachijojima area (Japan Coast Guard).

Red Relief Image Map

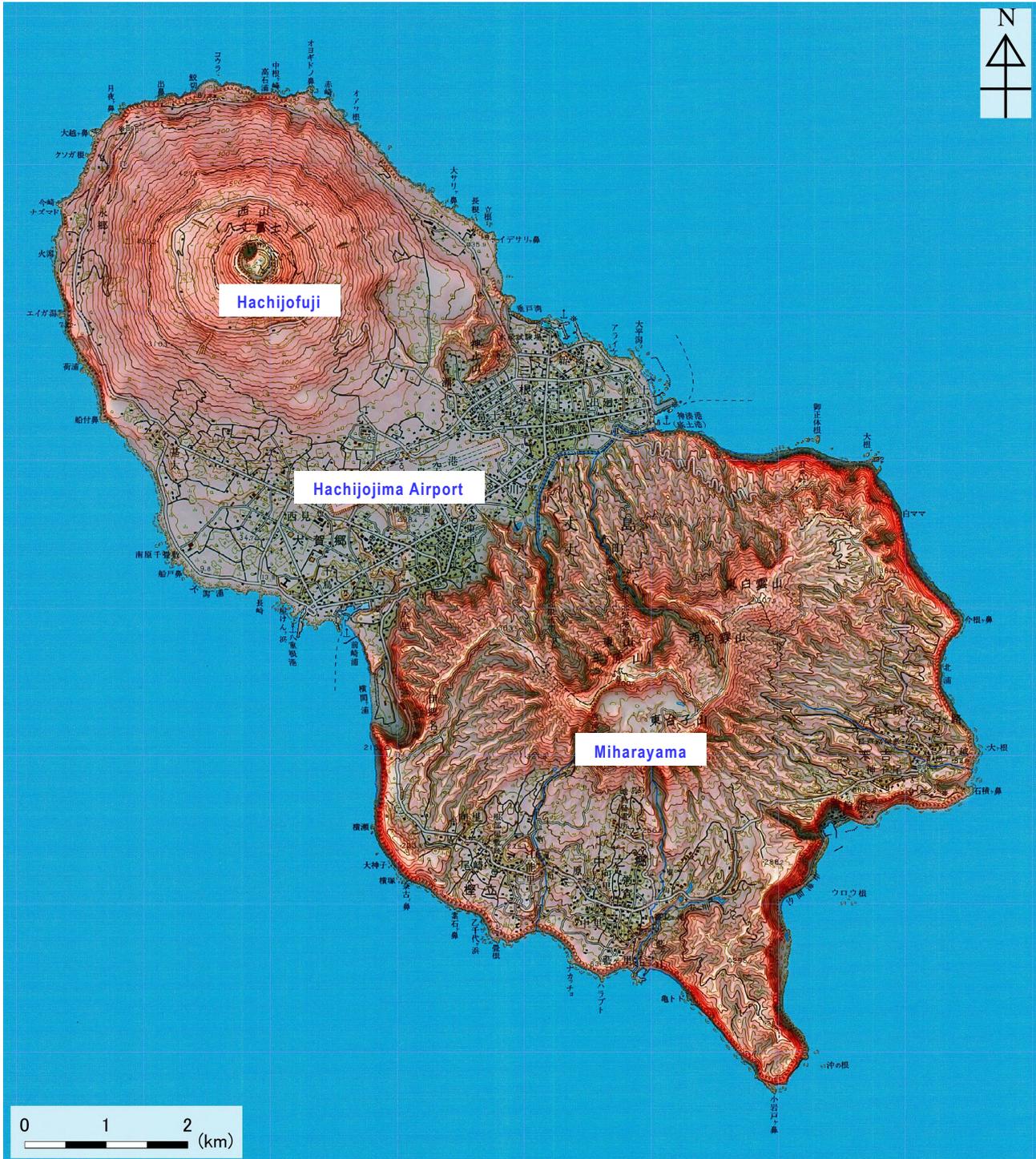


Figure 64-2 Topography of Hachijojima.

1:50,000 scale topographic map (Hachijojima) and digital map 50 m grid (elevation) published by the Geospatial Information Authority of Japan were used.

Geological Map

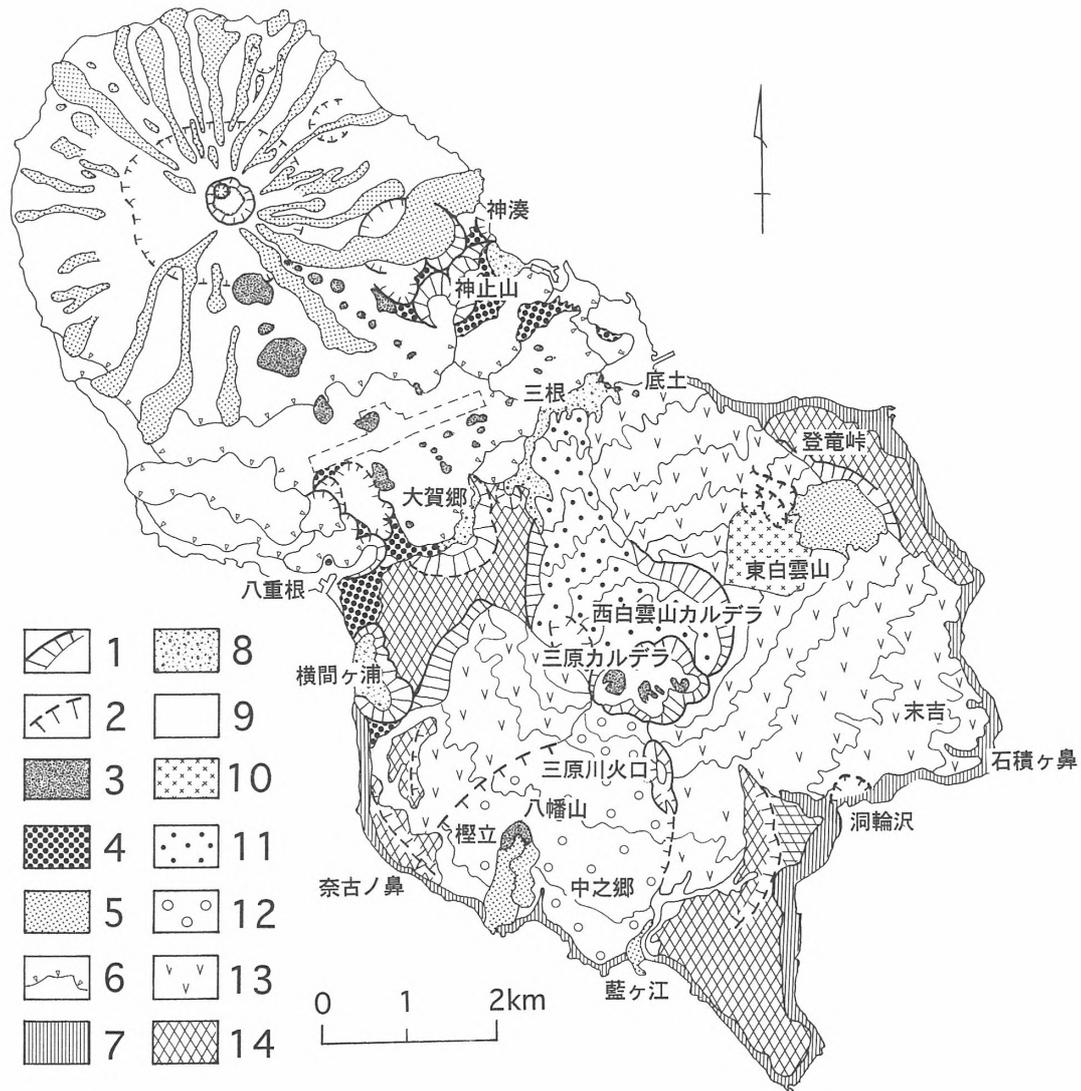


Figure 64-3 Map of topographical classifications at Hachijojima (Sugihara, 1998a).

- 1: Caldera wall or crater wall, 2: Hypothesized caldera wall or crater wall scarp, 3: Pyroclastic cone, 4: Tuff cone or tuff ring, 5: Clear lava lobe, 6: Lava flow edge cliff, 7: Abrasion cliff, 8: Valley bottom lowlands and terraces, 9: Nishiyama volcano, 10: Higashihakuun volcano, 11: New stratovolcano IIb, 12: New stratovolcano IIa, 13: New stratovolcano I, 14: Old stratovolcano

Chronology of Eruptions

▪ Volcanic Activity in the Past 10,000 Years

Activity at Higashiyama within the past 10,000 years consists of eruptions at parasitic craters from the volcano's slope to its foot. The most recent eruption was approximately 3,700 years ago. During the time between 10,000 and 3,700 years ago 4 pumice eruptions, 1 scoria emission, and 1 phreatic explosion occurred, for a total of 6 eruptions.

Deposits from at least 25 eruptions at Nishiyama between approximately 10,000 and 4,000 years ago have been confirmed. These deposits can be divided into those produced by phreatomagmatic explosions and by air fall scoria from other eruptions. Since the last eruption at Higashiyama, all activity has been confined to Nishiyama. Deposits from at least 10 air fall scoria eruptions and 1 phreatomagmatic explosion have been confirmed (Tsukui, 1993a,b; Suga, 1993; Sugihara, 1998a,b).

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
12.6←→12.4ka	Sea north of Higashiyama	Magmatic eruption	Tephra fall. Magma eruption volume = 0.02 km ³ DRE. (VEI 3)
12.6←→7.33ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 2 eruptions during this period)
12.6←→7.33ka	Nishiyama	Phreatomagmatic eruption	Pyroclastic surge. Magma eruption volume = 0.08 km ³ DRE. (VEI 4)
12.6←→7.33ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 3 eruptions during this period)
12.6←→7.33ka	Nishiyama	Phreatomagmatic eruption	Pyroclastic surge. Magma eruption volume = 0.08 km ³ DRE. (VEI 4)
12.6←→7.33ka	Higashiyama parasitic crater	Magmatic eruption	Tephra fall. Magma eruption volume = 0.004 km ³ DRE. (VEI 3)
12.6←→7.33ka	Nishiyama	Phreatomagmatic eruption	Pyroclastic surge. Magma eruption volume = 0.08 km ³ DRE. (VEI 4)
12.6←→7.33ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 2 eruptions during this period)
12.6←→7.33ka	Higashiyama northern parasitic crater	Magmatic eruption	Tephra fall. Magma eruption volume = 0.05 km ³ DRE. (VEI 4)
12.6←→7.33ka	Nishiyama	Phreatomagmatic eruption	Pyroclastic surge, tephra fall. Magma eruption volume = 0.1 km ³ DRE. (VEI 4)
12.6←→6.6ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 6 eruptions during this period)
12.6←→7.33ka	Hachimanyama (southwestern foot of Higashiyama)	Magmatic eruption	Tephra fall, lava flow. Magma eruption volume = 0.012 km ³ DRE. (VEI 2)
7.33←→6.6ka	Miharataki crater (southern slope of Higashiyama)	Phreatic eruption → (produced lahar)	Tephra fall → lahar. (VEI 3)
6.6ka	North of Kashitate (western foot of Higashiyama)	Magmatic eruption	Tephra fall. Magma eruption volume = 0.02 km ³ DRE. (VEI 3)
6.6ka	Nishiyama	Phreatomagmatic eruption	Pyroclastic surge. Magma eruption volume = 0.48 km ³ DRE. (VEI 5)
6.6←→4ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 4 eruptions during this period)
4.8←→4.6ka	Near Yokomagaura crater (western foot of Higashiyama)	Phreatomagmatic eruption	Pyroclastic surge. Magma eruption volume = 0.02 km ³ DRE. (VEI 3)
4.8←→4.6ka	Nishiyama area	Phreatomagmatic eruption	Pyroclastic surge, tephra fall. Magma eruption volume = 0.1 km ³ DRE. (VEI 4)

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
4 ka	horseshoe-shaped crater on northern slope of Higashihakuunzan (northeastern foot of Higashiyama)	Magmatic eruption	Tephra fall. Magma eruption volume = 0.004 km ³ DRE. (VEI 3)
4 ka	Kandoyama area (southeastern foot of Nishiyama)	Phreatomagmatic eruption	Tephra fall, pyroclastic surge. Magma eruption volume = 0.48 km ³ DRE. (VEI 5)
4←→2.4 ka	Nishiyama	Magmatic eruption	Tephra fall. (Deposits from 2 eruptions during this period)
3.8←→2.4 ka	Kandoyama (southeastern foot of Nishiyama)	Phreatomagmatic eruption	Tephra fall → pyroclastic surge. (Deposits from 3 eruptions during this period)
2.7←→1.9 ka	Yaene crater group (northwestern foot of Higashiyama)	Phreatomagmatic eruption	Pyroclastic surge, tephra fall. Magma eruption volume = 0.02 km ³ DRE. (VEI 3)
2.7 ka>	Nishiyama	Magmatic eruption	Lava flow.
2.4←→2.2 ka	Nishiyama summit	Magmatic eruption	Tephra fall.
1.218←→0.984 ka	Pyroclastic cone near western side of Kandoyama (southwestern foot of Nishiyama)	Magmatic eruption	Tephra fall.
1.218←→0.984 ka	Pyroclastic cone near western side of Kandoyama (southwestern foot of Nishiyama)	Magmatic eruption	Tephra fall.
1.218←→0.984 ka	Nishiyama summit	Magmatic eruption	Lava flow → tephra fall.

* Volcanic periods, areas of activity, and eruption types taken from the Active Volcano Database of Japan, AIST (Kudo and Hoshizumi, 2006). All years are noted in calendar year "ka" within the table indicates "1000 years ago", with the year 2000 set as 0 ka.

A←→B: Eruption events taking place at some point between year A and year B

A>: Eruption event after year A.

▪ Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
1487 (Chokyo 1)	Eruption	December 7. The eruption occurred at Nishiyama. The eruption resulted in a famine.
1518 to 1523 (Eisho 15 to Daiei 3)	Magmatic eruption	The eruption began on February 18, at the summit of Nishiyama. It resulted in significant mulberry farm damage.
1605 (Keicho 10)	Moderate: Magmatic eruption	October 27. Tephra fall, lava flow. The eruption occurred at the fissure crater chains on the southeastern slope of Nishiyama. It resulted in agricultural land damage. Magma eruption volume = 0.0046 km ³ DRE. (VEI 2)
1606 (Keicho 10)	Eruption	January 23. A submarine eruption near Hachijojima produced a volcanic island. (Note: Its position and following status is unknown)
1691 to 1692 (Genroku 4 to 5)	Earthquake	10 to 20 felt-earthquakes occurred per month.
1696 to 1697 (Genroku 9 to 10)	Earthquake	Several felt-earthquakes occurred per month.
2002 (Heisei 14)	Earthquake, crustal deformation	Mid- to late August. The seismic activity increased, with hypocenters at depths of 10 to 20 km, from Hachijojima Nishiyama to the sea to the northwest (JMA scale seismic intensity of 2 on the island itself). Crustal deformation resulting in a displacement by Hachijojima of 5 cm to the east was confirmed. Based on the deep low-frequency earthquakes and crustal deformation, it has been deduced that there was magma intrusion directly below Nishiyama. In mid-December there was also a slight temporary increase in earthquakes at a depth of approximately 10 km near Hachijojima Nishiyama.

* Reference documents have been appended with reference to the Active Volcano Database of Japan, AIST (Kudo and

Hoshizumi, 2006) for volcanic periods, areas of activity, eruption types, and eruption events.

Whole Rock Chemical Composition

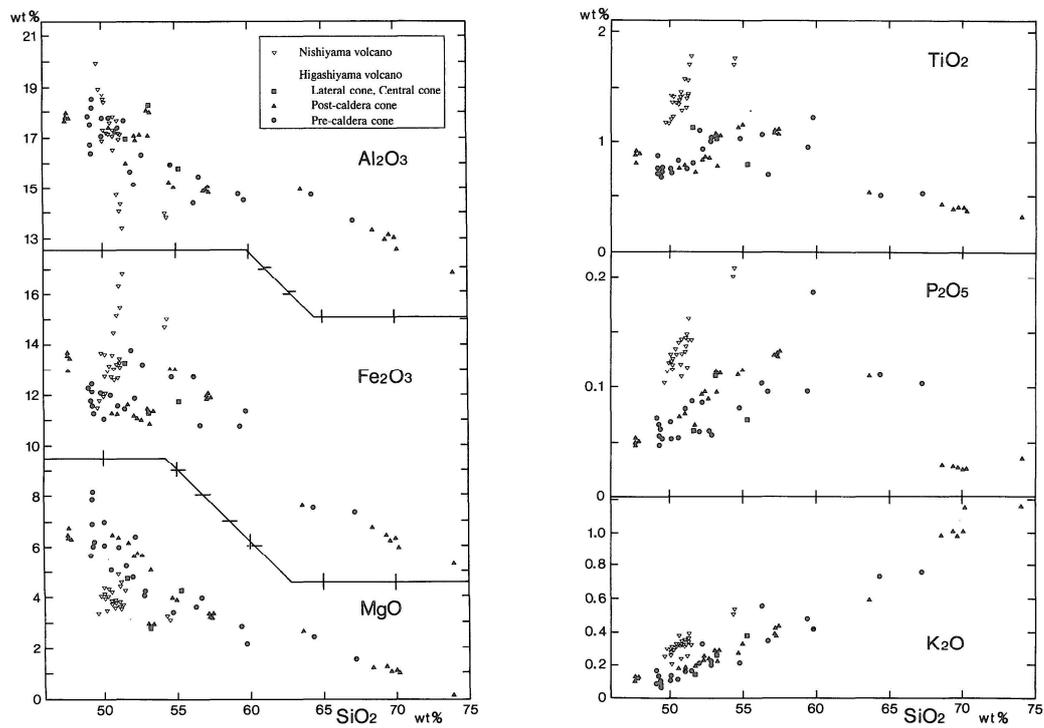


Figure 64-4 Whole rock chemical composition (Nakano, et al., 1997).

Precursory Phenomena

Although eruptions had not occurred recently, in 2002 prominent seismic activity and crustal deformation were observed, which are considered to have been caused by a magma intrusion deep underground.

Recent Volcanic Activity

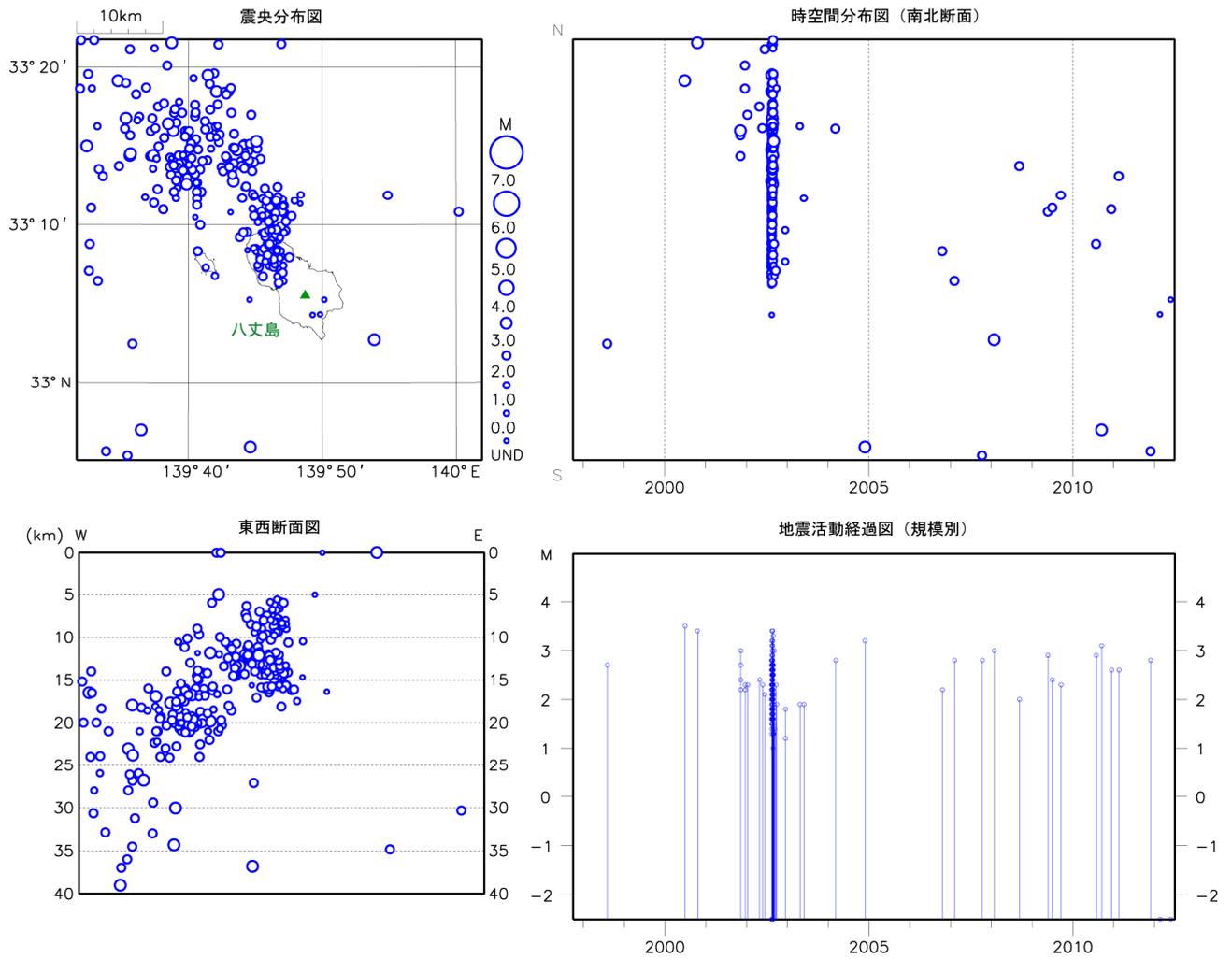


Figure 64-5 Activity of shallow VT earthquakes (blue circles) and deep low-frequency earthquakes (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (by scale) (lower right).

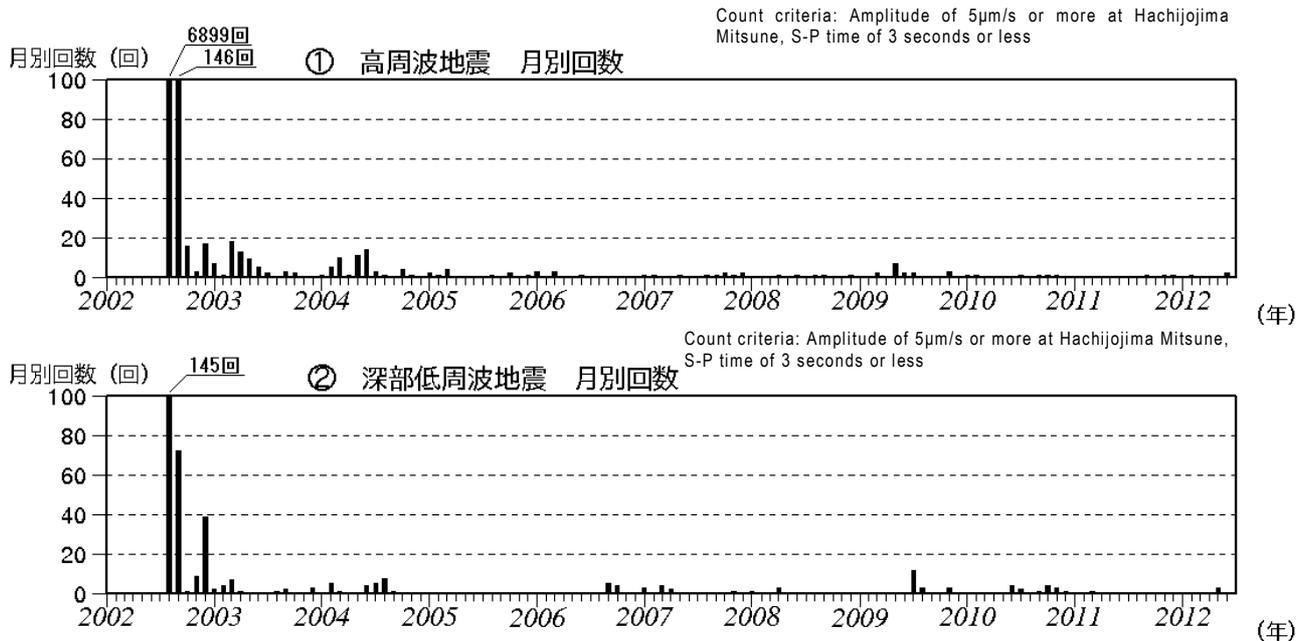


Figure 64-6 Number of earthquakes per month (August 13, 2002, to June 30, 2012).

- ① Number of high frequency earthquakes per month
- ② Number of deep low frequency earthquakes per month

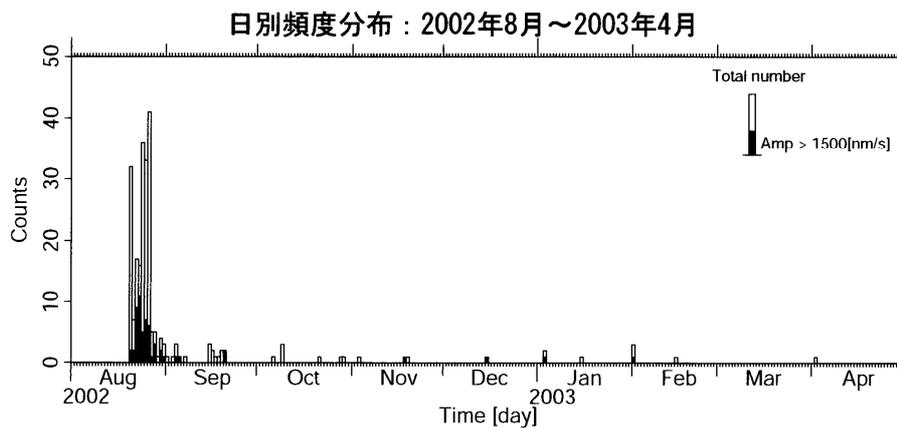


Figure 64-7 Changes in very-long-period seismic activity at Hachijojima (August, 2002, to April, 2003) (National Research Institute for Earth Science and Disaster Prevention, 2003).

Very-long-period seismic activity (with predominant periods of approximately 10 seconds) was observed, accompanying the earthquake swarm activity which began on August 13.

Several earthquakes per day occurred until mid-September, at which point the number fell to one to several per month.

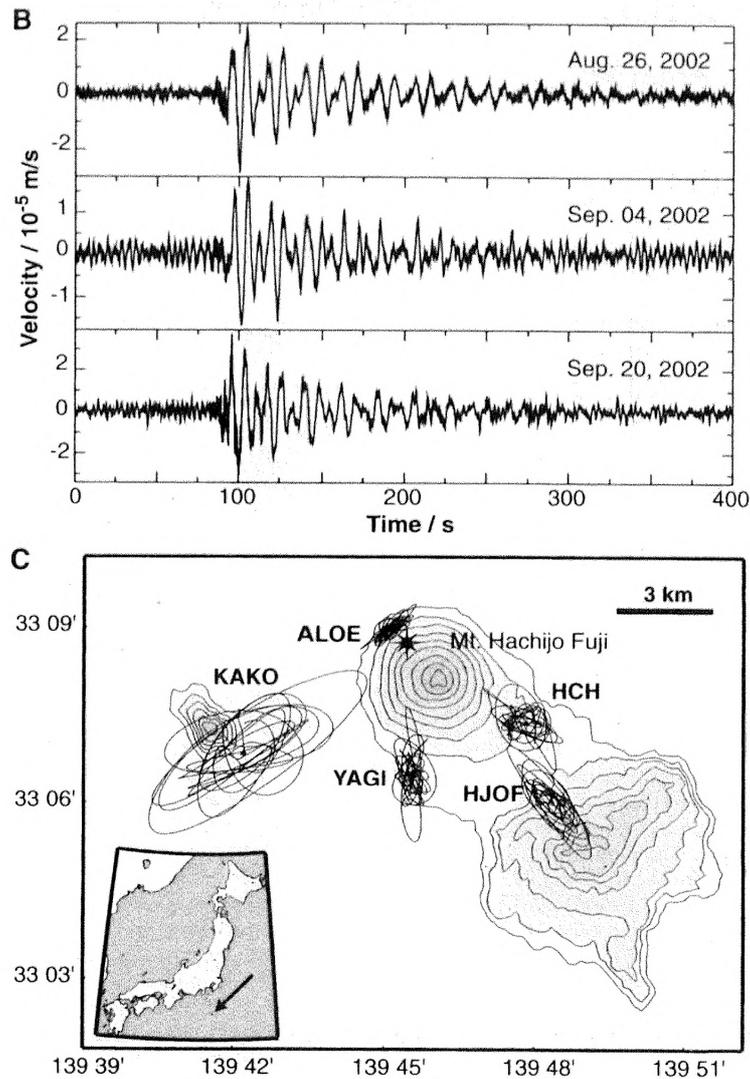


Figure 64-8 Horizontal particle motions of the VLP (Very-Long-Period) signals on 4 September in the band 6 to 13s. A solid star marks the epicenter determined by the moment-tensor inversion. The inset shows the location of Hachiojima island in Japan. (Kumagai et al., 2003)

Hypocenters were contained within the Hachiojima-Fuji area. This indicates the possibility that the long period earthquakes may have been caused by vibrations in dikes intruded below Hachiojima-Fuji.

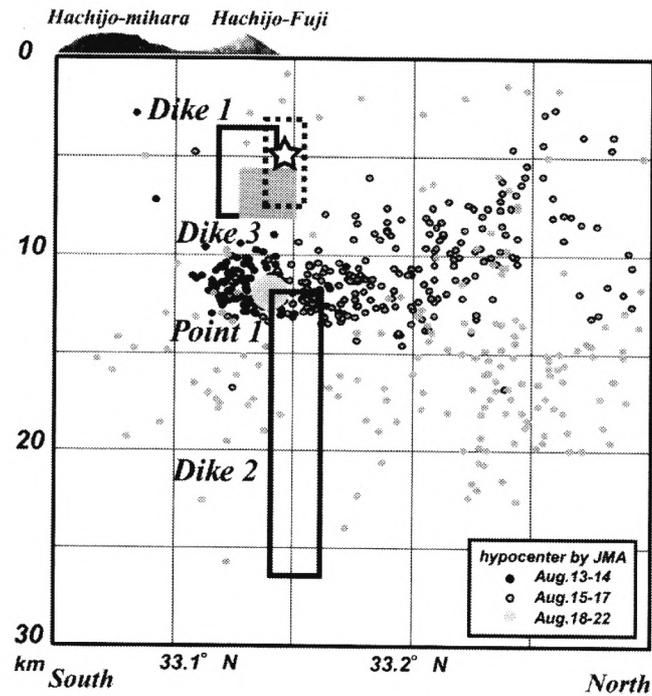


Figure 64-9 Dike intrusion model determined by GPS continuous measurement results at Hachiojima (Kimata, et al., 2004).

Small circles indicate earthquake hypocenters. Rectangular outlines indicate open cracks. Gray rectangles indicate closed cracks. Gray circles indicate deflation sources.

Based on GPS measurement, it is deduced that type 1 intrusion occurred (directly below Hachio-Fuji, slightly to the west, with the west edge of the earthquake swarm area moving roughly northward). The location of the dike intrusion is estimated to be shallower than that of the hypocenters, in a location with almost no recognized seismic activity.

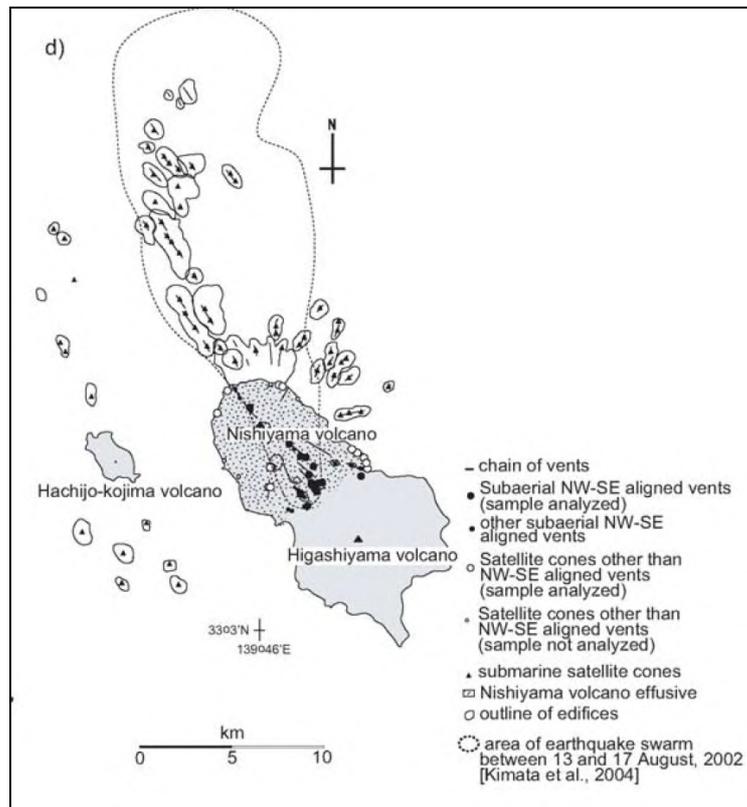


Figure 64-10 Distribution of submarine volcanic edifices in the Hachijojima area, and 2002 earthquake swarm area (Ishizuka et al., 2008).

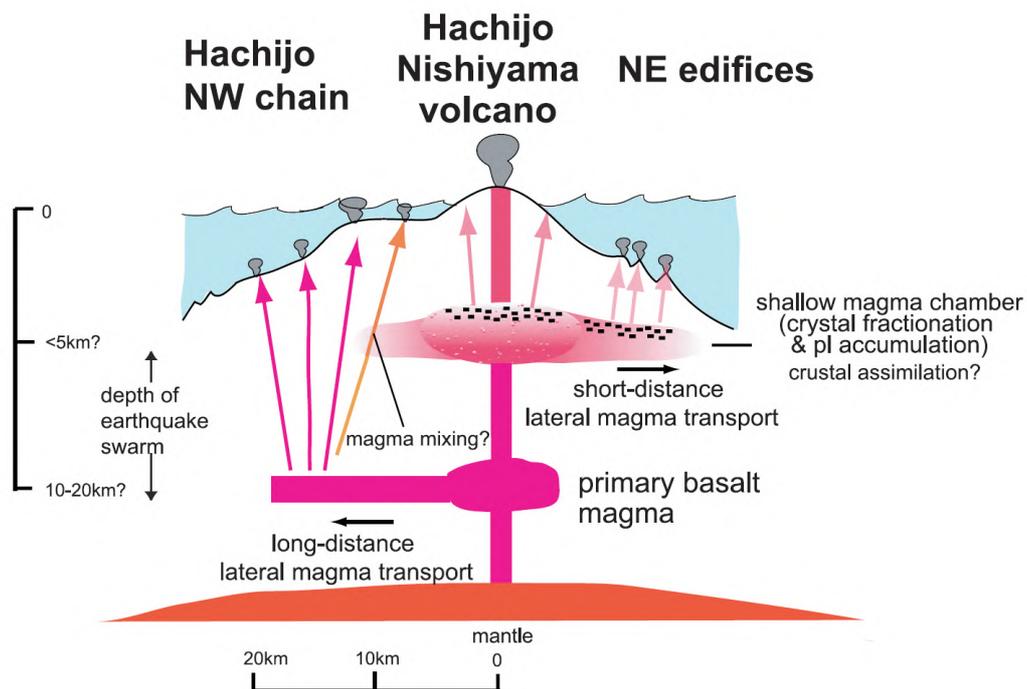


Figure 64-11 Magma supply system at Nishiyama volcano in Hachijojima (Ishizuka et al., 2008).

In the past eruptions, long-distance lateral movement of relatively undifferentiated magma was restrained by wide area stress fields in deep crust (the 2002 earthquake swarm's hypocenters are estimated to have been at a depth of 10 to 20 km: Kimata et al., 2004). However, crystal differentiation occurred in shallow crust, and amassed magma moved from shallow magma chambers under localized stress fields within the volcanic edifice, forming parasitic craters.

Information on Disaster Prevention

① Hazard Map

None

Social Circumstances

① Populations

- Island population: 8,206 (according to Hachijo statistics as of December 1, 2011)
- Volcano foot residential area, etc.: 2.0 km from the Hachijo-Fuji crater.

② National Parks, Quasi-National Parks, Number of Climbers

- Fuji-Hakone-Izu National Park Hachijojima
 - Number of sightseers per year: Approximately 100,000 (according to Hachijo statistics)
 - Number of mountain-climbers per year: Unknown

③ Facilities

- Port facilities

Kaminato Port (Sokodo Port), Yaene Port

Hachijo Visitor Center

Hachijo City Hall Museum of History and Folklore

Monitoring Network

* Monitoring sites with multiple observation instruments are indicated by small black dots, and other symbols indicate types of monitoring.



1:50,000 scale topographic map (Hachiojima) published by the Geospatial Information Authority of Japan was used.

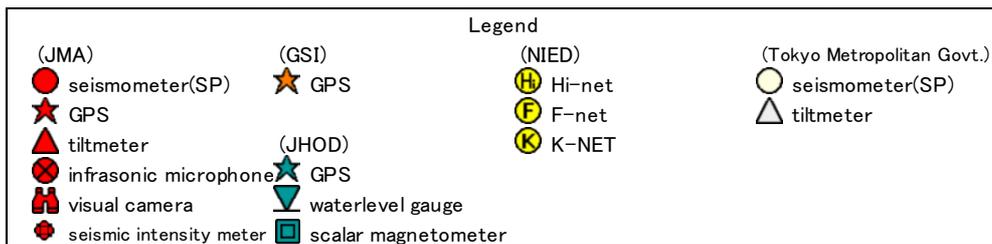


Figure 64-12 Monitoring network.

Bibliography

- Ishizuka, O., et al. (2008) *J. Geophys. Res.*, **113**, doi:10.1029/2007JB005325.
- Kimata, F., et al. (2004) *Bull. Volcanol. Soc. Jpn.*, **49**, 13-22 (in Japanese with English Abstract).
- Kumagai, H., et al. (2003) *Science*, **299**, 2058-2061.
- Nakano, S., et al. (1997) *Bull. Geol. Surv. Japan*, **48**, 93-105 (in Japanese with English Abstract).
- National Research Institute for Earth Science and Disaster Prevention (NIED) (2003) Report of Coordinating Committee for Prediction of Volcanic Eruption, 85, 79-81 (in Japanese).
- Suga, K. (1994) *Bull. Volcanol. Soc. Jpn.*, **39**, 13-24 (in Japanese with English Abstract).
- Suga, K. (1993) *Bull. Volcanol. Soc. Jpn.*, **38**, 115-127 (in Japanese with English Abstract).
- Sugihara, S. (1998a) *Jour. Geography (Chigaku Zasshi)*, **107**, 390-420 (in Japanese).
- Sugihara, S. (1998b) *Jour. Geography (Chigaku Zasshi)*, **107**, 695-712 (in Japanese).
- Tsukui, M. et al. (1991) *Bull. Volcanol. Soc. Jpn.*, **36**, 345-356 (in Japanese with English Abstract).
- Tsukui, M et al. (1993) *Bull. Volcanol. Soc. Jpn.*, **38**, 199-212 (in Japanese with English Abstract).
- Tsukui, M. (2003) Report of Coordinating Committee for Prediction of Volcanic Eruption, **83**, 67-69 (in Japanese).

(Tsukui, M.)