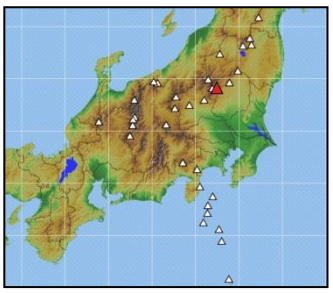
41. Nantaisan

Latitude: 36°45'54" N, Longitude: 139°29'27" E, Elevation: 2,486 m
(Nantaisan) (GSI Measuring Point)



Overview of Nantaisan taken from the south side on September 9, 2008 by Teruki Oikawa

Summary

Mt. Nantai (part of the Nikko volcano group) is a largely conical stratovolcano with a basal diameter of approximately 6 km, a relative height of around 1,200 m from its base and a crater with a diameter of about 1 km at its summit. Chuzenji, located to the southwest of the mountain, is a dammed lake formed as a result of volcanic activity. The volcano, discharging andesite-dacite (52.6 to 67.5 wt.% SiO_2), has been active three times over the last 30,000 years (Takahashi et al. 2009; Ishizaki et al. 2014). During the first period approximately 30,000 to 17,000 years ago, this activity was characterized by ongoing andesitic eruptions, which created the main body of the volcano. During the second period around 17,000 years ago, the volcano exhibited the largest eruption in its history; a large plinian andesitic to dacitic event accompanied by pyroclastic flows. Part of its north side subsequently collapsed, creating a horseshoe-shaped crater on the summit and a debris avalanche toward the north. The third period approximately 14,000 to 7,000 years ago began with an outflow of andesite-dacite lava, and several phreatic/phreatomagmatic eruptions occurred in the summit crater. The last known eruption was a phreatomagmatic event approximately 7,000 years ago. There is no current fumarolic activity on the volcano.

Photo

Summit crater of Nantaisan taken from the northwest side on November 16, 2010 by Teruki Oikawa

Red Relief Image Map

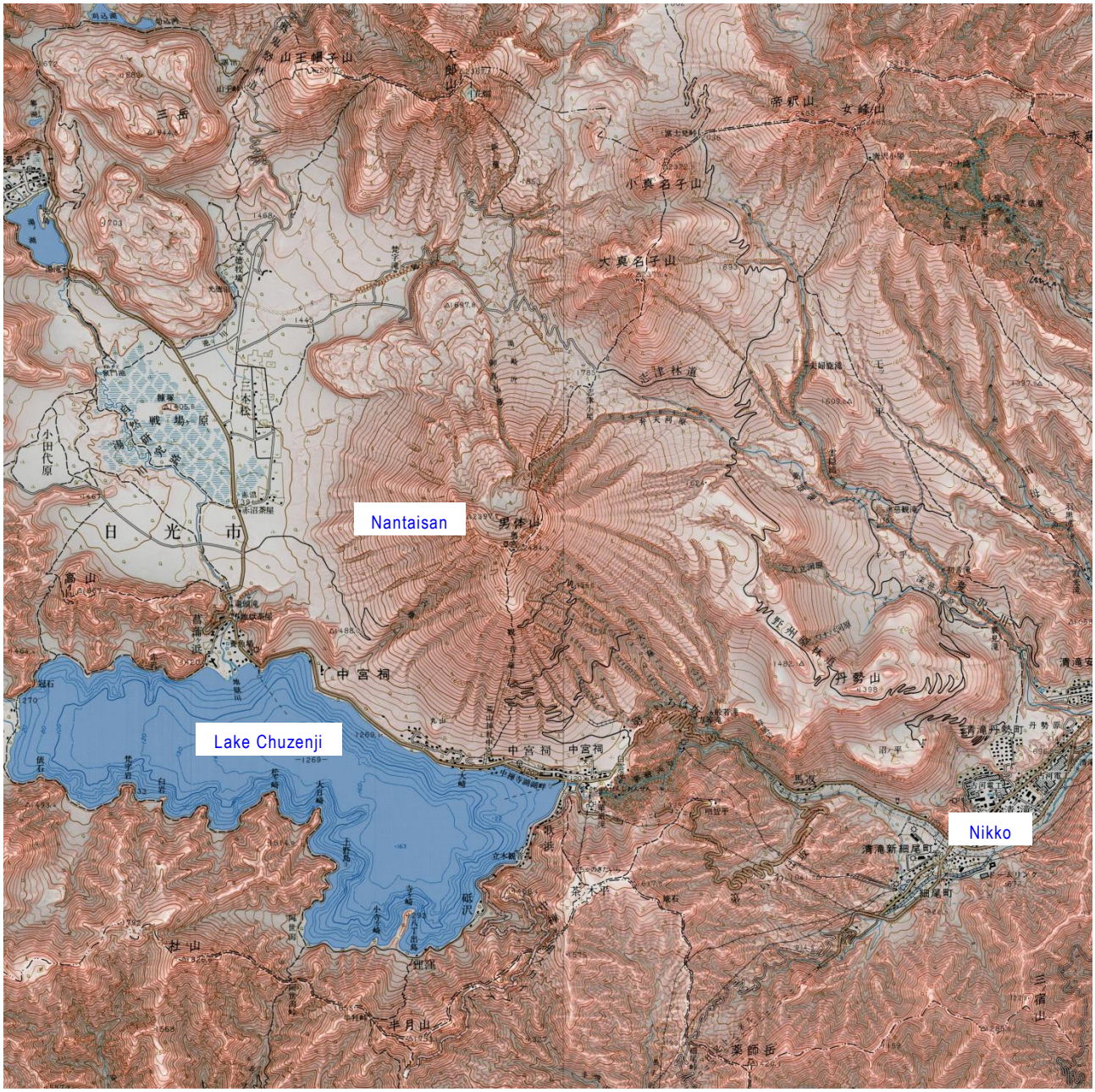


Figure 1 Topography of Nantaisan.

1:50,000 scale topographic maps and base map information published by the Geospatial Information Authority of Japan were used.

Chronology of Eruptions

・Volcanic Activity of the Past 10,000 Years

Over the last 10,000 years, at least four eruptions have occurred from a small vent in the summit crater. These have been magmatic (with subaqueous lava effusion in the crater lake), phreatomagmatic and phreatic, with ejecta reaching the inside of the crater and the northeastern foot of the mountain. In conjunction with this activity, a lake was temporarily present in the summit crater. The most recent eruption was a phreatomagmatic event that occurred approximately 7,000 years ago (Ishizaki et al. 2014).

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
12.4←→8.0 ka	Summit crater	Magmatic eruption	Subaqueous lava flow. It flowed out into the water of crater lake in the summit crater.
8.0 ka	Summit crater	Phreatomagmatic eruption	Tephra fall → lahar. Tuff ring which was formed within the summit crater collapsed and generated lahar extending northeastern flank (Nt-Bt3U).
7.5 ka	Summit crater	Phreatic eruption	Tephra fall: Nt-Bt2 extending northeast.
7.0 ka	Summit crater	Phreatomagmatic eruption	Tephra fall: Nt-Bt1 extending northeast.

* Tephra codes are same with Figure 5.
* All years are noted in Western date notation. "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

・Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
2011 to 2012 (Heisei 23 to 24)	Earthquake	March, 2011 to the autumn, 2012. After “The 2011 off the Pacific coast of Tohoku Earthquake” (March 11), the seismic activity has been high in the west of the summit and approximately 5 km north of the summit. The largest earthquake occurred on March 11, at 17:40 - M4.2 (JMA scale seismic intensity: 3 at Nikko city etc.).

Whole Rock Chemical Composition

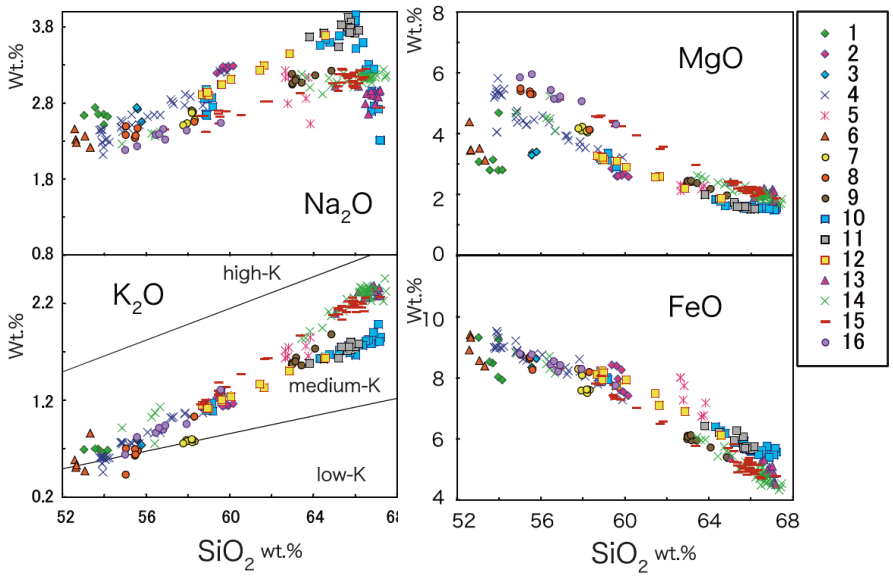


Figure 2 Whole rock chemical composition of Stage 1 to early part of Stage 3 Tephras (Takahashi et al., 2009)
1:Arasawa Lava, 2:Nantai-Minami Lava, 3:Kegon Lava, 4:Konagi Lava, 5:Nantai-Kita Lava, 6:Onagi Lava, 7:Furunagi Lava, 8:Furunagi Agglutinate, 9:Nantai-Nishi Lava, 10:Imaichi Scoria Fall Deposit, 11:Shizu Pyroclastic Flow Deposit, 12:Takanosu Scoria Fall Deposit, 13:Shichihonzakura Pumice Fall Deposit, 14:Shirogaki-Ryuzunotaki Pumice Flow Deposit, 15:Misawa (Osawa) Lava, 16: mafic inclusions of Misawa (Osawa) Lava.
According to Ishizaki et al. (2014), 1-9, 10-14 and 15-16 are categorized as Stage 1, Stage 2 and early part of Stage 3 respectively.

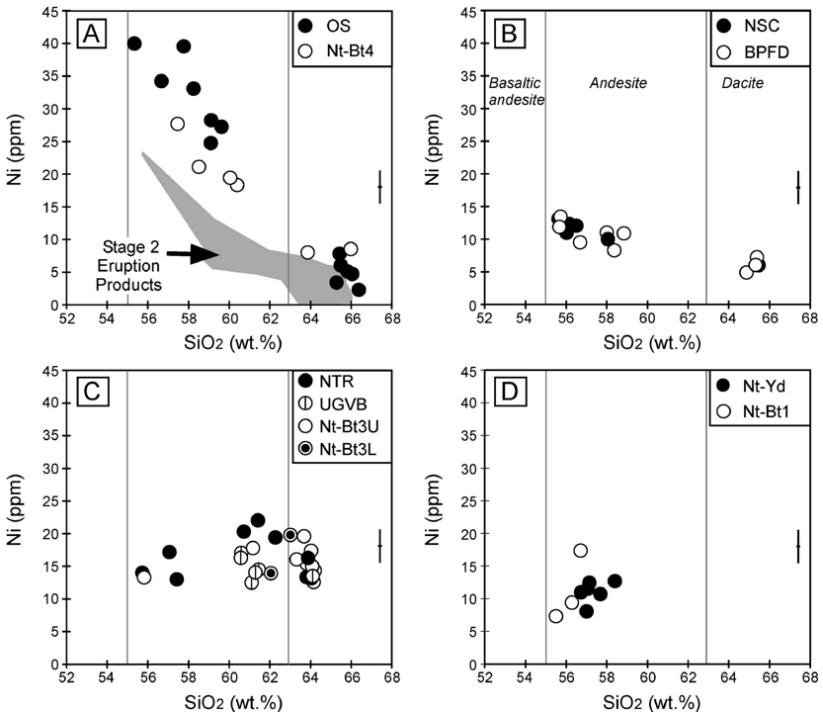


Figure 3 Whole rock chemical composition of Stage 3 Tephras (Ishizaki et al., 2014).

Ni-SiO_2 variation diagrams of juvenile materials/lavas of: (A) Osawa Lava (OS) and Nantai-Bentengawara Tephra 4 (Nt-Bt4); (B) Nantai Scoria Cone Deposit (NSC) and Bentengawara Pyroclastic Flow Deposit (BPFD); (C) Nantai Tuff Ring Deposit (NTR), the upper unit of Goshinbutsunagi Volcanic Breccia (UGVB), and Nantai-Bentengawara Tephra 3 (Nt-Bt3U and Nt-Bt3L); and (D) Nantai-Yudonoyama Tephra (Nt-Yd) and Nantai-Bentengawara Tephra 1 (Nt-Bt1). Division of basaltic andesite, andesite, and dacite is after Cox *et al*. (1979). Error bars indicate maximum 2 σ analytical error on replicate XRF analyses of three standards (JB-1, JA-3, and JR-1). The field of the compositional range for the Stage 2 eruption products is also shown in A (data source: Ishizaki, unpublished data).

Major Volcanic Activity

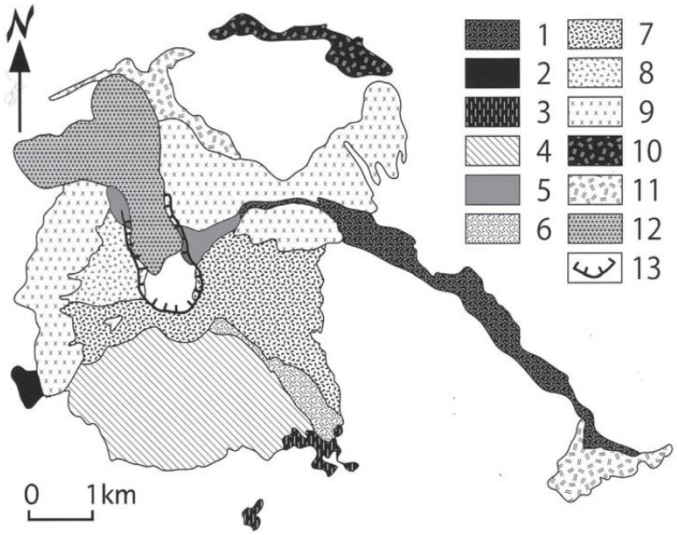


Figure 4 Geological map of Nantaisan (Takahashi et al., 2009)

1: Arasawa Lava, 2: Nantai-minami Lava, 3: Kegon Lava, 4: Konagi Stratovolcano (lava), 5: Nantai-Kita Stratovolcano (lava), 6: Onagi Lava, 7: Furunagi Agglutinate Cone and Lava, 8: Nantai-Nishi Lava, 9: Shizu Pyroclastic Flow Deposit, 10: Takanosu Scoria Fall Deposit, 11: Shirogake-Ryuzunotaki Pumice Flow Deposit, 12: Misawa (Osawa) Lava, 13: Horse-Shoe Shaped Crater

According to Ishizaki et al. (2014), 1-8, 9-11 and 12 are categorized as Stage 1, Stage 2 and Stage 3 respectively.

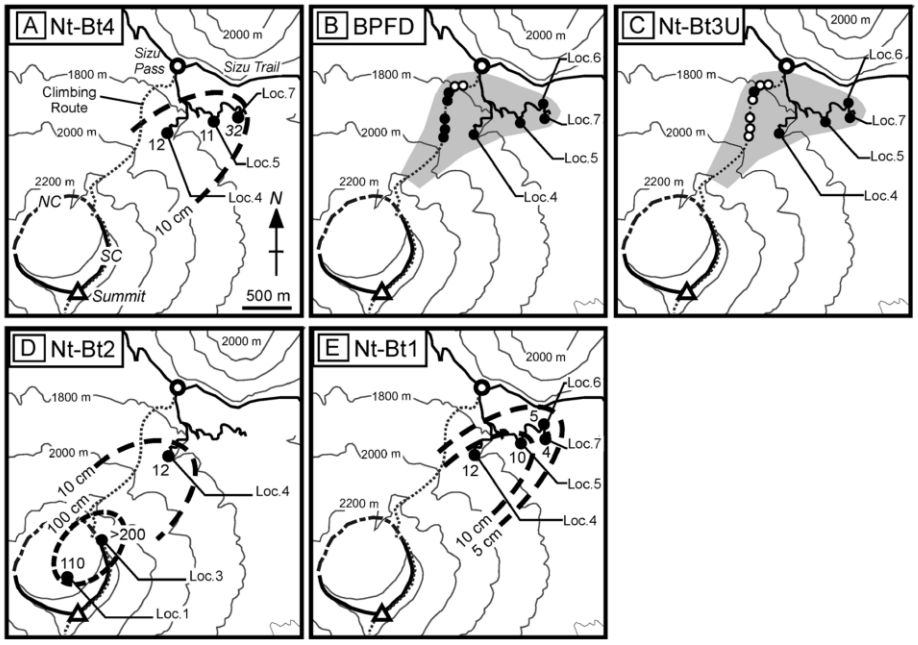


Figure 5 Isopach and distribution maps of Stage 3 Tephras, pyroclastic flow deposit, and lahar deposit (Ishizaki et al., 2014)

△:Summit of Nantaisan, NC and SC:Crater rim, dashed line: Isopach

Isopach maps of Stage 3 tephras, (A) Nt-Bt4, (D) Nt-Bt2, and (E) Nt-Bt1, and distribution maps of (B) BPFD(pyroclastic flow deposit) and (C) Nt-Bt3U (lahar deposit). Closed circles show the locations of the outcrop of the primary Stage 3 eruption products. Open circles in (B) and (C) show the locations where only boulder of the cauliflower bomb (major constituent of BPFD) or quench-fragmented lava block (major constituent of Nt-Bt3U) occurs without any finer-grained matrix parts. Contour interval is 200 m.

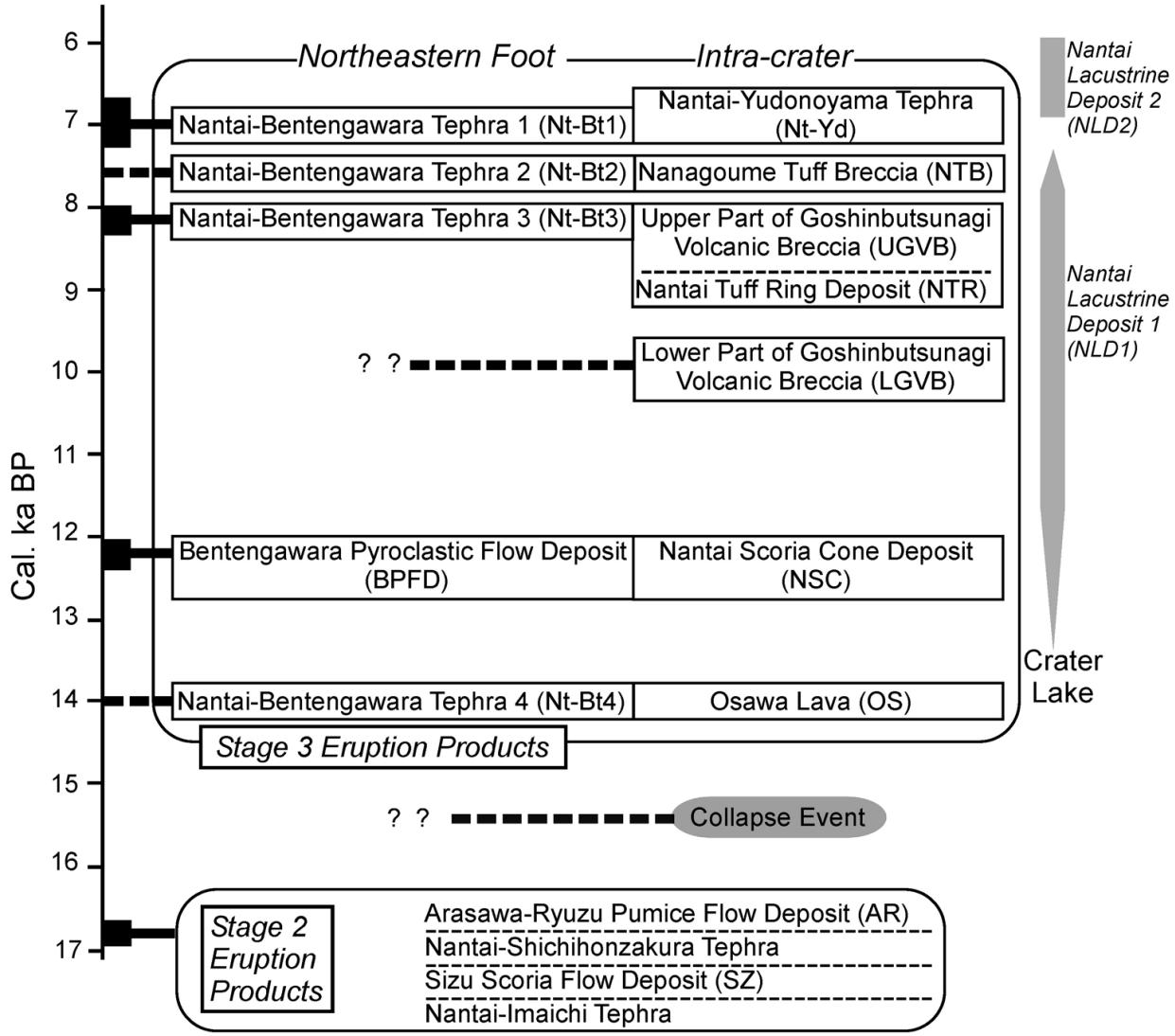


Figure 6 Summary of the stratigraphy and correlations between proximal (intra-crater) eruptives and the distal (northeastern foot) eruptives of Nantaisan during the last 17,000 yrs. (Ishizaki et al., 2014)

Black boxes show the range of the calendar ages of eruptives. Eruption ages of Nt-Bt2 and Nt-Bt4 are deduced from their stratigraphic positions. The ranges of ages for lacustrine deposits are also shown. Ages of LGVB and the collapse event are unknown.

Recent Volcanic Activity

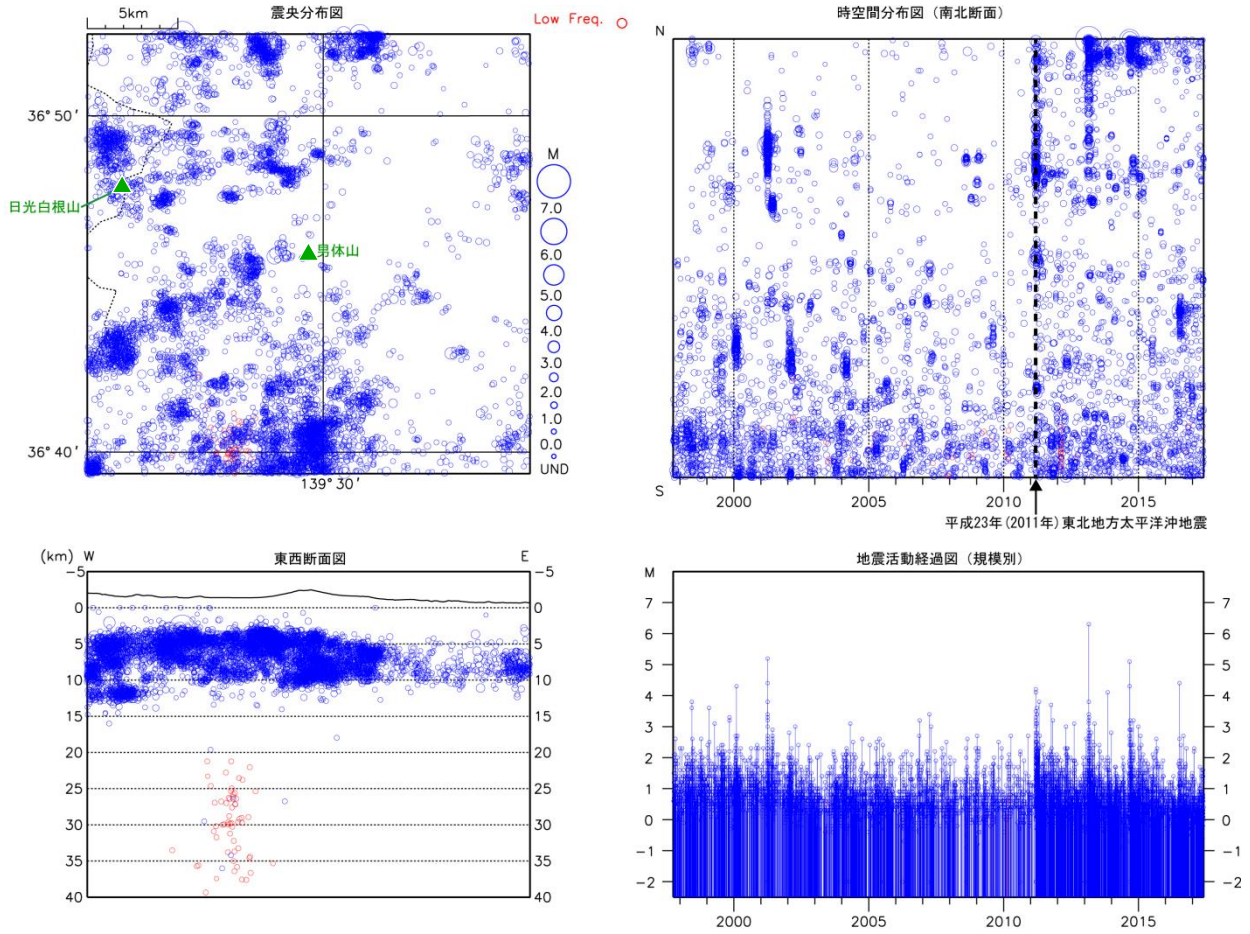


Figure 7 Activity of shallow VT earthquakes (blue circles) and deep low-frequency earthquakes (red circles) observed by a regional seismometer network (October 1, 1997, to May 31, 2017). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross -section (lower left) and magnitude-time diagram (lower right).

Information on Disaster Prevention

①Hazard Map

None

Social Circumstances

①Populations

- Nikko City: 84,445 (as of April 1, 2017)

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

- Nikko National Park

  Number of park visitors per year: Approx. 16,090,000

  (according to "National Park" website 2017 national park visitor figures)

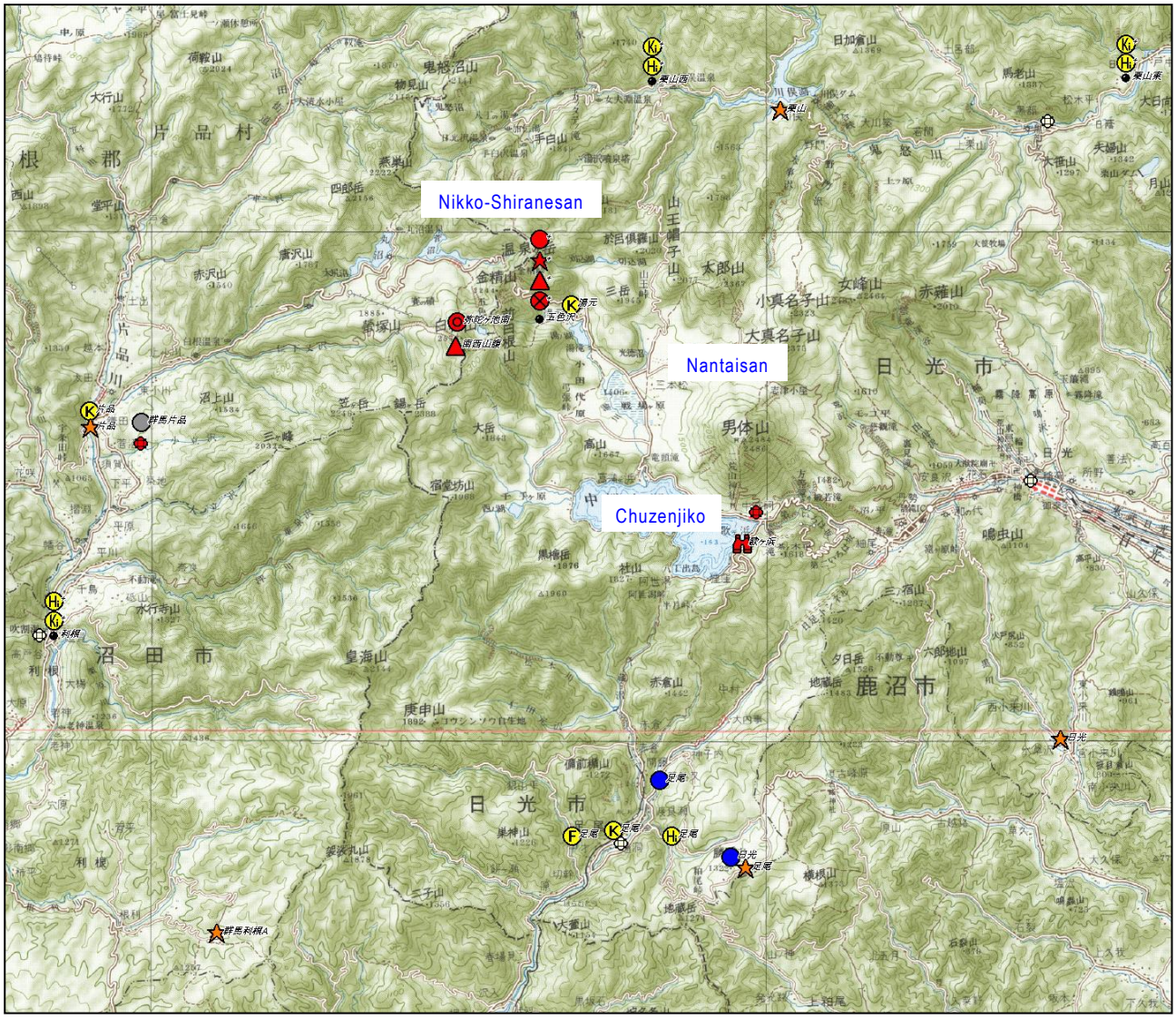
③Facilities

- Nikko Natural Science Museum

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 map (Nikko) published by the Geospatial Information Authority of Japan was used.

Legend

(JMA)
- seismometer(SP)
- seismometer(broadband)
- GNSS
- tiltmeter
- visual camera
- seismic intensity meter
- seismometer(SP) (For earthquakes and tsunamis)

(GSI)
- GNSS

(ERI)
- seismometer(SP)

(NIED)
- Hi-net
- F-net
- K-NET
- KiK-net

(Municipalities)
- seismic intensity meter

Figure 8 Regional monitoring network.

Bibliographies

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Miyake, Y., et al. (2009): Bull. Vol. Soc. Japan, **54**, 4, 163-173 (in Japanese with English abstract).

Takahashi, M., et al., (2009): Proceedings of the Institute of Natural Sciences, Nihon Univ., **44**, 63-120 (in Japanese).

(Ishizaki, Y., Furukawa, R., and Oikawa, T.)