Current state and problems of field examination concerning tephra dispersal after pyroclastic eruptions

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Dispersal pattern and volume or mass of tephra are fundamental factors determining type and magnitude of pyroclastic eruptions. However, the investigation method is outdated, and various problems exist to obtain highly precise data. This paper presents examples of field examination immediately after pyroclastic eruptions including Kirishima and Aso Volcanoes in Kyushu, SW Japan, and discusses the problems that appeared through the fieldwork.
The 2011 Shinmoedake eruption at Kirishima Volcano (southern Kyushu) was one of the largest eruption in Japan during the latest decade. Multiple subplinian eruptions occurred on January 26-27 and the tephra was dispersed throughout an area extending more than 20 km southeast from the source crater. Fieldwork was undertaken immediately after the eruption and a few months after the eruption. The eruption products were well preserved even a few months after the eruption, and it was possible to understand the tephra dispersal and correlate several fall units at different sites. Especially, it was clarify that the dispersal axis of the maximum size of pumice was slightly more northerly than that of thickness. This fact is consistent with the result of eruption plume simulation conducted by Suzuki et al. (2013). Our estimated volumes of the subplinian pumice-fall deposits on January 26-27 are one order of magnitude smaller than those of other studies probably because we use thickness data obtained at sites more than 2.5 km of the Shinmoedake crater. This suggests that proximal tephra data would be needed to give accurate estimates of the volume and mass of eruptive deposits.
Following the 1989-1995 eruptive sequence, multiple small ash emissions occurred at Nakadake crater, Aso Volcano (central Kyushu) in 2003-2008. A series of magmatic eruptions including ash, strombolian and phreatomagmatic eruptions occurred from November 2014 to December 2015. These eruptions provided valuable opportunities to examine eruption deposits in different volumes. It was useful to observe and sample ash deposited on artificial constructions or snow cover in the case of July 10, 2003 and January 14, 2004 small eruptions although it was difficult to recognized the ash on the natural surfaces.
In the initial stage of the 2014-2015 magmatic eruption at Nakadake, the ash-fall deposits could be easily observed and sampled on artificial surfaces at more than 40 sites, and the eruptive mass could be calculated using the isopleth map. Since subsequent ash-fall deposits could not be separated from the initial ash, ash samplers were installed at about 20 sites around the Nakadake crater. Although the ash observation system could be maintained, a big problem that fieldwork for ash sampling is restricted by road network has appeared. In the case of Nakadake, the eastern side of the crater is usually located downwind, and the downwind area has no road. Therefore, it is difficult to obtain the proximal data by fieldwork using cars. Moreover, it was experienced that ash sampling in the proximal area (<1 km of the crater) could not be often performed due to the risk of further eruptive activity. It is clarify that eruptive masses calculated by using both proximal and distal data are 1.4 times larger than those estimated by using only distal data. These evidences indicate that proximal tephra data would be needed to give accurate estimates of the volumes and masses of eruptive deposits as well as the 2011 Kirishima eruption.
As mentioned above, there is only one method to estimate distribution and mass of tephra deposits by fieldwork although the fieldwork immediately after pyroclastic eruptions has several serious problems. Therefore, it is expected to develop tephra plume simulation technique as well as

geological examination to give accurate estimates of eruptive volume and mass.

Keywords: pyroclastic eruption, tephra dispersal, eruptive volume

