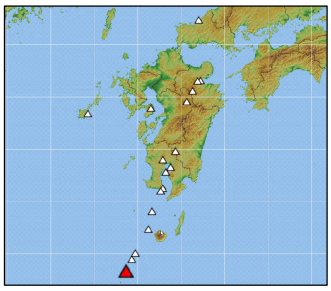
97. Suwanosejima



Continuously Monitored by JMA

Latitude: 29°38'18" N, Longitude: 129°42'50" E, Elevation: 796 m (Otake) (Elevation Point)

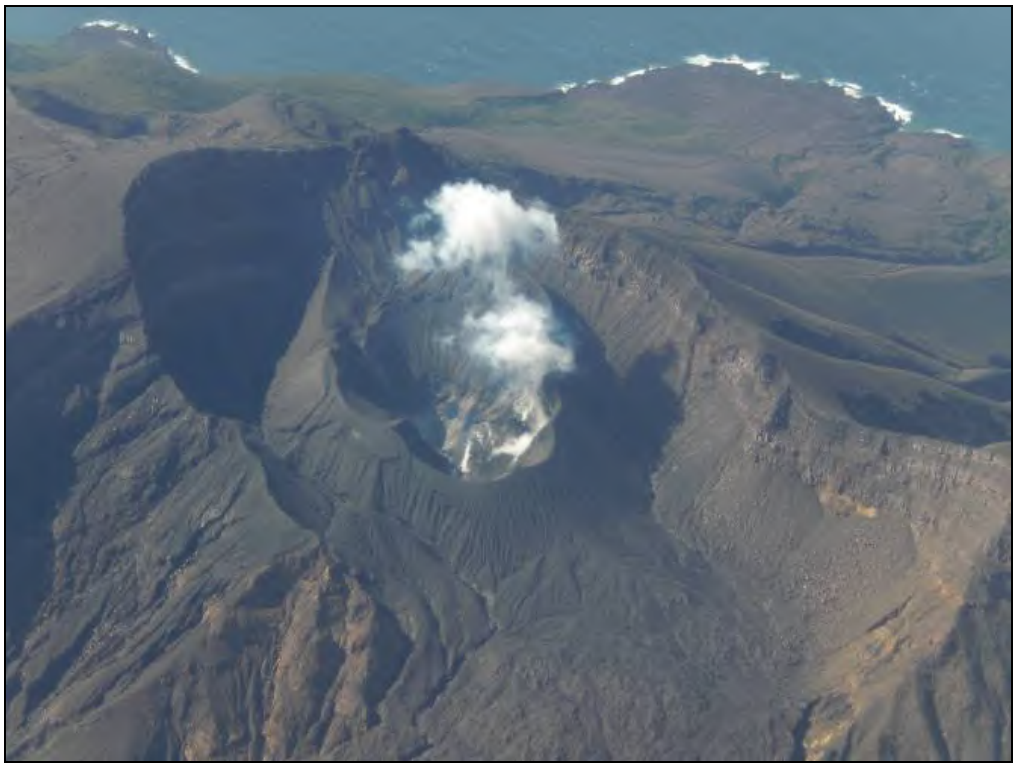
Overview of Suwanosejima taken from east side on September 17, 2009 by the Japan Meteorological Agency

Summary

Suwanosejima is an andesite stratovolcano, measuring 8 km along its longest diameter (north-northeast to south-southeast), and 5 km along its shortest diameter. Two craters, 200 m and 400 m in diameter, are arranged from southwest to northeast at its summit. Both have experienced eruptions and lava flows within recorded history. It is notable for having strombolian and vulcanian eruptions. It has erupted every year since 1956, and remains active. The SiO_2 content of andesite is between 57.3 and 60.1 wt %.

Photos

Continuous eruption of Otake crater taken from south side on December 5, 2002 by theJapan Meteorological Agency



Otake crater taken from east side on January 26, 2010 (Courtesy of theJapan Coast Guard)

Red Relief Image Map

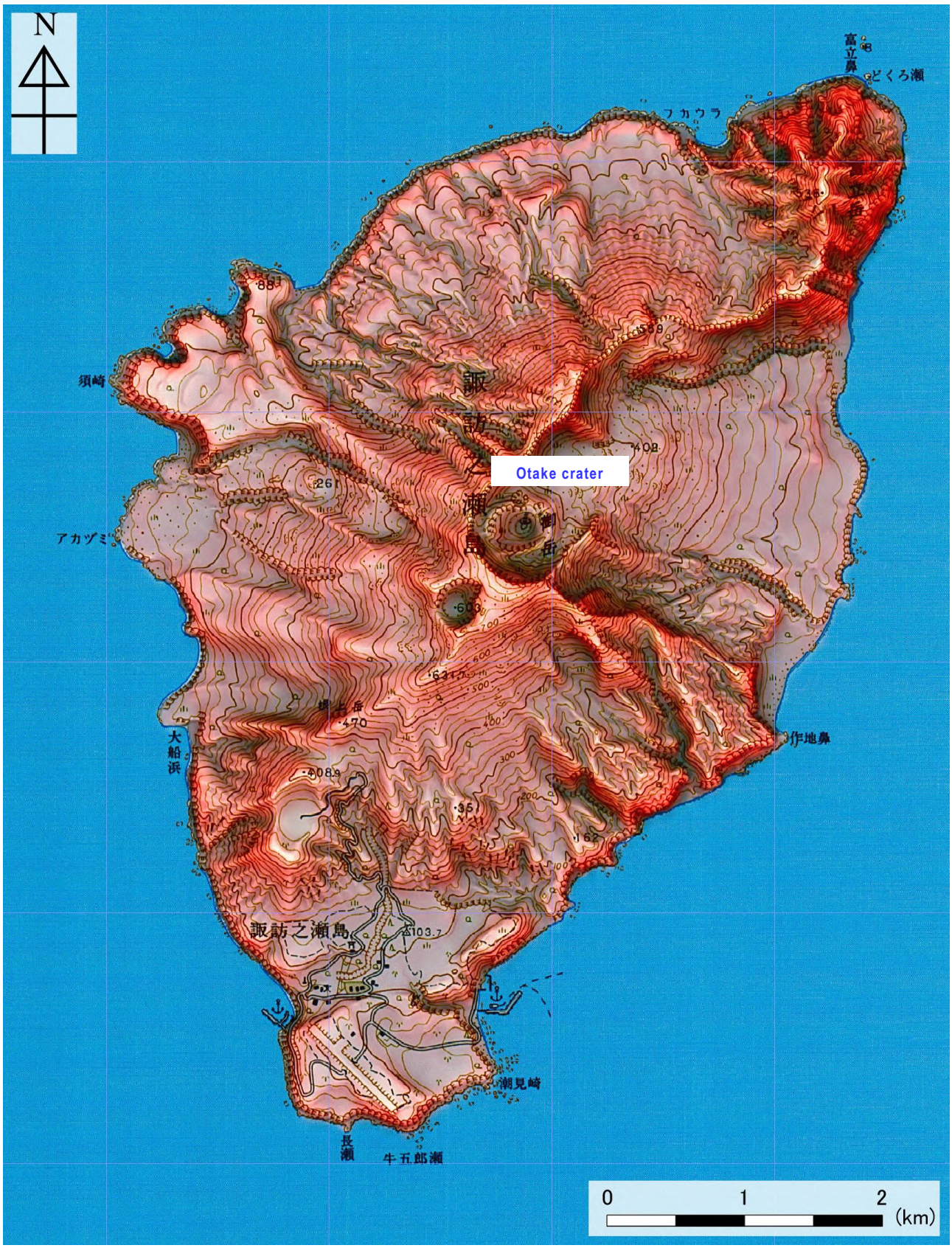


Figure 97-1 Topography of Suwanosejima.

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

Bathymetry

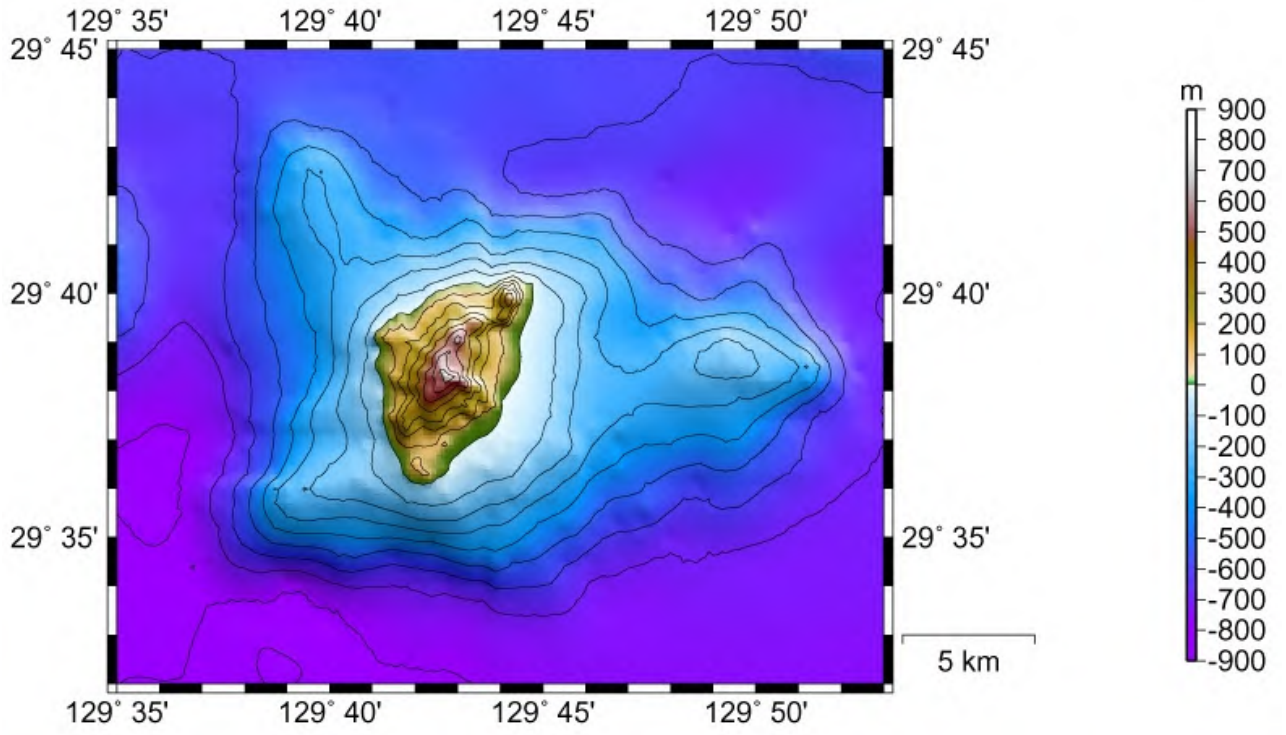


Figure 97-2 Bathymetric map of Suwanosejima (Japan Coast Guard).

Chronology of Eruptions

・Volcanic Activity in the Past 10,000 Years

The main stratovolcano edifice of the Suwanosejima volcano is Otake. Otake volcano can be divided, from bottom to top, into older, middle, and Younger Otake volcanoes. Most of the volcanic edifice which extends above sea level was formed 60,000 to 70,000 years ago or later.[1] At the bottom of the Younger Otake volcano, there exists Aira Tanzawa tephra (A-Tn; approximately 25 ka). All ejecta younger than this comes exclusively from the Otake volcano. Eruptive activity during the past 10,000 years is poorly understood, but there is a pyroclastic flow deposit of 8,600 years ago in the southeastern part of Suwanosejima, and layers of volcanic ash from 3,800 years ago or later are confirmed in the southern part of the island.[1]

Records exist of eruptions from the Edo era onwards, but no reports exist of records of historical eruptions before the Bunka eruption of 1813 (Shimano and Koyaguchi, 2001).

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
8.6ka	Otake	Magmatic eruption	Pyroclastic flow
3.8ka	Otake	Magmatic eruption	Volcanic ash emission

* Reference documents have been appended with reference to the catalog of eruptive events during the last 10,000 years in Japan, database of Japanese active volcanoes, and AIST (Kudo and Hoshizumi, 2006) for eruptive period, area of activity and eruption type. All years are noted in calendar years. "ka" within the table indicates "1000 years ago", with the year 2000 set as 0 ka.

・Historical Activity

The Bunka eruption (1813) has been followed by effusion of a lava flow, the Meiji eruption (1884), and discharges of volcanic ash by intermittent strombolian and vulcanian eruptions at least over the last 50 years.

Year	Phenomenon	Activity Sequence, Damages, etc.
1813 (Bunka 10)	Large: Eruption	"Bunka eruption". Eruptions at Otake crater and old crater. Tephra fall and pyroclastic flow, a lava flow occurred, reaching the ocean. A collapse also occurred. This activity resulted in the evacuation of the entire population of the island, which remained a desert island until 1883 (Meiji 16). Magma eruption volume = 0.1 km^3 DRE.
Approx. 1877 (Meiji 10)	Eruption	Volcanic sounds could be heard for 3 days. The eruption site was the Otake crater.
1884 (Meiji 17)	Eruption	"Meiji eruption". The eruption site was the Otake crater. A lava flow was emitted, which reached the sea. Eruptive activity continued until the following year. Tephra fall.
1885 (Meiji 18)	Eruption	The eruption site was the Otake crater. Rumbling and volcanic plume.
1889 (Meiji 22)	Eruption	October 2 to October 13. The eruption site was the Otake crater. Infrasonic wave and explosion sound at Naze Port, Amami Oshima.
1914 (Taisho 3)	Volcanic plume, rumbling	March 21. The eruption site was the Otake crater.
1915 (Taisho 4)	Volcanic plume	July, September. The eruption site was the Otake crater.
1921 (Taisho 10)	Eruption	December 8, December 9. The eruption site was the Otake crater.
1922 (Taisho 11)	Eruption	January 26. Minor activity followed until 1925. The eruption site was the Otake crater.
1925 (Taisho 14)	Eruption	May 13. Lava flow.
1938 (Showa 13)	Eruption	March 11. Frequent eruptions followed thereafter.
1940 (Showa 15)	Eruption	November 29. The eruption site was the Otake crater.
1949 (Showa 24)	Eruption	October. Black volcanic plume, rumbling, earthquakes, fissure. The eruption site was the Otake crater.
1950 to 1954 (Showa 25 to 29)	Eruption	Occasional eruptions. The eruption site was the Otake crater.
1956 (Showa 31)	Eruption	November, December. Volcanic plume, infrasonic wave. The eruption site was the Otake crater.
1957 to 1995 (Showa 32 to Heisei 7)	Eruption	Frequent eruptions. The eruption site was the Otake crater.
1989 (Heisei 1)	Earthquake	October. A felt-earthquake occurred at Suwanosejima.
1992 (Heisei 4)	Eruption	February, October. Tephra fall on the island in February. Red-hot volcanic blocks were ejected by the October eruption. Intermittent eruptions then continued until April, 1997. Glowing was observed during the December, 1994 eruption. The eruption site was the Otake crater.
1997 (Heisei 9)	Eruption	March, April. A small amount of volcanic ash was emitted. The eruption site was the Otake crater.
1998 (Heisei 10)	Earthquake	October 23 and 24. A M2.2 and a M2.3 earthquake occurred on Suwanosejima.
1999 (Heisei 11)	Eruption	January, September, November. Tephra fall was occasionally confirmed in the village. The eruption site was the Otake crater.
2000 (Heisei 12)	Eruption	Tephra fall was confirmed in the village in January, February, and December. A new pit in the Otake crater was formed in December.
2001 (Heisei 13)	Eruption	January to May, July, October to December. The eruption site was the Otake crater. Tephra fall was occasionally confirmed in the village. The level of volcanic seismic activity was heightened from July onwards. Volcanic tremors with small amplitudes also occurred occasionally .
2002 (Heisei 14)	Eruption	Explosive eruptions occurred every month except February, for a total of 306 explosions over the course of the year. The level of eruptive activity was high, with 22 explosive eruptions on August 19, 22 on November 22, and 72 on December 5, as well as a continuous eruption from August 19 to 21. Continuous volcanic tremors occurred in late January, early March, mid-April, and from July onwards. On August 20 tephra fall was confirmed at Naze, Amami Oshima. The eruption site was the Otake crater.

Year	Phenomenon	Activity Sequence, Damages, etc.
2003 (Heisei 15)	Eruption	Explosive eruptions occurred every month except August and November, for a total of 64 explosions over the course of the year. 7 explosive eruptions occurred on July 4, and 13 on July 5, for a total of 20 over the course of 2 days. Eruptions occurred on March 7 from 3:00 to 13:00 and on June 10 from 8:00 to after 9:00. Continuous volcanic tremors occurred intermittently from late February to mid-March, and in July. High numbers of volcanic earthquakes occurred repeatedly within short periods of time. The eruption site was the Otake crater.
2004 (Heisei 16)	Eruption	Explosions occurred in January, from March to July, in October, and in December. A new crater formed on the northeast side of the Otake crater in February.
2005 (Heisei 17)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred in January, May to July, October, and December, with a total of 46 explosive eruptions over the course of the year. The eruption site was the Otake crater.
2006 (Heisei 18)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred from January to March, in July, in August, and from October to December, for a total of 519 explosions over the course of the year. The eruption site was the Otake crater.
2007 (Heisei 19)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred from January to May and from September to December, for a total of 70 explosions over the course of the year. The eruption site was the Otake crater.
2008 (Heisei 20)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred from January to February and May to December, for a total of 156 explosions over the course of the year. The eruption site was the Otake crater.
2009 (Heisei 21)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. 216 explosive eruptions occurred over the course of the year. The eruption site was the Otake crater.
2010 (Heisei 22)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred every month except June, for a total of 283 explosions over the course of the year. The eruption site was the Otake crater.
2011 (Heisei 23)	Eruption	Volcanic activity remained high, with repeated small eruptions, including explosive eruptions. Explosive eruptions occurred from January to May and in September, for a total of 51 explosions over the course of the year. An earthquake swarm occurred in the sea to the northeast in February. Since the 2011 off the Pacific coast of Tohoku Earthquake (March 11, 2011), seismic activity temporarily increased. The eruption site was the Otake crater.
2012 (Heisei 24)	Eruption	Explosive eruptions occurred from January to March. The eruption site was the Otake crater.

* Reference documents have been appended with reference to the catalog of eruptive events during the last 10,000 years in Japan, database of Japanese active volcanoes, and AIST (Kudo and Hoshizumi, 2006) for eruptive period, area of activity and eruption type.

Recent Volcanic Activity

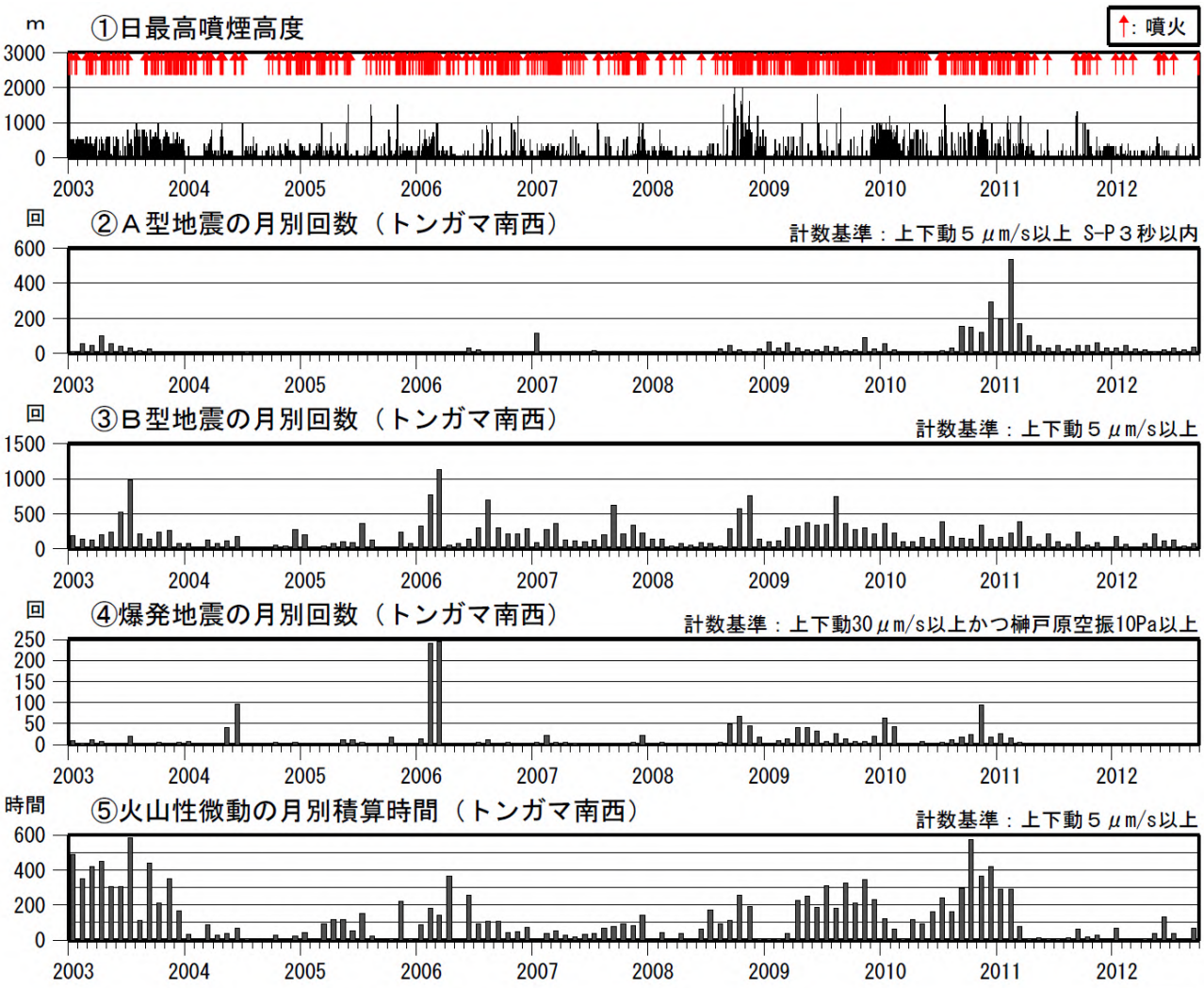


Figure 97-3 Volcanic activity (January, 2003 to Septemer 30, 2012).

Intermittent eruptions, including explosive eruptions, have occurred at the Otake crater, and the level of eruptive activity has remained high.

① Daily maximum height of volcanic plume

② Monthly number of A-type earthquakes (southwest of Tongama)

③Monthly number of B-type earthquakes (southwest of Tongama)

④Monthly number of explosive earthquakes (southwest of Tongama)

⑤ Monthly duration of volcanic tremor (southwest of Tongama)

Table 97-1 Suwanosejima Activity Table (▲ : eruption) (as of June 30, 2012)

Year \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1975		▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	10
76	▲	▲	▲				▲			▲	▲	▲	7
77				▲	▲	▲	▲	▲	▲				6
78					▲	▲	▲	▲	▲	▲	▲	▲	8
79		▲	▲			▲	▲		▲			▲	6
1980		▲	▲	▲	▲	▲	▲	▲	▲		▲	▲	10
81	▲	▲	▲	▲	▲	▲	▲	▲			▲	▲	10
82	▲	▲	▲	▲	▲			▲	▲	▲	▲	▲	10
83	▲	▲	▲	▲	▲	▲	▲		▲	▲	▲	▲	11
84	▲		▲	▲	▲					▲			5
85									▲	▲	▲	▲	4
86		▲	▲		▲		▲	▲	▲	▲	▲	▲	9
87	▲			▲		▲							3
88	▲	▲	▲	▲			▲	▲		▲			7
89	▲	▲	▲	▲		▲	▲		▲	▲	▲	▲	10
1990				▲	▲	▲	▲	▲	▲	▲	▲		8
91	▲	▲	▲	▲		▲			▲	▲	▲	▲	9
92	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		11
93	▲	▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	11
94	▲	▲	▲		▲		▲	▲	▲	▲	▲	▲	10
95			▲	▲	▲	▲		▲	▲	▲	▲	▲	9
96	▲	▲	▲			▲						▲	5
97			▲										1
98													0
99	▲								▲		▲		3
2000	▲	▲										▲	3
1	▲	▲	▲	▲	▲		▲			▲	▲	▲	9
2	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
3	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
4	▲	▲	▲	▲	▲	▲	▲		▲	▲	▲	▲	11
5	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
6	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
7	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
8	▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	▲	11
9	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	12
2010	▲	▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	11
11	▲	▲	▲	▲	▲	▲	▲		▲	▲	▲		10
12	▲	▲	▲		▲	▲							5

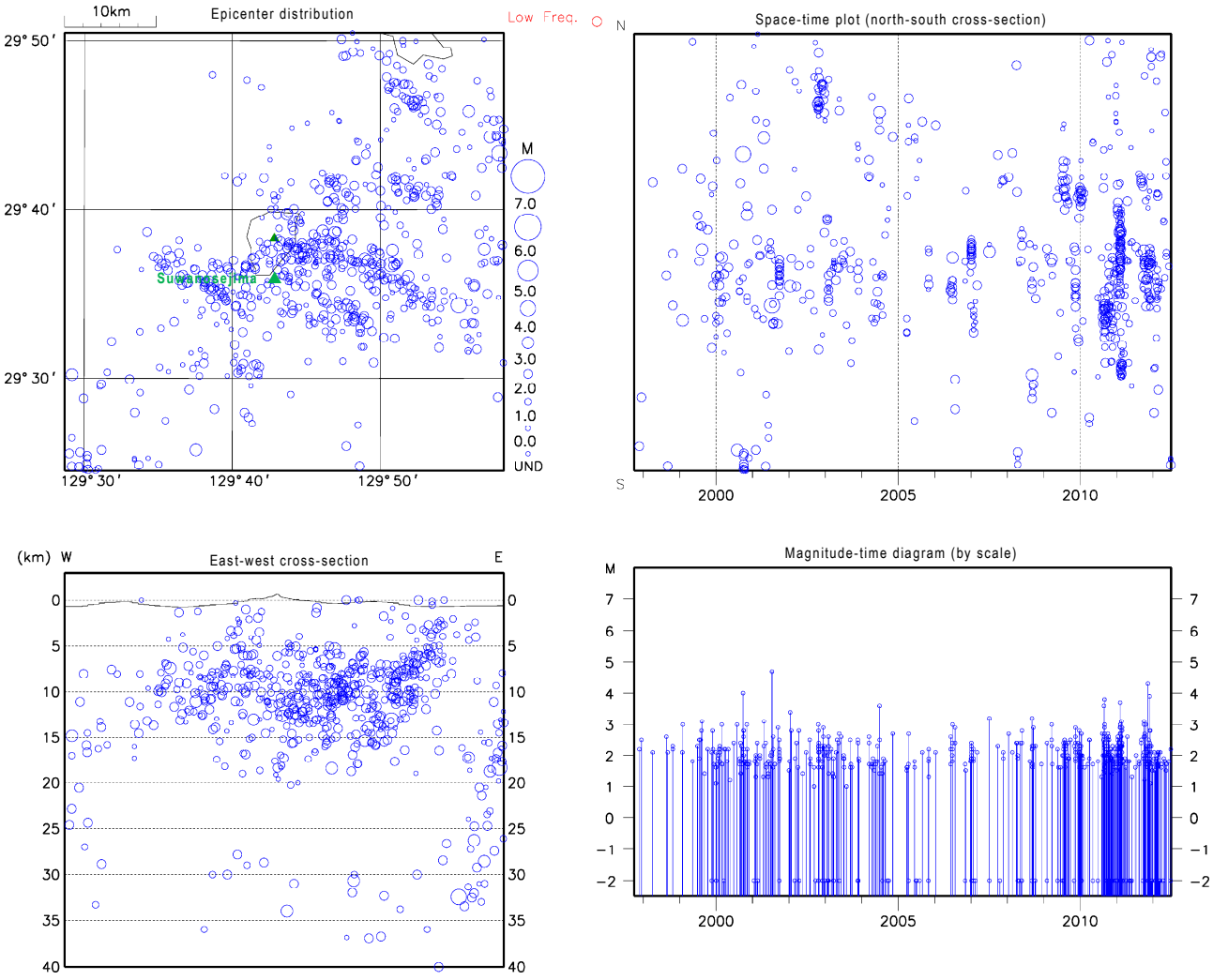


Figure 97-4 Shallow VT earthquake (blue circles) observed by regional seismometer network (October 1, 1997 to June 30, 2012).Epicenter distribution(upper left),space-time plot(N-S cross-section)(upper right),E-W cross-section(lower left) and magnitude-time diagram(lower right).

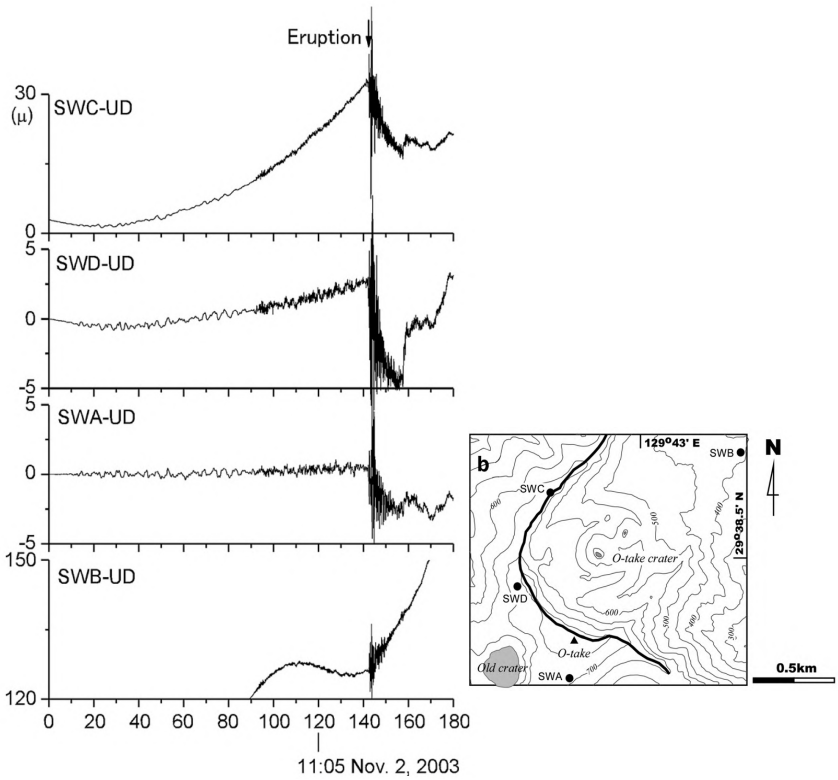


Figure 97-5 Upward vertical displacement immediately before an eruption (Iguchi et al., 2008).

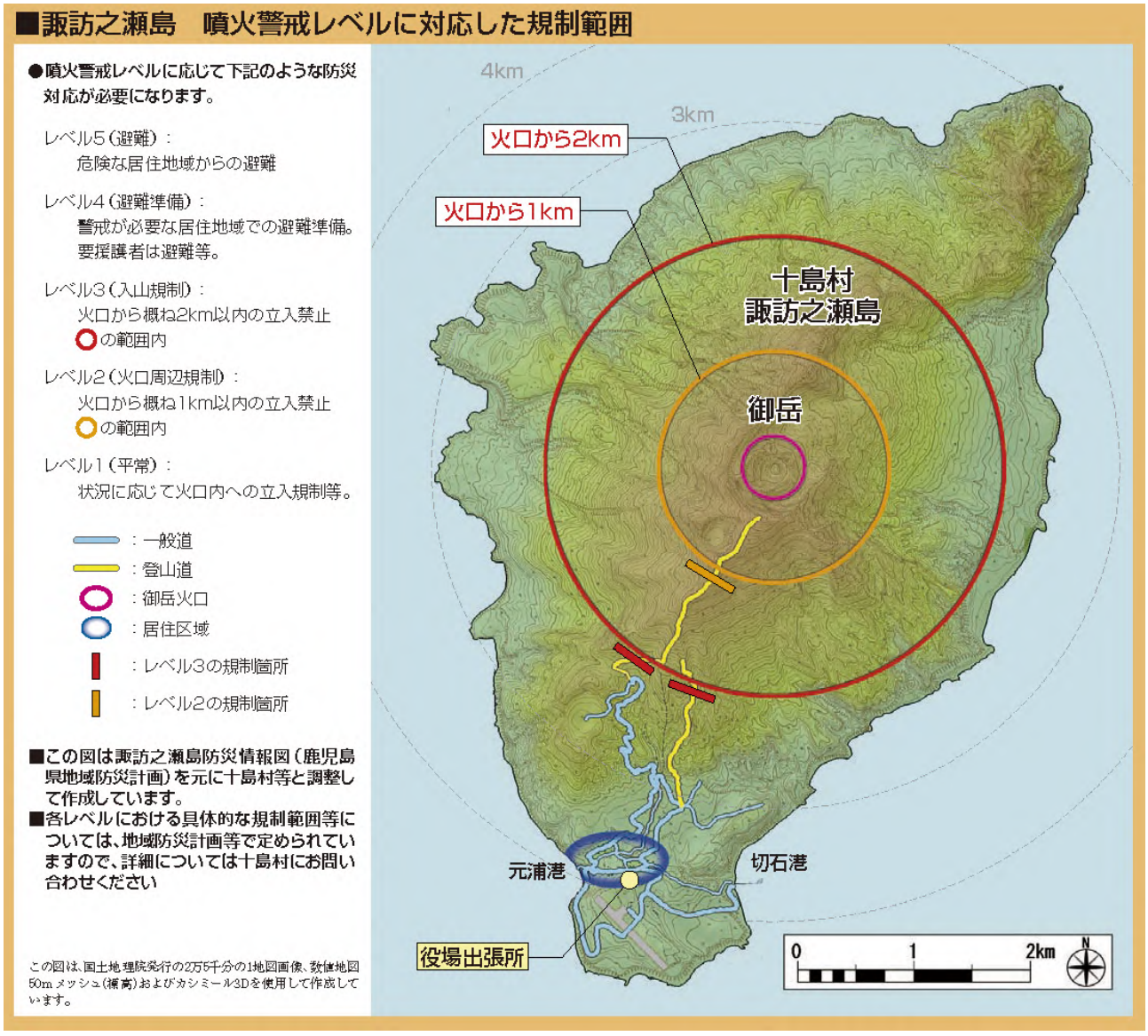
Information on Disaster Prevention

①Hazard Map

- "Suwanosejima Volcano Disaster Danger Area Forecast Map"
- "Suwanosejima Disaster Prevention Information Map"
- Both created by Kagoshima Prefecture in 1996

  URL:http://www.pref.kagoshima.jp/aj01/bosai/sonae/keikaku/h23/documents/24696_20120419165952-1.pdf

②Volcanic Alert Levels (Used since December 1, 2007 (Heisei 19))



Volcanic Alert Levels for the Suwanosejima Volcano (Valid as of December 1, 2007)

Warning and Forecast	Target Area	Levels & Keywords	Expected Volcanic Activity	Actions to be Taken by Residents and Climbers	Expected Phenomena and Previous Cases
Eruption Warning	**Residential areas and areas closer to the crater**	**5 Evacuate**	**Eruption or imminent eruption causing significant damage to residential areas**	**Evacuate from the danger zone**	●Eruption or imminent eruption, with pyroclastic flow and/or lava flow reaching residential areas. 1813 Eruption Example Eruptions from crater chain extending from the Tongama crater to the Otake crater. A pyroclastic flow extended approximately 4 km from the Tongama crater, a lava flow occurred, and a debris avalanche was caused by a collapse (Bunka eruption).
		4 Prepare to evacuate	**Possibility of eruption causing significant damage to residential areas (increased probability).**	**Those within the alert area should prepare for evacuation. Those requiring protection in the event of an disaster must be evacuated.**	●Eruption expansion with possibility of pyroclastic flow and/or lava flow reaching residential areas. Past Examples No observed examples
Crater Area Warning	**Non-residential areas near the volcano**	**3 Do not approach the volcano**	**Eruption or prediction of eruption causing significant damage to areas near residential areas (entering area is life threatening).**	**Residents can go about daily activities as normal. When necessary, evacuation preparations should be performed for those requiring protection in the event of a disaster. Access restrictions for dangerous areas, including mountain climbing and mountain access prohibitions, etc.**	●Possibility of volcanic blocks being scattered within approximately 2 km of crater, or scattering caused by growth of small eruption. May, 1925, Eruption Example Explosive eruption and earthquake swarm.
	Crater area	**2 Do not approach the crater**	**Eruption or prediction of eruption affecting area around crater (entering area is life threatening).**	**Residents can go about daily activities as normal. Access to crater area restricted, etc.**	●Small eruption, with scattering of volcanic blocks within a distance of approximately 1km from the crater. Past Examples August, 1980: Volcanic blocks were scattered approximately 500 m from the crater. ●Possibility of small eruption. Past Examples Very small-scale eruptions from 1956 to 1997, and from 1999.
Eruption Forecast	**Inside the crater**	**1 Normal**	**Little or no volcanic activity. Volcanic ash may be emitted within the crater as a result of volcanic activity (entering area is life threatening).**	**Access to interior of and area around crater restricted as necessary, etc.**	●Little or no volcanic activity. Possibility of discharge which may affect summit crater interior.

Note 1) The volcanic blocks mentioned in this table refer mainly to blocks large enough that their trajectories are not affected by wind.

Note 2) Levels 1 through 3 are envisioned for eruptions occurring at the Otake crater.

Social Circumstances

①Populations

Toshima Village: 607 (Suwanosejima: 58) (Toshima Village: as of October 31, 2011)

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

- National Parks, Quasi-National Parks: None designated. However, a Kagoshima Prefecture nature park exists.
- Number of sightseers per year: 1,032 (according to 2010 Toshima Village survey)
- Number of mountain-climbers per year: -

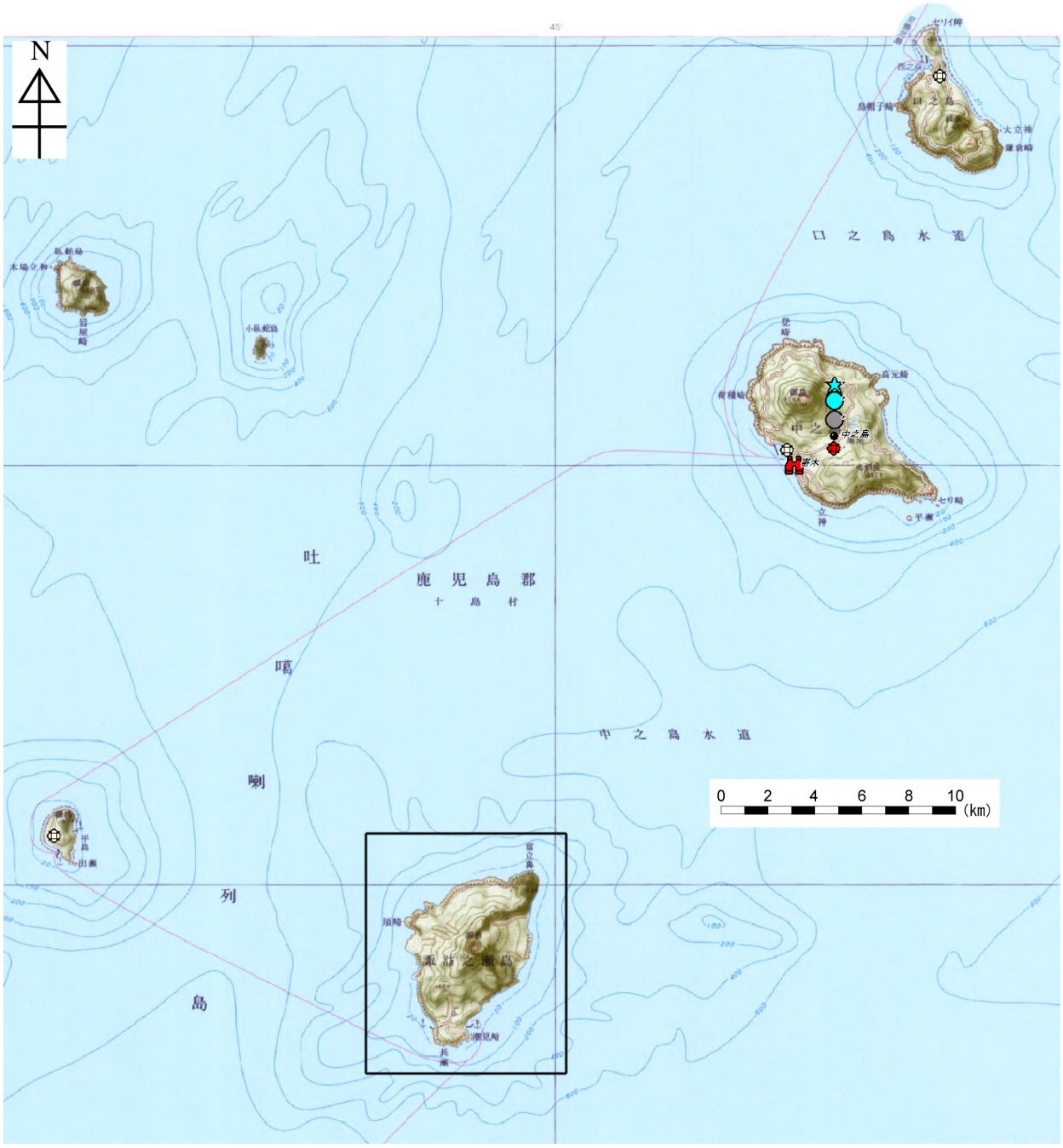
③Facilities

None

Monitoring Network

Wide Area

* Including Kuchinoshima and Nakanoshima monitoring networks.



1:200,000 scale regional map (Nakanoshima) published by the Geospatial Information Authority of Japan was used.

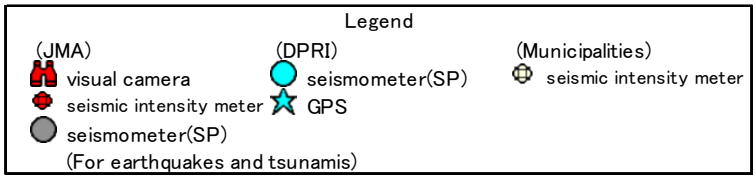
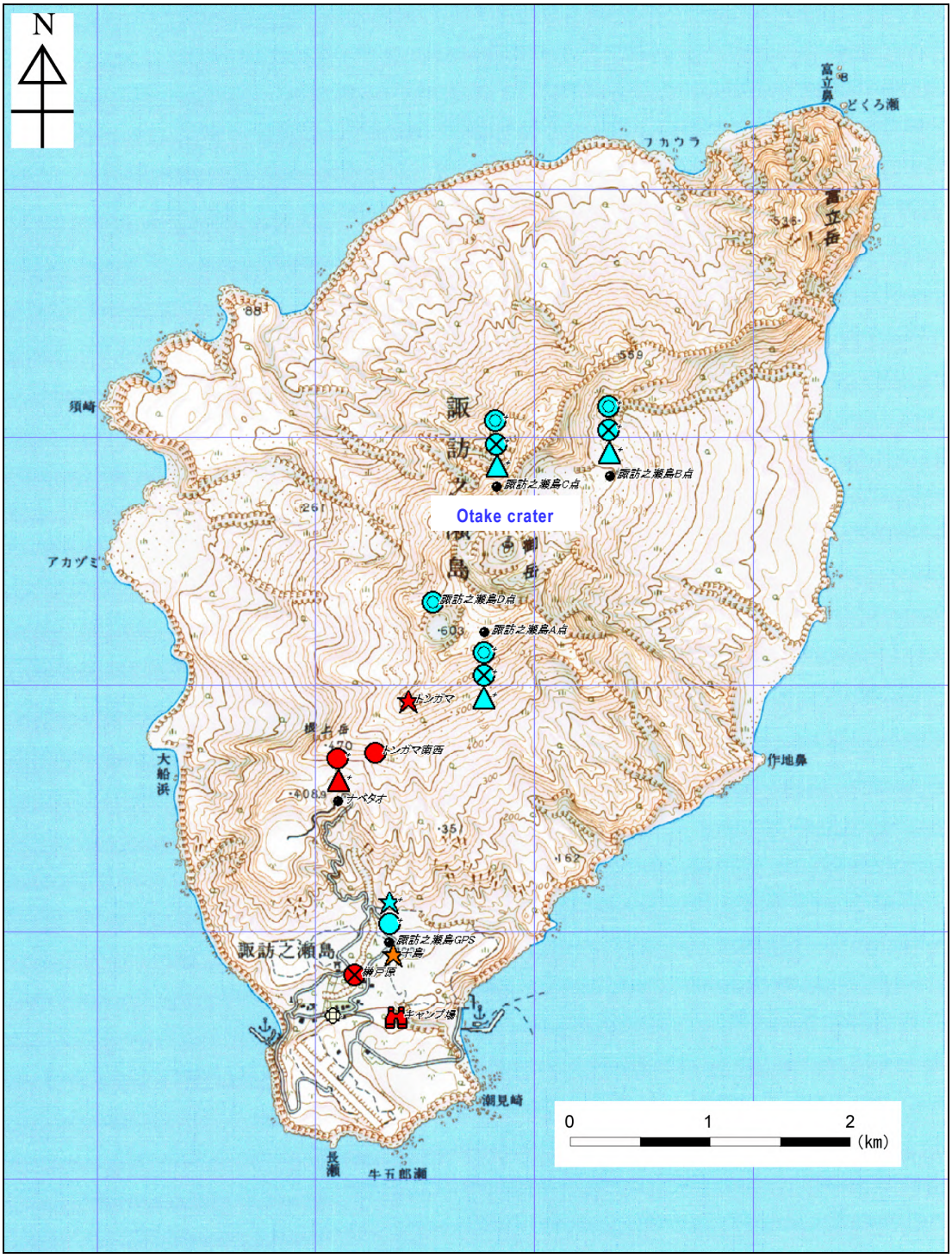


Figure 97-6 Regional monitoring network.

* Monitoring sites with multiple observation instruments are indicated by small black dots, and other symbols indicate types of monitoring. The area enclosed in the black rectangle is shown in detail in a smaller scale summit area map.

In and Around the Summit

* 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 (Suwanosejima) published by the Geospatial Information Authority of Japan was used.

Legend

(JMA)	(GSI)	(DPRI)	(Municipalities)
seismometer(SP)	GPS	seismometer(SP)	seismic intensity meter
GPS		seismometer (broadband)	
tiltmeter		GPS	
infrasonic microphone		tiltmeter	
visual camera		infrasonic microphone	

Figure 97-7 Local monitoring network.

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