# Investigation of Ground Movement and Geothermal State of Main Active Volcanoes in Japan

by

Seismology and Volcanology Division, M.R.I.

## Abstract

There have been instances of the crater bottom rising and the temperature inside the crater changing, as precursors of a volcanic eruption. It seems that the volcanic eruption is closely related with topographical deformation and geothermal change of the volcano.

The Seismology and Volcanology Division of the Meteorological Research Institute of Japan carried out a project, "Prediction of volcanic eruption", during the period since 1974 through 1978, for the purpose of making special researches into this subject.

Thus distance measurement for estimating ground deformations by use of the geodimater, observation of ground tilt by the tiltmeter, temperature measurement in and around a crater by remote sensing by the airborne infrared scanner or the infrared radiation thermometer, etc. were performed on seven main active volcanoes in Japan shown in the table below.

Another investigation "Routine observation system of volcanic activity by means of the infrared radiation thermometer" was carried out from 1974 to 1975, as part of the above research, for the purpose of developing a remote sensing method of temperature measurement in and around the crater.

On August 7, 1977, big eruptions took place at volcano Usuzan and great damage was reported around the volcano. Therefore, a special research entitled "Investigation of the 1977 eruption of Usuzan" was carried out under the financial aid of the Science and Technology Agency. In this investigation, distance measurement for estimating ground deformations at the

foot of Usuzan by use of the geodimeter and ground surface temperature measurements at the same volcano by means of the airborne infrared scanner were carried out several times. Then the relation was analyzed between these observation results and the variation of volcanic activity.

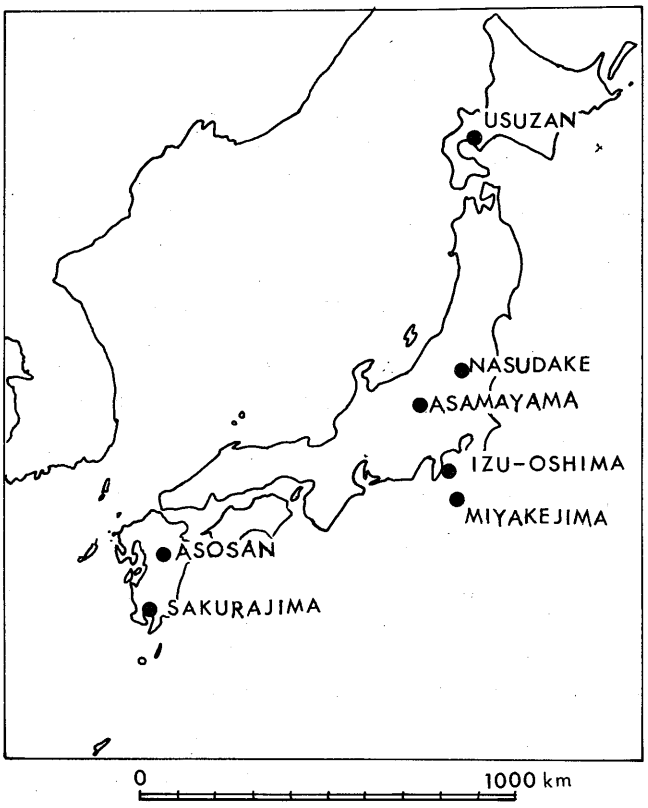
The above mentioned researches have somewhat similar content and supplement each other.

For the purpose of the prediction of volcanic eruption, we have to put together all the information obtained by many kinds of approaches, such as volcanic earthquakes, volcanic tremors, crustal deformations, geothermal changes, physical and chemical analysis of volcanic products, etc.. The present routine volcano observations of the Japan Meteorological Agency do not include all of the above items, while the present researches deal with new items hitherto neglected by the J.M.A.. We hope that the results of these resarches will be reflected in the routine volcano observation work in the future.

In the present paper, the results of the above researches are reported in four chapters. The name of the volcanoes and the methods of study are shown in the table and the figure below.

Volcanoes and Methods of Study

| Item / Volcano | Topographical survey | Distance measurement | Tilt observation | Temperature observation |
|---|---|---|---|---|
| Sakurajima | o | o | o | o |
| Asosan | o | o | o | o |
| Izu-Oshima | o | o | o | o |
| Asamayama | o | o | o | o |
| Miyakejima | | | | o |
| Nasudake | | | | o |
| Usuzan | o | o | | o |




Geographical position of the volcanoes cited in this report

In Chapter 1, the results of the "Topographical survey of the active crater" at 5 volcanoes are reported.

Topographical maps of 1/2500 or 1/5000 scale in and around the active crater were made, and accurate locations of the main spots were plotted in them. The maps and the data made in this study are used in the studies reported in Chapter 2 to Chapter 4. If ground deformation takes place at these volcanoes in the future, it is easy to catch them by referring to these map.

In Chapter 2, the results of "Distance measurement for estimating ground deformations by use of the geodimeter, at the active volcano" at the same volcanoes as in Chapter 1, are reported.

At Usuzan, large deformations with maximum value of $10^{-3}$

are observed, but the other volcanoes, no more than $10^{-5}$ is observed. It has since transpired that length at the several measuring lines change immediately with strong volcanic activities. Thus the distance measurement is considered a useful method for watching the state of volcanic activities.

In Chapter 3, the results of "Observations of ground tilt by tiltmeters" at four volcanoes are reported.

In this study, BIAXIAL tiltmeters were used at 3 to 4 points around the crater or at the foot of the volcano. This type of tiltmeter is a gauge using a bubble level, ensures good stability, and makes telemtering possible.

Observations of tilt were carried out in a cabin on the ground or in a hole of 1m to 3m in depth. The influence of air temperature upon the ground tilt was smaller in the deeper holes, while at all the volcanoes great tilt changes were observed that far outweigh such influence.

Secular changes of tilt probably due to volcanic activities were observed at Sakurajima, Izu-Oshima and Asamayama, while remarkable uplifts of the ground which are considered to be a precursor to an eruption, were observed at Asosan.

In Chapter 4, the results of "Temperature measurements in and around a crater by means of remote sensing" are reported.

An airborne infrared scanner is used at Sakurajima, Asosan, Izu-Oshima and Usuzan, while an infrared radiation thermometer is used on the ground at Asosan, Izu-Oshima, Miyakejima and Nasudake. The high temperature zone in and around the crater at the eruption time extended several times as large as that of the calm period. Furthermore, these anomalous high values of temperature at the eruption time were higher than that of the calm period. This suggests that some thermally anomalous areas in the crater changes their thermal characteristics before or at an eruption. The thermal infrared survey is very useful to volcano observation for the monitoring of some potentially hazardous

crater. It has, moreover, the advantage of being done with safety and quikness.

The topography of a crater and the summit of a volcano is so irregular that infrared radiation images taken from the air are grossly distorted. Therefore, a new method of correction for topography in infrared images was developed.