Recent Volcanic Disaster Countermeasures Taken by GSI

Geographical Survey Institute

1. Volcanic Activities in Japan

There are 108 active volcanoes or 10% of world's active volcanoes in the Japanese archipelago. It means that Japan is one of the world's major volcanic countries. Geographical Survey Institute (GSI) and related organizations monitor and study for volcanic eruption prediction.

We experienced volcanic disasters at Mt. Unzen Fugen in 1990, Mt. Usu and Mt. Oyama in Miyake Island in 2000. (Fig.1)

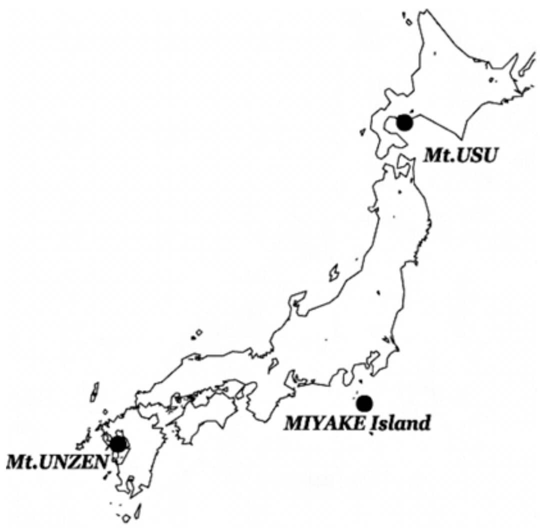

Fig. 1

GSI was newly decided by the Prime Minister in 2001 as one of the "Designated Administrative Organs" pursuant to the Disaster Countermeasures Basic Act and expected more involvement in disaster prevention from the survey and cartographic field.

2. Countermeasures against eruption of Mt. Usu

2.1. Summary

Increasing volcanic earthquakes were observed in Mt. Usu from the morning of March 27, 2000 and then the mountain erupted at the western piedmont around 13:07 of March 31. An emergency volcanic alert announced before the eruption, resulted in quick evacuation of residents and no human damages though as many as 6,874 families or 15,815 people evacuated by orders.

The area around Mt. Usu has regained normal life and revival plans are going on aiming at "coexistence with the volcano".

2.2 Countermeasures taken by GSI

GSI set up the Mt. Usu Volcanic Disaster Taskforce headed by Director General and on-site branch headed by Director of Hokkaido Regional Survey Department on March 29. The taskforce conducted crustal deformation monitoring such as GPS continuous observation and leveling, and topographic monitoring such as aerial photography and on-site emergency survey. (Fig.2)

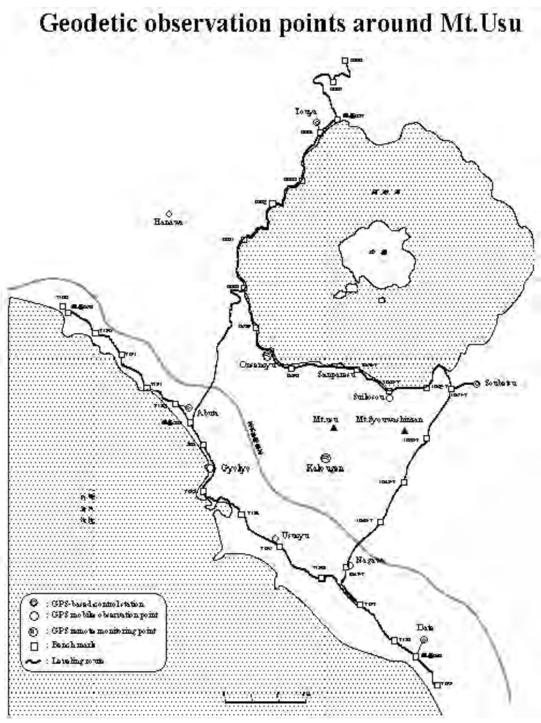

Fig. 2

2.3 Crustal Deformation Monitoring

2.3.1 Monitoring by GPS-based Control Station Networks

GSI usually conducts baseline analysis for GPS-based Control Stations once a day using dataset for 24 hours. We shifted it to the emergency baseline analysis which was conducted every 3 hours using dataset for 6 hours at 3 GPS-based Control Stations of Sobetsu, Abuta and Date around Mt. Usu,

In order to understand changes in the shape of the mountain caused by its active volcanic activity that had been observed from March 27.

<Pre-Eruption Monitoring>

Monitoring results before 6 a.m. March 30 showed that baselines between 3 GPS-based Control Stations extended approximately 1 cm and the mountain swelled due to its uprising magma.

Monitoring results before 6 a.m. March 31 showed further 1 cm extension of the baseline between Date and Sobetsu control stations, 2 cm or more extension between Sobetsu and Abuta as well as Date and Abuta. It seemed that the mountain would erupt very shortly.

< Post-eruption Monitoring>

The post-eruption baseline analysis showed that the baselines between Sobetsu and Abuta, and Date and Abuta shrunk approximately 8 cm since May 30 before the eruption.

2.3.2 Monitoring by GPS Volcanic Deformation Remote Monitoring System (REGMOS)

GSI Taskforce conducted remote monitoring by observation systems, which integrated monitoring apparatus, communication and power equipment and wave installed at the top of the mountain and near piedmont.

2.3.3 Leveling

The first leveling conducted from May 14 to 19 resulted in at most 30 cm of upheaval since prior observation at the eastern area of Mt. Usu near Sobetsu Onsen. The 2nd leveling in June showed approximately 1 cm subsidence and the 3rd one in August confirmed continuous trend of subsidence after the eruption.

2.3.4 Monitoring by SAR (Synthetic Aperture Radar) Image Matching

Crustal deformation was estimated by measuring positional changes on images from SAR, which was mounted on the satellite RADARSAT. It confirmed at most 22 meter upheaval, 12 meter displacement to the north and 7 meter displacement to the south during April 2 to 26 after the eruption.

2.4 Topographic Variation Survey

GSI studied topographic changes caused by volcanic eruption using photogrammetric technology. The aerial triangulation was conducted based on aerial photographs taken after the eruption and consequently the deformation was calculated from the elevation change. GSI Taskforce prepared topographic maps and photomaps reflecting the survey result and distributed to the field headquarters of the government and related organizations.

The updated topographic maps showing topographic changes caused by the eruption in two different colors included following 2 types with a scale of 1/50,000 topographic maps around the crater and topographic maps of volcano Mt. Usu which covered adjacent areas.

2.5 Topographic Analysis

GSI prepared “Mt. Usu Volcanic Activity Map” and “GIS Data for Mt. Usu Volcano Hazard” as fundamental data with the aim of contributing to effective measures against volcanic phenomena and safety of residents. These data were disseminated to related organizations. In particular, GIS data was opened to the public through GSI website.

“Mt. Usu Volcanic Activity Map” shows volcanic topography and phenomena caused by eruption. It was prepared to understand the form of volcanic eruption and topographic changes in chronological order. The crater, faults and crevices, where significant topographic change was observed, were differently colored depending on when photographed.

“GIS Data for Mt. Usu Volcano Hazard” contains geographical data necessary to take effective measures against volcanic disaster, such as base map information including topographic maps with a scale of 1/25,000, public facilities, geographic names, control points and thematic map information including land condition map of volcano. In addition to above, it also contains information necessary to understand the status of volcanic activities, such as data of topographic changes supplied by aerial photointerpretation and observation result of crustal deformation.

3. Countermeasures against eruption of Mt. Oyama in Miyake Island

3.1 Summary

Increasing volcanic earthquakes were observed in Miyake Island from June 26, 2000 and Mt. Oyama erupted with massive collapse at the mountaintop around 18:43 of July 8. The eruption continued more than a month and massive eruption occurred on August 18 and 29. The mountain started emitting vast amount of volcanic gases, such as sulfur dioxide, from September 2000 and it maintains daily emission of 3,000 to 10,000 tons of gas until today.

The evacuation directive was given out on September 2 and all residents (total 3,855 people) left the island until September 4. It is still unknown for the residents if they can return to the island due to continuous significant gas emission.

3.2 Countermeasures taken by GSI

GSI set up the Miyake Island Volcanic Disaster Taskforce headed by Director General on June 26 and prepared disaster situation maps as well as GIS data for Miyake Island Volcanic Hazard, which were distributed to related organizations.

3.3 Crustal Deformation Monitoring

3.3.1 Monitoring by GPS-based Control Station Networks

GSI set up emergency analysis system to understand crustal deformation in Miyake Island where numerous volcanic tremors had been observed and provisional volcanic alert was given off. The system enabled us to analyze every 3 hours using dataset for 6 hours regarding 4 GPS-based Control Stations in the island. However, the observations at Sone GPS-based Control Stations were frequently interrupted due to landslips caused by earthquakes and mud flows.

3.3.2 Monitoring by GPS Volcanic Deformation Remote Monitoring System (REGMOS)

In place of the GPS-based Control Stations damaged by the landslide and madflow GSI set up REGMOS at 4 observation points to enhance existing GPS-based Control Station Networks and the monitoring system.

3.3.3 Leveling

GSI conducted a leveling from October 8 to 18 for the leveling routes in Miyake Island. It helped us to understand the detailed vertical movement caused by volcanic activities, which were almost 1 m subsidence at the south side of the island and over 10 cm subsidence at the north side of the island.

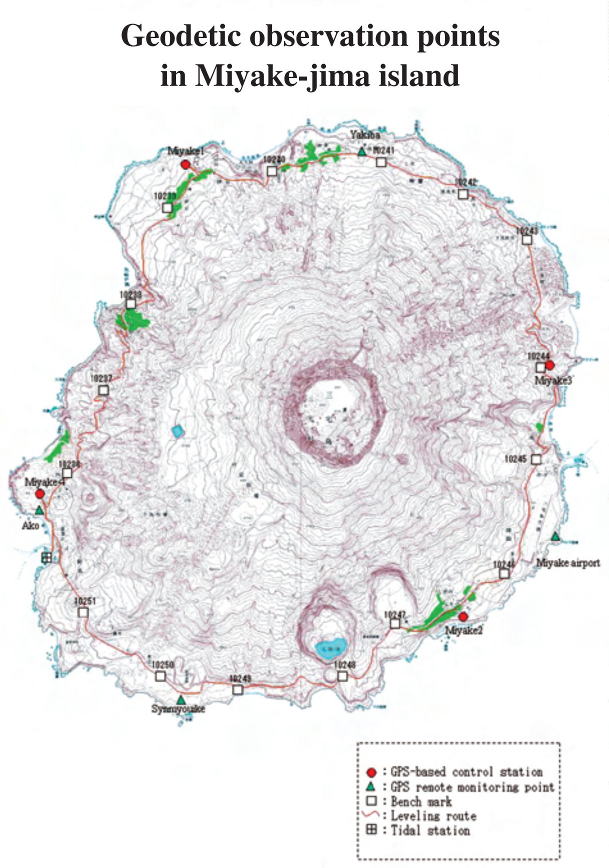

Fig. 3

3.4 Topographic Variation Survey by Airborne SAR and Laser Scanner

GSI surveyed the crater using SAR mounted on an airplane instead of aerial photogrammetry or aerial photo interpretation due to volcanic fumes. SAR images were opened to the public through the GSI website.

GSI also surveyed using a laser scanner. The system mounted of helicopter irradiates laser pulse to the ground, scans it, calculates arrival times of the reflected pulse and displays the three-dimensional coordinates as an image. DEMs, cross sections, volume survey and contour maps of 1 m intervals were prepared based on the survey.

3.5 Topographic Analysis and GIS

GSI prepared “GIS Data for Miyake Island” and “Topographic Map of Miyake Island at Volcanic Eruption in 2000” as a fundamental data with the aim of contributing to effective measures against volcanic phenomena and safety of residents. These data were distributed to the Central Disaster Prevention Council and related organizations including Miyake village office. GIS data were opened to the public through the GSI website.

“GIS Data for Miyake Island” contain following information with the aim of understanding the status of volcanic activities and contributing to disaster prevention in the future: base map information including topographic maps with a scale of 1/25,000, public facilities, geographic names, control points, thematic map information including land condition map of volcano, information of topographic variation supplied by aerial photointerpretation and extracted information of houses damaged by mudflows.