

36. Bandaisan

Continuously Monitored by JMA

Latitude: 37°36'04" N, Longitude: 140°04'20" E, Elevation: 1,816 m (Bandaisan)
(Triangulation Point - Bandai)



Overview of Bandaisan, taken from the west side on September 21, 1984. Courtesy of Asia Air Survey Co., Ltd.

Summary

Bandaisan is located at the north of Lake Inawashiro, Fukushima Prefecture. It is an andesitic stratovolcano with a base diameter between 7 and 10 km, and a relative height of approximately 1 km. The Numanotaira crater is surrounded by peaks such as Akahaniyama, Obandai, and Kushigamine, forming a conical volcanic edifice. The current topography is the result of repeated collapses. The 1888 collapse and debris avalanche, caused by a phreatic eruption, is famous, but there are also debris avalanche deposits such as the Okinajima and Zunashi deposits to the southwest, and corresponding collapsed walls were identified in the volcanic edifice. The SiO₂ content is between 56.5 and 64.4 wt %.

Activity of Bandaisan can be divided into two stages, the old and new stages, separated by a period of inactivity (Yamamoto and Suto, 1996). Activity in the old-stage consisted mainly of the formation of Akahaniyama and Kushigamine. Activity in the new-stage included the formation of Kobandaisan, which collapsed in the 1888 eruption, and Obandaisan. During the new stage, Okinajima debris avalanche and pumice flow deposits deposited at the southern foot of the volcano (Chiba et al., 1994; Mimura and Endo, 1997). A volcanic edifice was formed again inside the horseshoe-shaped caldera left by the collapse. Major magmatic eruptions stopped several tens of thousands of years ago, after which activity shifted to phreatic eruptions (Chiba et al., 1994; Yamamoto and Suto, 1996).

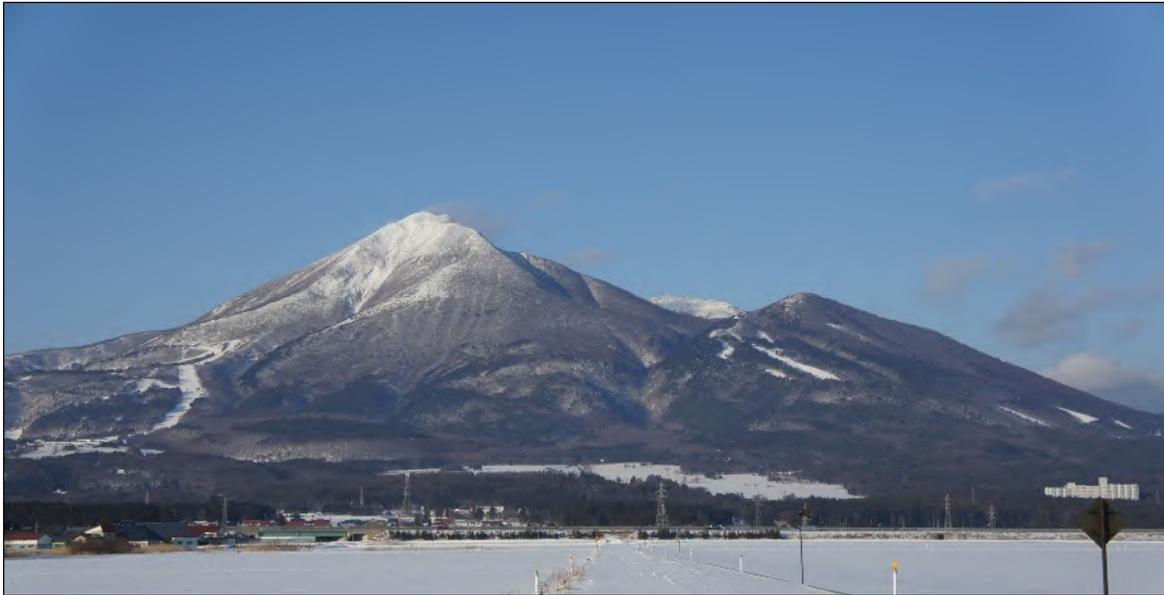
All eruptions within recorded history were phreatic. Detailed records are only available for the 1888 eruption. There are small fumaroles in the caldera wall were formed by the 1888 eruption, and the summit Numanotaira crater. A debris avalanche caused by the collapse of the caldera wall also occurred in 1936 and 1954 (Machida and Watanabe, 1988).

Bandaisan is also known as Aizu-Fuji.

Photos



North crater wall, taken from the north side on April 16, 2010 by the Japan Meteorological Agency.



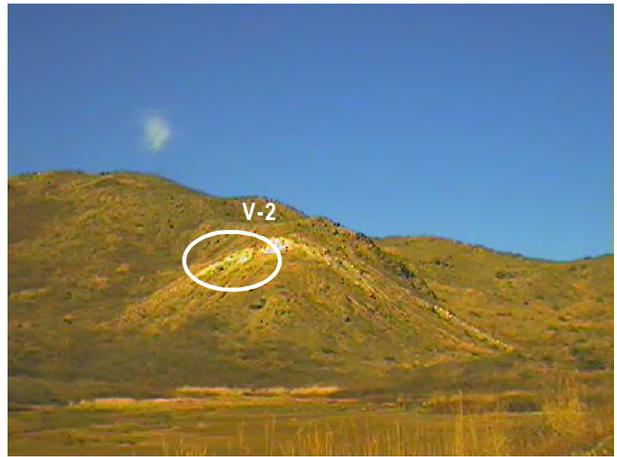
Overview of Bandaisan, taken from Inawashiro Town, southeastern side, on January 10, 2012 by the Japan Meteorological Agency.



Fumarolic area at the bottom of the crater wall, taken on October 5 2010 by the Japan Meteorological Agency.



Fumarolic area at the top of the crater wall, taken on October 5, 2010 by the Japan Meteorological Agency.



Numanotaira fumarolic area, taken on October 28, 2011 by the Japan Meteorological Agency.

Topography around the Crater

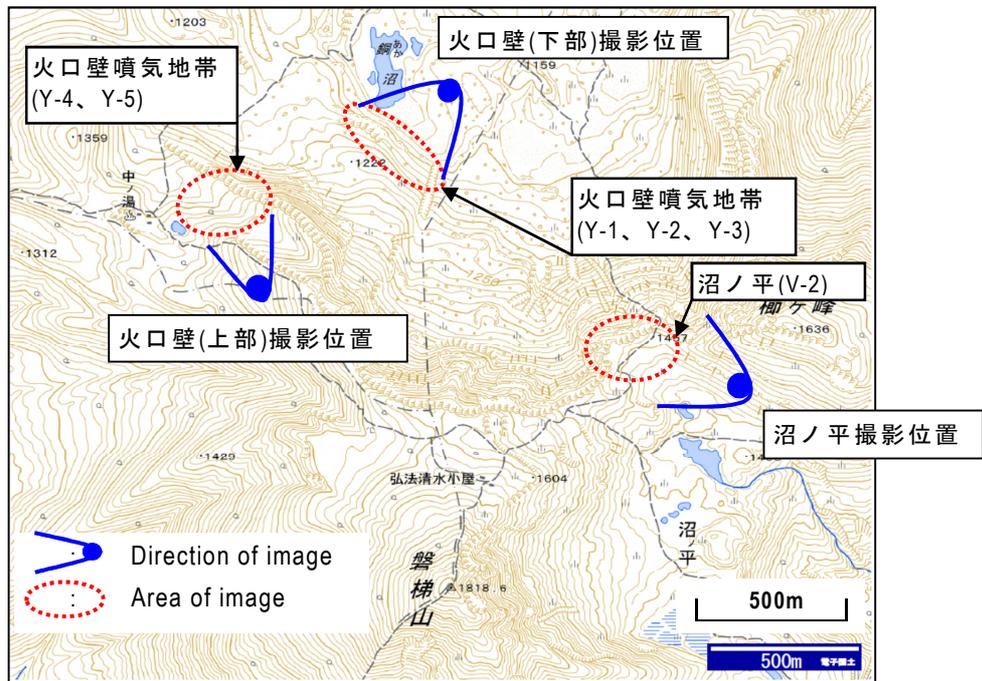


Figure 36-1 Topography around the 1888 crater.

The 1:25,000 Scale Digital Map (Map Image) published by the Geospatial Information Authority of Japan was used to create this map.

Red Relief Image Map

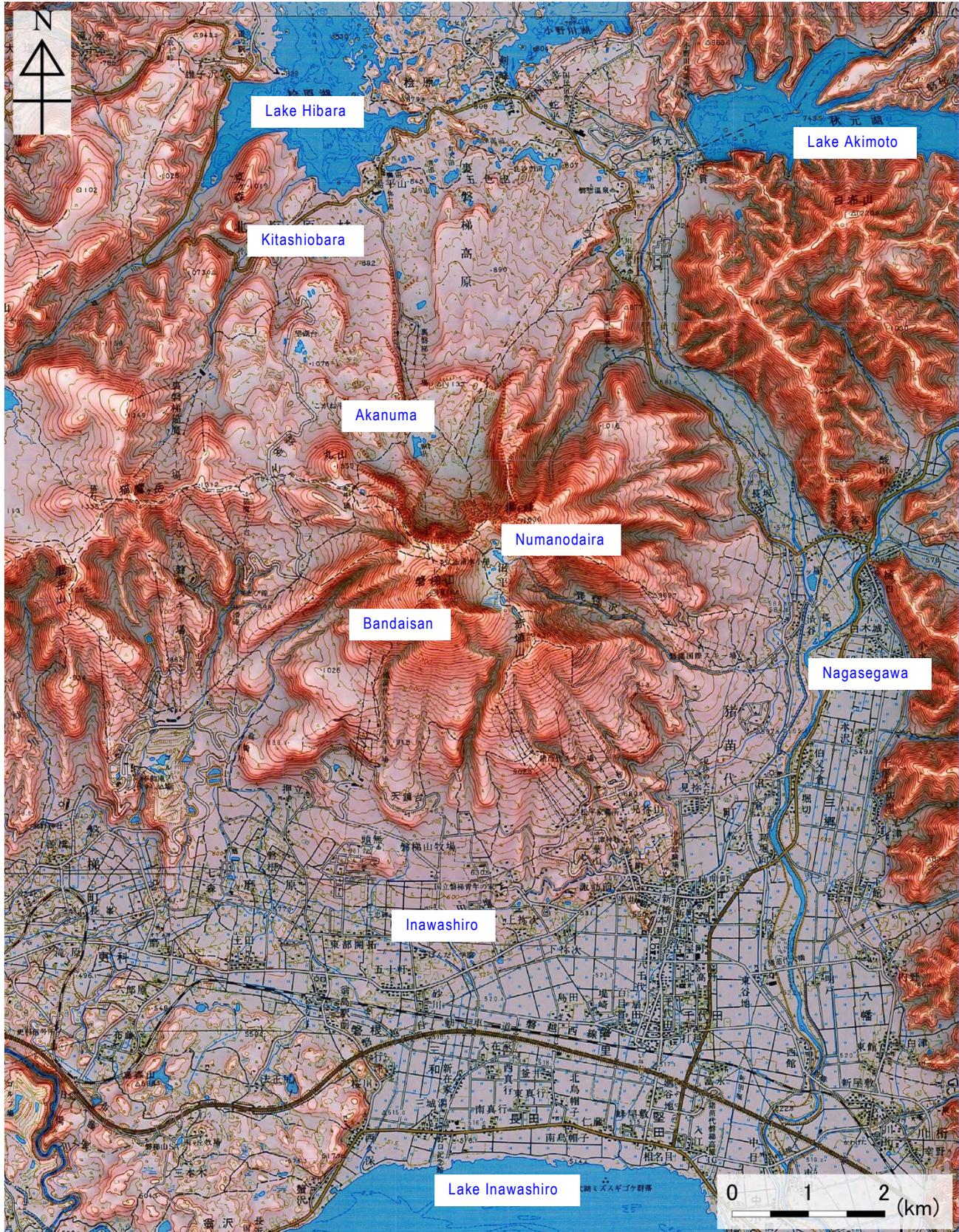


Figure 36-2 Topography of Bandaisan.

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

Geological Map

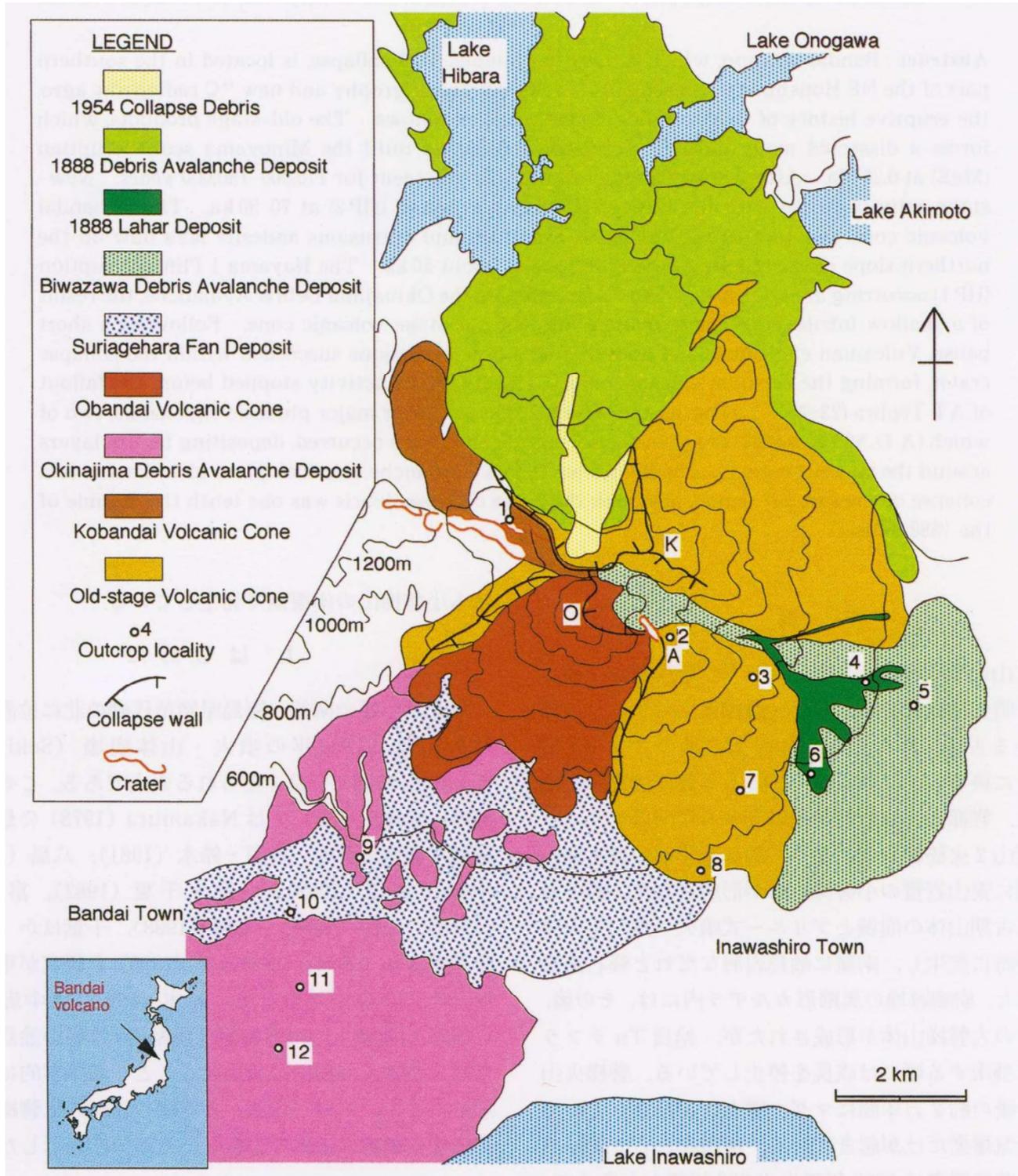


Figure 34-3 Simplified geological map of Bandaisan (Yamamoto and Suto, 1996). O: Mt. Obandai, A: Mt. Akahani, K: Mt. Kushigamine. The Okinajima Debris Avalanche Deposit includes an intercalated pumice flow deposit.

Chronology of Eruptions

▪ Volcanic Activity in the Past 10,000 Years

No magmatic eruptions at the Bandai volcano are recorded over roughly the past 25,000 years. All eruptions during that period were phreatic (Yamamoto and Suto, 1996). 4 phreatic eruptions have occurred, including the eruptions in 1888 and 806, within the past 5,000 years, as evidenced by their deposits. These eruptions were separated by intervals of between 1,100 and 1,700 years. In addition to the collapse in 1888, there was also another debris avalanche facing Biwazawa approximately 2,500 years ago.

Period	Area of Activity	Eruption Type	Main Phenomena / Volume of Magma
9.4ka		Magmatic eruption	Tephra fall.
8.3ka		Phreatic eruption	Tephra fall.
7ka		Phreatic eruption	Tephra fall.
6.6ka		Phreatic eruption	Tephra fall.
5.8ka		Phreatic eruption	Tephra fall.
5.4ka<	Biwazawa upstream area	(Collapse)	Kosuizawa debris avalanche.
5.4←→2.5ka	Numanotaira to NW flank?	Phreatic eruption	Tephra fall.
2.7←→2.5ka	Numanotaira to NW flank?	Phreatic eruption → (lahar production)	Tephra fall → lahar.
2.7←→2.5ka	Obandaisan east collapse wall and southeast side of Kobandaisan	(Collapse)	Biwazawa debris avalanche (0.1 km ³).

* 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<: Eruptive event before year A.

▪ Historical Activity

Year	Phenomenon	Activity Sequence, Damages, etc.
806 (Daido 2)	Phreatic eruption	Tephra fall. The eruptive activity occurred at the old crater on the east side of Obandaisan.
1643 (Kan'ei 20)	Rumbling?	
1655 (Meireki 1)	Rumbling?	
Approximately 1719 (Kyoho 4)	Eruption?	
Approximately 1787 (Tenmei 7)	Eruption?	
1888 (Meiji 21)	Moderate: Phreatic eruption (collapse, lahar)	July 15. Low temperature pyroclastic surge → debris avalanche → tephra fall, lahar. The eruptive activity occurred on the northern side of Obandaisan. It was preceded by several days by weak earthquakes. Rumbling began at approximately 7:00 and 3 strong earthquakes began at approximately 7:30. At approximately 7:45 an explosion occurred, accompanied by a loud boom, followed rapidly by 15 to 20 explosions, with the majority of Kobandaisan collapsing. At the same time, there was a blast (pyroclastic surge) and debris flow along Biwazawa, destroying a village at the southeast foot of the volcano. The explosion sound could be heard 50 to 100 km away, and tephra fall reached as far as the coast of the Pacific Ocean. A houseshoe-shaped crater opened to the north, and 1.5x10 ⁹ m ³ of deposits were distributed over an area measuring approximately 2.2 km east-west and 2 km north-south. A large debris avalanche (45 to 77 km/hour) occurred, burying 5 towns and 11 villages at the foot of the volcano, killing 461 people (alternatively reported as 477 people). It caused significant damage to houses, mountain forest land, and agricultural land, and dammed up rivers to create lakes, such as Lake Hibara. There were many subsequent lahar flows (volcanic lahar) afterward. (VEI 2)

Year	Phenomenon	Activity Sequence, Damages, etc.
1897 (Meiji 30)	Rumbling	July 5 to July 8.
1938 (Showa 13)	Debris avalanche	May 9 and 15. Crater wall collapse caused debris avalanche. The collapse extended approximately 3 km, with a surface area of over 2.3×10^5 m ² . Over the two days 2 people were killed, 5 people were injured, and 4 homes were swept away or partially destroyed.
1954 (Showa 29)	Crater wall collapse	April 3, 6, 7, 22, 24, 25, 29, May 5. The 1888 explosion crater wall collapsed.
	Earthquake	July 1 to 5.
1987 (Showa 62)	Earthquake	June. Maximum magnitude of M4.5. An earthquake swarm occurred, with its hypocenter near the western coast of Lake Inawashiro. 14 earthquakes felt at Wakamatsu City occurred between June 16 and the end of June. On November 8 there was an earthquake swarm in a nearby location, with a maximum magnitude of M4.3 and JMA scale seismic intensity of 4 at Wakamatsu.
1988 (Showa 63)	Earthquake	November to December. An earthquake swarm occurred, with its hypocenter near Numanotaira, at the summit of Bandaisan (maximum magnitude of M1.4).
2000 (Heisei 12)	Earthquake	From late April seismic activity increased in the summit area. On May 10 the first volcanic tremor since the observation began in 1965 was detected. On May 21 a M1.9 earthquake occurred. In August the number of earthquakes increased dramatically. On August 15 M2.1 and M2.4 earthquakes occurred, both registering a JMA scale seismic intensity of 1 in Jonan, Inawashiro Town. These were followed by frequent low-frequency and very-long-period earthquakes, and volcanic tremor with their hypocenters in shallow areas beneath the summit. No significant ground deformation corresponding to this seismic activity was observed, nor were changes in surface phenomenon observed.
2001 (Heisei 13)	Earthquake	Slightly high level of seismic activity. There continued to be low-frequency, very-long-period, and deep low-frequency earthquakes, as well as volcanic tremor with their hypocenters in shallow areas beneath the summit. The seismic activity dropped after May.

* 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 Activity

▪ July 15, 1888, Eruption

On July 15, 1888, a phreatic eruption caused a collapse of the north side of the volcano, including the summit of Kobandaisan. The debris avalanche created by this collapse caused severe damage. The explosion sound could be heard 50 to 100 km away, and ash fall reached as far as the coast of the Pacific Ocean. At the same time, there was a blast (pyroclastic surge) and debris flow along Biwazawa, destroying the village of Shibutani at the southeast foot of the volcano (Sekiya and Kikuchi, 1890; Yamamoto et al., 2000). Notable landforms created by this collapse and debris avalanche include the horseshoe-shaped caldera wall on the northern side of the summit (measuring approximately 2.2 km east-west and approximately 2 km north-south), as well as large and small lakes and marshes, and the hummocky topography of the Ura-Bandai Plateau, at the northern foot of the volcano, Hibara Lake, Lake Onogawa, and Lake Akimoto. There were many subsequent lahars (volcanic lahars) inside the explosion crater.

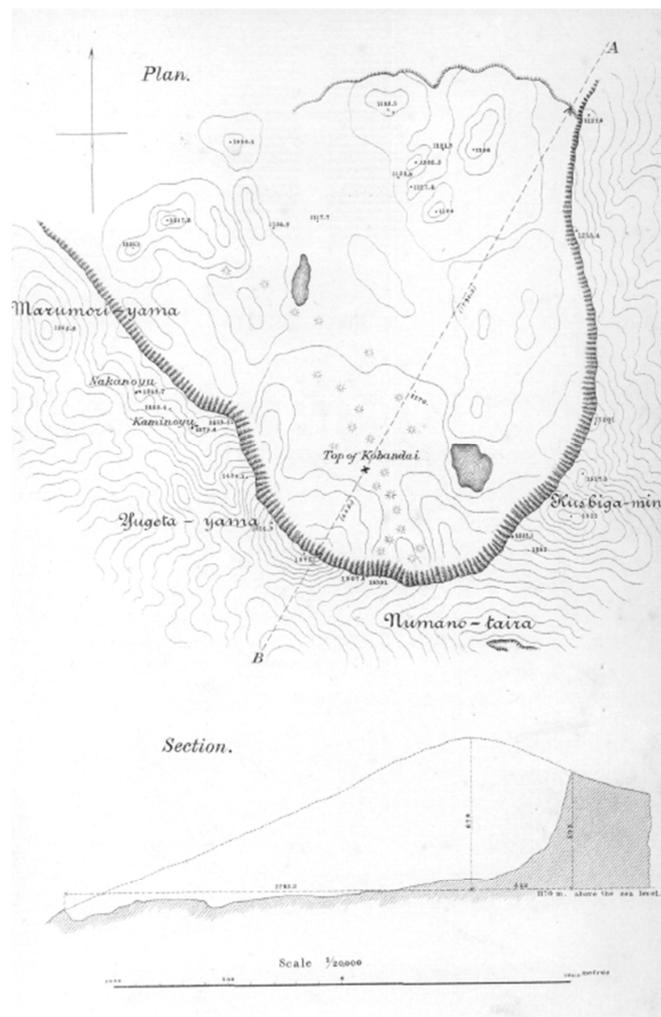


Figure 36-4 Topography of the crater area after the 1888 eruption (Sekiya and Kikuchi, 1890).



Figure 36-5 Shibutani village (located at the southeastern foot of the volcano), in which houses were destroyed and trees were knocked over by the blast (pyroclastic surge) which came down Biwazawa (Courtesy of the Archives and Mausolea Department, the Imperial Household Agency).

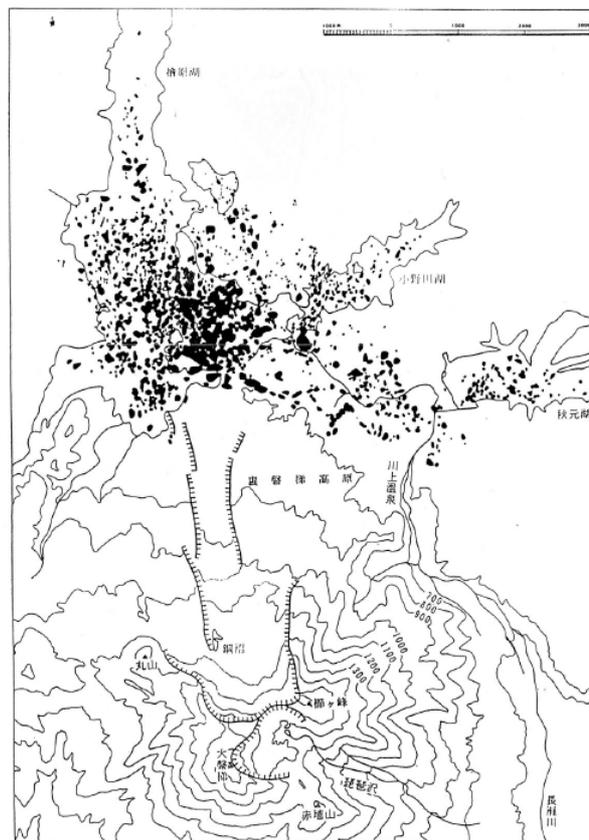


Figure 36-6 Distribution of hummocks caused by the 1888 collapse (Hoshino et al., 1995).

Subsurface Structure

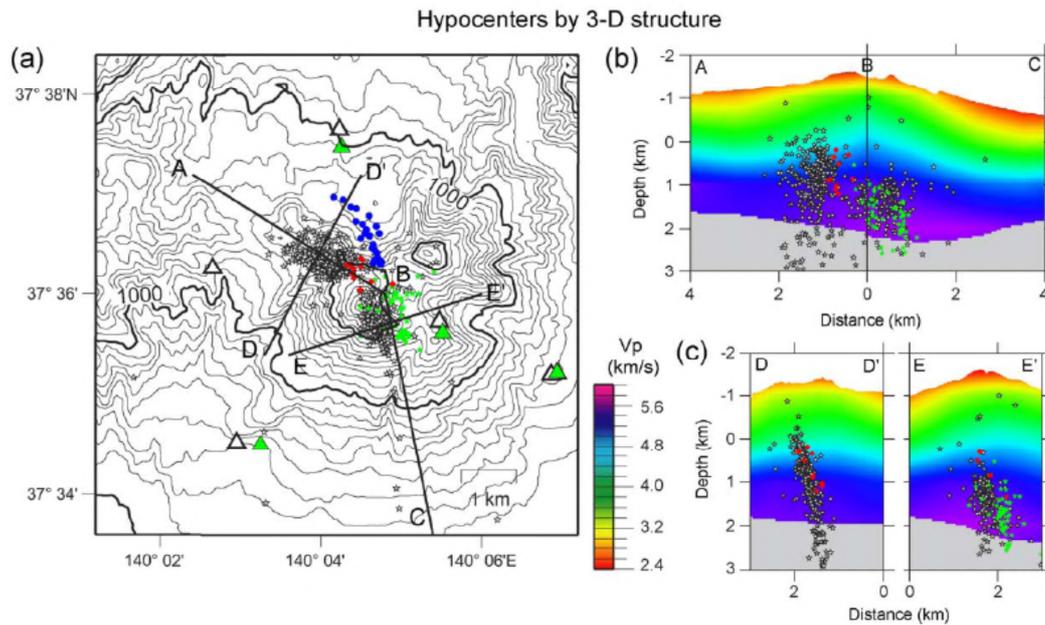


Figure 36-7 3-D P-wave velocity structure (color scale) revealed by a seismic exploration, and distribution of hypocenters determined by using the 3-D velocity structure (Yamawaki et al., 2004). Green stars: 1988 hypocenters. White stars: 2000 hypocenters. Red diamonds: Hypocenters of low-frequency earthquakes which occurred during the 2000 earthquake swarm. Green triangles: Earthquake observation points in 1988. White triangles: Earthquake observation points in 2000. Blue circles: Fumaroles observed after the 1888 eruption.

Recent Volcanic Activity

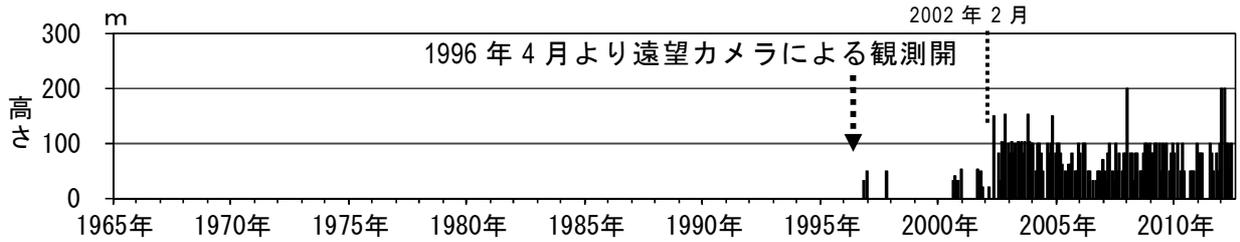


Figure 36-8 Temporal change in maximum fume height per month (April, 1996, to June, 2012).

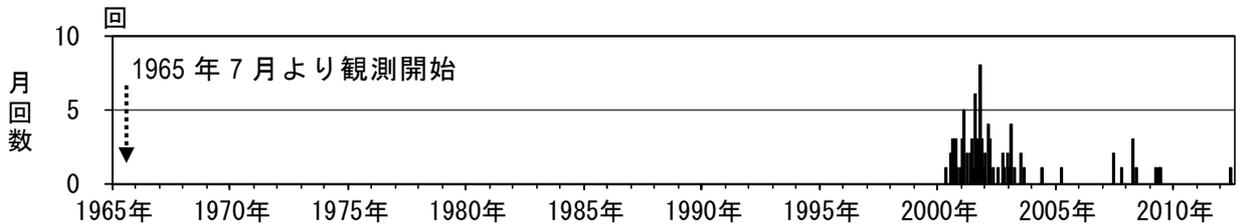
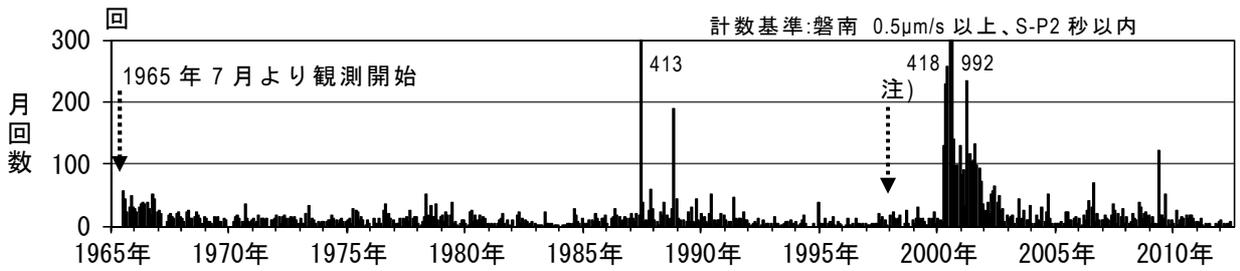
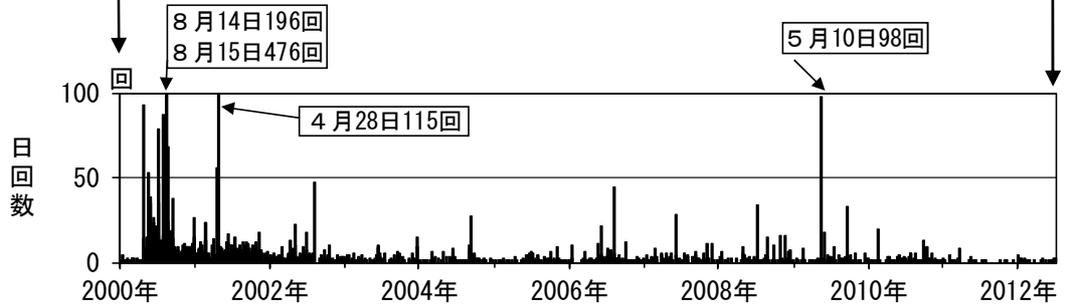
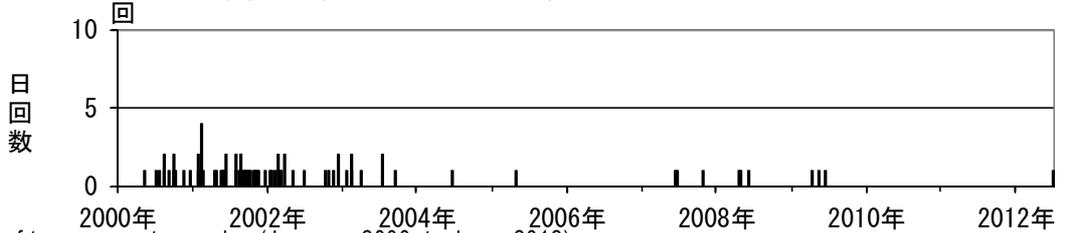


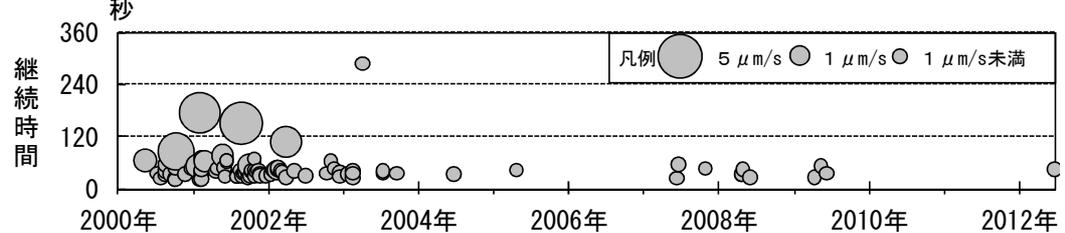
Figure 36-9 Seismic activity (July, 1965, to June, 2012). Monthly number of earthquakes (top) and tremor events (bottom).



① Number of earthquakes per day (January, 2000, to June, 2012)



② Number of tremor events per day (January, 2000, to June, 2012)



③ Tremor duration (vertical axis) and maximum amplitude (circle radius) (January, 2000, to June, 2012).

Figure 36-10 Recent seismic activity (January, 2000, to June, 2012).

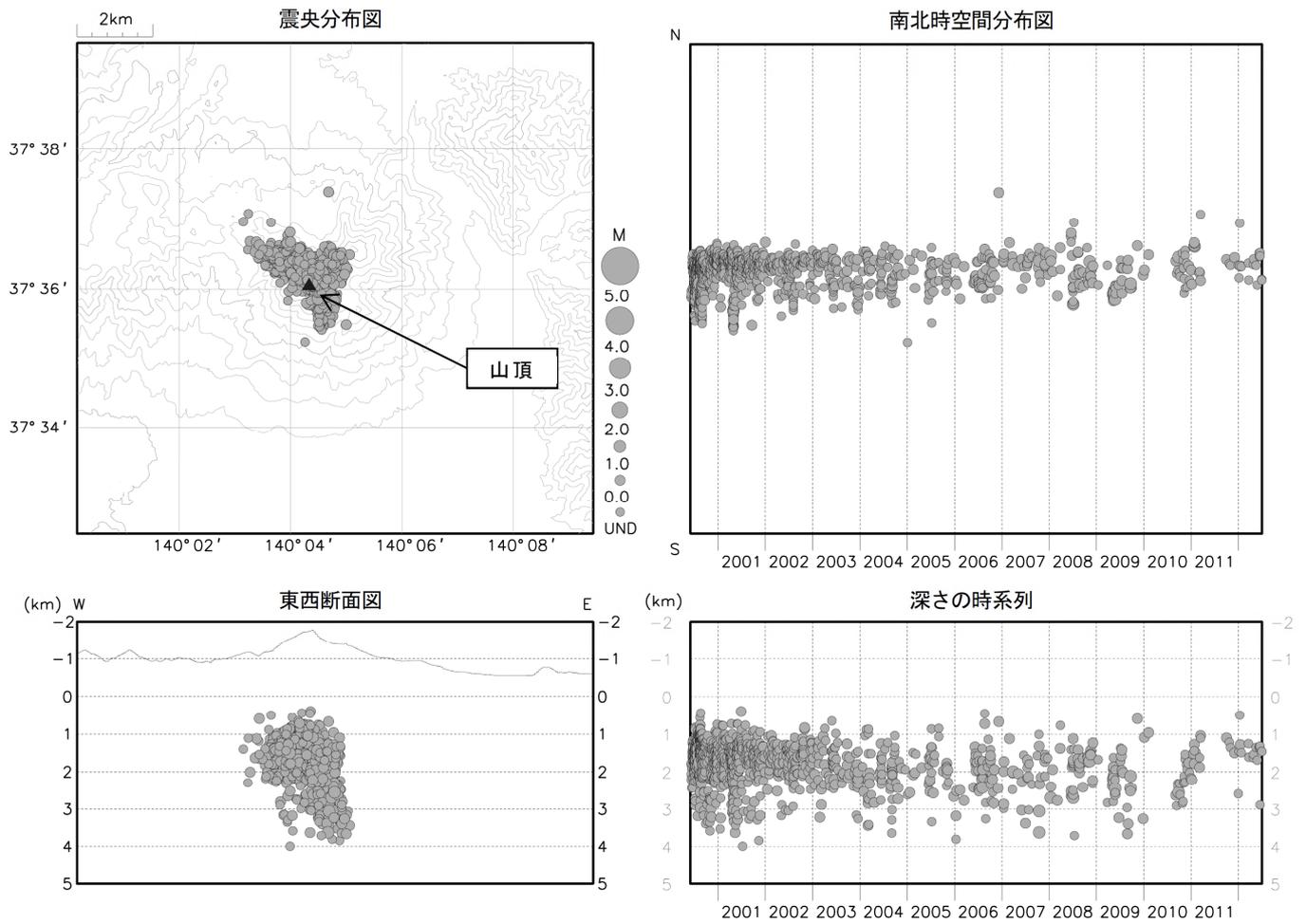


Figure 36-11 Distribution of volcanic earthquakes in and around the summit area (June 1, 2000, to June 30, 2012). Epicenter distribution (upper left), space-time plot in a N-S cross-section (upper right), hypocenter distribution in a E-W cross-section (lower left) and depth-time plot (lower right).

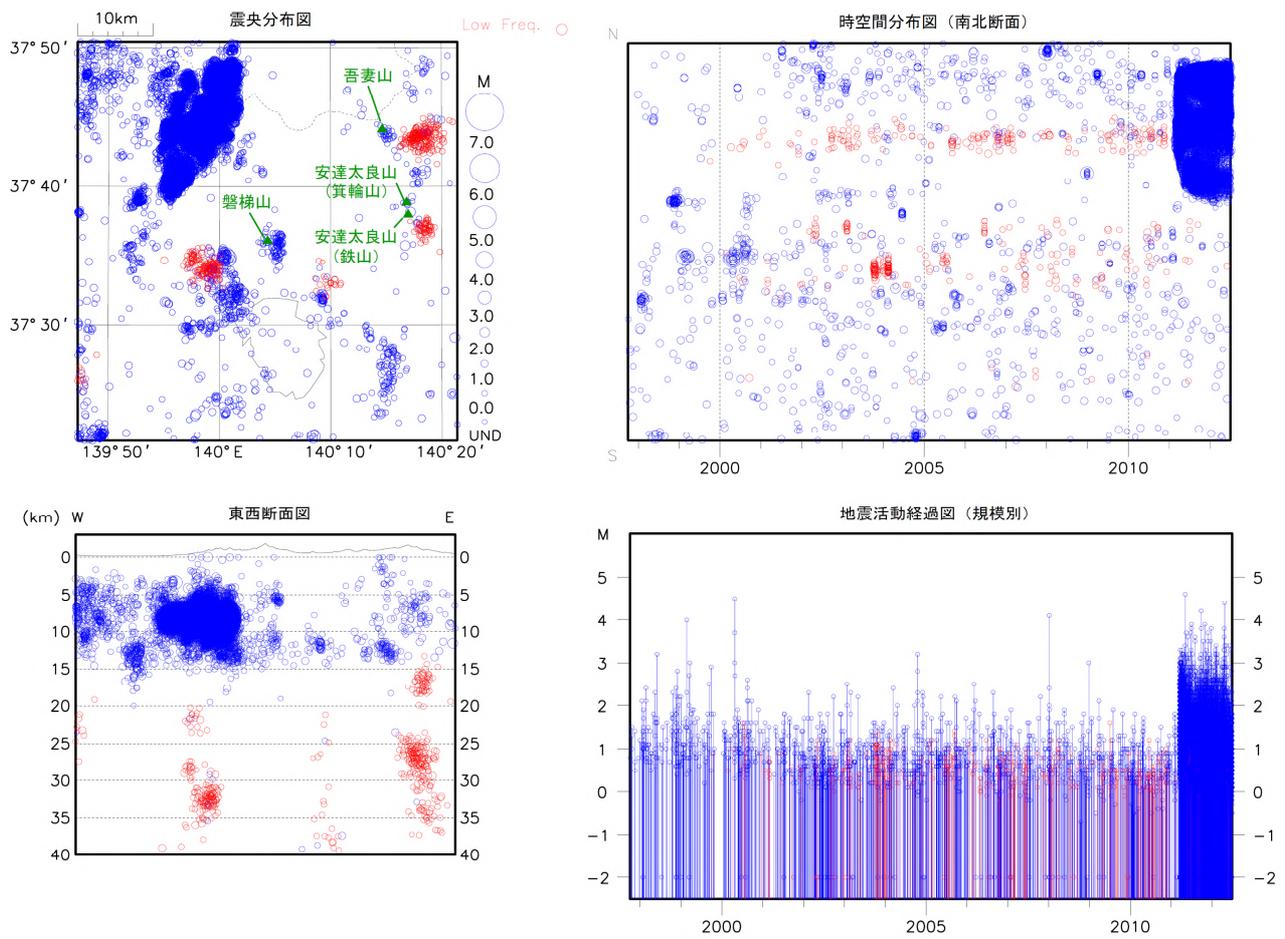


Figure 36-12 Activity of shallow VT earthquakes (blue circles) and deep low-frequency earthquakes (red circles) observed by a regional seismometer network (October 1, 1997, to June 30, 2012). Epicenter distribution (upper left), space-time plot (N-S cross-section) (upper right), E-W cross-section (lower left) and magnitude-time diagram (lower right).

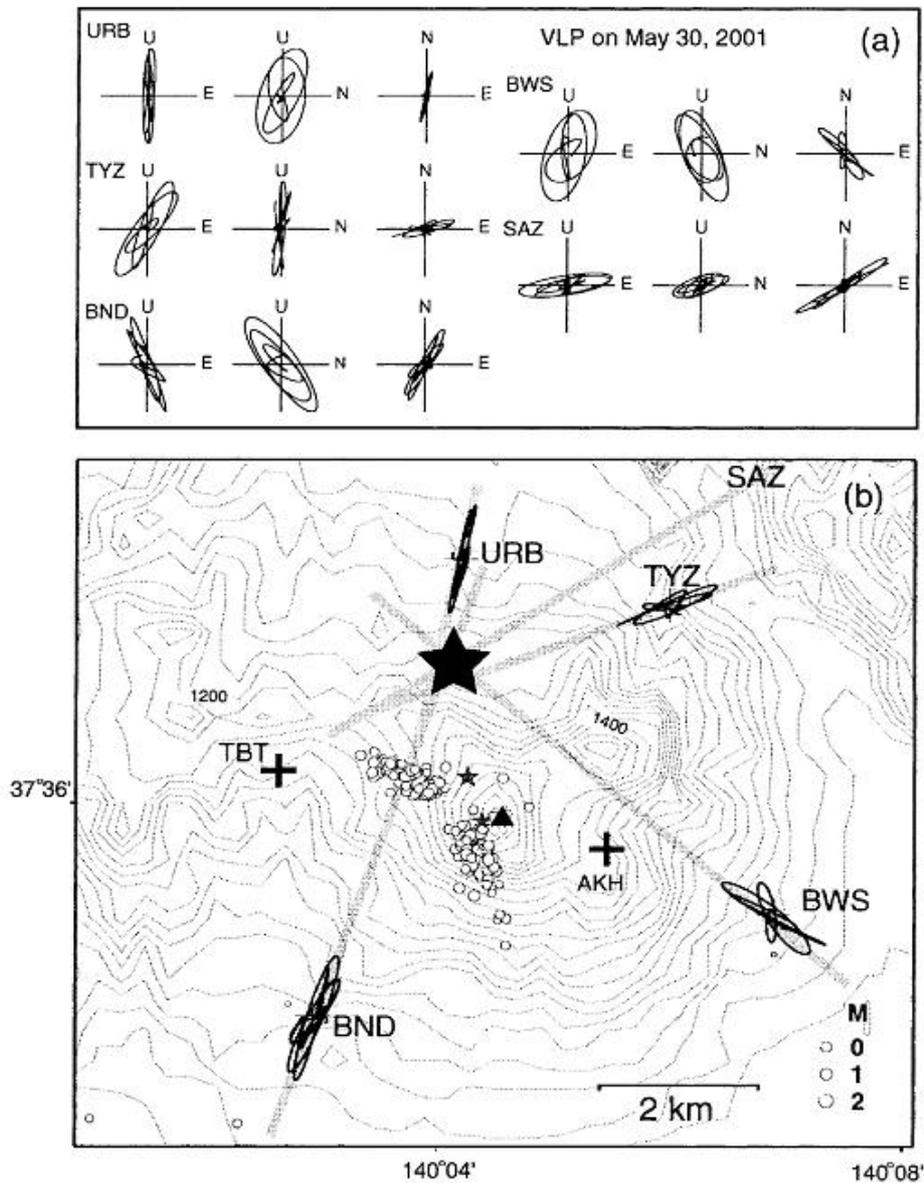


Figure 36-13 Hypocenter distribution observed during the unrest of 2000-2001 (Nishimura et al., 2002). (a) Very-long-period particle motions at 5 observation points, and (b) the epicenter of the very-long-period earthquake located from that particle motions (large star). The small stars indicate the epicenters of short-period earthquakes included within the very-long-period earthquake. The white circles indicate the epicenters of volcano-tectonic earthquakes occurring between January, 2000, and May, 2001. The epicenters of the short-period earthquake included within the very-long-period earthquake are located in the areas near the summit of Bandai where there are no volcano-tectonic earthquakes, and the epicenter of the very-long-period earthquake is estimated to be 1 km north of that area, below the horseshoe-shaped crater.

Information on Disaster Prevention

① Hazard Map

Bandaisan Volcano Disaster Prevention Map (Wide Area Version) May, 2001 (Revised January, 2012)

Published by Koriyama City, Aizuwakamatsu City, Kitakata City, Bandai Town, Kitashiobara Village, and Inawashiro Town.

Editorial supervision by the Bandaisan Volcano Disaster Prevention Coordinating Committee

Source: Bandaisan Volcano Disaster Prevention Map

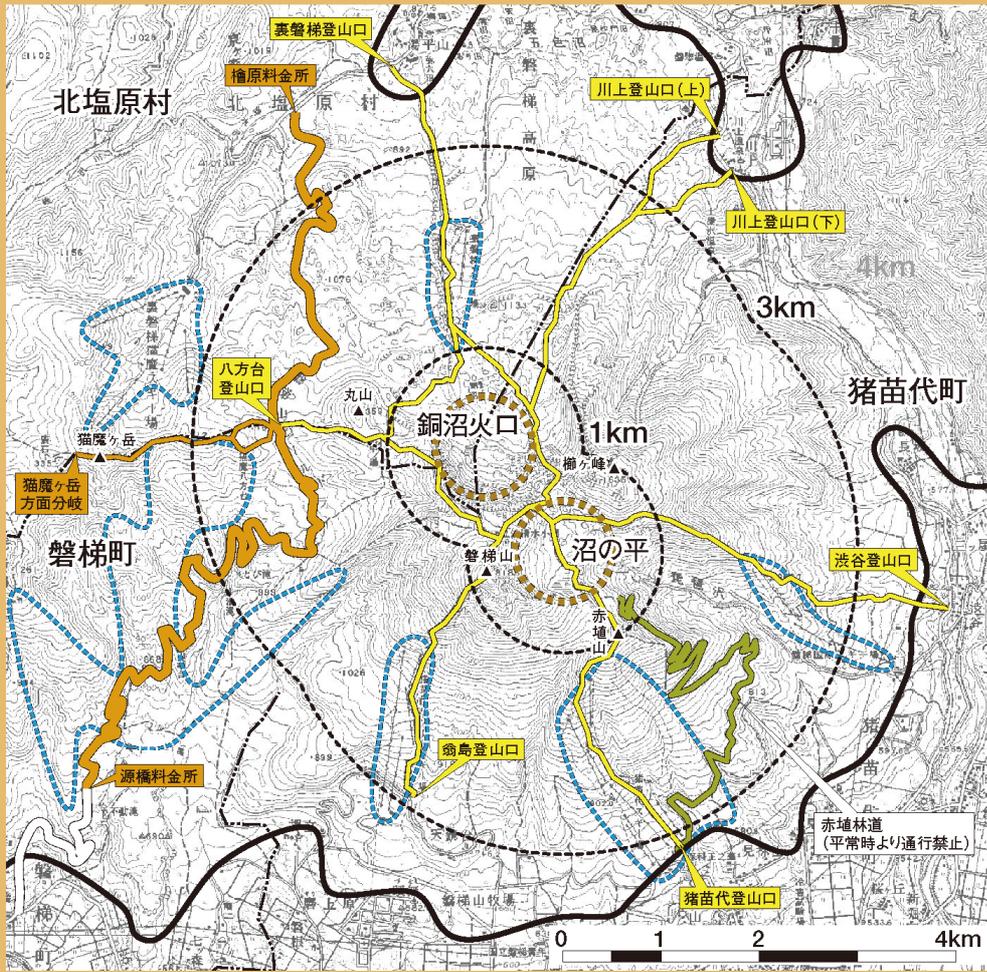
Published: May, 2001 (revised January, 2012)

Created by: Koriyama City, Aizuwakamatsu City, Kitakata City, Bandai Town, Kitashiobara Village, and Inawashiro Town

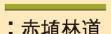
Editorial supervision: Bandaisan Volcano Disaster Prevention Coordinating Committee

UEL: <http://www.town.inawashiro.fukushima.jp/cb/hpc/Article-203-433.html>

■磐梯山の噴火警戒レベルと規制範囲



■磐梯山の火山活動
1888年に発生した水蒸気爆発により山体の北側が崩壊し、発生した岩屑なだれで山麓の村落が埋没し大被害を生じました。この噴火で460余名が犠牲になりました。

-  : レベル1の規制範囲
火口内等状況に応じて立入規制
-  : 登山道
レベル2で通行規制
-  : 登山道
レベル3で通行規制
-  : 赤埴林道
-  : 居住地域範囲
-  : スキー場

この図は、国土地理院「数値地図50000（地図画像）『福島』」を使用して作成しています。

- 噴火警戒レベルに応じて以下のような防災対応が必要になります。
- レベル5（避難）：危険な居住地域からの避難等。
 - レベル4（避難準備）：警戒が必要な居住地域での避難準備。
 - レベル3（入山規制）：想定火口から概ね3 km以内の立入規制
 - レベル2（火口周辺規制）：想定火口から概ね1 km以内の立入規制
 - レベル1（平常）：状況に応じて火口内等への立入規制

- 上の図は、噴火警戒レベルに応じた規制範囲等を示しています。レベル2で規制する登山道については、登山口において通行規制の対応がとられます。
- レベル4及びレベル5では、融雪型火山泥流による影響が想定される居住地域での防災対応が必要になります。
- 具体的な規制範囲や防災対応等については、地域防災計画等で定められています。詳しくは猪苗代町、北塩原村、磐梯町にお問い合わせください。

Volcanic Alert Levels for the Bandaisan Volcano (Valid as of March, 2009)

Warning and Forecast	Target Area	Levels & Keywords	Expected Volcanic Activity	Actions to be Taken by Residents and Climbers	Expected Phenomena and Previous Cases
Eruption Warning	Residential areas and areas closer to the crater	5 Evacuate	Eruption or imminent eruption causing significant damage to residential areas	Evacuate from the danger zone	<ul style="list-style-type: none"> ● Large eruption. ● Eruption or imminent eruption, with lahar by melted snow flow reaching residential areas. Past Examples None Expected Situations Moderate eruption like the 1888 phreatic explosion during winter when snow has accumulated
		4 Prepare to evacuate	Possibility of eruption causing significant damage to residential areas (increased probability).	Those within the alert area should prepare for evacuation. Those requiring protection in the event of a disaster must be evacuated.	<ul style="list-style-type: none"> ● Possibility of a large eruption. ● Possibility of melted snow volcanic lahar caused by eruption, extending to residential areas in the event of continuation of eruption. Past Examples None Expected Situations Moderate eruption like the 1888 phreatic explosion during winter when snow has accumulated.
Crater Area Warning	Non-residential areas near the volcano	3 Do not approach the volcano	Eruption or prediction of eruption causing significant damage to areas near residential areas (entering area is life threatening).	Residents can go about daily activities as normal. When necessary, evacuation preparations should be performed for those requiring protection in the event of a disaster. Access restrictions for dangerous areas, including mountain climbing and mountain access prohibitions, etc.	<ul style="list-style-type: none"> ● Moderate eruption, with scattering of volcanic blocks within a distance of approximately 3 km from the crater. Past Examples None <ul style="list-style-type: none"> ● Possibility of moderate eruption. Past Examples August 15, 2000: 403 earthquakes per day, felt-earthquakes, slight changes in GPS baselines, mountain access restrictions, Bandaisan Gold Line usage restrictions
	Crater area	2 Do not approach the crater	Eruption or prediction of eruption affecting area around crater (entering area is life threatening).	Residents can go about daily activities as normal. Access to crater area restricted, etc.	<ul style="list-style-type: none"> ● Small eruption, with scattering of volcanic blocks within a distance of approximately 1 km from the crater. Past Examples None <ul style="list-style-type: none"> ● Possibility of small eruption. Past Examples None
Eruption Forecast	Inside the crater	1 Normal	Little or no volcanic activity. Volcanic ash may be emitted within the crater as a result of volcanic activity (entering area is life threatening).	Access to interior of and area around crater restricted as necessary, etc.	Situation at present.

Note 1) The volcanic blocks mentioned in this table refer mainly to blocks large enough that their trajectories are not affected by wind.

Note 2) Level 3 restrictions include access restrictions on some roads.

Note 3) Craters refer to both the Numanotaira and the Akanuma area old craters.

Social Circumstances

① Populations

- Inawashiro Town: 16,075 (as of October 31, 2011)
- Bandai Town: 3,863 (as of November 1, 2011)
- Kitashiobara Village: 3,250 (as of November 1, 2011)

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

- Bandai-Asahi National Park - Bandaisan

Number of sightseers per year: 5,483,878 (according to Fukushima Prefecture sightseeing figures (2010) for Bandai and Inawashiro)

Number of mountain-climbers per year: 85,373

(according to Fukushima Prefecture sightseeing figures (2010) for Bandaisan from Inawashiro, Kitashiobara, and Bandai)

- Bandaisan area registered as "Japanese Geopark" in September, 2011.

③ Facilities

- Kitashiobara
 - Mt. Bandai Eruption Museum
 - Urabandai Visitor Center

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