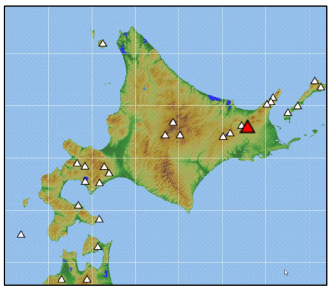
4.Mashu



Latitude: 43°34'20" N, Longitude: 144°33'39" E, Elevation: 857 m (Kamuinupuri)
(Elevation Point)

Overview of Mashu taken from 3rd Observation Platform on west side on October 16, 2012 by the Japan Meteorological Agency

Summary

Mashu volcano is located on the east wall of the Kussharo caldera (26km east-west, 20km north-south), and formed as a stratovolcano no later than 34,000 years ago (Hasegawa et al., 2009), but approximately 7,000 years ago a large eruption formed a caldera (the Mashu caldera, 5.5km east-west, 7.5km north-south). Inside the Mashu caldera is Lake Mashu, and in the center of the lake is a dacitic lava dome (Kamuishu Island). On the southeast wall of the caldera is Kamuinupuri (Mashudake), a small andesite and dacite stratovolcano. The SiO_2 content is between 52.4 and 73.0 wt %.

Photos

Summit Crater -Mashu Kamuinupuri - ,taken from southeast side on October 9, 1999. Courtesy of KOKUSAI KOGYO CO., LTD.

Topography around the Crater

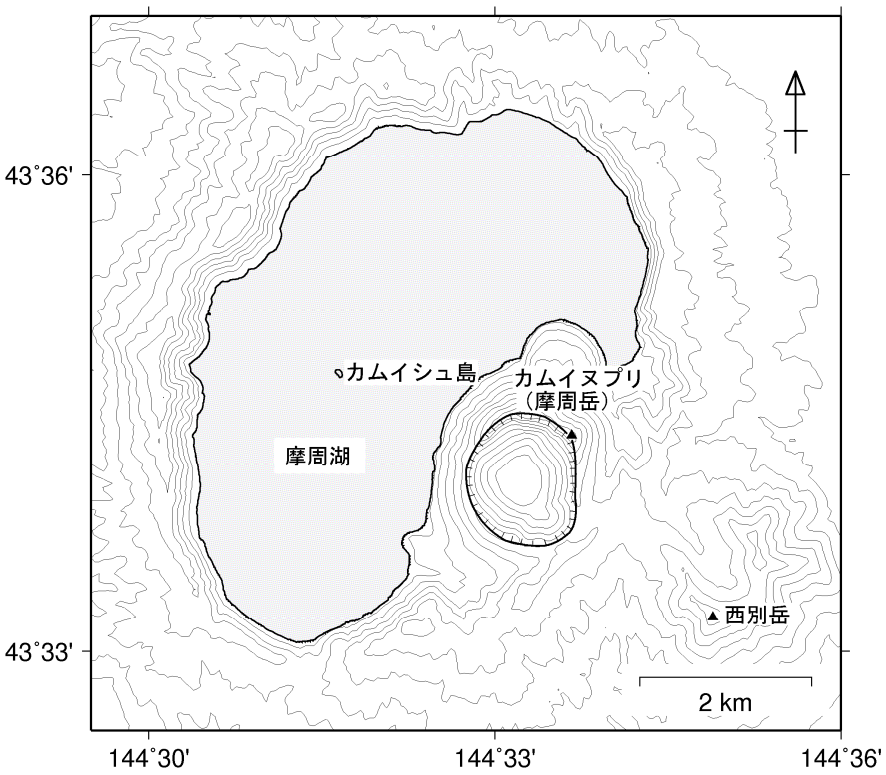


Figure 4-1 Detailed topography of the crater area.

Red Relief Image Map

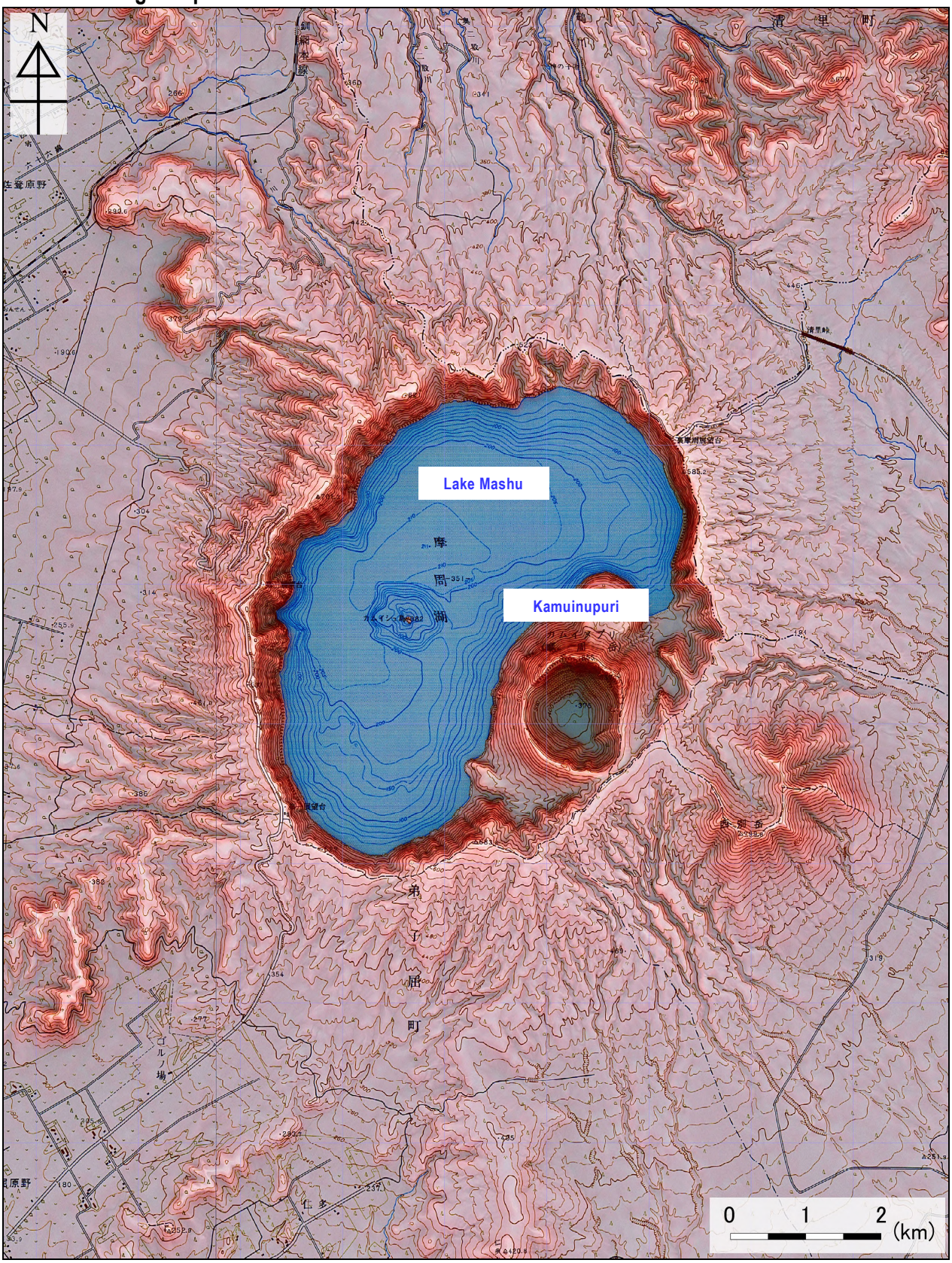


Figure 4-2 Topography of Mashu.
1:50,000 scale topographic maps (Kussharo Ko and Mashu Ko) and digital map 50 m grid (elevation) published by the Geospatial Information Authority of Japan were used.

Chronology of Eruptions

・Volcanic Activity in the Past 10,000 Years

Approximately 7,000 years ago a large eruption occurred (emitting air-fall ash, air-fall pumice, and pyroclastic flow), and forming the Mashu caldera that is now Lake Mashu. It was active at least 7 more times until approximately 2,000 years ago, ejecting pumice and volcanic ash, and in addition to creating Kamuinupuri on the southeast wall of the caldera, it also formed Kamuishu Island, a lava dome in the center of the caldera. Kamuinupuri also experienced a large plinian eruption approximately 1,000 years ago, forming a crater 1km in diameter on the summit (Katsui, 1983; Katsui et al., 1986, Kishimoto et al., 2009). Currently, no fumarolic activity has been observed.

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
7.7←→7.6ka	Mashu caldera	Phreatomagmatic eruption → magmatic eruption	Ma-f,g,h,l eruptions: Began with phreatomagmatic eruptions, shifting midway to plinian eruptions and producing pyroclastic flows. Sedimentation of air-fall pyroclastic material. Magma eruption volume = 7.4 km^3 DRE. (VEI 6)
5.4←→1.6ka	Kamuishu Island	Magmatic eruption	Lava dome created
5.4←→1.6ka	Kamuinupuri	Magmatic eruption	Lava flow
5.4ka	Kamuinupuri	Phreatomagmatic eruption	Ma-e eruption: Discharged pyroclastic flow. Sedimentation of air-fall pyroclastic material. Magma eruption volume = 0.11 km^3 DRE. (VEI 4)
5.4←→4ka	Kamuinupuri	Phreatomagmatic eruption	Ma-e' eruption: Sedimentation of air-fall pyroclastic material. Magma eruption volume = 0.004 km^3 DRE. (VEI 3)
4ka	Kamuinupuri	Phreatomagmatic eruption → magmatic eruption	Ma-d eruption: Began with phreatomagmatic eruptions, shifting midway to plinian eruptions and producing pyroclastic flows. Sedimentation of air-fall pyroclastic material. Magma eruption volume = 0.13 km^3 DRE. (VEI 4)
2.5ka←→1.6ka	Kamuinupuri	Phreatomagmatic eruption	Ma-c eruption: Sedimentation of air-fall pyroclastic material through 4 main eruptions. Magma eruption volume = 0.0008 to 0.1 km^3 DRE. (VEI 3～4)
1ka	Kamuinupuri	Magmatic eruption, phreatomagmatic eruption	Ma-b eruption: Repeated phreatomagmatic and plinian eruptions. Formed crater 1km in diameter at summit, with sedimentation of air-fall pyroclastic material. Magma eruption volume = 1.8 km^3 DRE. (VEI 5)

* 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 taking place at some point between year A and year B

・Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
2003 (Heisei 15)	Earthquake	In February and June, earthquake activity with hypocenters in a shallow part of the caldera became high. 3 felt earthquakes occurred on February 13 (maximum M3.6, JMA scale seismic intensity 2 at Teshikaga), and 1 on June 16 (M3.5, JMA scale seismic intensity 1 at Teshikaga).

* 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

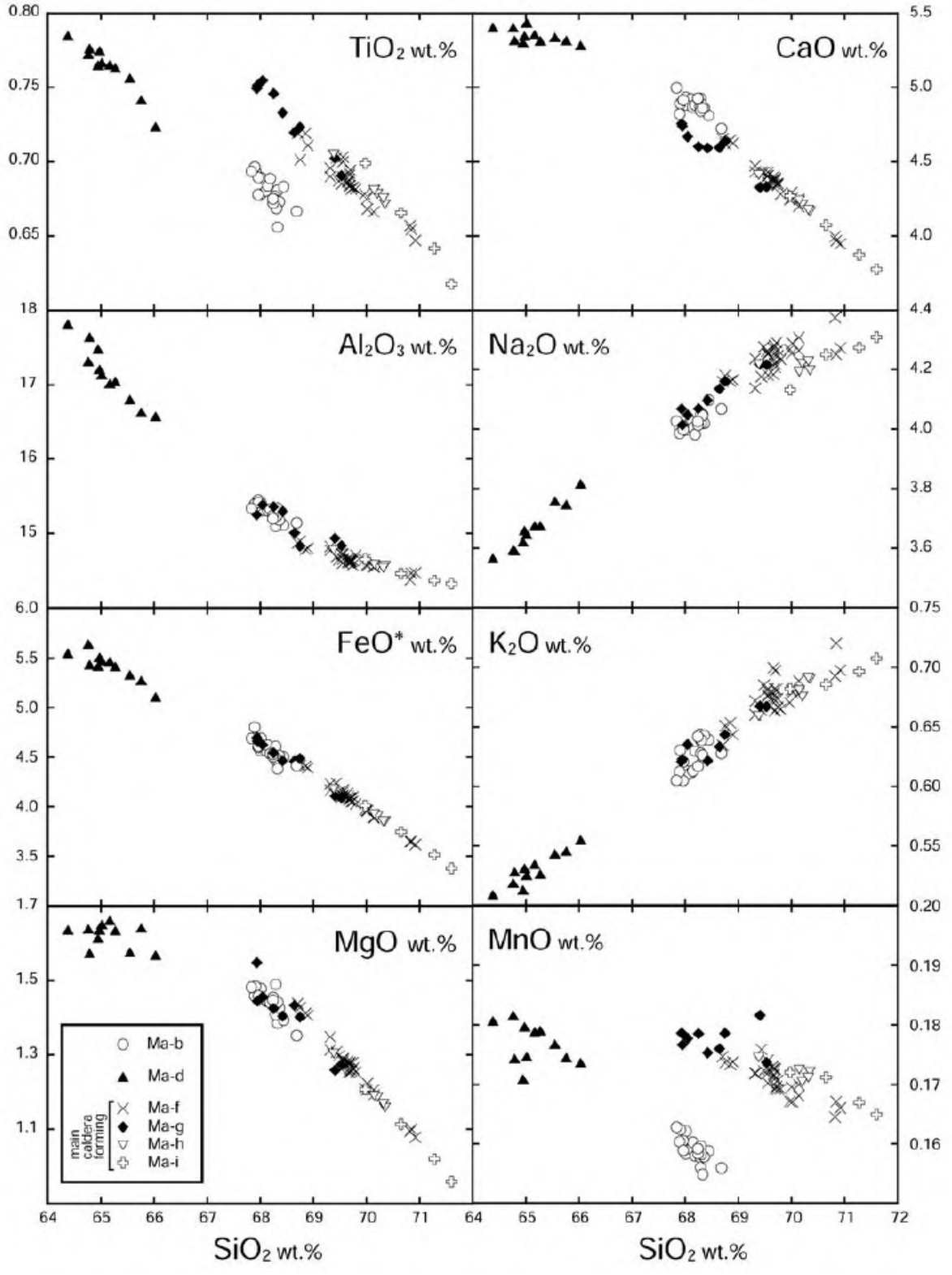


Figure 4-3 Whole rock chemical composition Harker diagram (Kishimoto et al., 2009).

Period - Cumulative Magma Volume

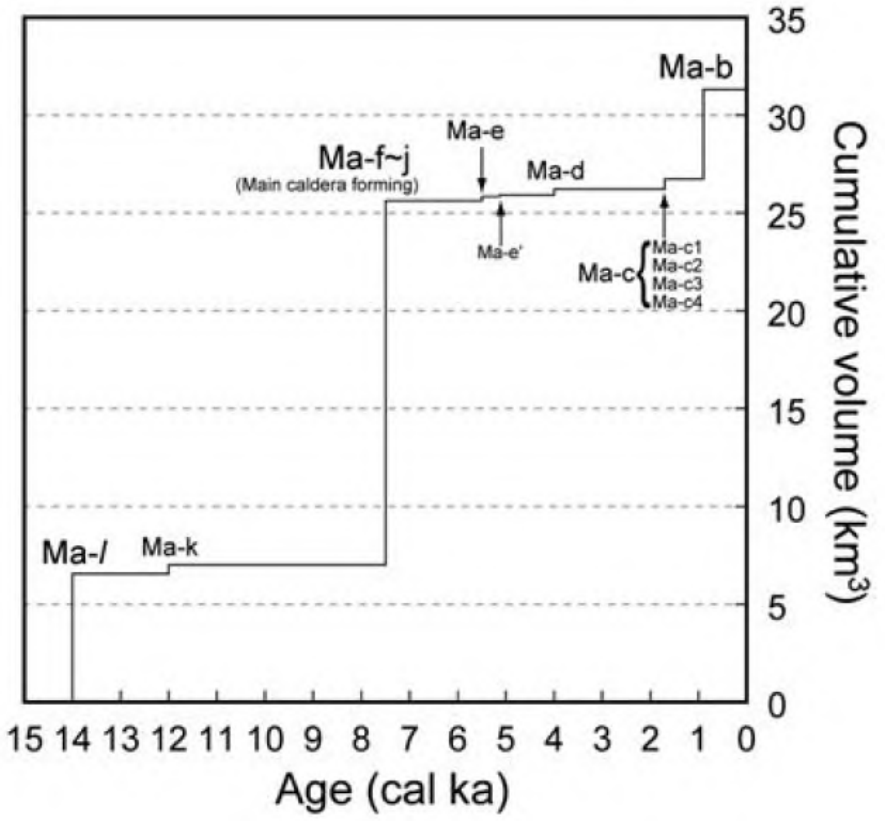


Figure 4-4 Period - cumulative magma volume (Kishimoto et al., 2009).

Major Volcanic Activities

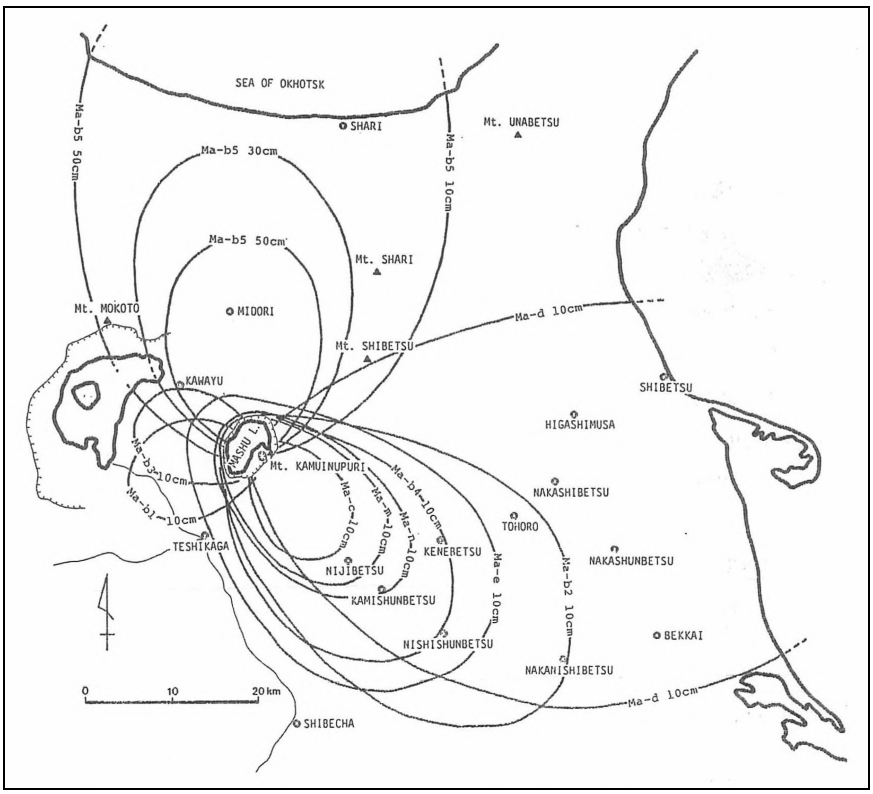


Figure 4-5 Tephra distribution during Mashu central cone formative period (approx.. 3,500 to 1,000 years ago) (Katsui et al., 1986).

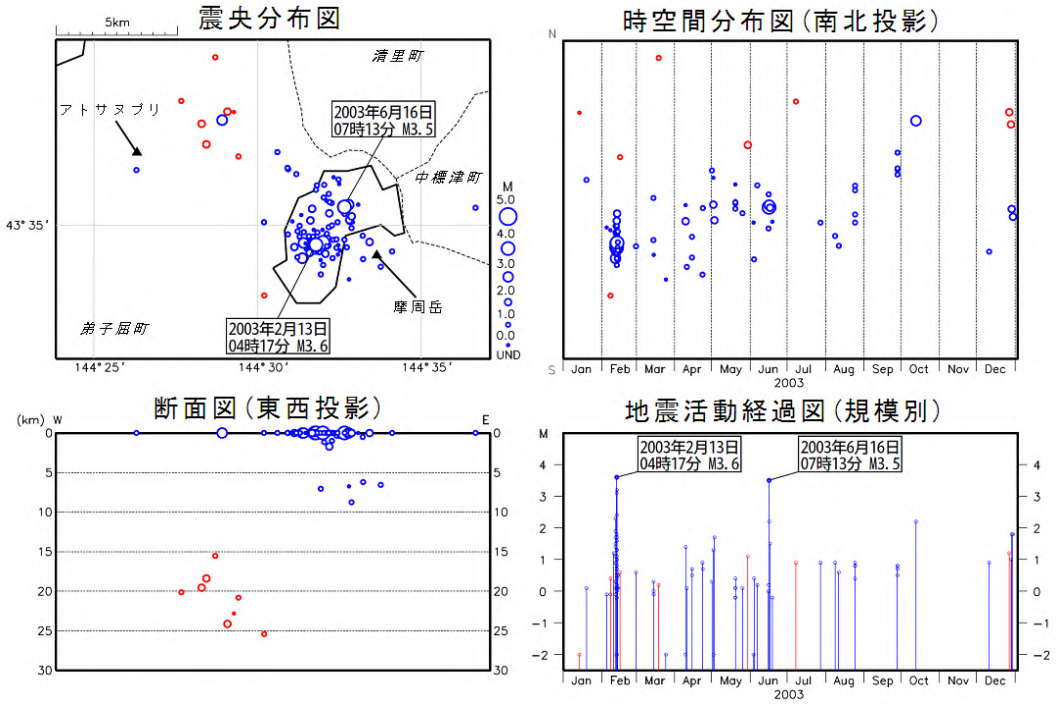


Figure 4-6 Activity of shallow VT earthquakes (blue circles) and deep low-frequency earthquakes (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (lower right).

Recent Volcanic Activity

・Seismic Activity

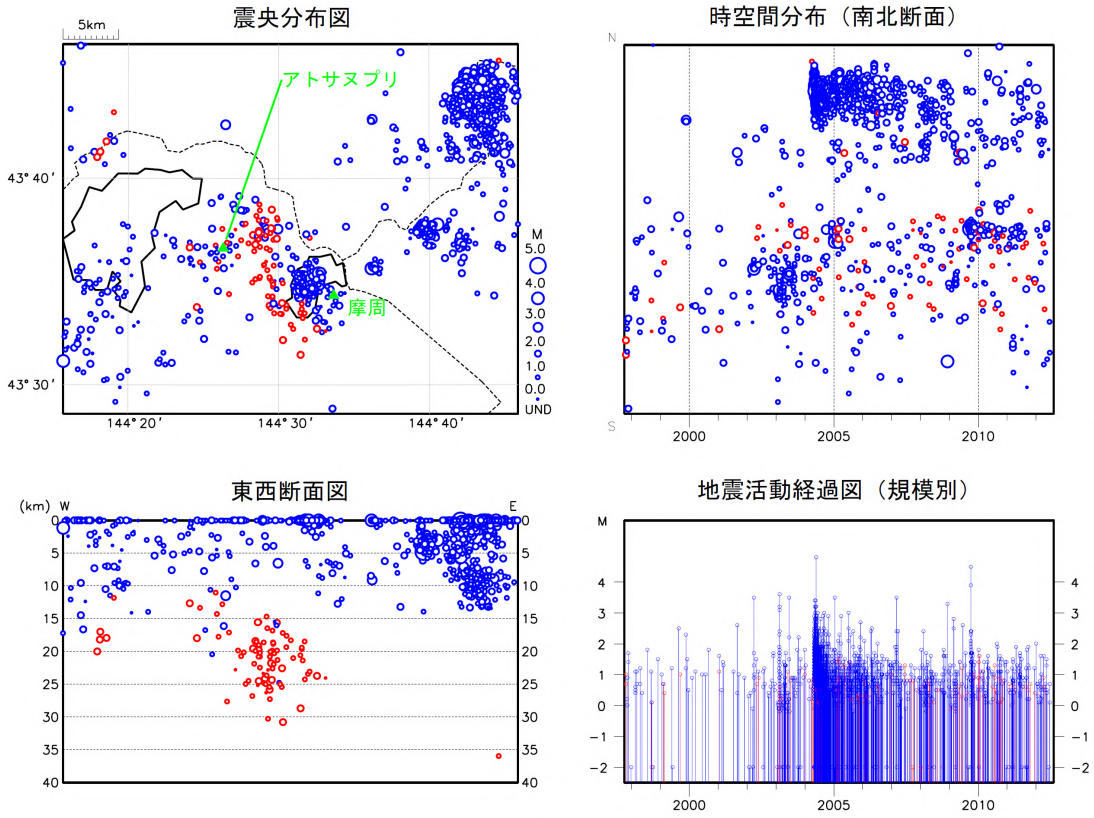


Figure 4-7 Shallow VT earthquake activity (blue circles) and deep low-frequency earthquake activity (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (lower right).

Information on Disaster Prevention

①Hazard Map

None

Social Circumstances

①Populations

- Teshikaga Mashu Lake spa area population: 6,562 (from statistics current as of October 2011)

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

- Akan National Park, Mashu Onsen area
- Number of sightseers per year: 558,737 (according to 2010 Hokkaido-wide municipal study)
- Number of mountain-climbers per year: Approx. 2,500 (June 1 to November 30, 2010)

  According to Kawayu Ranger Office for Nature Conservation Mashu 1st Lookout mountain-climber counter

  * Number of mountain-climbers accessing mountain from Nishibetsudake is unknown

③Facilities

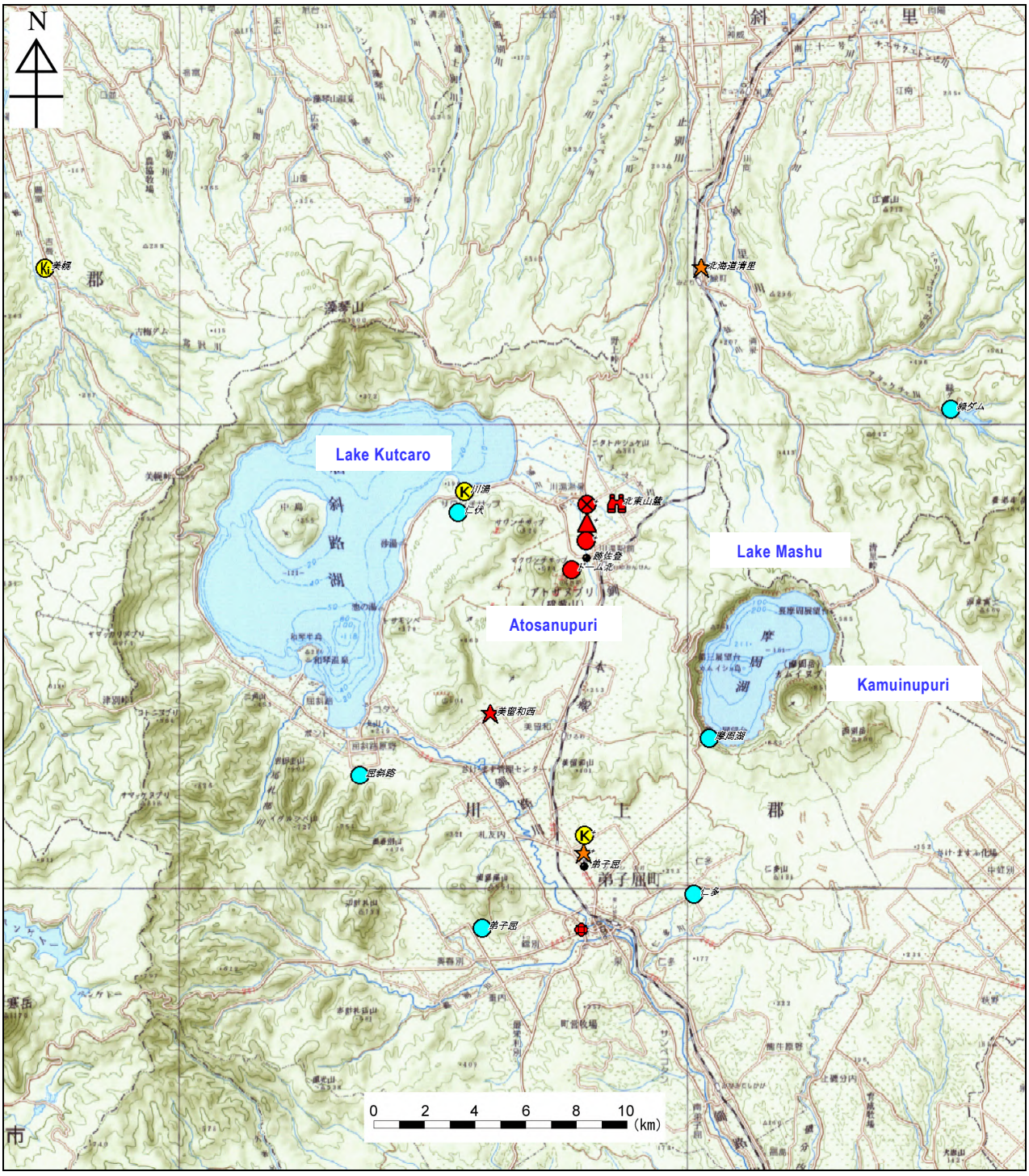
- Teshikaga

  Kawayu Eco Museum Center

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

Legend

(JMA)
seismometer(SP)
GPS
tiltmeter
infrasonic microphone
visual camera
seismic intensity meter

(GSI)
GPS

(NIED)
K-NET
KiK-net

(Hokkaido Univ.)
seismometer(SP)

Figure 4-8 Regional monitoring network.

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(Nakagawa, M., and Yamamoto, T.)