Development of a sinkhole at Oana crater, Azumayama Volcano

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1. Introduction

Azumayama Volcano, located on the border between Fukushima and Yamagata Prefectures, experienced repeated phreatic eruptions around the Oana crater, Tsubakurosawa fissure, and Ioudaira after the magmatic eruption in 1331. The last eruption in 1977 occurred in and around the Oana crater. In addition, the present volcanic earthquakes, crustal deformations, and fumaroles also occurred in and around the crater.

A sinkhole was formed in the Oana crater from August to September 2021.

It is important to reveal the characteristics and developmental processes of such local sinkholes because their formation may suggest a change in the behavior of hot water and/or hot volcanic gas in the shallow underground region of the crater.

This presentation compiles the results of field surveys and the circumstances of fumarolic and geothermal activities in and around the Oana crater before and after sinkhole formation.

2. Timing

The sinkhole was recognized by the survey of Meteorological Research Institute on September 20, 2021, while the authors confirmed that it did not exist on August 19, 2021. Based on the survey conducted by Tohoku University on September 7, the sinkhole had already formed previously. Therefore, it can be concluded that the sinkhole was formed between August 19 and September 7, 2021.

3. Description

The first survey was conducted by the Sendai Regional Headquarters, Japan Meteorological Agency, on September 22, 2021. The sinkhole, located to the north of the crater, is almost circular. The wall is almost vertical, and the dimension of the sinkhole is approximately 10 m in diameter (measured value) and approximately 5 m in depth. The volume loss when the shape of the hole was assumed to be almost cylindrical was approximately 400 m^3.

A talus was created in a sinkhole. A white hot water pool was formed on the west side of the bottom, and its temperature was approximately 50 ℃ using infrared thermal imaging camera, and bubbles rose from the bottom of a part of the hot water pool. From the sinkhole wall on the southeast side, water at approximately 40 ℃ (slightly lower in temperature than the hot water pool) flows out, and the flow path turns red. Additionally, a high-temperature region was observed between the sinkhole wall and talus.

4. Estimating the cause of formation

As no new deposits or craters due to volcanic bombs were found around the sinkhole, ejection seemingly did not occur during the sinkhole formation.

However, at the location of sinkhole formation, a geothermal area with a small steam vent and precipitated sulfur appeared after August 2020. In addition, volcanic gas (H_2S) of around 17 ppm was detected by a portable gas detector. The ground temperature at a depth of approximately 15 cm was approximately 90 ℃, and the maximum temperature was 94.3 ℃.

A mud explosion occurred in 1966 at the location of the sinkhole. The crater was buried by secondary

deposits. However, because there are more voids than in the surrounding area, convection of hot water and volcanic gas from underground is expected to occur, weakening the ground and leading to collapse. The sulfur burned from the night of July 22 to the night of July 24, and flowed down from the W-6b fumarole in the Oana crater. Subsequently, the height of the fumarole from W-6b decreased significantly, while that of the W-5 fumarole near the sinkhole exceeded 50 m. This suggests that there may be change in the heat transfer path in the shallow underground region of the Oana crater from July to August 2020.

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Fig. Oana crater from north rim (left) and detail of sinkhole (right)

