20. Measurement of Gases Emitted from Volcano Mihara by using an Automatic Recording Instrument

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In 1963, the authors stated in "Bulletin Volcanologique" that from the chemical composition and amount of gases emitted from an active volcano, it is possible to predict the time of an approaching eruption with some degree of accuracy. However, it is dangerous to examine volcanic gases at the edge of an active vent for a week or ten days before the eruption. It is desirable to examine and record more safely an amount of volcanic gas.

In 1958, the authors used an instrument which was made by Denkikagakukeiki Co. to detect and record automatically an amount of sulphur dioxide in fumaloric gases. The principle of this instrument was to record a difference between two electric conductivity values of iodine containing potassium iodide solution measured before and after the solution absorbed sulphur dioxide in gases. Carbon dioxide does not affect the electric conductivity of the solution, none of hydrogen sulphide being detected. Hydrogen chloride increases distinctly the conductivity of the solution.

A hot volcanic gas was led from a fumarole of 350°C at the bottom of the vent created in 1954 to the instrument which was placed at the detached shop of Tea Shop Kakochaya by using a hard glass pipe of 2.5 cm in diameter and 8 m in length, connected with a hard vinyl pipe of 2.5 cm in diameter and 220 m in length, and a suction pump. If chloride content in gas is one fifth of the content of sulphur compound, and fluoride content is one hundredth of sulphur compound content as stated in Bulletin Volcanologique 1963 by the authors, it is possible to consider that the record taken by this instrument indicates mainly sulphur dioxide content in gases emitted from the fumarole, after water vapour was condensed by air cooling.

In the present report, the conductivity increase of the solution caused by volcanic gas absorption is expressed, for convenience, as the increase of sulphur dioxide absorbed.

This instrument was operated from 11th to 15th, April, 1958. The gas emitted from a fumarole which showed 350°C at the orifice

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was diluted with a large amount of air which entered into the upward current of volcanic gas under the ground.

For the measurement of fumarolic temperature, an alumel-chromel thermocouple made by Hokushin Electric Works was used. The thermocouple and the recorder were connected to each other by copper wire of 2 mm in diameter and 220 m in length. Temperature of the fumarole was recorded on a graph automatically from March 28th to April 17th, 1958. The results of those studies were reported in 1958.2)

After that, volcanic activity gradually decreased and the bottom of the active vent created in 1957 descended year by year. The adjoining vent created in 1954 collapsed and then disappeared.

Recently, a much more sensitive gas instrument for the same purpose, designed by Denkikagakukeiki Co., was placed in a small cottage which is located at 245 m from the active vent. Volcanic gas containing air at the edge of the vent was led to the gas instrument by using a hard vinyl pipe of 2.5 cm in diameter and 245 m in length as shown in Fig. 1 and a suction pump. The structure of the gas instrument is shown in Fig. 2. In this figure, the mixed solution of 0.006% H₂O₂ and 5 × 10⁻⁵ N H₂SO₄ is led by pump from the storing tank through the standard cell to the measuring cell and stopped automatically, when water level in the measuring cell reaches the end of the plunger rod. Gas is led through dust filter and flow meter and then bubbled into the measuring cell from the nozzle. The difference between two conductivity values of the solution in the standard cell and the measuring cell is amplified and recorded. After gas is bubbled with a flow rate of 0.5 l/min for 30 minutes, the solution in the measuring cell is discharged. The cell is washed with the solution one time, then filled with the solution to the lower end of the
Fig. 2. Diagram for measuring system.

Fig. 3. Variation of sulphur dioxide content in air at the edge of the active vent (from 1:30 a.m. to 1:00 p.m., September 18th, 1969).
plunger rod and then conductivity of the solution begins to be measured and recorded at the same time that bubbling of the gas starts. All processes are operated automatically. In this case, hydrogen chloride affects distinctly the electric conductivity of the solution, while carbon dioxide does not affect it and hydrogen sulphide was not detected. It was found by analysis that chloride content in gas is one fifth of the content of sulphur compound.

For convenience, a conductivity increase of the solution caused by volcanic gas being absorbed is expressed as a result from sulphur dioxide absorbed.

The record by the instrument from 1:30 a.m. to 1:00 p.m. on September 18th, 1969 is shown in Fig. 3. The top of each peak indicates an average of sulphur dioxide content in air for thirty minutes. Fig. 4 shows sulphur dioxide content in air from 11:30 a.m. on 14th to 7:30 p.m. on 18th, September, 1969. If a variation of sulphur dioxide content in air is compared with volcanic tremors which are observed by the seismograph of 500 magnifications placed near Kakochaya by the Oshima Meteorological Station, on the condition that the largest amplitude of the tremors which occurred in the two minutes at each observed time (0, 6, 12, 18 o'clock) were used, it is clear that on the 17th and 18th, September, stronger tremors occurred.
in a short time before sulphur dioxide content was high. Moreover, during the nights of 17th and 18th, the smoke emitted from the active vent was red on account of the light from the hot lava being reflected on the smoke. Therefore, the mountain was slightly in an active state on 17th and 18th, September.

Fig. 5 shows the highest, lowest and mean values of the sulphur dioxide content observed for about three hours each day from June 25th to October 23th, 1969. The largest amplitude of volcanic tremors observed in two minutes at 0, 6, 12, and 18 o’clock on each day and the rain fall reported by the Oshima Meteorological Station also are shown in Fig. 5. On July 3rd, strong tremors larger than 10 \( \mu \) in amplitude occurred 8 times and on July 4th, tremors of 5.0 to 9.9 \( \mu \) occurred 9 times and those higher than 10 \( \mu \) 5 times. Corresponding to those volcanic tremors, sulphur dioxide content increased distinctly in early July. That is, on July 1st, 2.8 ppm SO\(_2\) on the average. Then, SO\(_2\) content increased gradually and on the value respectively, on July 10th, 5.7 ppm SO\(_2\) and 7.9 ppm SO\(_2\) as the average and the highest respectively. After that, SO\(_2\) content in air decreased remarkably and showed from 0.6 to 1.4 ppm SO\(_2\) on the average. Then, SO\(_2\) content increased gradually and on 30th, September, 2.6 ppm SO\(_2\) and on 3rd and 4th, October, 2.8 ppm and 3.0 ppm were observed as average respectively. On those days,
number of volcanic tremors larger than 2 in amplitude increased. Therefore, it is clear that seismic activity increases with increasing sulphur dioxide content. On 3rd and 4th July, 1969, when the strongest tremors occurred, $SO_2$ content was very low such as 0.9 ppm and in a short time after that, gas increased remarkably.

The phenomena similar to the above were observed by the authors at the tops of Volcanoes Asama and Aso. There, immediately after an earthquake occurred, black smokes were emitted in a large amount. Accordingly, it could be supposed that some of the earthquakes in Volcano Mihara are caused by gaseous pressure.

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References
