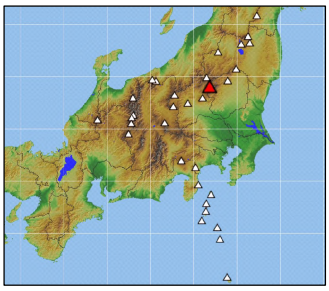
41. Nikko-Shiranesan



Continuously Monitored by JMA

Latitude: 36°47'55" N, Longitude: 139°22'33" E, Elevation: 2,578 m
(Shiranesan) (Elevation Point)

Overview of Nikko-Shiranesan taken from the west side on August 31, 2006 by the Japan Meteorological Agency

Summary

The Nikko-Shirane volcano is an andesite and dacite volcano located on the border of the prefectures of Tochigi and Gunma. It is composed of a lava dome with roughly 1000 m in diameter and approximately 300 m high, and multiple thick lava flow strata. There are lava domes, such as the highest peak, Shiranesan (Okushirane) on top of the thick lava flow strata that extend to the west. Phreatic eruptions from Okushirane are known to have occurred within the historical era. There are no fumarolic areas at present. There was a large amount of micro-seismic activity in the area 10 to 20 km south of Nikko-Shirane from July, 1993, to roughly February, 1995 (Hasegawa and Matsumoto, 1995). The SiO_2 content of the andesite and dacite is between 58.0 and 70.0 wt %.

Red Relief Image Map

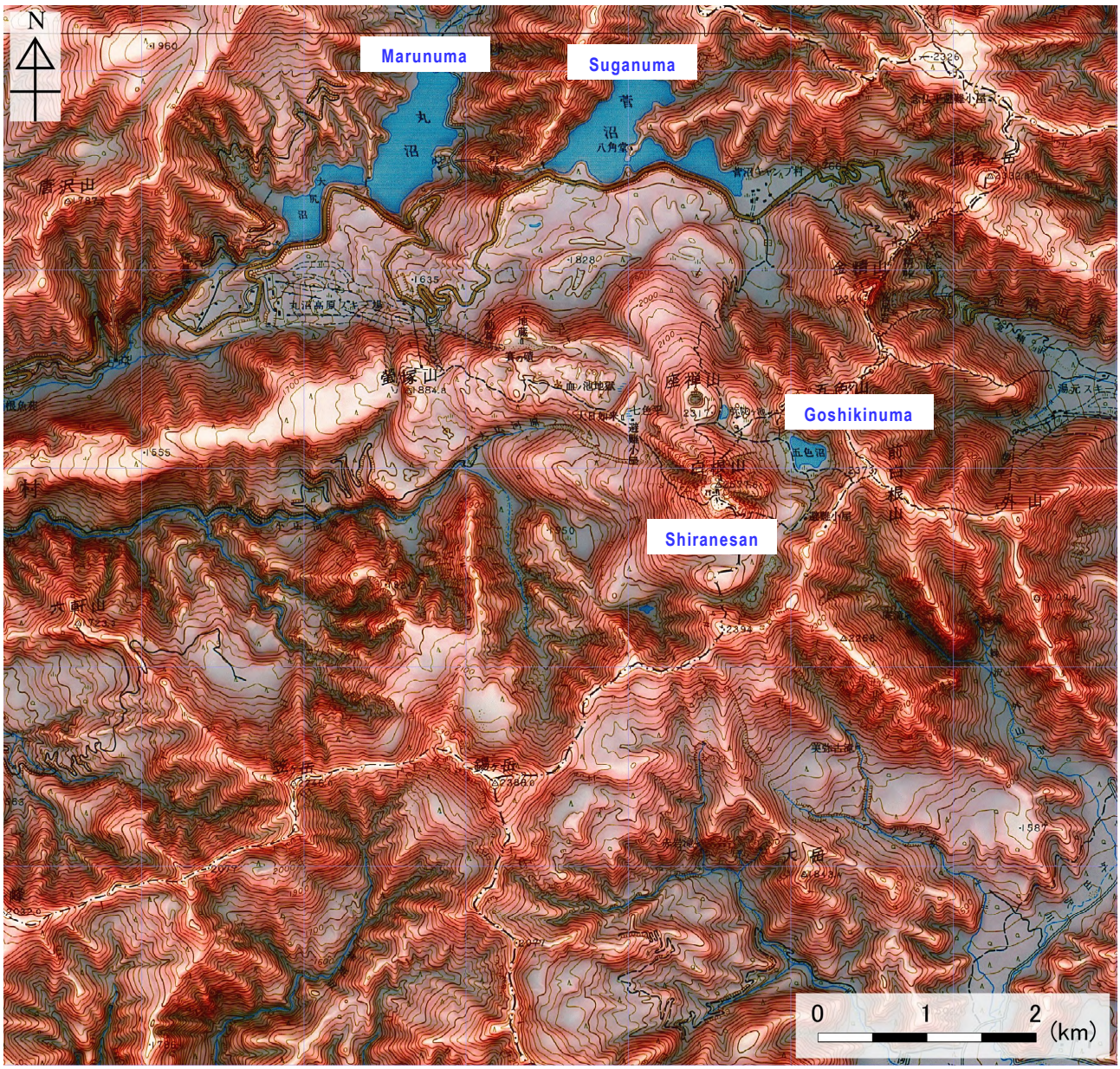


Figure 41-1 Topography of Nikko-Shiranesan.

1:50,000 scale topographic maps (Nantaisan and Hiuchigatake) 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

Since approximately 6,000 years ago, at least 6 eruptions occurred, distributing deposits in the area (Okuno et al., 1994; Suzuki et al., 1994; Tsutsui et al., 2005). The lava and lava dome discharges which have retained the most of their surface microtopography are considered to correspond to these eruptions. The uppermost deposits are newer than the Haruna Futatsudake FP pumice (middle of the 6th century), and their distribution matches with historical records, so they are considered to have come from the 1649 eruption.

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
6.3←→6 ka	Details unknown	Phreatic eruption → magmatic eruption	Tephra fall.
4 ka	Details unknown	Phreatic eruption → magmatic eruption	Tephra fall.
2.4 ka	Details unknown	Phreatic eruption → magmatic eruption	Tephra fall.
1.2 ka	Details unknown	Phreatic eruption	Tephra fall.
0.8 ka	Details unknown	Phreatic eruption	Tephra fall.

* Volcanic periods, areas of activity, eruption types, and eruption events, etc. taken from the Active Volcano Database of Japan, AIST (Kudo and Hoshizumi, 2006). 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

Period	Phenomenon	Activity Sequence, Damages, etc.
1649 (Keian 2)	Moderate: Phreatic eruption	Tephra fall. The eruptive activity occurred at the Shiranesan summit crater. There was a summit eruption, a large amount of tephra fall, and a new crater (approximately 200 m in diameter and approximately 10 m deep) was formed. The shrine at the summit was completely destroyed. (VEI 2)
1872 (Meiji 5)	Phreatic eruption?	May 14. The eruption occurred on the southwestern hillside. A crater over 200 m in diameter was formed on the southwestern hillside, and a volcanic plume was discharged.
1873 (Meiji 6)	Phreatic eruption?	March 12. Tephra fall. Details regarding the eruption location are unknown. Volcanic plume, ash and sand fall. Fish in the Tone River were killed.
1889 (Meiji 22)	Phreatic eruption?	December 4. Tephra fall. The eruptive activity occurred on the western slope of Shiranesan. The explosion occurred at the old crater, bordering Ogawa Village. Rumbling, tephra fall, and clouding of the Katashina River.
1952 (Showa 27)	Volcanic smoke, rumbling	July to September. From early July a volcanic plume was visible from Kamata, Katashina, in Gunma prefecture, and volcanic smoke could occasionally be smelled near the crater. There was rumbling at the foot of the volcano from early September.
1993 to 1995 (Heisei 5 to 7)	Earthquakes, volcanic tremors	July, 1993, to September, 1995. Micro-seismic activity increased near Lake Chuzenji, and micro-earthquake and micro-tremor activity increased directly below the summit.
2001 (Heisei 13)	Earthquake	From March 31 to early April seismic activity occurred from the northwest to the northeast of Nikko-Shiranesan (less than 5 km deep). The largest earthquake was measured to be M5.2 (JMA scale seismic intensity of 4 in Nikko). For several days from June 5 there was seismic activity with shallow hypocenters (with a maximum JMA scale seismic intensity of 1) approximately 5 km to the east of Nikko-Shiranesan.
2011 (Heisei 23)	Earthquake	Since the 2011 off the Pacific coast of Tohoku Earthquake (March 11, 2011) there has been a large amount of seismic activity in the areas approximately 5 km to the west and northwest, and approximately 5 to 10 km to the east and southeast. High number of felt-earthquakes occurred. The largest was on March 12, at 00:24 - M4.5 (JMA scale seismic intensity: 4).

* 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

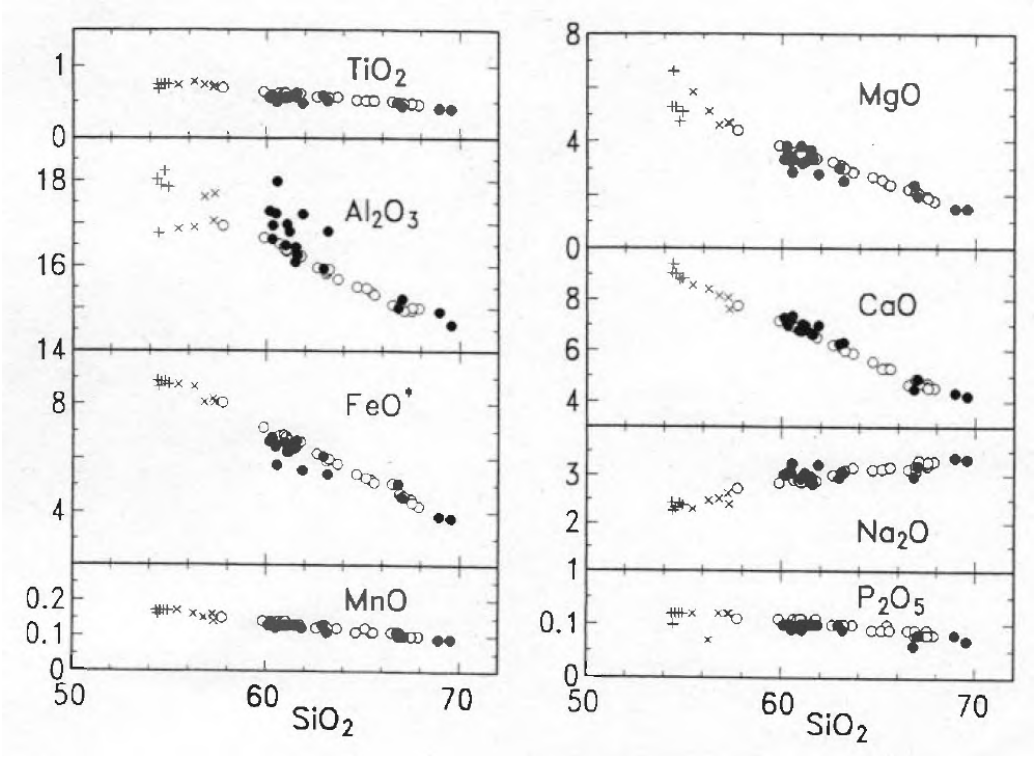


Figure 41-2 Nikko-Shirane volcano and Mitsutake volcano whole rock chemical composition Harker diagram (Sasaki et al, 1993).

Nikko-Shiranesan - ● symbols indicate lavas (host rocks), X symbols indicate mafic inclusions

Mitsutake - ○ symbols indicate lavas (host rocks), + symbols indicate mafic inclusions.

Main Volcanic Activity

・Seismic Activity between 1993 and 1995

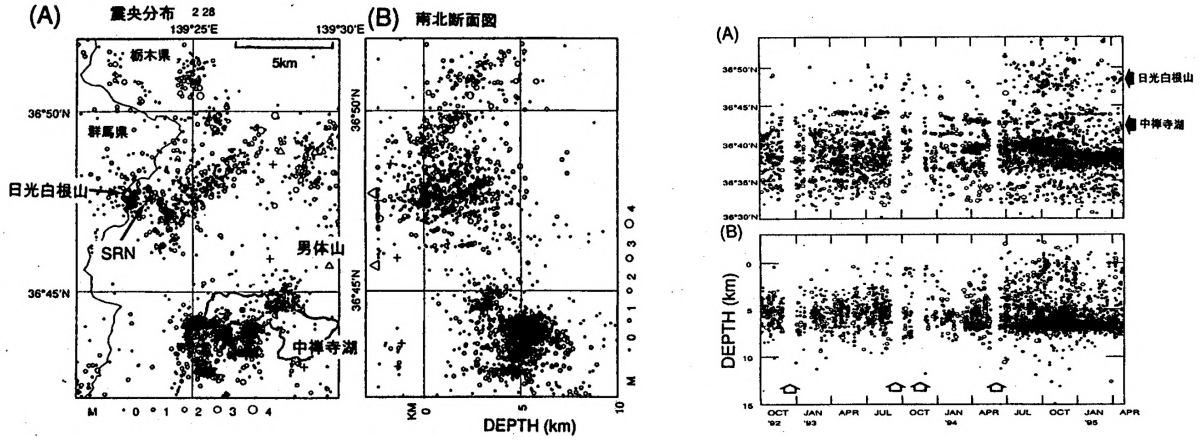


Figure 41-3 Seismic activity in and around Nikko-Shiranesan (September 29, 1992, to February 28, 1995) (Utsunomiya University et al., 1995)

(A) Epicenter distribution, (B) North-south cross-section Arrows indicate periods for which data is unavailable.

Earthquakes with hypocenters less then roughly 4km occurred below the surface directly below Nikko-Shiranesan. Overall, the shallower the hypocenters, the closer they tended to be to Nikko-Shiranesan. From around 1994 seismic activity expanded towards Nikko-Shiranesan. From approximately July, 1994, seismic activity also began directly below Nikko-Shiranesan.

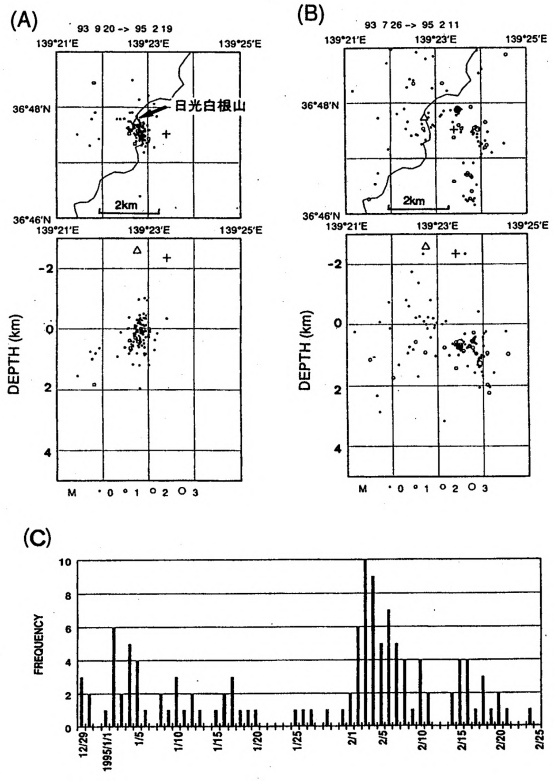


Figure 41-4 Seismic activity in and around Nikko-Shiranesan (Utsunomiya University et al., 1995).

(A) Distribution of epicenters of earthquakes with long durations deduced to be tremors (top) and east-west cross-section (bottom). (B) Distribution of hypocenters of volcano-tectonic earthquakes (top) and east-west cross-section (bottom). (C) Frequency distribution of earthquakes with long durations deduced to be tremors.

Over the period shown, the sources of volcanic tremors were concentrated in an extremely shallow area extending 2 to 3km deep directly below Nikko-Shiranesan. The number of volcanic tremors fluctuated repeatedly.

Recent Volcanic Activity

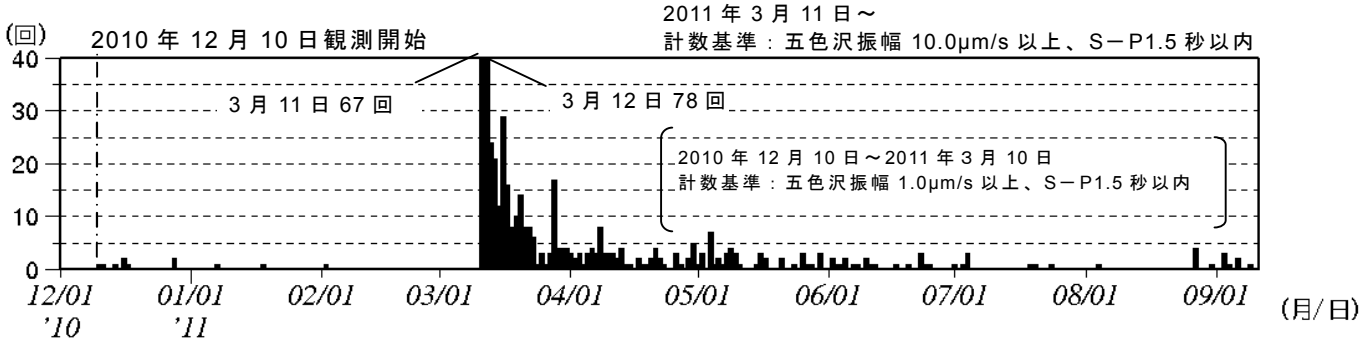


Figure 41-5 Number of earthquakes per day (December 1, 2010, to June 30, 2012).

Since the 2011 off the Pacific coast of Tohoku Earthquake seismic activity has been high, but no signs directly related to eruptive activity, such as volcanic tremors, etc., have been observed.

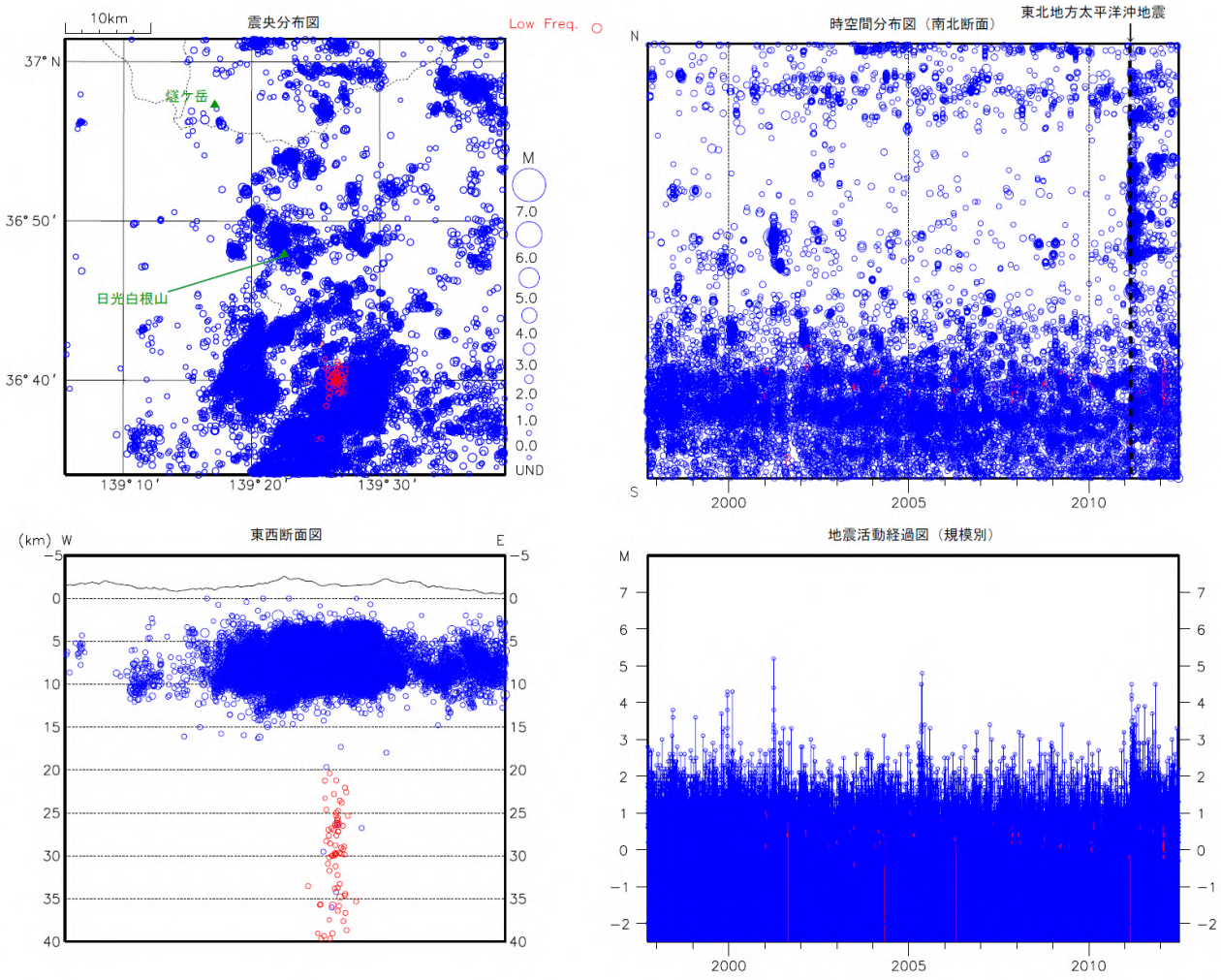


Figure 41-6 Shallow VT seismic activity (blue circles) and deep low-frequency seismic activity (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (by scale) (lower right).

Subsurface Structure

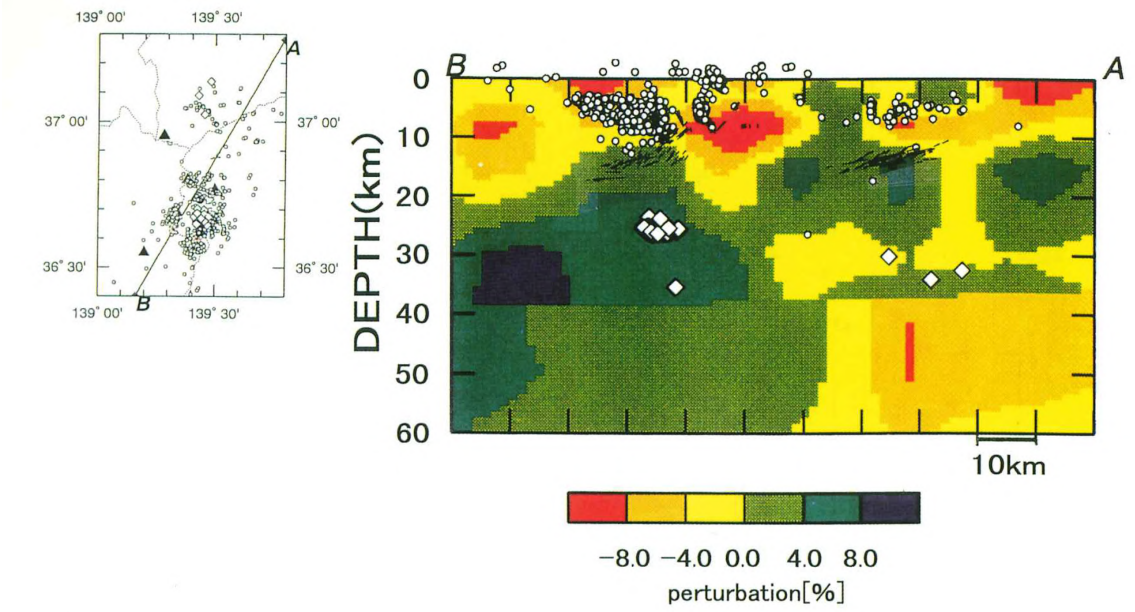


Figure 41-7 Seismic activity near Nikko-Shiranesan (September 29, 1992, to February 28, 1995) (Matsumoto and Hasegawa, 1997)

(A) Epicenter distribution, (B) North-south cross-section

Predominant low P-wave velocity area directly below Nikko-Shiranesan, which indicates that magma exists below this area.

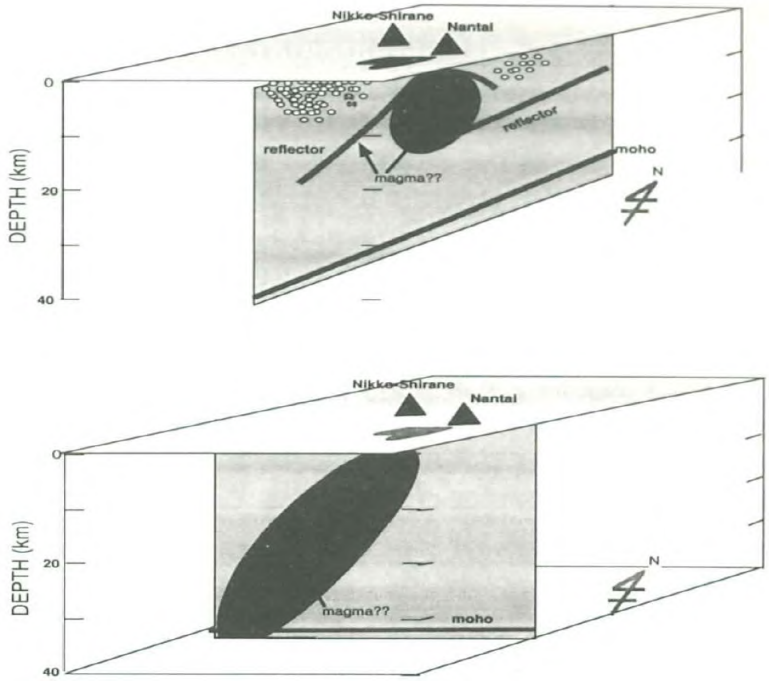


Figure 41-8 Crustal structure in and around the Nikko-Shiranesan area (Matsumoto and Hasegawa, 1997)

The top and bottom figures shows perpendicular and parallel cross-sections of the volcanic front, respectively.

The S wave reflectors to the south of Nikko-Shiranesan tend to be shallower conically towards Nikko-Shiranesan.

The low-velocity area directly below Nikko-Shiranesan and the reflectors appear to be connected, indicating that there is a magma supply to Nikko-Shiranesan.

Information on Disaster Prevention

①Hazard Map

None

Social Circumstances

①Populations

- Nikko City: 89,594 (as of October, 2010)
- Katashina Village: 5,177 (as of November, 2011)
- Numata City: 52,670 (as of October 31, 2011)

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

- Nikko National Park

Number of visitors per year to Nikko-Shiranesan: Approximately 17,888,000 (Fukushima Prefecture: 270,000, Tochigi Prefecture: 17,058,000, Gunma Prefecture: 560,000) (according to "National Park" website 2009 national park visitor figures)

Nikko-Shiranesan

Gunma Prefecture side ropeway users: Approximately 75,000, with approximately 10,000 travelling to the summit

Tochigi Prefecture side - Number of people notifying the Nikko Yumoto substation that they will be climbing: 30 to 40

35x12=420, plus many climbers who do not notify the substation.

③Facilities

Nikko City, Tochigi Prefecture

- Nikko Natural Science Museum

Katashina Village, Gunma Prefecture

- Nikko-Shiranesan ropeway summit station, volcano foot station (on Gunma Prefecture side)

Monitoring Network

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 maps (Nantaisan, Nikko, Hiuchigatake and Kawaji) published by the Geospatial Information Authority of Japan were used.

Legend

(JMA)	(NIED)
seismometer(SP)	K-NET
GPS	
tiltmeter	
infrasonic microphone	

Figure 41-9 Local monitoring network.

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