27. Iwatesan

Continuously Monitored by JMA

Latitude: 39°51'09" N, Longitude: 141°00'04" E, Elevation: 2,038 m (Iwatesan)
(Triangulation Point)

Overview of Iwatesan, taken from Morioka on May 19, 2010 by the Japan Meteorological Agency.

Summary

The Iwatesan volcano consists of Nishi-Iwate and Higashi-Iwate, two basalt-andesite with rare dacite stratovolcanoes. There is a small caldera (the Nishi-Iwate caldera) at the summit of Nishi-Iwate volcano. The volcano is characterized by explosive eruption, but a large number of lava flows were also identified. In the surrounding area there are many layers of air-fall pyroclastic deposits from explosive eruptions. At least 7 large collapses have occurred, and debris avalanche deposits cover a wide area at the foot of the volcano. The number of comfirmed collapses is the largest among the active volcanoes in Japan. The Higashi-Iwate has continued magmatic eruptions until recently as compaired to the Nishi-Iwate, and Yakushidake at the Higashi-Iwate is the highest peak (elevation of 2038 m) of the Iwate volcano.

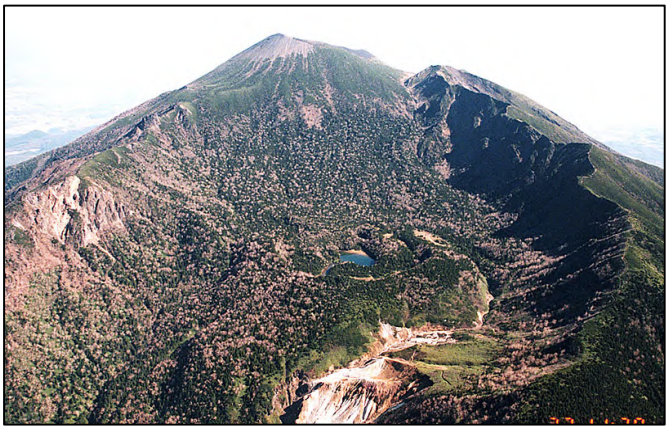
All eruptions within recorded history occurred at Higashi-Iwate with the exception of one small explosion in 1919 at Ojigokudani, Nishi-Iwatesan (where fumarolic activity is still ongoing). The two eruptions within recorded history at Higashi-Iwate have both been magmatic eruptions. Fumarolic activity was identified as high during several years (1934 to 1935, 1959 and 1972) at the Yakushi crater and Myokodake, located inside the Yakushi crater, but at present only a few weak fumes have been observed. The SiO_2 content of basalt-andesite is between 50.2 and 62.7 wt %.

Photos

Ubakurayama, Kurokurayama, Iwatesan summit. taken from the west side on April 9, 2010 by the Japan Meteorological Agency

Summit of Iwatesan, taken from the east side on October 23, 1997

Yakushidake and Myokodake, taken from the south side on October 23, 1997. Courtesy of T. Chiba.



Byobuone, Onashiroko, and Onigajo, taken from the west side on October 23, 1997. Courtesy of T. Chiba.

Ojigokudani. Photo taken from the northwest side on October 15, 2009 by the Japan Meteorological Agency

Red Relief Image Map

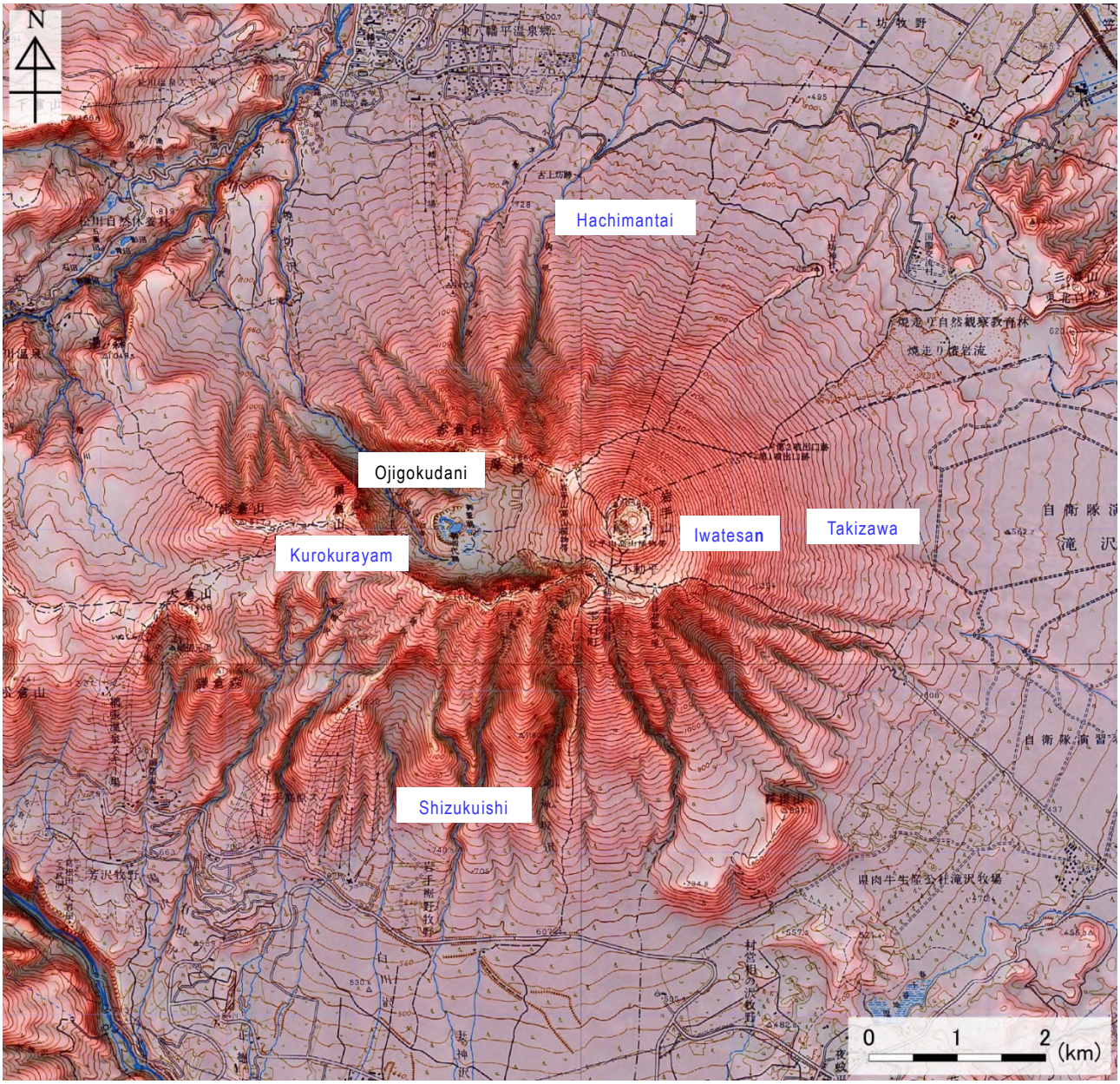


Figure 27-1 Topography of Iwatesan.

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

Geological Map

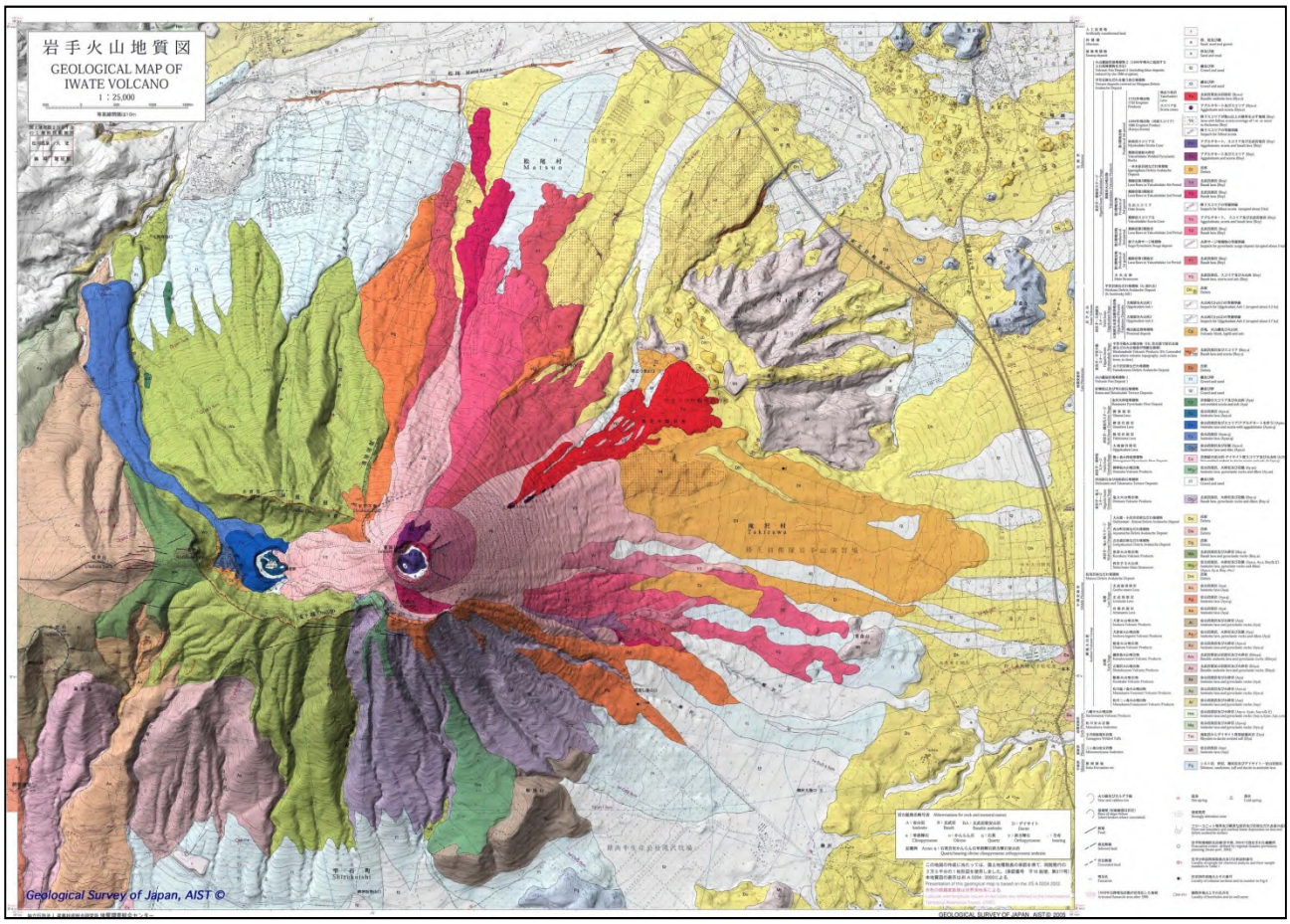


Figure 27-2 Geological Map of Iwatesan (after Itoh and Doi, 2005).

Chronology of Eruptions

・Volcanic Activity in the Past 10,000 Years

Approximately 7,000 years ago the summit of the Higashi-Iwate volcano collapsed, forming a horseshoe-shaped crater. This collapse produced the Hirakasa debris avalanche deposits spread over the eastern foot of the volcano. Magmatic eruptions within the horseshoe-shaped caldera then formed the present Yakushidake. All recorded historical eruptions occurred in the 17 th century or afterwards, but geological surveys indicated that small collapses and summit eruptions occurred from the Heian to the Edo eras (15C-17C). At least 4 relatively large phreatic eruptions have also occurred at the Nishi-Iwate volcano within approximately the past 7,000 years. The 1686 (Jokyo 3) summit eruption and the 1732 (Kyoho 16 to 17) flank eruption are the only ones recorded in the literature and for which eruption scales are known. The 1686 (Jokyo 3) eruption began with a phreatomagmatic eruption at the Omuro crater on the summit, producing tephra fall on the former Nishine Town, the former Tamayama Village, Takizawa Village, and Morioka City, as well as pyroclastic surges and volcanic lahars.

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
10←→6.8ka	Higashi-Iwatesan	Magmatic eruption	Tephra fall.
8.4←→8.2ka	Nishi-Iwate volcano Ojigokudani area?	Phreatic eruption	Tephra fall.
7.7←→7.6ka	Nishi-Iwate volcano Ojigokudani area? [6,10]	Phreatic eruption	Tephra fall.
7←→6.8ka	Higashi-Iwate volcano	(Collapse) → magmatic eruption	Hirakasa debris avalanche. Debris avalanche → pyroclastic surge → tephra fall?
6.8←→5.8ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Lava flow. Lava flow eruption resulting from multiple eruptive events.
7←→5.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
7←→5.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
7←→5.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall?
6.9←→6.8ka	Nishi-Iwate volcano Ojigokudani area?	Phreatic eruption	Tephra fall.
5.8←→5.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Sugo scoria: Tephra fall, pyroclastic surge.
5.8←→5.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
5.8←→4.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Lava flow. Lava flow eruption resulting from multiple eruption events.
5.8←→5ka	Nishi-Iwate volcano Ojigokudani	Phreatic eruption	Tephra fall.
4.8←→4.5ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Pyroclastic surge.
4.8←→4.5ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Pyroclastic surge.
4.8←→4.5ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
4.8←→4.5ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
4.2←→3.9ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Pyroclastic surge.
4ka	Nishi-Iwate volcano Ojigokudani area	Phreatic eruption	Tephra fall.
3.7→3.2ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
3.6ka	Nishi-Iwate volcano Ojigokudani area	Phreatic eruption	Tephra fall.
3.5←→3.3ka	Nishi-Iwate volcano Ojigokudani area	Phreatic eruption	Tephra fall.
3.2ka	Higashi-Iwate volcano Yakushidake	Phreatomagmatic eruption, magmatic eruption	Oide scoria tephra fall.
3.2→1.8ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Lava flow. Collective name for lava flow eruptions resulting from multiple eruption events.
2.4ka	Nishi-Iwate volcano Ojigokudani area	Phreatic eruption	Tephra fall.
1.8ka	Higashi-Iwate volcano Yakushidake	Phreatomagmatic eruption, magmatic eruption	Tephra fall.
0.7←→0.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	
0.7→0.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Lava flow. Collective name for lava flow eruptions resulting from multiple eruption events.
0.7←→0.6ka	Higashi-Iwate volcano Yakushidake	(Collapse)	Debris avalanche.
0.7→0.6ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Tephra fall.
0.7←→0.6ka	Higashi-Iwate volcano Myokodake	Magmatic eruption	Tephra fall.
0.6←→0.4ka	Nishi-Iwate volcano Ojigokudani	Phreatic eruption	Tephra fall.
0.6←→0.4ka	Higashi-Iwate volcano Yakushidake	Magmatic eruption	Pyroclastic surge.

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: Eruptive events taking place at some point between year A and year B.

A→B: Indicates a continuous chain of eruptive events beginning in year A and ending in year B.

▪ Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
1686 (Jokyo 3)	Moderate: Phreatomagmatic eruption → magmatic eruption	March to December. Pyroclastic surge → tephra fall. The eruption occurred at the Higashi-Iwate volcano, Myokodake. Eruptions from the Omuro crater, on the summit. Tephra fall around the eastern foot of the volcano (with heavy tephra fall even as far as castle town of Morioka). A lahar by melted snow occurred from March 25 to 27, causing livestock and home damage. Magma eruption volume = 0.034 km^3 DRE. (VEI 3)

Year	Phenomenon	Activity Sequence, Damages, etc.
1732 (Kyoho 16 to 17)	Moderate: Magmatic eruption	January 22 to 31. Lava flow and tephra fall. The eruptive activity occurred at the Higashi-Iwate volcano's northeastern flank.[10,13,14] Lava flow from the northeastern flank (Yakehashiri lava flow), 3.4 km long and up to 1.1 km wide. The climax of the eruption was during the first a few days. It was accompanied by rumbling and earthquakes. Magma eruption volume = 0.0064 km^3 DRE. (VEI 2)
1919 (Taisho 8)	Small-scale: Phreatic eruption	July 15. Tephra fall. The eruption occurred at the Nishi-Iwate volcano, Ojigokudani.[6,7,10,14] Volcanic blocks were scattered to the mountain path along the side of Ojigoku. A new crater was formed, and ash fell. (VEI 1)
1934 to 1935 (Showa 9 to 10)	Fume	Fumarolic activity increased from July at the Higashi-Iwate volcano Yakushidake summit and Myokodake.
1959 (Showa 34)	Fume	Fumarolic activity increased on the southeastern slope Myokodake and the western Omuro crater rim.
1972 (Showa 47)	Fume	April 10. Fumarolic activity increased at the Higashi-Iwate volcano Yakushidake summit. A white volcanic plume extended 300 m above Myokodake.
1995 (Heisei 7)	Earthquake, tremor	September and October. Intermediate-depth low-frequency earthquake and tremor activity began.
Approximately 1997 to 2004 (Heisei 9 to 16)	Earthquake, crustal deformation, fume	From late December, 1997, seismic activity began at a shallow depth on the western side of the volcanic edifice. From approximately February, 1998, seismic activity increased, including very-long-period earthquakes. At the same time, according to Tohoku University and the Geospatial Information Authority of Japan, etc., ground deformations started. On April 29, 1998, a large number of volcanic earthquakes were observed in a short period of time, as well as large tiltmeter changes. The activity peaked from June to July, and gradually tailed off from August. On September 3 a M6.2 earthquake occurred approximately 10km southwest of Iwatesan, followed immediately by a temporary increase in seismic activity, but by October the volcano had returned to normal. From 1999 seismic activity in shallow areas decreased further, but intermediate-depth low-frequency earthquake and tremor activity continued. Fumarolic activity on the western side of Iwatesan increased from roughly June, 1999, peaking in 2002 and 2003, and then gradually returning to normal. This activity did not culminate in an eruption.
2011 (Heisei 23)	Earthquake	March. The 2011 off the Pacific coast of Tohoku Earthquake (M9.0, March 11, 2011) triggered a seismic activity approximately 10 km west-northwest of the summit.

* 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.

Major Volcanic Activities

・1686 Eruption

A summit eruption occurred at the Yakushidake crater during the Edo era. On March 26, 1686 (lunar calendar: March 3, Jokyo 3) a volcanic plume from the summit was visible from Morioka castle, 10 km southeast of the summit, confirming that an eruption was taking place. Records exist of a precursor phenomenon, rumbling which began approximately 10 days before the eruptive activity, but details are unknown. During the early morning on March 25 a loud sound could be heard in the castle town of Morioka, and some trees and parts of houses were found in the waters of the Kitakami River, so the explosive eruptions are considered to have begun at approximately this time. The high level of eruptive activity resulting in ash fall ended by the early morning of March 27.

This eruption occurred at the Omuro crater, which had appeared on the side of the Myokodake scoria cone inside the Yakushidake crater, and discharged air-fall scoria accompanied by base surge deposits. These deposits flowed towards Fudodaira from the eastern rim of the Yakushidake crater, but some were also distributed to the southwest. The Kariya scoria fell from the summit towards the northeast and the southeast, with ash fall in the Morioka castle town as well. After the peak

of the eruptive activity volcanic ash and scoria were discharged around the summit from the Omuro crater for several months, and small, phreatic explosions repeatedly occurred, widening the crater walls. The activity ended by the end of the year. Lahars by melted snowtook place on March 25-27, causing damage to livestock and 4 houses at the foot of the volcano (near present Ippongi) (Itoh, 1998).

・1732 Eruption

A flank eruption occurred on the northeastern flank of Higashi-iwate. A precursory activity of earthquakes started at the northeastern foot of the volcano roughly on January 20, 1732 (December 23, Kyoho 16). From the late night on January 21 to 22 these earthquakes increased in intensity, and several parasitic craters opened in a nearly straight line along the mountain slope, forming scoria cones and discharging the Yakehashiri lava flow. The lava flow continued for roughly one week, until January 30 or 31. No records exist of damage caused directly by the lava flow, but volcanic earthquakes occurred frequently, so residents living at the northeastern foot of the volcano evacuated temporarily (Ito, 1998).

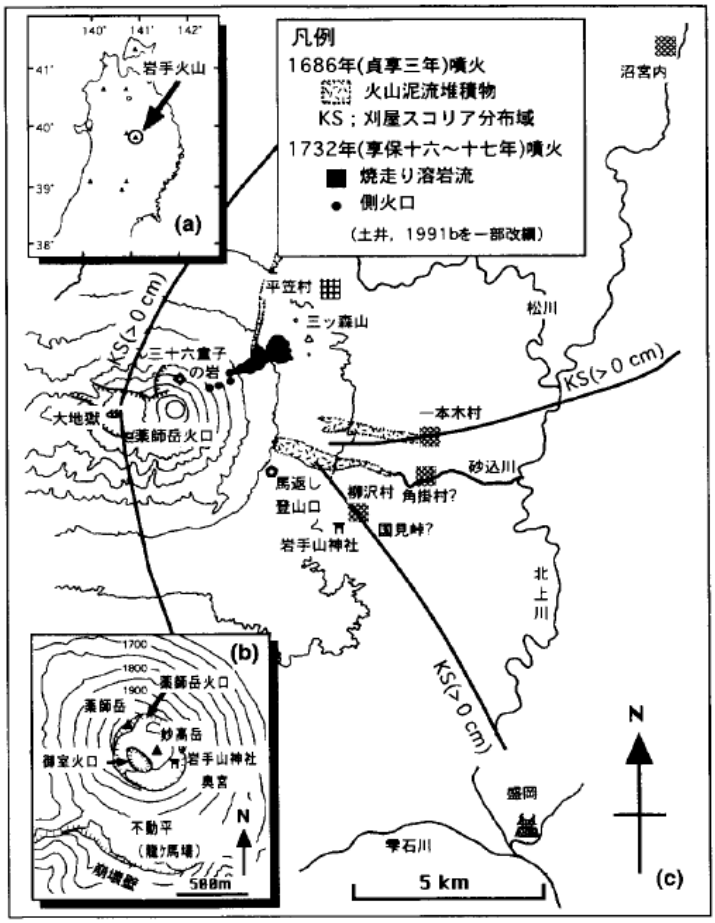


Figure 27-3 Summary of the eruptions at Iwatesan in 1686 and 1732 (Ito, 1998). (a) Location of Iwate volcano, (b) topography around the Yakushidake crater, and (c) distribution of air-fall scoria deposits, volcanic lahar deposits and a lava flow in the Edo era (by the 1686 and 1732 eruptions).

・1919 Eruption

A phreatic explosion occurred at the Ojigokudani area of the Nishi-Iwate volcano in July, 1919 (Taisho 8). On July 14, a white volcanic plume was seen from the flank of Hachimantai (the Matsuo mining office) to be rising from Iwatesan. On July

15 employees of the Matsuo mining office observed ash fall deposits and fumes in the area. While the specific date is unknown, in late June no anomalies were confirmed in Ojigokudani, so this activity is considered to have started in roughly early July, and strong volcanic plume activity is considered to have occurred repeatedly thereafter. The crater created by this activity was between 5 m to 10 m in diameter, and a notable amount of ash fall was deposited in an area 100 m from the crater, decreasing to several cm in the surrounding area. It is said that the ash fall reached approximately 4 km to the southwest. For some time after the eruptive activity fumarolic activity was high. Over several months the crater was widened by a crater wall collapses, and the interior of the crater was filled with hot water. The water became cool by around 1927. While fumarolic activity continued in the Ojigokudani area, no more fumarolic activity occurred inside the Taisho crater.

▪ 1998 Volcanic Unrest

In September, 1995, an activity of intermediate-depth volcanic tremor and low-frequency earthquakes on the eastern side of the summit was observed for the first time since the monotoring began in 1982. The number of earthquakes remained low thereafter. From late December, 1997, another seismic activity began at a shallower depth on the western side of the volcanic edifice. This activity rapidly increased in number and magnitude from approximately February, 1998. On April 29 285 earthquakes successively occurred in a day. Low-frequency earthquakes and volcanic tremor also occurred. On July 10 volcanic tremor with large amplitudes occurred. During this period, the area of shallow seismic activity expanded towards the west, and a belt-shaped hypocenter area approximately 10 km from east to west was formed. Clear volcanic inflation was observed by tiltmeters, strainmeters and GPS, synchronized with the seismic activity. The deformation source moved to the west in conjunction with the western expansion of the hypocenter area. Shallow very-long-period earthquakes and deep low-frequency earthquakes occurred with increased frequency. The peak of this activity was in June and July, and then the activity gradually tailed off from August. On September 3 a M6.2 earthquake hit the area approximately 10 km southwest of Iwatesan, followed by a temporary increase in seismic activity in the shallow areas of Iwatesan. By October the volcano had returned to normal. From 1999 the number of earthquakes continued to fall, but sporadic M3 earthquakes and a volcanic tremor occurred. From 2000, seismic activity almost returned to normal. Ground deformation also stabilized at roughly the same time. However, fumarolic activity at Kurokurayama, etc. on the western side of Iwatesan increased from roughly June, 1999, peaking in 2002 and 2003, and then gradually returning to normal. Intermediate-depth low-frequency seismic activity continued thereafter (Miura et al., 2000; Tanaka et al., 2002b; Nishimura et al., 2000; Nakamichi et al.,2003).

This period of increased volcanic activity did not culminate in an eruption.

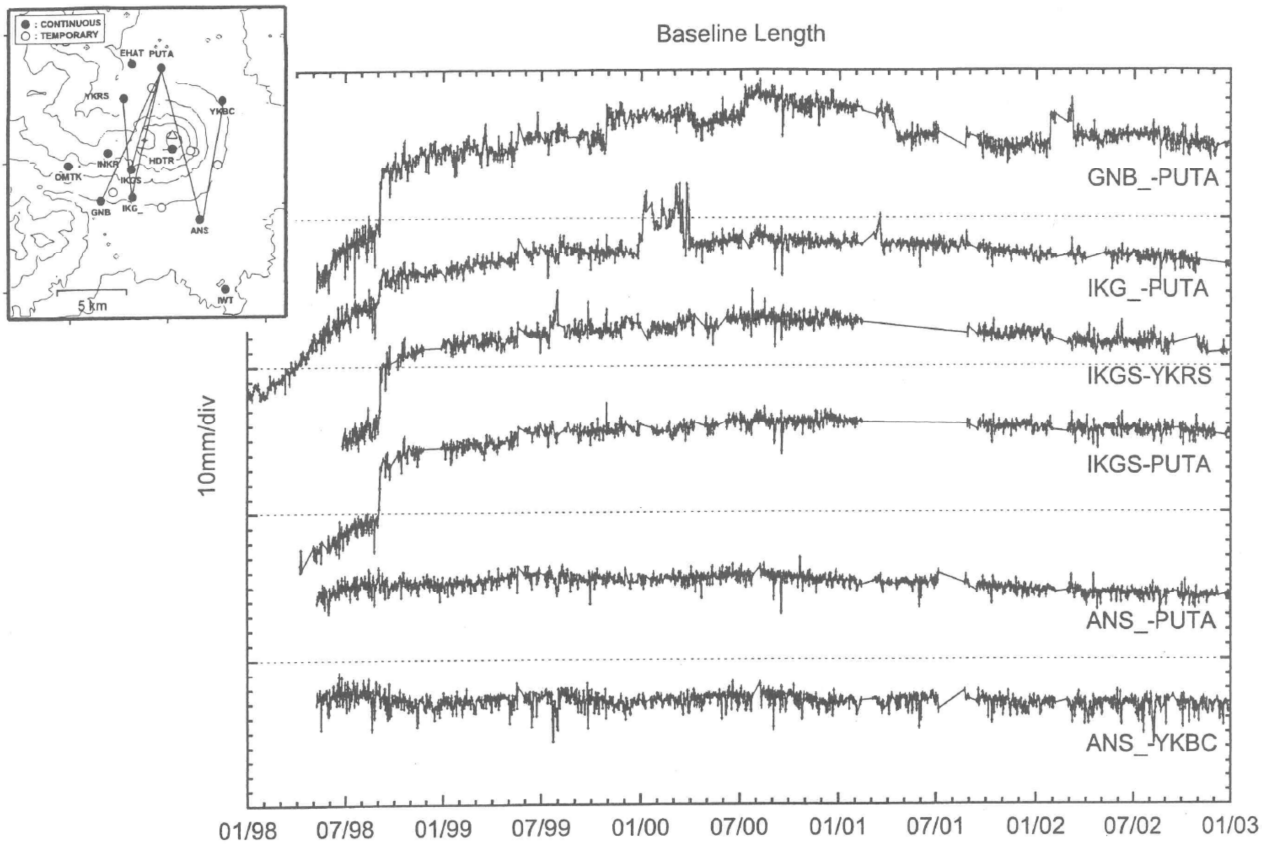


Figure 27-4 Changes in north-south baselines observed by GPS measurement. The baselines traversing Nishi-Iwatesan extended quickly until roughly July, 1998. Their rate of increase then fell, and from roughly mid-2000 began shortening.

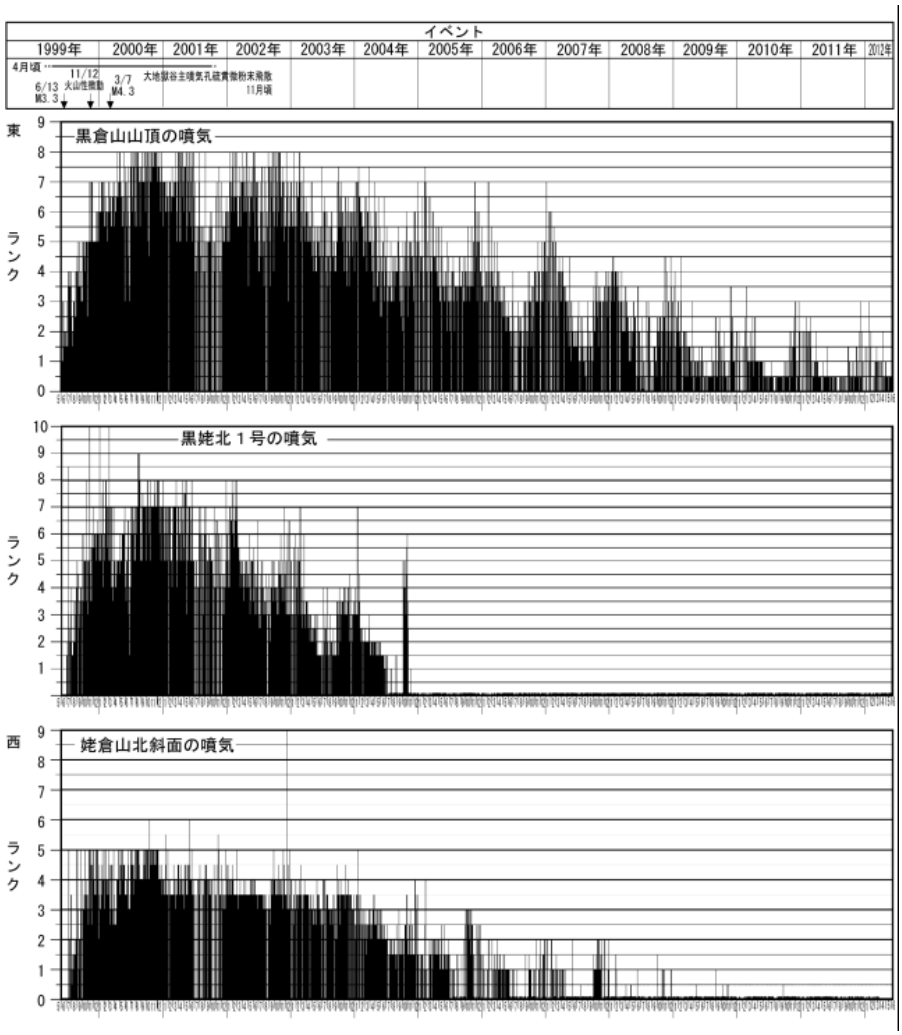


Figure 27-5 Strength of fumarolic activity from the summit of Kurokurayama (top) to Ubakurayama (bottom) from 1999 to 2012. The amount of fumarolic activity at the three points began increasing sharply from 1999, peaking in 2000 and tailing off thereafter.

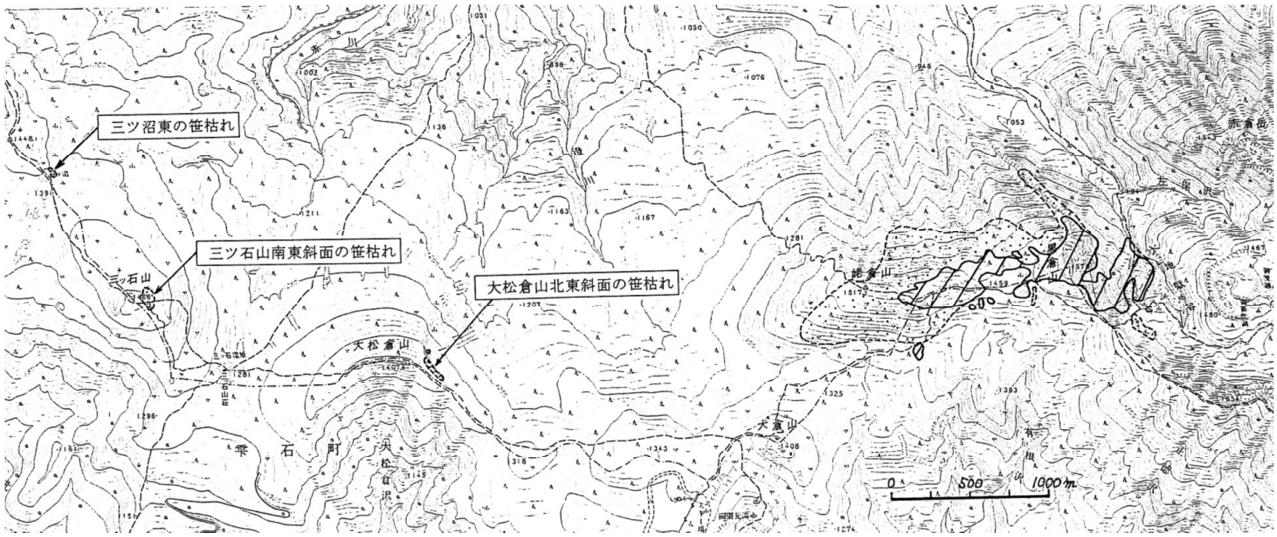


Figure 27-6 Area in which surface phenomena were confirmed between Nishi-Iwatesan, Omatsukurayama, and Mitsuishiyama between March, 1999, and May, 2001 (Doi, 2002). The area enclosed in dotted lines is that in which visitation was damaged. The dashed area is that in which fumes appeared in 1999 and 2000 (including non-phreatic volcanic gas fumes).

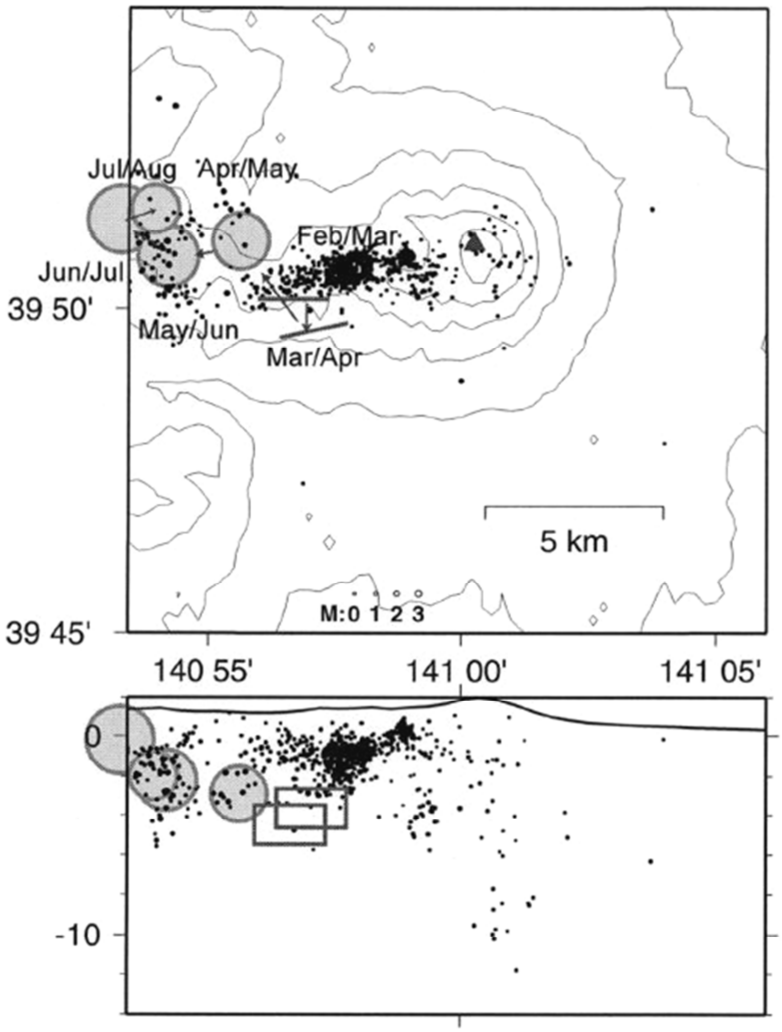


Figure 27-7 Distribution of pressure sources during the 1998 Iwatesan volcanic crisis (Miura et al., 2000). Rectangles: Dikes, Gray circles: Isotropic pressure sources, Black dots: Hypocenters.

Subsurface Structure

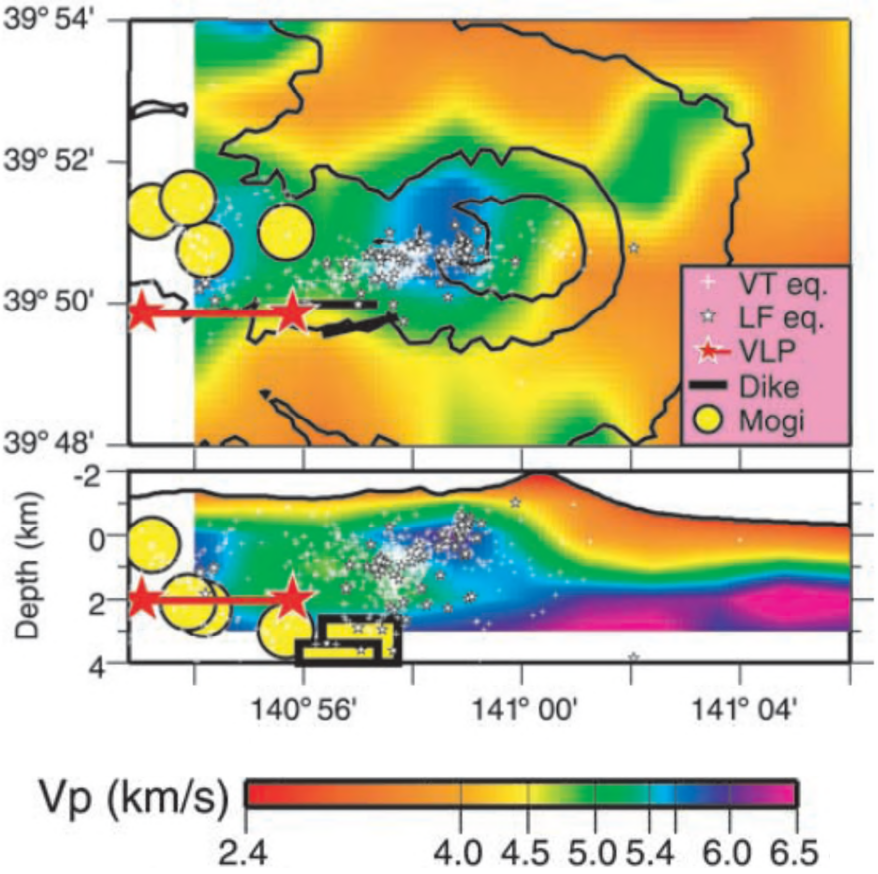


Figure 27-8 P wave velocity structure beneath the Iwatesan volcanic region, determined by analysis of artificial earthquake exploration data, and distribution of hypocenters and ground deformation sources for the 1998 activity period (February to August, 1998) (Tanaka et al., 2002a). Map view at 0km above the sea level (top) and east-west cross-section of the summit area (bottom) are presented. + symbols indicate volcano-tectonic earthquakes (VT). Stars indicate low-frequency earthquake (LF) hypocenters. Red stars indicate very-long-period earthquake (VLP) hypocenters. Yellow symbols indicate ground deformation sources, with rectangles indicating dikes (February to April). Circles indicate isotropic pressure sources (Mogi) (April to August). On the west side of the summit, the high velocity area is distributed over the shallow area, but on the east side thick, low velocity areas exist in the surface layer. Both the hypocenters and ground deformation sources during the 1998 activity period were distributed over the high velocity zone on the west side.

Precursory Phenomena

- While it did not culminate in an eruption, for several years before the 1998 unrest, volcanic tremor, an increased volcanic seismic activity, and progressive crustal deformations were observed, as well as increased fumarolic activities.

Recent Volcanic Activity

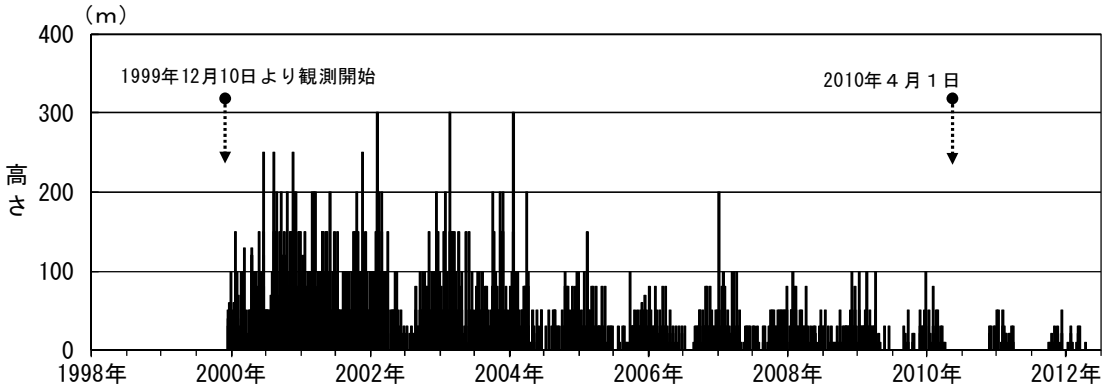


Figure 27-9 Maximum fumes height per day (December 10, 1999, to June 30, 2012). Observation began via the long-range camera at Kashiwadai from December 10, 1999. Kurokurayama was the only target of observation until March, 2010. From April 1, 2010, the observation scope was expanded to include all of Iwatesan.

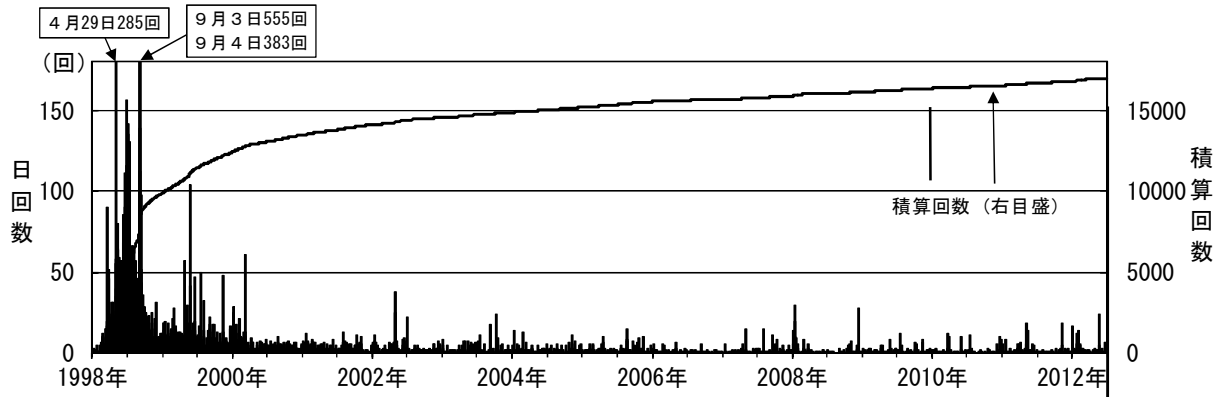


Figure 27-10 Number of earthquakes per day at Iwatesan (January, 1998, to June, 2012).

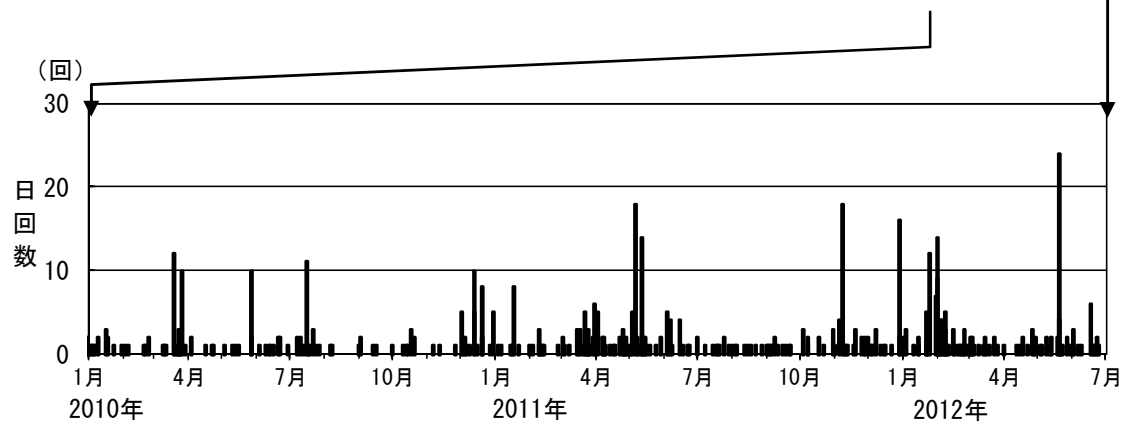


Figure 27-11 Number of earthquakes per day at Iwatesan (January, 2010, to June, 2012).

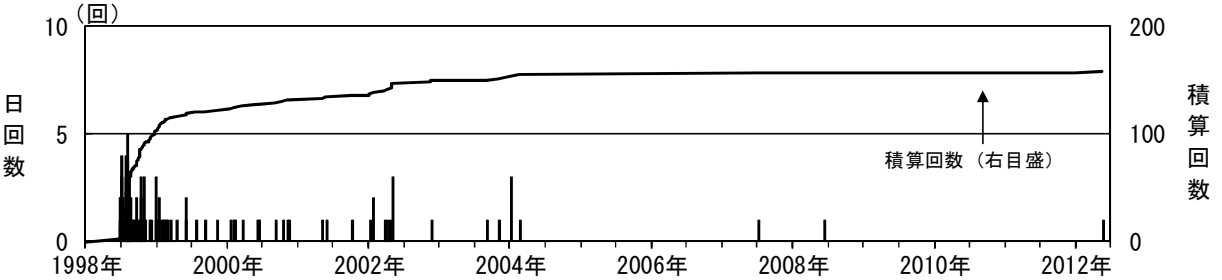


Figure 27-11 Number of low-frequency earthquakes per day at Iwatesan (January, 1998, to June, 2012)

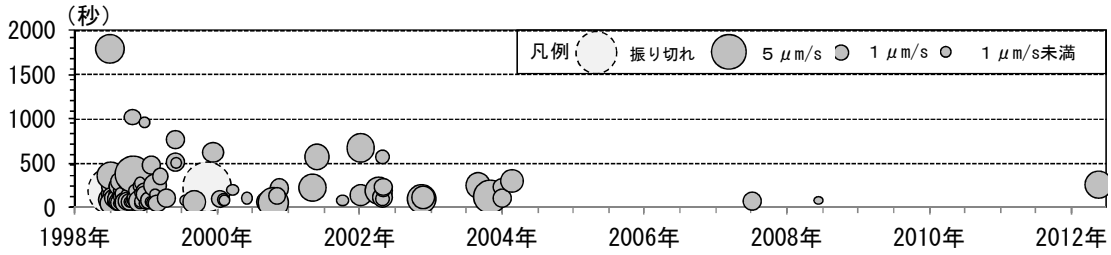


Figure 27-12 Tremor duration (vertical axis) and maximum vertical amplitude (radiuse of the circle) at Iwatesan (January, 1998, to June, 2012).

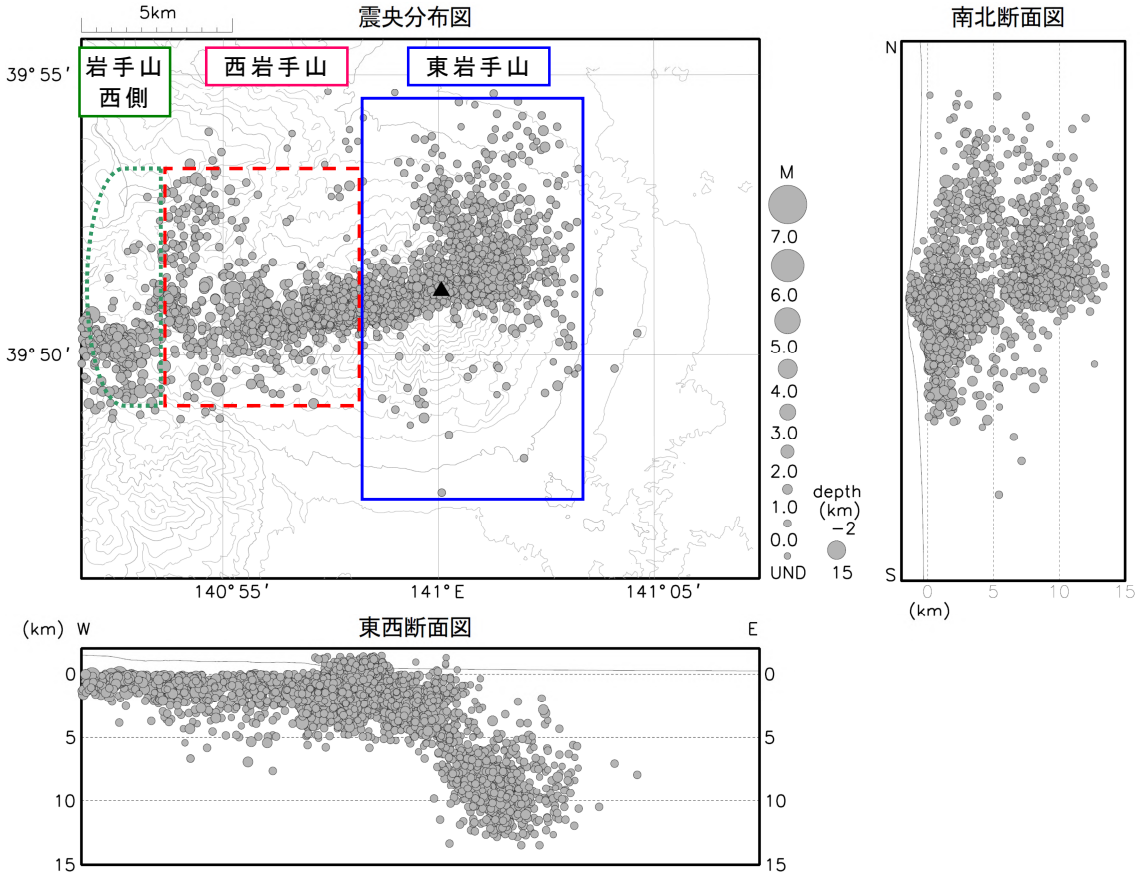


Figure 27-13 Hypocenter distribution (Depth ≤ 15 km, January 1, 1998, to June 30, 2012). The M6.2 earthquake on September 3, 1998, and aftershocks were excluded from the data since September, 1998. Hypocenters were determined based on the data from the Japan Meteorological Agency, Tohoku University, and the National Research Institute for Earth Science and Disaster Prevention.
The digital map 50 m grid (elevation) published by the Geospatial Information Authority of Japan was used to create this map.

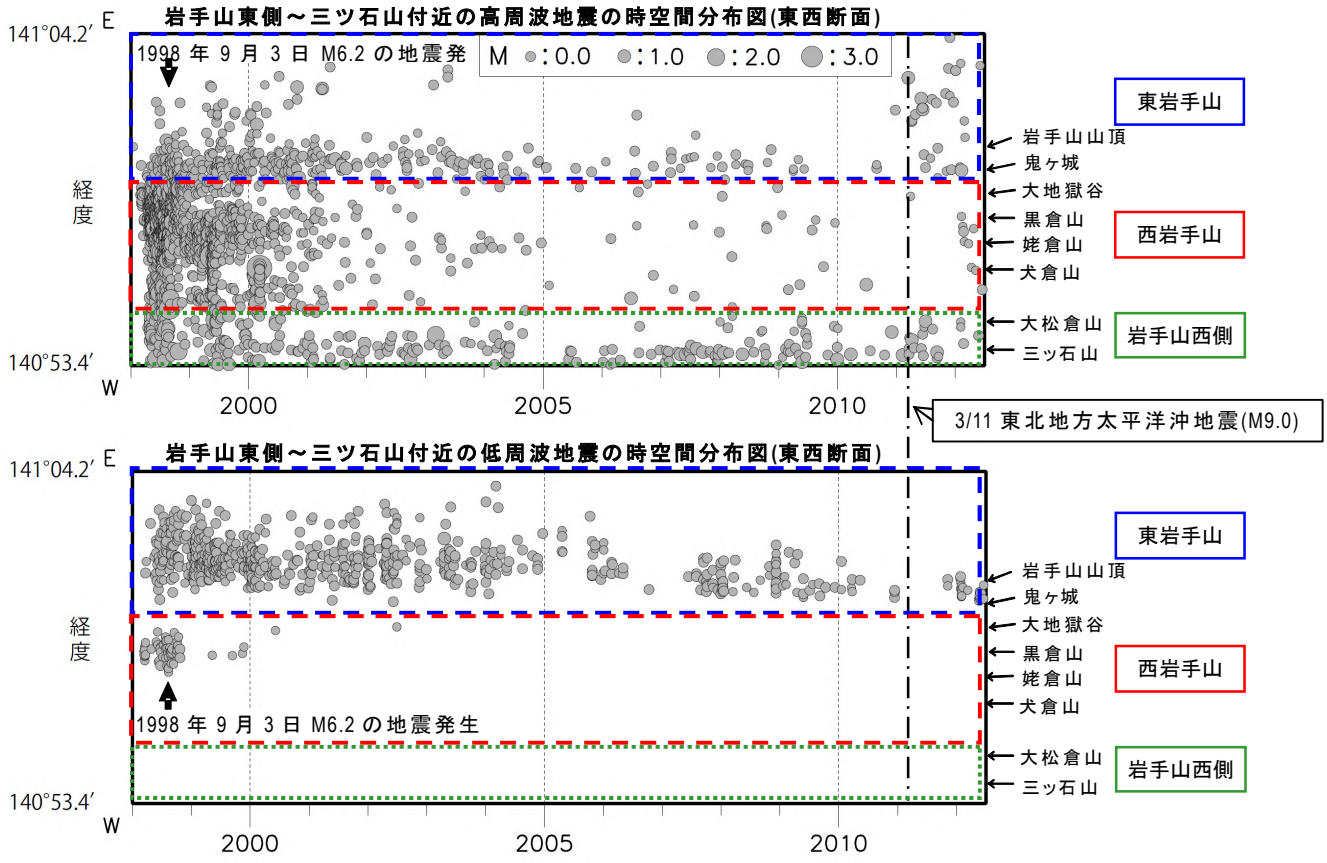


Figure 27-14 Space-time plot from the east side of Iwatesan to the Mitsuishiyama area in the west (January 1, 1998, to June 30, 2012). The earthquakes shown in Figure 27-13 have been plotted separately for high-frequency earthquakes (top) and low-frequency earthquakes (bottom).

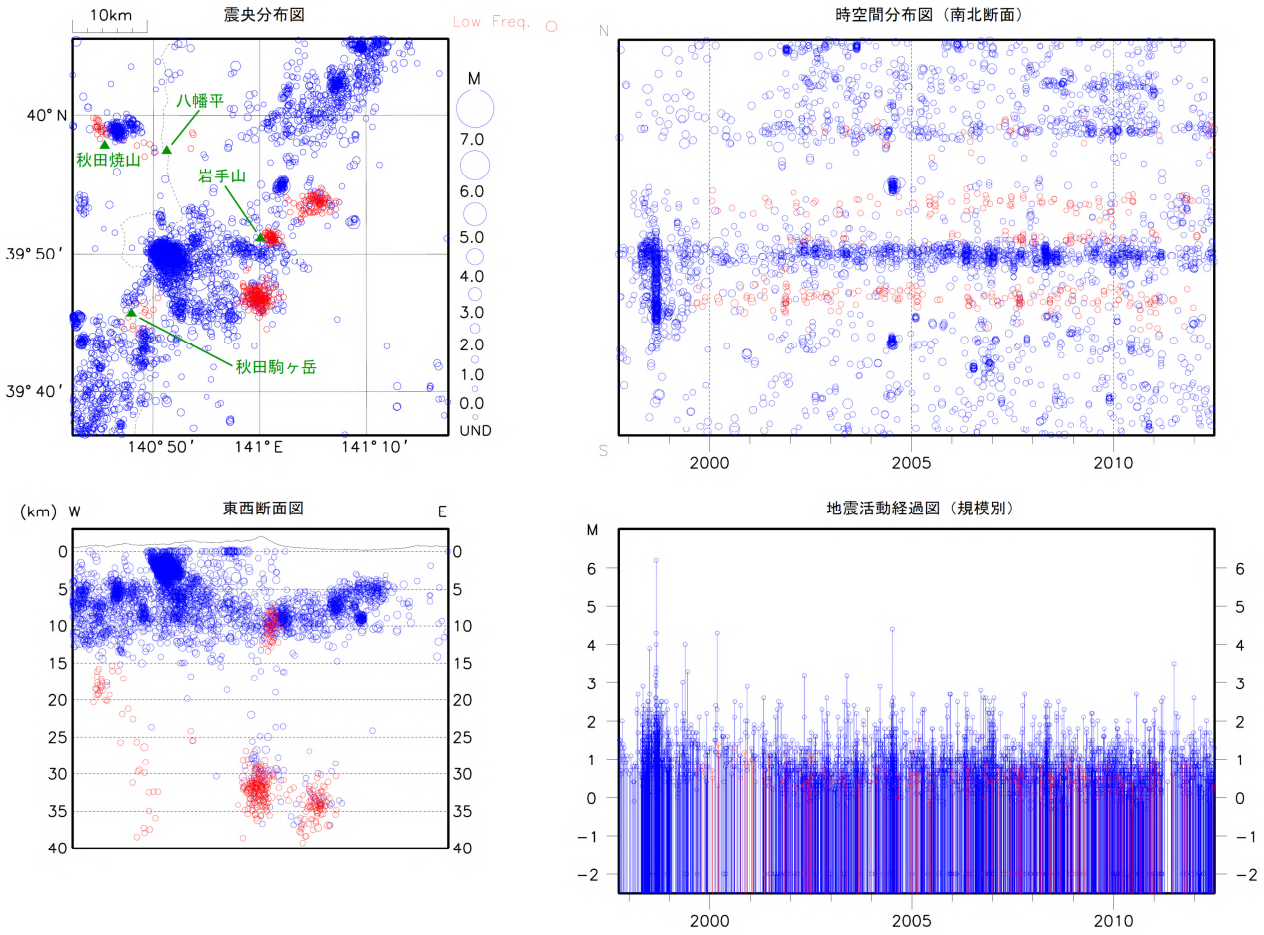


Figure 27-15 Activity of shallow VT earthquakes (blue circles) and deep low-frequenc y earthquakes (red circles) observed by aregional seismometer network (October 1, 1997, to June 30, 2012). Epicenter di stribution (upper left), space-time plot (N-Scross-sec tion) (upper right), E-W cross -section (lower left) and magnitude-time diagram (lower right).

Information on Disaster Prevention

①Hazard Map

Iwatesan Volcano Disaster Prevention Map (Wide Area Version) October, 1998 - Published by Ministry of Land, Infrastructure, Transport and Tourism Iwate River and National Road Office, Iwate Prefecture, Morioka City, Hachimantai City, Shizukuishi Town, and Takizawa Village

2000 Iwatesan Volcano Disaster Countermeasure Map (Morioka City Version) - Published by Morioka City

2000 Iwatesan Volcano Disaster Countermeasure Map (Hachimantai City Version) - Published by Hachimantai City

2010 Iwatesan Volcano Disaster Countermeasure Map (Shizukuishi Town Version) - Published by Shizukuishi Town

2000 Iwatesan Volcano Disaster Countermeasure Map (Takizawa Village Version) - Published by Takizawa Village

Source: Iwatesan Volcano Disaster Prevention Map (Wide Area Version)

Date of Publication: October, 1998

Created by: Iwatesan Volcano Disaster Countermeasure Deliberating Committee (Iwate River and National Road Office of the Ministry of Land, Infrastructure, Transport and Tourism, Iwate Prefecture, Morioka City, Hachimantai City, Shizukuishi Town, and Takizawa Village)

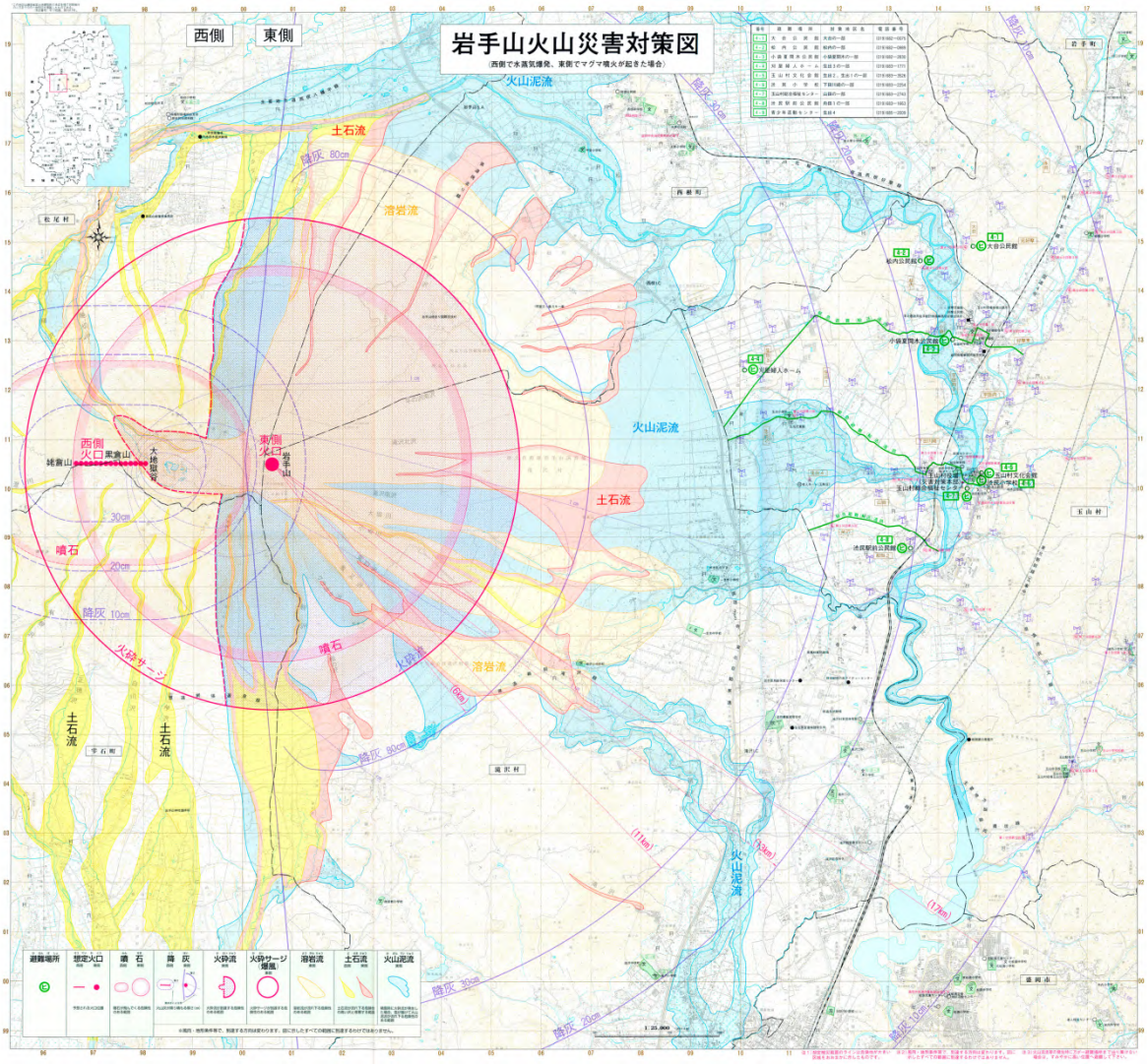
URL:

Iwate Prefecture

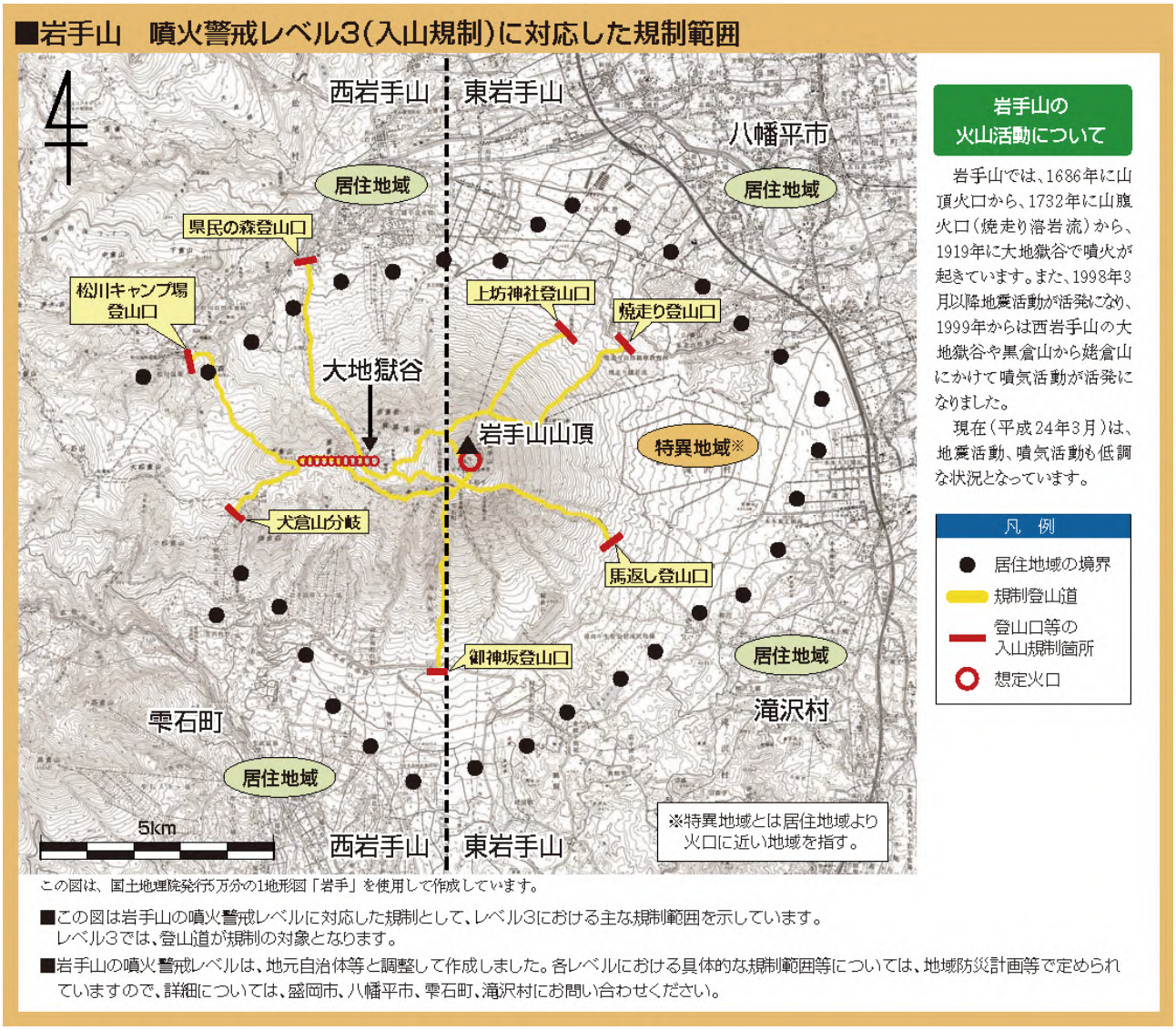
http://www.pref.iwate.jp/~hp0108/bosai_map/bosaimap_s.html

Iwate River and National Road Office of the Ministry of Land, Infrastructure, Transport and Tourism

http://www.thr.mlit.go.jp/iwate/bousai/sonae/kazan_map/map_kakudai.htm



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



Black dots indicate the border of “residental area”.

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

<table>
<tr><td rowspan="2">Warning and Forecast</td><td rowspan="2">Target Area</td><td rowspan="2">Levels & Keywords</td><td colspan="4">Explanation</td></tr>
<tr><td>Expected Volcanic Activity</td><td>Past Examples</td><td>Actions to be Taken by Residents and Climbers</td><td>Mountain Climbers</td></tr>
<tr><td rowspan="2">Eruption Warning</td><td rowspan="2">Residential areas and areas closer to the crater</td><td>5
Evacuate</td><td>Eruption or imminent eruption causing significant damage to residential areas</td><td>①1686
Higashi-Iwatesan summit eruption</td><td>Evacuate from dangerous residential areas</td><td rowspan="3">Restriction of access to mountain from trail entrances</td></tr>
<tr><td>4
Prepare to evacuate</td><td>Possibility of eruption causing significant damage to residential areas (increased probability).</td><td>②1732 Higashi-Iwate slope eruption (Yakehashiri lava discharge)</td><td>Those within the alert area should prepare for evacuation.

Those requiring protection in the event of an disaster, special areas** and areas for which especially high levels of damage are expected*** must be evacuated.</td></tr>
<tr><td rowspan="2">Crater Area Warning</td><td>Non-residential areas near the volcano</td><td>3
Do not approach the volcano</td><td>Eruption or prediction of eruption causing significant damage* from crater area to areas near residential areas.</td><td>③1919 Nishi-Iwatesan (Ojigokudani) phreatic explosion
④April 29, 1998
A large number of earthquakes, and large earthquakes, occurred within a short period of time</td><td>Residents can go about daily activities as normal.

Those requiring protection in the event of an disaster, special areas** and areas for which especially high levels of damage are expected*** should prepare for evacuation as necessary.</td></tr>
<tr><td>Crater area</td><td>2
Do not approach the crater</td><td>Eruption or prediction of eruption affecting area around crater.</td><td>⑤March 17, 1998
The number of volcanic earthquakes increased and crustal deformation began</td><td rowspan="2">Residents can go about daily activities as normal.</td><td>Restriction of access to western side of Iwatesan (Ojigokudani)</td></tr>
<tr><td>Eruption Forecast</td><td>Inside the crater</td><td>1
Normal</td><td>Little or no volcanic activity.</td><td></td><td>Unrestricted mountain access</td></tr>
</table>

*: "Significant damage" is defined as the risk of death for those entering the area.

**: "Special areas" are defined as the areas between the crater and residential areas.

***: "Areas for which especially high levels of damage are expected" are defined as areas along the Sunagome River in the Ippongi area of Takizawa Village, where a risk of lahars by melted snow exists during eruptions in the winter.

Social Circumstances

①Populations

- Morioka City: 292,834 (as of March 31, 2008, according to basic resident register annual report)
- Hachimantai City: 30,543 (as of March 31, 2008, according to basic resident register annual report)
- Shizukuishi Town: 18,906 (as of March 31, 2008, according to basic resident register annual report)
- Takizawa Village: 52,999 (as of March 31, 2008, according to basic resident register annual report)

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

- Towada Hachimantai National Park

  Number of sightseers: 159,504 (according to the “Table of Estimated Numbers of Sightseeing Location Visitors", 2009 Iwate Prefecture sightseeing statistic summary)

  Number of mountain-climbers: 26,986 (according to the 2001 survey by Iwate Prefecture Police Department)

③Facilities

- Hachimantai City:

  Iwatesan Volcano Disaster Prevention Information Station (Ihatove Volcano Station)

  Matsuo Hachimantai Visitor Center

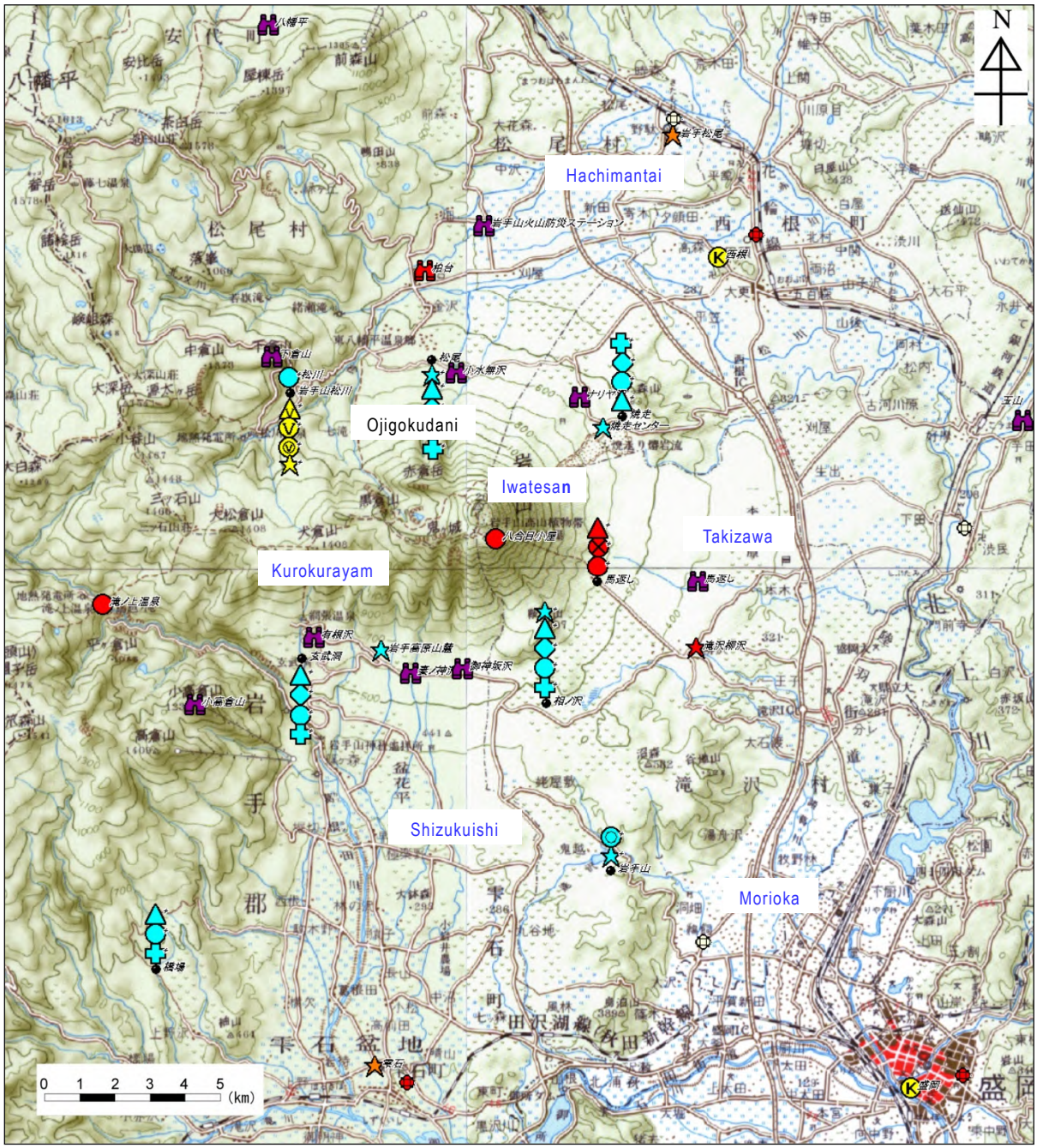
- Shizukuishi Town:

  Amihari Visitor 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 maps (Hirosaki, Hachinohe, Akita and Morioka) published by the Geospatial Information Authority of Japan were used.

Legend

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

(GSI)
- GPS

(NIED)
- V-net(SP)
- V-net(broadband)
- V-net(tiltmeter)
- K-NET
- GPS

(Tohoku Univ.)
- seismometer(SP)
- seismometer (broadband)
- GPS
- tiltmeter
- strainmeter
- thermometer

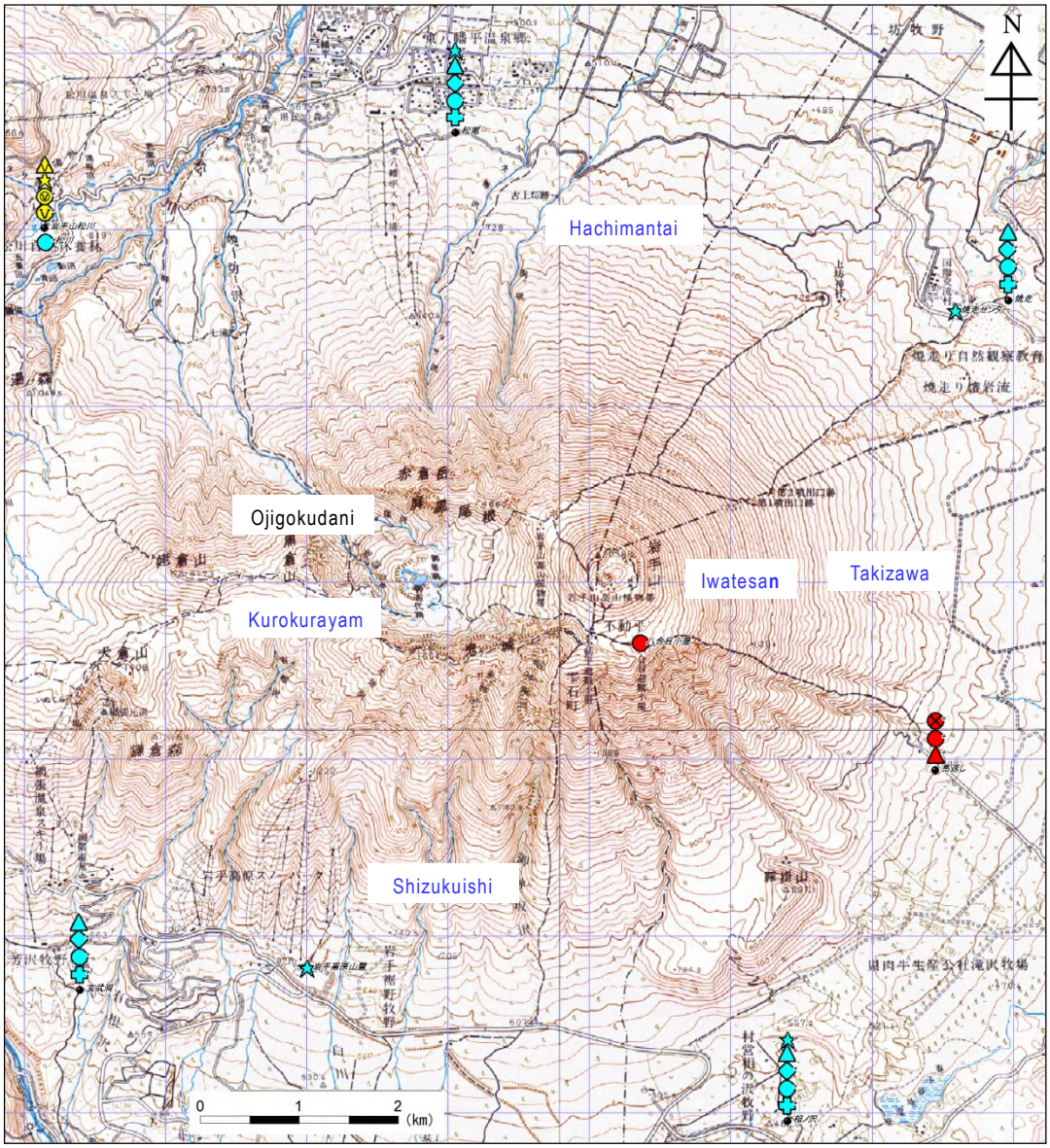
(Municipalities)
- seismic intensity meter

(MILT)
- visual camera

Figure 27-16 Regional 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 (Shizukuishi, Hachimantai, Morioka and Numakunai) published by the Geospatial Information Authority of Japan were used.

Legend

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

(GSI)
- GPS

(NIED)
- V-net(SP)
- V-net(broadband)
- V-net(tiltmeter)
- K-NET
- GPS

(Tohoku Univ.)
- seismometer(SP)
- seismometer (broadband)
- GPS
- tiltmeter
- strainmeter
- thermometer

(Municipalities)
- seismic intensity meter

(MILT)
- visual camera

Figure 27-17 Local monitoring network.

Bibliography

Doi, N. (2002) Report of CCPVE, **79**, 44-48 (in Japanese).

Doi, N. (2004) Report of CCPVE, **88**, 44-45 (in Japanese).

Itoh, J. (1998) Bull. Volcanol. Soc. Japan, **43**, 467-481 (in Japanese with English Abstract).

Itoh, J. and N. Doi (2005) Geological Map of Iwate Volcano, GSJ, AIST (in Japanese with English Abstract).

Miura, S. et al. (2000) Earth Planets Space, **52**, 1003-1008.

Nakamichi, H. et al. (2003) Geophys. J. Int., **154**, 811-828.

Nishimura, T. et al. (2000) J. Geophys. Res., **105**, 19135-19147.

Tanaka, S. et al. (2002a) Geophys. Res. Lett., **29**, 10.1029/2002GL014983.

Tanaka, S. et al. (2002b) J. Volcanol. Geotherm. Res., **113**, 399-414.

(Kawanabe, Y., and Ueki, S.)