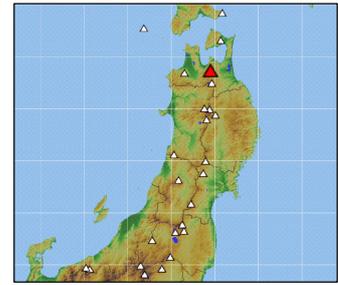


23. Hakkodasan

Latitude: 40°39'32" N, Longitude: 140°52'38" E, Elevation: 1,585 m (Otake)
(Triangulation Point - Hakkodasan)



Overview of Hakkodasan taken from south side on December 3, 2002 by the Japan Meteorological Agency

Summary

Hakkodasan consists of at least 17 stratovolcanoes and lava domes, and can be divided into the north and south groups. To the north is the Kita-Hakkoda volcanic group, and to the south is the Minami-Hakkoda volcanic group. The Kita-Hakkoda volcanic group has been active since approximately 0.4 million years ago, while the Minami-Hakkoda volcanic group was active between approximately 1.1 and 0.3 million years ago (Kudo et al., 2004; Takarada and Muraoka, 2004). The eruptive rocks from the north and south groups are composed of basalt and andesite with minor dacite. The whole-rock SiO₂ content of eruptive rocks ranges between 49.4 and 63.2 wt.% (Sasaki et al., 1985, 1986, 1987). There are fumes around Sukayu and Jigokunuma on the southwestern foot of Otake, which is the highest peak in the Kita-Hakkoda volcanic group. The Hakkoda caldera (approximately 9 km in diameter) was formed by several large-scale pyroclastic flow eruptions (dacite-rhyolite) which occurred approximately 1 to 0.4 million years ago (Kudo et al., 2006). The southwestern half of the Hakoda caldera is concealed by the Kita-Hakkoda volcanic group.

Red Relief Image Map

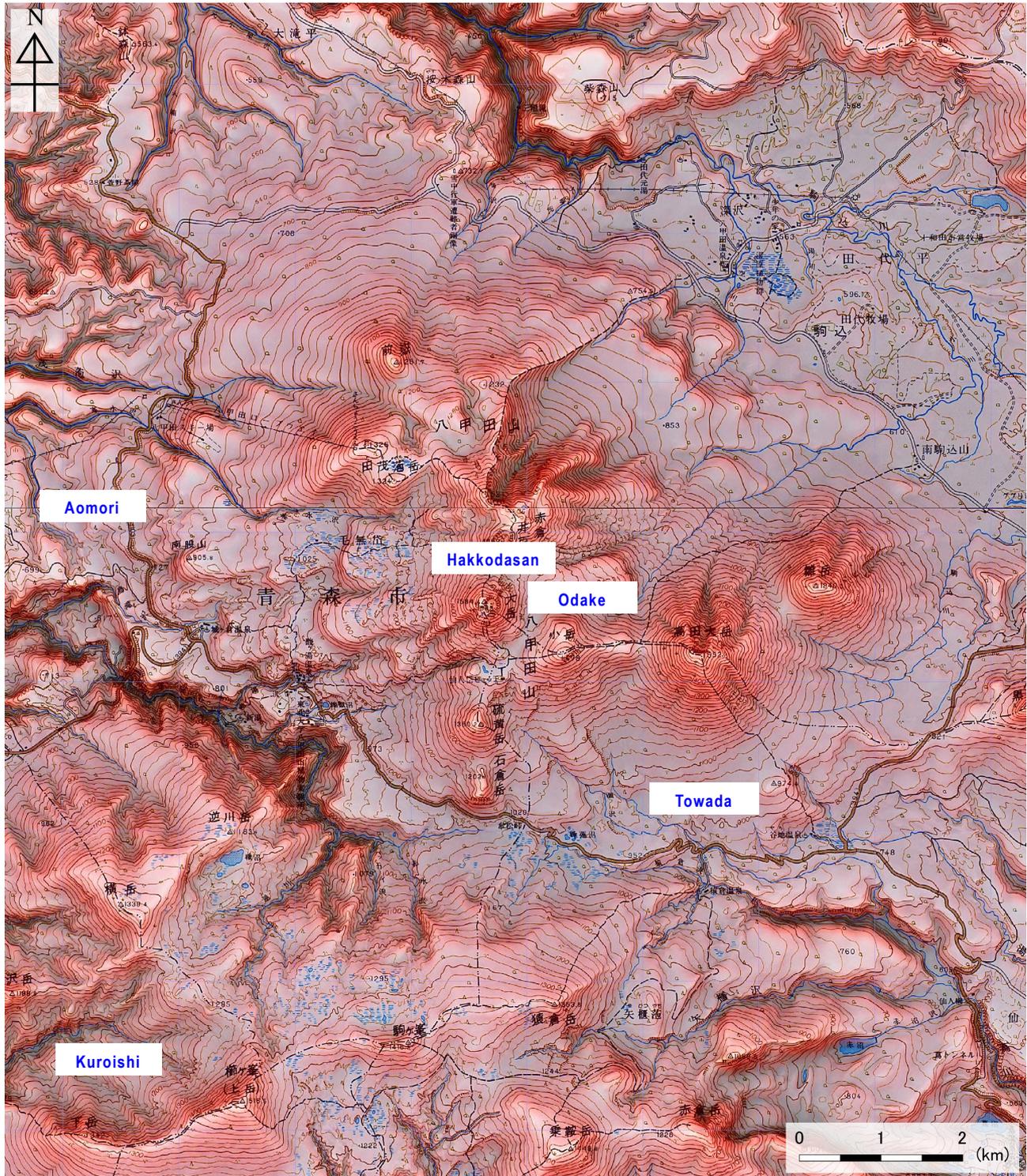


Figure 23-1 Topography of Hakkodasan.

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

Chronology of Eruptions

▪ Volcanic Activity in the Past 10,000 Years

8 eruptive events occurred in the Kita-Hakkoda volcanic group during the past 6,000 years, including phreatic and vulcanian eruptions. 4 eruptive events occurred at the summit of Odake, 1 eruptive event possibly occurred at the Odake, and the 3 recent eruptive events occurred at Jigokunuma on the southwestern foot of Odake during the 13th to 17th centuries (Kudo et al., 2000, 2003).

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
4.8ka	Odake summit	Magmatic eruption → phreatomagmatic eruption → magmatic eruption	Hk-5: Tephra fall. Magma eruption volume: 0.002 km ³ DRE
4.2ka	Odake summit	Phreatic eruption → magmatic eruption	Hk-4: Tephra fall. Magma eruption volume: 0.003 km ³ DRE
3.1ka	Odake summit	Magmatic eruption	Hk-3: Tephra fall. Magma eruption volume: 0.0001 km ³ DRE
2ka	Odake?	Phreatic eruption	Hk-2: Tephra fall.
1.5ka	Odake summit	Phreatic eruption	Hk-1: Tephra fall.
0.7←→0.6ka	Jigokunuma	Phreatic eruption	Hk-J3: Tephra fall.
0.6←→0.4ka	Jigokunuma	Phreatic eruption	Hk-J2: Tephra fall.
0.6←→0.4ka ¹	Jigokunuma	Phreatic eruption	Hk-J1: Tephra fall.

* 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.

A←→B: Eruption events occurred at some point between year A and year B.

▪ Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
1986 (Showa 61)	Earthquake	Earthquake swarm at the northwestern foot of the volcano. August 10 to 12. The largest earthquake was an M4.8 earthquake on August 10 at 17:50. It could be felt in Hakkoda Onsen, Sukayu, etc., and caused minor damage at Kayanochaya, etc.
1997 (Heisei 9)	Volcanic gas	July 12. At Tashirota, at the northeastern foot of the volcano, carbon dioxide which had accumulated inside a hollow killed 3 Ground Self-Defense Force members undergoing ranger training.
2010 (Heisei 22)	Volcanic gas	June 20. Volcanic gas (hydrogen sulfide) caused the death of a female junior high school student picking mountain herbs and vegetables near Sukayu.

* 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.

Whole Rock Chemical Composition

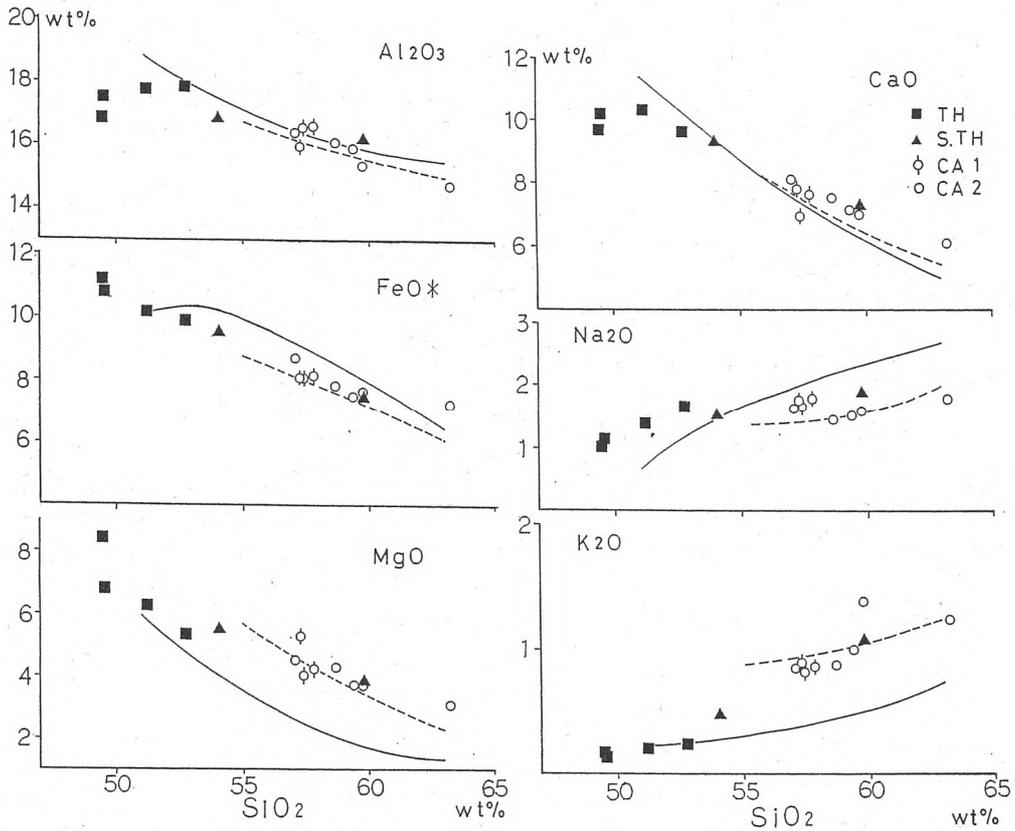


Figure 23-2 Whole-rock chemical compositions of eruptive rocks from Kita-Hakkoda volcanic group (Sasaki et al., 1985) Solid lines and dotted lines represent average composition trends for tholeiite and calc-alkaline rocks, respectively, in the northern Nasu volcanic zone (Kawano et al., 1961).

Period - Cumulative Magma Volume

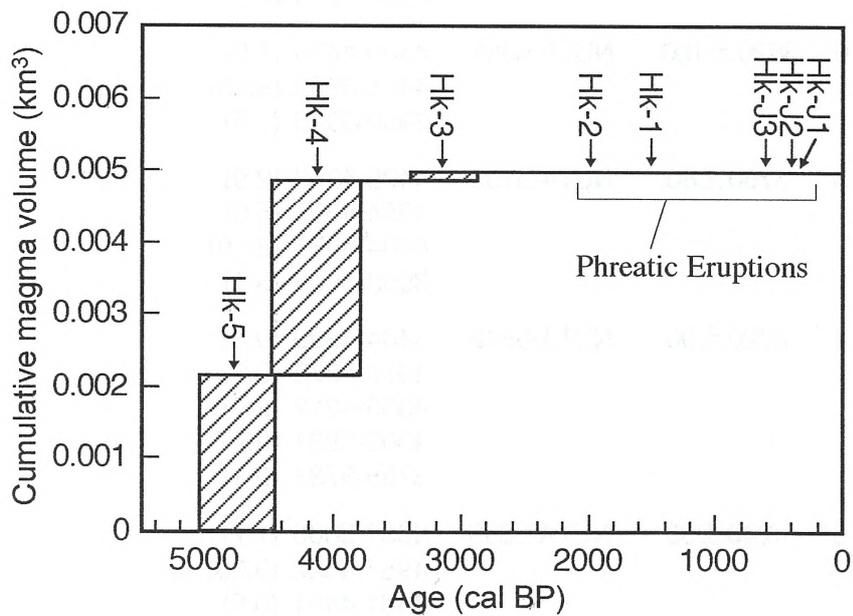


Figure 23-3 Cumulative magma volume versus age for the eruptive products of the Kita-Hakkoda volcanic group during the last 5,000 years (Kudo et al., 2003).

Recent Volcanic Activity

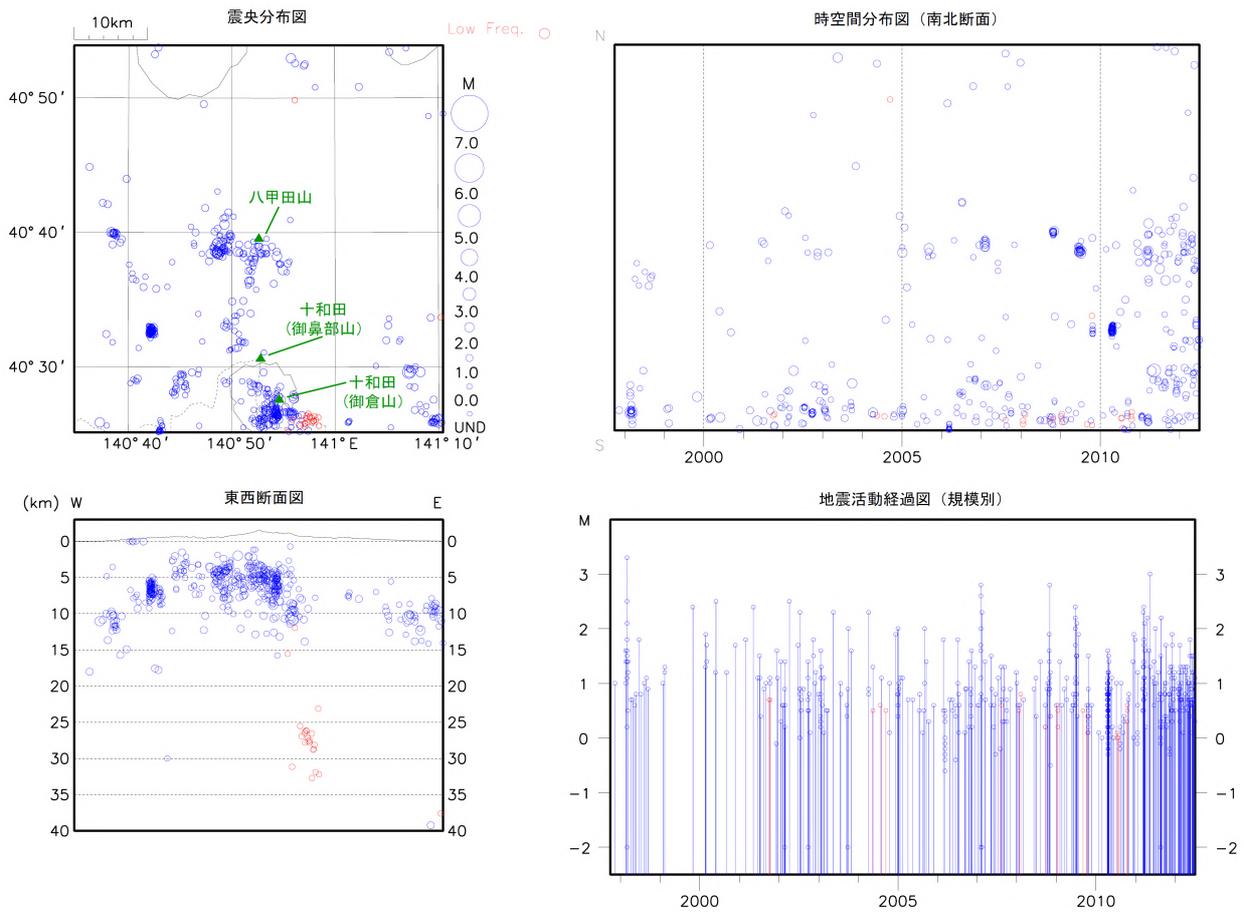


Figure 23-4 Shallow VT seismic activity (blue circles) and deep low-frequency seismic activity (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot(N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (lower right).

Information on Disaster Prevention

① Hazard Map

None

Social Circumstances

① Populations

- Aomori City: 302,616 (as of October 31, 2011)
- Kuroishi City: 36,785 (as of October 31, 2011)
- Towada City: 65,726 (as of October 31, 2011)

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

- Towada Hachimantai National Park - Hakkodasan
- Number of sightseers per year: 2,555,000

(total number for Towada Hachimantai National Park, according to Aomori Prefecture sightseeing statistics from 2009)

③ Facilities

None

Monitoring Network

Wide Area

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



1:200,000 scale regional maps (Aomori, Hirosaki, Noheji and Hachinohe) published by the Geospatial Information Authority of Japan were used.

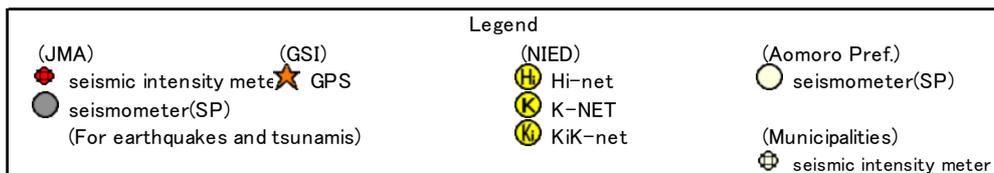


Figure 23-5 Regional monitoring network.

Bibliography

- Kawano, Y., et al. (1961) Petrography and petrochemistry of the volcanic rocks of Quaternary volcanoes of northern Japan. *Sci. Rep. Tohoku Univ. Ser. III*, **7**, 1-46.
- Kudo, T., et al. (2000) The eruptive products from Jigoku-numa Hot Pool in Kita-Hakkoda volcano group, Northeast Japan : Eruption style, magnitude and age -. *Bull. Volcanol. Soc. Japan*, **45**, 315-322 (in Japanese with English Abstract).
- Kudo, T., et al. (2003) Eruptive history of Kita-Hakkoda volcanic group during the last 6000 years, Northeast Japan. *Jour. Geol. Soc. Japan*, **109**, 151-165 (in Japanese with English Abstract).
- Kudo, T., et al., (2004) Geology and volcanic history of Kita-Hakkoda volcanic group, Northeast Japan. *Jour. Geol. Soc. Japan*, **110**, 271-289 (in Japanese with English Abstract).
- Kudo, T., et al., (2006) Stratigraphy and source caldera of pyroclastic flow deposits during the latest Pliocene to Middle Pleistocene in the southeastern foot area of the Hakkoda caldera, Northeast Japan. *Jour. Geogr. (Chigaku Zasshi)*, **115**, 1-25 (in Japanese with English Abstract).
- Sasaki, Y., et al. (1985) Geochemical study of Kita-Hakkoda volcanic group, northern Nasu volcanic zone. *Res. Rep. Lab. Nucl. Sci.*, **18**, 175-188 (in Japanese with English Abstract).
- Sasaki, Y., et al. (1986) Geochemical study of the eruptive products from the stage 1 and 2, Hakkoda volcanic group. *Res. Rep. Lab. Nucl. Sci.*, **19**, 288-299 (in Japanese with English Abstract).
- Sasaki, Y., et al. (1987) Geochemical study of tholeiitic magma in the stage 1, Hakkoda volcanic group. *Res. Rep. Lab. Nucl. Sci.*, **20**, 363-374 (in Japanese with English Abstract).
- Takarada, S. and Muraoka, H. (2004) Geology of the Hakkoda San District. Quadrangle Series, 1:50,000, Geological Survey of Japan, AIST, 86p (in Japanese with English Abstract).

(Okuno, M.)