

Re-evaluation of hydrothermal activity based on magnetic measurements at Kusatsu-Shirane volcano, Japan

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Kakioka Magnetic Observatory, Japan Meteorological Agency commenced geomagnetic measurements around the summit crater lakes of Kusatsu-Shirane volcano in 1976 to monitor the thermal activity of the volcano. We re-analyzed the geomagnetic data over 36 years starting in 1978 and evaluated the long-term thermal activity beneath the crater lakes.

Changes in the geomagnetic total intensity due to thermal activity were observed in three periods: 1982-1985, 1988-1991, and 1996-2012. A thermal-demagnetization source related to phreatic eruptions during 1982-1983 was estimated to be 400 m below Mizugama crater lake during 1982-1985. The demagnetized body was also detected at a depth of 600 m below Mizugama crater lake in 1988-1991 when substantial thermomagnetic signals and numerous volcanic earthquakes were observed without an eruption. These demagnetization sources represent a hydrothermal fluid reservoir beneath the summit area. We suggest a possible mechanism of the phreatic eruptions during 1982-1983, based on our thermomagnetic model and previous geophysical and geochemical studies.

In contrast, magnetization associated with cooling of rocks beneath the crater lakes was recorded from 1996 to 2012. According to our thermomagnetic modeling of this period, the source of the magnetization was 400 to 700 m below an area immediately northeast of Yugama crater lake. In addition, we found that the cooling migrated gradually to shallower depths during this period. These suggest that the decline phase of the volcanic activity was under way at this period.

Changes in the geomagnetic total intensity after 2013 show a different tendency from those before 2013. Therefore, these suggest that the decline of volcanic activity came to an end in 2013.

Keywords: Kusatsu-Shirane volcano, geomagnetic measurement, thermomagnetic effect, phreatic eruption, hydrothermal fluid