Total grain-size distribution of pyroclastic density current deposits discharged during the 1929 eruption of Hokkaido-Komagatake

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Pyroclastic density current (PDC) is one of the most destructive phenomena in volcanic eruptions, and predicting its runout distance is an important issue for volcano disaster prevention. To predict the runout distance of a PDC, it is essential to construct a highly accurate numerical model, and various models have been proposed (Bursik and Woods, 1996; Patra et al., 2005; Shimizu et al., 2019; Tadini et al., 2021). To constrain the initial parameters for numerical simulations and to examine the validity of the results, it is preferable to study a well-observed eruption case.

The 1929 eruption of Hokkaido-Komagatake is known to have produced a Plinian eruption with VEI=4 and pyroclastic flows in every direction of the volcano at the end of the outbreak (Katsui et al., 1986). Since this eruption occurred after modern observations were established, there is a wealth of time-series data based on volcanic plume photographs, seismic tremor observations, and eyewitnesses. In addition, the runout distance of flow units of the PDC can be determined from aerial photographs taken before and after World War II, which can provide significant constraints for numerical model calculations. Furthermore, the detailed validity of the numerical results can be examined if the unit thickness, grain size variation, total volume, and total grain-size distribution of the PDC can be obtained from geological studies (e.g., Tadini et al., 2021).

However, calculating the total volume and total grain size distribution of PDCs is still a challenging task (Cioni et al., 2020). Therefore, the authors firstly focused on the westernmost part of the PDC deposits distributed on the south to the southwest slope of the volcano, because Murai (1960) reported the results of the grain-size analysis along the flow direction and the exposure is good nowadays. In this paper, we estimate the volume and total grain size distribution of the westernmost part of the PDC deposits using the grain size analysis of Murai (1960). The methods are as follows:
1. Anaglyphs were created from black-and-white aerial photographs taken by the U.S. Army in 1944, and geo-referenced with QGIS using special anaglyph glasses.
2. A polygon surrounded the distribution area. The distribution of the western edge generally agrees with the existing volcanic geological map.
3. The sampling points of Murai (1960) were geo-referenced and digitized with QGIS.
4. The area was divided into four sections so that the sampling points were representative of the distribution area.
5. The area of distribution was calculated using QGIS, and the total mass of ejecta was calculated for each section, assuming an average layer thickness of 5 m (Katsui et al., 1986) and a sediment density of 1600 kg/m^3.
6. The total mass of each grain size was calculated by multiplying the grain-size distribution at the representative site by the volume of ejecta and adding up the mass of each grain size. Then, the total grain-size distribution was calculated. When two grain-size distributions were obtained at a representative point, the mass of the corresponding section was multiplied proportionally.

In conclusion, the total volume of the PDC deposit at the western end is 0.148 km^3, and the total grain-size distribution shows a trimodal distribution with peaks at -4~-3 ϕ, 0~-1 ϕ, and 6~7 ϕ. Based on the definition of Folk and Word (1957), the median grain size (Md ϕ) is 0.26, the degree of selection is 3.44, the skewness is -0.208, and the kurtosis is 1.3. In the future, we will collect as much geological information as possible, such as the distributions of subunits, grain size distribution, an actual measurement of sediment density, and unit thickness, to improve the accuracy of the total grain-size distribution calculation.

Keywords: Hokkaido-Komagatake, Pyroclastic density current, Total grain-size distribution