Estimating ashfall volumes for the 2018 Shinmoedake eruptions using the Ellipse Approximated Isopach (EAI) method - How to quantify ashfall volumes from limited ashfall observation locations

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A volcanic ash eruption began on March 3, 2018 at the Shinmoedake Volcano, in the Kirishima Volcanoes Group. Eruption activity increased to March 5, and lava flow was observed on March 6. Eruptions continued until June 27. We observed volcanic ashfall amounts around the Shinmoedake Volcano and analyzed volcanic ashfall volumes for each eruption using the EAI method (EAI ashfall volume) proposed by Tajima et al. (2013). The EAI method can be used in four different ways. Firstly, ashfall volume is estimated based on one ashfall deposit data point. Second, the estimation is undertaken using two ashfall deposit data points. Third, the estimation is based on three ashfall deposit data points. Fourth, the estimation is based over four ashfall deposit data points.

Tajima et al. (2013) suggest that if an accurate calculation axis and an accurate aspect ratio of a distribution are determined, we can calculate the total volume of ashfall deposit using the EAI method using only one ashfall deposit data point. The calculation axis for the ellipse must be accurate, but it is difficult to determine an accurate calculation axis from the observation. Tajima et al. (2013) determined the lower threshold of detectable ashfall as 0.1 g/m^2 for an eruption of the Sakurajima Volcano. This lower threshold of detectable ashfall value is used in this calculation. The EAI method is used based on one data point calculation, and we have taken a suitable aspect ratio of the ellipse which is fitted between the EAI isopach from 0.1 g/m^2 and a limit location of detectable ashfall. We calculated ashfall deposit volumes for the period of eruption from 11 am on March 1 to 7 am on March 2.

Next, we demonstrate a calculation using two data points. Tajima et al. (2013) suggest, if an accurate axis of the ellipse distribution is determined, we can calculate an EAI ashfall volume of the deposit using two ashfall data points. In this case, we would need a limit location of a detectable ashfall deposit, because it is difficult to determine an accurate calculation axis. In this case we select two ashfall deposit data points for the EAI calculation, then we determine a suitable axis which is fitted between the EAI isopach as 0.1 g/m^2 and a limit location of visible ashfall. In this way, we estimated the EAI ashfall volume of the eruption at 15:58 pm on March 9. For comparison, we observed a limit location of visible ashfall on a car.

We show a calculation procedure for three ashfall deposit data points. This is a normal calculation case shown by Tajima et al (2013). We select two ashfall deposit data values for the EAI calculation, and determine a suitable axis to fit the observation points and the calculated distribution. However, sometimes it is take the over or under estimated volume from the calculation, because estimation of EAI ashfall volume can be influenced by environmental variables, such as wind direction changes, depositional conditions of ash-fall, and other research conditions. Lastly, we demonstrate the estimation of ashfall deposit volumes using four ashfall deposit data points. In this case, we select two ash-fall values for the EAI calculation. We determined a suitable axis which best fits the observation points and the calculated distribution. Using four ashfall deposit data points improves accuracy.

It is determined the EAI ashfall volumes of over 10 eruptions of the 2018 Shinmoedake eruptions. We assume that the eruption rate of each volumes per an hour increased before the lava flow producing. We will discuss the accuracy of the EAI method and the practical applications of this method.

Keywords: Shinmoedake, ash fall, EAI