Data Criteria

1. Definition of "Active Volcano"

In the past, "active volcano" was used in Japan to refer to volcanoes currently experiencing eruptions. Volcanos which have records of eruptions, but which currently have no eruptive activity, were called "dormant volcanoes". Volcanoes which have no records of eruptions were called "extinct volcanoes". However, volcano lifetime is long, and volcanoes which have not erupted currently may erupt in future. It is also difficult from a technical standpoint to clearly distinguish between "active volcanoes" and "dormant volcanoes", so instead of using the "dormant volcano" and "extinct volcano" categorizations, we consider all volcanoes with a possibility of eruption to be "active volcanoes". In 1968, the Guidelines for Volcanic Observations published by the Japan Meteorological Agency (JMA) contained a list of "Japanese Active Volcanoes". It contained summaries for 66 active volcanoes, excluding the northern territories. These included not only volcanoes for which eruption records exist, but also volcanoes which, although having no eruption records, were proven scientifically to have experienced eruptions within approximately the past 1,000 years, volcanoes which currently show fumarolic and geothermal phenomena, and volcanoes which occasionally exhibited volcanic anomalies such as fumarolic activity and earthquake swarms.

The first work performed by the Coordinating Committee for Prediction of Volcanic Eruption (CCPVE), established in 1974, was the publication of the National Catalog of the Active Volcanoes in Japan in 1975, for use as the basic data in eruption forecast research activities. This contained 77 volcanoes, including the northern territories. These were volcanoes "which have records of past eruptions, or which currently show fumarolic activity". The National Catalog of the Active Volcanoes in Japan published in 1984 was enriched in content, including volcano name changes, though the definition of active volcano and the number were not treated.

Research into ancient documents and volcanic studies such as geological surveys prompted the CCPVE to change the definition of "active volcano" to be "volcanoes which have erupted within approximately the past 2,000 years, or which are currently experiencing fumarolic activity". They designated 83 volcanoes as active volcanoes, publishing “National Catalog of the Active Volcanoes in Japan (Second Edition)” in 1991. In 1996, 3 volcanoes which meet these criteria (Rausudake, Hiuchigatake, and Kita-Fukutokutai) were added, bringing the number of active volcanoes to 86.

However, some volcanoes are known to have erupted after dormancy as long as several thousand years, and with advances in volcanology, it became generally accepted internationally to define active volcanoes as volcanoes which have erupted within the past 10,000 years. In January 2003, CCPVE changed the definition of "active volcano" to "volcanoes which have erupted within approximately the last 10,000 years, or which currently show fumarolic activity". With this definition, further 21 volcanoes were added, bringing the number of active volcanoes to 108, where two submarine volcanoes were redefined separately from single volcano and areas of 2 volcanoes were redefined.

As scientific papers showed that 3 volcanoes in Hokkaido (Tenchozan, Oakandake, and Fuppushidake) had erupted within the past 10,000 years, CCPVE inspected these 3 volcanoes and concluded in 2011 that they fit the criteria for active volcanoes. Tenchozan and Oakandake were designated as new, independent active volcanoes. On the other hand, Fuppushidake is adjacent to Tarumaesan, already designated as an active volcano, and, based on past eruptive activity trends, it was concluded that both volcanoes together comprise a single active volcano. Tarumaesan was included within Tarumaesan; the area of Tarumaesan was expanded. This brought the number of active volcanoes in Japan from 108 to 110. This Catalog contains these 110 active volcanoes.

2. Volcanic Numbers

As with “National Catalog of the Active Volcanoes in Japan (Third Edition)”, volcanoes have been numbered, roughly in order from north to south within the areas of Hokkaido, Tohoku, Kanto and Chubu, Izu Ogasawara, Chugoku, Kyushu, Okinawa, and the northern territories. Other than new 2 volcanoes indicated in section 1, the order is the same as in “National Catalog of the Active Volcanoes in Japan (Third Edition)”.

3. Volcano Names

As in “National Catalog of the Active Volcanoes in Japan (Third Edition)”, the place names (mountain and island names) indicated on maps published by the Geospatial Information Authority of Japan (GSI) had been used for volcanoes, though some consideration into local appellations was taken. Names ending by "san", “yama”, "dake" and “take” were kept, but ”san”, “yama”, “dake” and “take” were not appended to volcanoes which do not have appropriate peaks. English names in “Heights of 1003 Mountains in Japan (October 31, 2011 edition)”published by GSI, and “List of Volcanoes and their Activities Records in the Adjacent Seas of Japan, 4th Edition” published by the Japan Coast Guard were referred.

4. Volcano Latitudes, Longitudes, and Elevations (Depths)

The National Catalog of the Active Volcanoes in Japan (Third Edition) contained both global geodetic reference system and Japanese geodetic reference system positions, but this edition contains only the former.

Active volcano locations, latitudes, longitudes, and elevations (depths), were based on the highest points of each volcanic edifice. However, when there are triangulation points at positions of ongoing volcanic activity other than the highest point, these points were also listed.

Volcano latitudes, longitudes, and elevations were determined using the following procedure.

4-1. Volcanoes with their highest point on land (above sea surface)

(1) When the highest point was listed in “Heights of 1003 Mountains in Japan (October 31, 2011 edition)” published by GSI, the data contained therein was used.

(2) When the highest point was not listed in “Heights of 1003 Mountains in Japan”, triangulation point data for the highest point were used.

(3) When there were no triangulation points for the highest point, the position of the elevation point indicated as the highest point in the 1:25,000 topographic map published by GSI.

(4) Where the highest point is not clear in caldera and maar volcanoes, the position of the center of caldera or maar was measured using a 1:25,000 topographic map.

4-2. Volcanoes with their highest points below the sea surface

As a rule, the data contained in “List of Volcanoes and their Activities Records in the Adjacent Seas of Japan 4th edition”, published by the Japan Coast Guard, was used.

5. Explanations of Individual Items

The data for each volcano generally contain the following items. Their explanations and notes are indicated below.

5-1 Volcanic Numbers and Volcano Names (Japanese Names and English Names)

In June 2009, the CCPVE working group evaluated the medium-term possibility of eruption and its societal impact, and selected 47 volcanoes which require improved monitoring and observation systems. JMA specified these as "Continuously Monitored Volcanoes" in March 2011. These 47 volcanoes are marked as "Continuously Monitored

Volcano" below their names. Volcanic activity of Japanese volcanoes had been ranked based on past volcanic activity histories and types of eruption for the past 100 and 10,000 years. However, according to the discussion in CCPVE working group, the ranking became no longer used. For details, please refer to "Past Volcanic Activity Based Categorization (Ranking)" at the end of the Data Criteria section.

5-2 Volcano Location Maps

Each volcano was indicated with a red triangle, and nearby volcanoes are with smaller white triangles, to understand the relative positions each other.

5-3 Elevations (or Depths), Latitudes, Longitudes

These values were shown according to the procedure written above.

5-4 Photos

Photos of the volcano's panoramic view and crater areas with the surrounding areas taken from the air or from a distance were shown in the front page and following pages, respectively. Most of aerial photos were taken by JMA in cooperation with other related organizations*. The photograph directions, photographers, and dates are also indicated whenever possible.

* Ministry of Defense (Ground Self-Defense Force, Japan Maritime Self-Defense Force, and Japan Air Self-Defense Force), Ministry of Land, Infrastructure, Transport and Tourism (Hokkaido Development Office, Tohoku Regional Bureau, Kyushu Regional Bureau, and Maritime Safety Agency), National Institute of Advanced Industrial Science and Technology, Hokkaido Prefecture, Aomori Prefecture, Akita Prefecture, Iwate Prefecture, Miyagi Prefecture, Fukushima Prefecture, Tokyo Fire Department, Kagoshima Prefecture, Iwate Prefecture Police Department, Nagano Prefecture Police Department, City of Takayama, Fukushima Jododaira Astronomical Observatory, Hot Springs Research Institute of Kanagawa Prefecture, Asia Air Survey Co., Ltd.

5-5 Summary

This section contains information on topography, geology, rock chemistry, outline of activity history, fumarolic and geothermal activity, etc. It contains aspects pertaining to eruption history and characteristics from the perspective of disaster prevention, as well as additional volcano names, etc. SiO_2 content (wt.%), as a suggestive of magma property, is after the Committee for Quaternary Volcanoes in Japan Catalogue (1999).

5-6 Topography around the Crater

This section contains sketches of the crater area, distribution maps, etc.

5-7 Red Relief Image Map

This section contains red relief image maps (Chiba and Suzuki, 2007) which make it easy to understand the locations of volcanoes, and to make easy to read detailed topographical characteristics of volcanic edifice such as lava flows. For land volcanoes, 1:50,000-scaled topographic maps and digital map of 50m-grid in elevation, published by the Geospatial Information Authority of Japan, and aerial laser measurement data by Ministry of Land, Infrastructure, Transport and Tourism, were used. For submarine volcanoes, topographic maps from "List of Volcanoes and their Activities Records in the Adjacent Seas of Japan 4th edition", and "Basic Map of the Sea", published by the Japan Coast Guard, were used.

5-8 Geological Map

Geological maps published by the National Institute of Advanced Industrial Science and Technology (AIST), and basic maps of the sea, published by the Japan Coast Guard, are shown here. Additional detailed maps are provided by sources other than these when available.

5-9 Chronology of Eruptions

The past 10,000 years of volcanic activity history, as determined by geological research, was indicated here. The volcanic activity in past 10,000 years and volcanic activity within recorded history are listed separately.

5-9-1 Volcanic Activity in Past 10,000 Years

The volcanic periods, areas of activity, eruption types, main phenomena, and volume of magma were quoted from “Active Volcano Database of Japan” by AIST. Data for volcanoes not contained within “Active Volcano Database of Japan” was quoted from other references.

Popular names of eruptions and eruption products are also shown.

5-9-2 Historical Activity

The information contained in this section was taken from “Active Volcano Database of Japan” by AIST, “Quaternary Volcanoes in Japan Catalog”, “Sea Volcano Database” by the Maritime Safety Agency Hydrographic and Oceanographic Department, and volcanic activity records in ancient documents, as well as recent observation results. In addition to eruptions, activity such as increases in earthquakes and volcanic smoke production was also listed.

The purpose of this section is to provide a history of the volcanic activity and to list major historical records regarding volcanic activity. Therefore, even small activities are listed when they were documented, and abundant recording may not be equal to high activity of the volcano. In contrary, periods without any documentation do not necessarily indicate the absence of eruptions. Instead, it should be considered that volcanoes experienced many small but unrecorded eruptions. Do not use this section to perform simple comparisons of numbers of eruptions, or statistical inferences regarding eruption intervals. In addition to the information contained in ancient documents, we endeavored to add research results from geological surveys.

Observation data by JMA, etc. increased significantly from the Taisho era, so those of smaller events were listed. The number of events including small-scale volcanic phenomena, such as fumarolic and earthquake activities, has increased greatly over the past several decades; this merely reflects not elevation in activity but increased observation data with high measurement accuracy.

Other important notes are indicated below.

- We endeavored to gather multiple sub-events which are part of a single period of activity into a single event, but for readability reasons, items for activity during recent years have been written on a year-by-year basis as a general rule.
- Conversions from Japanese dates to Western ones have been performed using the Nihon Rekijitsu Genten (Uchida, 1975). Dates within sentences were converted to Western dates as a general rule.
- Eruptions were shown mainly as “large eruptions”, “small eruptions” and others (see 5-9-3(4)). The word "eruption" was used alone when the scale of the eruption was unknown. The common definition of "eruption" was used as a volcanic phenomenon which ejects solid material (volcanic ash, blocks, etc.) outside the crater, or which discharges molten material or lava.
- Earthquake activity: When possible, the magnitude and activity periods were indicated. The accuracy of

measurements by organizations such as JMA is increasing, and it has become possible in recent years to detect even minor activity, but it is difficult to apply uniform standards (magnitude, frequency, location, etc.), so only prominent earthquakes were listed. We endeavored to list the data of both distances from volcanoes and earthquake scales.

- Ejecta volume: We included ejecta volume materials determined by geological surveys. “Active Volcano Database of Japan” by AIST was used as a reference for ejecta volumes and VEI scales.
- Terminology within the “phenomena” column was made as uniform as possible.

5-9-3 Chronology of Eruptions

(1) Periods and Notation

The periods of eruption events within the past 10,000 years are indicated in "ka", Western dates, and Japanese dates. "ka" indicates "1,000 years ago". "1 ka" would mean "1,000 years ago". The year 2000 is set as 0 ka, and age calibration (described later) was performed. Western dates* in the Historical Activity sections consist of months, days, and years, while Japanese dates consist of years only.

* In accordance with recommendations by Hayakawa and Koyama (1997), the Julian calendar was used for dates up to October 4, 1582, and the Gregorian calendar for dates from October 15, 1582.

When a single eruption event spanned multiple years, the eruption period may be indicated as a span of years. The following notation was used to indicate this.

Period			Explanation
A	→	B	Indicates a continuous chain of eruption events beginning in year A and ending in year B.
A	←→	B	Eruption events taking place at some point between year A and year B
A	>		Eruption event after year A.
A	<		Eruption event before year A.
A	?		Eruption event apparently occurred in year A, but may have actually occurred in a different year.

(2) Basis for Deciding Periods

The periods were taken from ”Active Volcano Database of Japan” of AIST, records of eruptions from recent volcanic observations, and ancient documents. ”Active Volcano Database of Japan” of AIST determines the periods based on records, stratigraphy, radiocarbon dating, K-Ar periods, archaeological records, and topography. Refer to “Active Volcano Database of Japan” for details regarding how individual eruption periods were determined.

(3) Eruption Record Criteria

As written above, an eruption is the volcanic phenomenon which ejects solid material (volcanic ash, blocks, etc.) outside the crater, or which discharges molten material or lava, though JMA also wrote it as an eruption events that solid material or ejecta was discharged over 100 to 300m vertically or horizontally from the emission point. However, smaller phenomena are sometimes included as eruption too, such as mud eruptions at Asosan.

(4) Eruption Scales

In publishing the Fourth Edition, we organized the eruption scale notation used by JMA in all the past eruptions within the historical record.

The accumulated weight (in tons) or magma discharge volume (km^3 DRE)*1 of air-fall tephra, pyroclastic flows, pyroclastic surges, lava flows, lava domes, etc. was used for the ejecta amount. When only volume of ejecta was shown in the references, the volume was recalculated into the weight by assuming densities 1.0 for ejecta and 2.5 for lava. When eruptive activity continued over a long period of time, the total amount of ejecta has been used. For an eruption involving a sector collapse, care must be taken when categorizing eruptions based on total ejecta volume including collapse volume.

When the amount of ejecta is shown in "Active Volcano Database of Japan" of AIST, it was used with the VEI.

*1 Magma discharge (km^3 DRE)

Total amounts of ejecta produced by magmatic eruptions or phreatomagmatic eruptions were converted into the equivalent magma volumes.

*2VEI (Volcano Explosivity Index)

Table 1 VEI (Volcano Explosivity Index) Definitions

Volcano Explosivity Index (VEI)	0	1	2	3	4	5	6	7	8
Scale	Non-explosive eruption	Small	Moderate	Somewhat large	Large	Extremely large			
Tephra Volume (m^3)	10^4	10^6	10^7	10^8	10^9	10^{10}	10^{11}	10^{12}	

From Newhall and Self (1982).

* The VEI is used to estimate the scale of an eruption based on the amount of air-fall tephra, but it must be noted that amounts of lava flow and dome are not involved.

The eruption scales contained herein, based on the amount of ejecta and VEI, are categorized as below.

Very small-scale: Less than 10^4 tons (generally VEI 0:non-explosive)

Small-scale: 10^4 to 10^6 tons (generally VEI 1: small)

Moderate: 10^6 to 10^8 tons (generally VEI 2 or 3: moderate or relatively large)

Large: 10^8 tons or more (generally VEI 4: large or greater)

The relationship between the ejecta volumes (VEI) and the scales of eruptions categorized above is shown below.

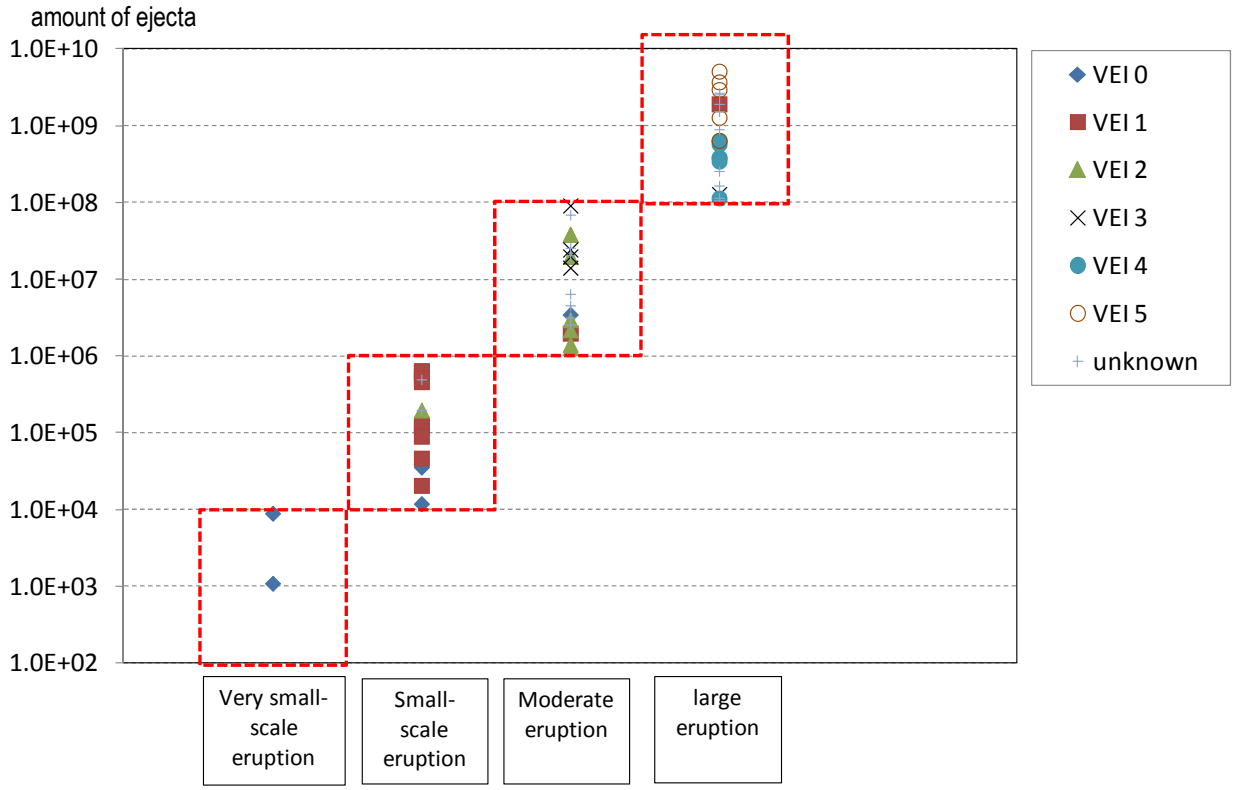

Figure 1 Notations of eruption scales based on ejecta volume categorization

5-10 Whole Rock Chemical Composition

This section contains figures showing the chemical compositions of rocks for each volcano (major elements).

5-11 Period - Cumulative Magma Volume

This section shows the diagram showing eruption times and cumulative volume of erupted magma. It is useful to evaluate the magma discharge rates in the past or future.

5-12 Major Eruptive Activity

On the eruptions which occurred in recorded history, results of data analysis by JMA and other organizations, eruption photos, etc. are shown here for major eruption events within the past 100 years.

5-13 Precursory Phenomena

This section contains findings regarding precursor phenomena observed before eruptions at the 47 continuously monitored volcanoes discussed in 5-1. This includes not only recent instrument measurements, but also refers to historical documentation. In some cases, it also includes anomalous phenomena which did not culminate in eruptions.

5-14 Recent Volcanic Activity

This section contains figures and eruptive activity data, etc. from scientific papers, CCPVE materials, CCPVE reports, etc.

In the hypocenter distributions indicated in the form of "Earthquake activity near XX (October 1997 to June 2012)", etc., blue and red circles indicate high-frequency earthquakes, and red circles indicate deep low-frequency earthquakes.

These earthquake activity diagrams also indicate very minor earthquake activity, such as volcano-tectonic earthquakes around the volcano, from October 1997, based on the processing results (hypocenter data) using the data received by JMA from universities and related organizations*3 such as the National Research Institute for Earth Science and Disaster Prevention (NIED) in accordance with “Act on Special Measures for Large-Scale Earthquakes”. It is noted that data exchanging condition*4 in the high sensitivity earthquake measurement network (Hi-net) by NIED, which includes relocation and elimination of observation points, generate different detection capabilities for very-small earthquake in each volcanic region and period.

*3 As of August 2004 (GSI, Hokkaido University, Hirosaki University, Tohoku University, University of Tokyo, Nagoya University, Kyoto University, Kochi University, Kyushu University, Kagoshima University, National Research Institute for Earth Science and Disaster Prevention, National Institute of Advanced Industrial Science and Technology, Japan Agency for Marine-Earth Science and Technology, Aomori Prefecture, the city of Tokyo, Shizuoka Prefecture, Hot Springs Research Institute of Kanagawa Prefecture, and the city of Yokohama

*4 Use of Kinki, Chugoku, Shikoku, and Kyushu area Hi-net began officially from October 1, 2000.
Partial use of Hokkaido, Tohoku, Kanto, and Chubu area Hi-net began officially from October 1, 2001.
In addition to the small amount of Hi-net data from the Kanto and Chubu areas, used in advance by the Sendai and Osaka areas, usage began of all remaining observation points from the end of 2001.

5-15 Information on Disaster Prevention

5-15-1 Hazard Map

This section contains representative hazard maps for individual volcanoes which were issued by local municipalities with information regarding publishing dates, publishers and editors, and websites.

Maps which could not be included herein are contained on the attached DVD.

5-15-2 Volcanic Alerts and Volcanic Alert Levels

(1) Volcanic Alerts

In order to reduce eruption damage, JMA issues volcanic alerts and forecasts for all 110 active volcanoes in Japan, based on measurement, observation, and evaluation results. Volcanic alerts are issued when a volcanic event (phenomena, such as volcanic block ejection, pyroclastic flows, melted snow volcanic lahar, etc., which would reach from craters to residential areas in a short amount of time, leaving little or no time for evacuation) which would present danger to human lives is forecast to occurs or expand, and clearly indicates alert areas (areas in which there is a danger to human life).

When the alert area is limited to the crater area, the alert is issued as a "Volcanic Alert (Crater Area)" (sometimes shortened to "Crater Area Alert"). When the alert area includes residential areas, the alert is issued as a "Volcanic Alert (Residential Area)". When the alert is for a submarine volcano, the alert is issued as a "Volcanic Alert (Surrounding Sea Area)". These volcanic alerts are issued to the media and related prefectural organizations, as well as being immediately issued to residents. "Volcanic forecasts" are issued when volcanic alerts are released, etc.

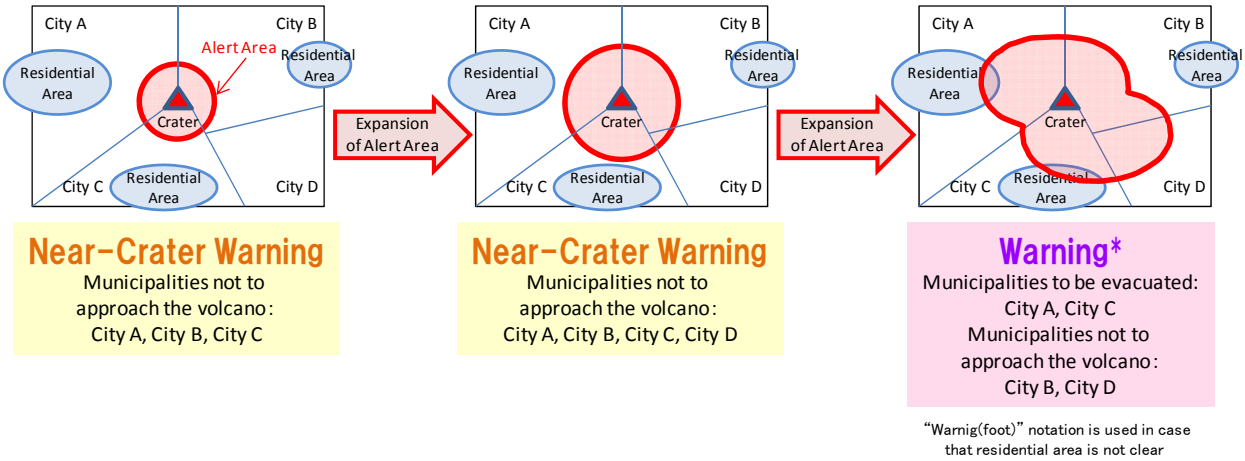

Figure 2 Relationship between alert areas and volcanic alerts

(2) Volcanic Alert Levels

Volcanic alert levels are used to indicate what actions should be taken by disaster prevention organizations and residents, considering hazard areas based on the status of ongoing volcanic activity. They are divided into five levels: "Evacuate", "Prepare to Evacuate", "Do Not Approach the Volcano", "Do Not Approach the Crater", and "Normal".

Based on the nationwide Disaster Prevention Master Plan and Guidelines for Volcano Disaster Prevention Systems for Evacuations in the Event of Eruptions, the individual prefectures in which volcanoes are located have established volcano disaster prevention committees (composed of personnel from prefectures, cities, meteorological observatories, Sabo Department, and volcano specialists, etc.) which jointly consider eruption evacuation plans in advance. As a result of these joint considerations by the volcano disaster prevention committees, evacuation initiation timing and evacuation areas are decided based on volcanic activity conditions. Volcanic alert level usage is implemented for volcanoes, for which alert areas and disaster prevention response measures had been decided for individual alert levels in the regional disaster prevention plans of individual cities and prefectures.

JMA clearly defines alert areas for volcanoes for which volcanic alert levels are used, based on criteria agreed in advance in volcano disaster prevention committees. They add the corresponding volcanic alert levels to these alert areas, issuing volcanic alerts and forecasts integrated with local evacuation plans. City disaster prevention organizations can quickly implement disaster prevention measures and countermeasures, such as volcano access restrictions and evacuation recommendations, for areas agreed in advance, thereby, it is expected to minimize damages from eruptions.

Table 2 Volcanic Alerts and Volcanic Alert Levels

Abbreviated Term	Target area	Levels & Keyword	Explanation		
			Expected volcanic activity	Action to be taken by inhabitants	Action to be taken by climbers
Warning	Residential areas	Level 5 Evacuate	Eruption that may cause serious damage in residential areas, or imminent eruption.	Evacuate from the danger zone. (Target areas and evacuation measures are determined in line with current volcanic activity.)	
		Level 4 Prepare to evacuate	Possibility or increasing possibility of eruption that may cause serious damage in residential areas.	Prepare to evacuate from alert areas. Let disabled persons evacuate. (Target areas and evacuation measures are determined in line with current volcanic activity.)	
Near-crater Warning	Non-residential areas near the crater	Level 3 Do not approach the volcano	Eruption or possibility of eruption that may severely affect places near residential areas (threat to life is possible in these areas).	Stand by, paying attention to changes in volcanic activity. Let disabled persons prepare to evacuate in line with current volcanic activity.	Refrain from entering the danger zone. (Target areas are determined in line with current volcanic activity.)
	Around the crater	Level 2 Do not approach the crater	Eruption or possibility of eruption that may affect areas near the crater (threat to life is possible in these areas).	Stay as usual.	Refrain from approaching the crater. (Target areas around the crater are determined in line with current volcanic activity.)
Forecast	Inside the crater	Level 1 Normal	Calm: Volcanic ash emissions or other related phenomena may occur in the crater (threat to life is possible in these areas).		No restrictions. (In some cases, it may be necessary to refrain from approaching the crater.)

The following points must be noted when using volcanic alert levels.

- Some volcanic eruptions may occur without any anomalies being observed, and level announcements are not always raised or lowered in a linear fashion.
- The volcanic activity conditions, areas for which individual eruption disaster prevention response measures are to be implemented, and specific response measures vary from region to region.
- Close attention must also be paid to phenomena which are not included in the scope of volcanic alerts, such as debris flows caused during times of rain. Close attention must be paid to other information, such as information regarding heavy rains, etc., as well.

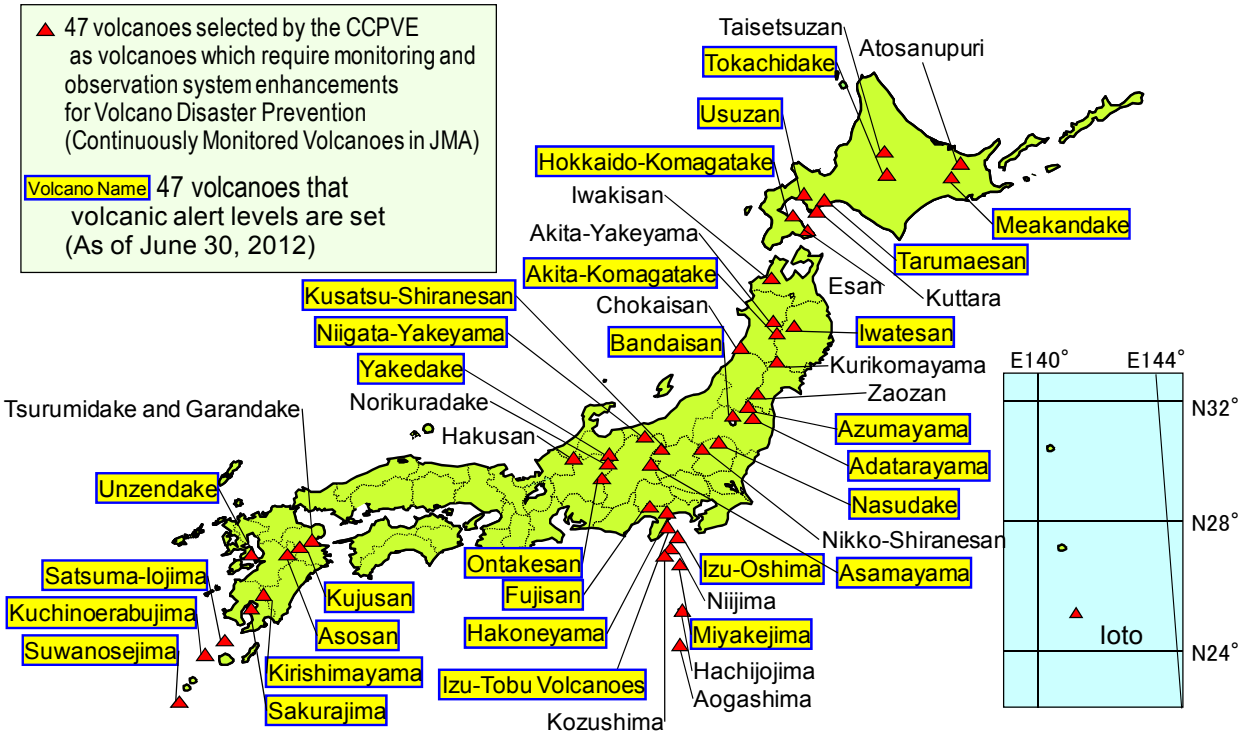

Figure 3 Volcanoes for which volcanic alert levels are used (as of June 30, 2012)

Volcanic alert levels are, as of April 2012, adapted to 29 of 47 volcanoes selected by the CCPVE as volcanoes which require monitoring and observation system enhancements. In the future, volcanic alert levels (who to evacuate, from where and when) will be set or revised together with local organizations in conjunction with considerations of evacuation plans (who should evacuate, from where and when, to where, and in what way) by local volcano disaster prevention committees, for the other volcanoes as well.

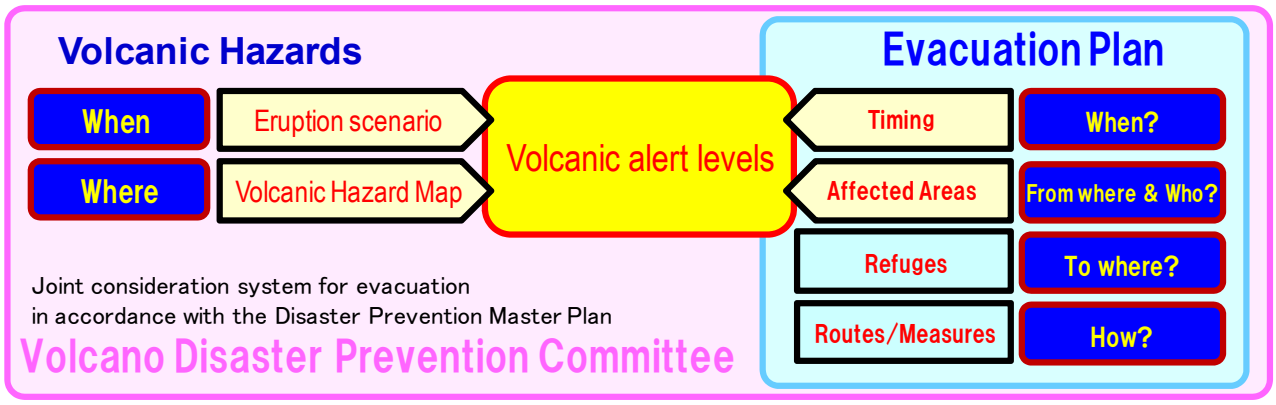

Figure 4 Relationship between volcano disaster prevention committees, evacuation plans, and volcanic alert levels, in accordance with the Disaster Prevention Master Plan

5-16 Social Circumstances

5-16-1 Populations

This section contains the recent information on national parks, geoparks and climbers.

5-16-2 National Parks, Quasi-National Parks, Number of Climbers

This section contains the most recent information on national parks, geoparks and climbers. Territories designated as Japanese Geoparks or Global Geoparks as of September 2012, are also listed.

5-16-3 Facilities

This section contains the names of volcano related facilities, such as museums and commemorative halls, other than local public organizations and national organizations. Facilities are listed for each municipality.

5-17 Monitoring Network

This section contains maps of observation points in the monitoring networks for each volcano. These maps are based on materials acquired by monitoring and research organizations. Detailed maps show the areas where a large number of observation points were installed near the crater, as of June, 2012.

The map also includes observation points of high sensitivity earthquake monitoring network (Hi-net) of NIED in accordance with the objectives of “Act on Special Measures for Large-Scale Earthquakes” and “Earthquake Versatile Observation Systems” of JMA to enable it to issue earthquake information announcements, together with volumetric strainmeters installed in order to predict earthquakes in the Tokai area, etc.

Although GEONET (GNSS Earth Observation Network System) of GSI was renamed the GNSS Earth Observation Network System in April 2012, the name of "GPS" was still used in this catalogue.

Names of some observation points such as electronic distance measurement points were omitted here.

Observation points with multiple measuring devices located in the same place were indicated with small black circles. As a general rule, types of instruments are indicated above the observation points, identified by different symbols and

colors.

The attached DVD contains detailed information (observation point name, location, measurement type, measuring organization, etc.) for each observation point for each volcano except the seismic intensity.

It must be noted that some observation points established by university research organizations are temporary to use for researches on volcano eruption forecasting, so that those observation points and specifications may be changed or eliminated.

For detailed information regarding individual observation points, please inquire with the corresponding organization.

1:200,000 regional maps and 1:50,000 topological maps published by GSI were used to show these monitoring networks.

5-18 Bibliography

This section contains references from which figures and tables in the Summary and other sections were quoted.

6. Materials

Calderas in Japan

Caldera volcanoes have activity lifetimes far longer than 10,000 years, and it is not appropriate to judge the activity only based their volcanic histories within the past 10,000 years. As caldera-forming eruptions may have occurred in cycles of several tens of thousands of years, so a list of large calderas which were formed within roughly the past 200,000 years was appended.

Fatalities in Japan

This section contains eruptions which produced fatalities or serious damages on constructions and others. The Fourth Edition listed up major volcano disasters from the year 1600, for which there are comparatively detailed records in ancient documents, etc., and incidents of volcanic gas which resulted in multiple deaths from 1950 onwards.

7. Appendices

The appendices contain the following materials, as supplements to the text, figures, and tables of the body of the Catalog.

- **List of Active Volcanoes in Japan**
- **List of Volcanic Observation Points**

The contents of this Catalog are, as a general rule, current as of June 30, 2012, but more current information has been provided when available for highly active volcanoes. For the latest volcanic activity data, and new discoveries regarding past volcanic activity as a result of new research, please consult the JMA website (http://www.jma.go.jp/jma/index.html).

In addition to the reference documents listed on the last page of each volcano, the following documents were also referred to in the creation of this Catalog.

Seismological and Volcanological Section, Observations Department, Japan Meteorological Agency (1959) Japanese Eruption Bulletin, p. 348

Japan Meteorological Agency (1975) National Catalog of the Active Volcanoes in Japan, p. 119.

Japan Meteorological Agency (1984) National Catalog of the Active Volcanoes in Japan, p. 482.

Japan Meteorological Agency (1991) National Catalog of the Active Volcanoes in Japan (Second Edition), p. 483.

Japan Meteorological Agency (1996) National Catalog of the Active Volcanoes in Japan (Second Edition), p. 500.

Japan Meteorological Agency (2005) National Catalog of the Active Volcanoes in Japan (Third Edition), p. 635.

CCPVE Working Group (2009) Selection of volcanoes which require monitoring and observation system enhancements in order to evaluate the medium and long-term potential for eruptions, 635p.

Please contact JMA and its Volcanological Division in Volcanological Department with any question and requests regarding the content of this Catalog.

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Hayakawa, Y. and Koyama, M. (1997): Jour. Geography (Chigaku Zasshi), **106**, 102-104 (in Japanese).

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[Appendix] Past Categorization (Ranking) Based on Level of Volcanic Activity

In January 2003, the CCPVE published active volcano rankings consisting of the 10,000-year activity index, and the 100-year activity index, by categorizing active volcanoes based on geological analysis on the past volcanic activities.

This active volcano ranking defined the 100-year activity index, based on detailed observation and measurement data gathered systematically over the past 100 years, and the 10,000-year activity index, based on the history of major eruptions (activity frequency, eruption type, and activity type) over the past 10,000 years, which are recorded geologically.

Volcanoes were divided into three ranks, A, B, and C. Rank A is for a volcano with particularly high 100-year activity index (>5) and/or particularly high 10,000-year activity index (>10).

Rank B is for a volcano, except Rank A volcano, with high 100-year activity index (>1) and/or high 10,000-year activity index (>7).

Rank C is for a volcano not ranked as A and B and with low 100-year and 10,000-year activity indices.

There was insufficient data to rank submarine volcanoes and volcanoes in the northern territories, so they were not ranked.

it is noted that this ranking was performed based on the past volcanic activity mainly evaluated geologically, and not on how imminent eruptions were. Peripheral societal factors were also not taken into consideration.

* Evaluating Levels of Volcanic Activity

The levels of volcanic activity were expressed as follows.

(level of volcanic activity) = (activity frequency) x (eruption scale) x (activity type)

As the eruption frequency and eruption scale can vary in orders among eruptions, a common logarithm expression of the above formula was employed to represent the activity index. That is,

$$(\text{activity index}) = \log_{10}(\text{activity frequency}) + \log_{10}(\text{eruption scale}) + \log_{10}(\text{activity type})$$

- **10,000-Year Activity Index**

In order to assess the level of volcanic activity within roughly the past 10,000 years, the following 3 items were identified and added to calculate the 10,000-year activity index.

10,000 year activity index = activity frequency index + eruption scale index + activity type index

Activity frequency index

Evaluation of eruptive activity frequency: 0.5 was added for each of the following periods during which there was eruptive activity: the past 300 years, the past 1,000 years, the past 3,000 years, and the past 10,000 years.

Eruption scale index

This is the Volcano Explosivity Index of the largest eruption within the past 10,000 years.

Activity type index

The following scores were assigned for eruptions whose impact extended to the foot of volcano, based on the strength of the eruption phenomena, such as the speed of ejections, the amount of area affected, and the temperature of the ejecta (Table 1).

Pyroclastic flow/surge: 3, Sector collapse: 3, lahar: 2, phreatomagmatic eruption: 2, lava flow: 1. In order to place greater emphasis on the eruptive activity within the past 1,000 years, activity period was divided into two, which occurred 1,000 years ago or older and within the past 1,000 years. The maximum value for the eruption phenomena was treated as the point for each period. The value for the activity period older than

1,000 years ago is multiplied by 0.5, and the value for the past 1,000 years was multiplied by 1. The greater of the two resulting figures was used as the activity type index.

・100-Year Activity Index

In order to assess the level of volcanic activity within the past 100 years, the following 3 terms were identified, and added to produce the 100-year activity index. Here, the activity type could be replaced with the degree of volcanic anomalies, not limited to just eruptions, but also including, for example, increases in amount of volcanic smoke.

100-year activity index = 100-year activity frequency index + 30-year activity frequency index + 100-year eruption scale index

100-year activity frequency index

This is a common logarithm of the total number of years that eruptions or volcanic anomalies were observed + 1, based on observation data for the past 100 years.

30-year activity frequency index

This is a common logarithm of the total number of years that eruptions or volcanic anomalies were observed + 1, based on observation data for the past 30 years, during which a greater amount of observation has been available. 1 is added before taking the common logarithm when there has been fumarolic activity.

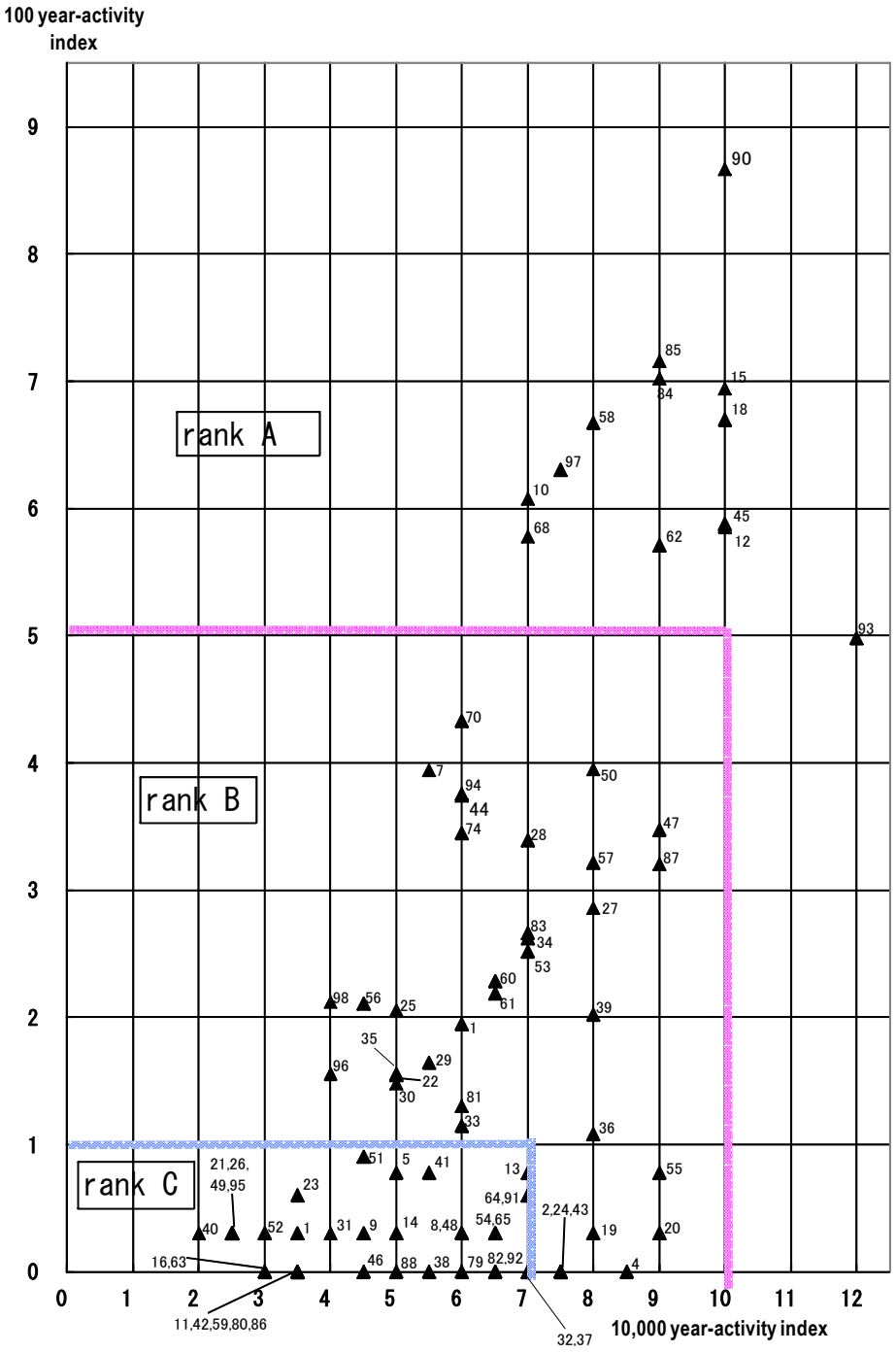
100-year eruption scale index

This is the common logarithm of the total volume of ejecta (in 10,000m^3 unit) over the past 100 years.

Table 1 Average Ejecta Movement Speeds, Effect Areas, and Ejecta Temperatures for Each Activity Type

Activity Type	Ejecta Moving Speed	Effect Area	Ejecta Temperature
Pyroclastic Flow / Pyroclastic Surge	20 to 30m/s	5 to 20km^2	600 to 700°C or less
Sector Collapse			
Volcanic Lahar	3 to 10m/s	5 to 20km^2	100°C or less
Lava Flow	5m/s or less	2km2 or less	750 to 1150°C

Partially revised from Blong (1984). This table indicates average values, and individual events may fall outside these ranges.



* The numbers to solid triangles indicate the volcano numbers which are shown in the List of Active Volcanoes in Japan.

Rank A volcanoes with particularly high 100-year activity indices and/or particularly high 10,000-year activity indices
Rank B volcanoes with high 100-year activity indices and/or high 10,000-year activity indices
Rank C volcanoes with small activity indices
(Note) Submarine volcanoes and volcanoes in the northern territories are not ranked, and not shown above.
This ranking was done based on the volcanic activity mainly evaluated geologically, and not on how imminent eruptions were.

The following organization name abbreviations are used in the National Catalog of the Active Volcanoes in Japan (Fourth Edition).

AIST	National Institute of Advanced Industrial Science and Technology
AVL	Institute for Geothermal Science, Graduate School of Science, Kyoto University
CCPVE	Coordinating Committee for Prediction of Volcanic Eruption
DPRI	Disaster Prevention Research Institute, Kyoto University
ENV	Ministry of the Environment
ERI	Earthquake Research Institute, University of Tokyo
GSH	Geological Survey of Hokkaido, Hokkaido Research Organization
GSI	Geospatial Information Authority of Japan (after April, 2010) Geographical Survey Institute (before April, 2010)
HSRI	Hot Springs Research Institute of Kanagawa Prefecture
JCG	Japan Coast Guard (after April 2002; Maritime Safety Agency (before April 2002))
JMA	Japan Meteorological Agency
KMO	Kakioka Magnetic Observatory, JMA
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
NIED	National Research Institute for Earth Science and Disaster Prevention
UVO	Usu Volcano Observatory, Hokkaido University
VFRC	Volcanic Fluid Research Center, Tokyo Institute of Technology