Comparison of eruption volume estimation methods of pyroclastic fall deposit

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1. Introduction

There are two methods about volume estimation of pyroclastic fall deposits. One is the 'crystal method', which measured the total quantity of crystals using tendency that crystals in pyroclastic fall deposit accumulates near the source, because crystals have high density and coarse-grained. The total quantity of crystals divided by the crystal content ratio within magma (crystal mode of pumice fragments) would give the total amount of ejecta (Walker, 1980). The other is the method based on isopach map together with modeling for the extrapolation to outside area of the isopach map (e.g. Rose et al., 1973; Suzuki, 1981; Pyle, 1989). Crystal method is a accurate way of volume estimation, but the execution example is few because it is complicated. On the other hand, the method of using isopach map and extrapolation is comparatively easy. Therefore, eruption volumes are estimated in many cases by this method. However, there is a problem that is the result of crystal method indicating about 2-4 times the value compared with the estimate of isopach map and extrapolation method. In this study, both methods were compared, and the reason why the result is different was considered.

2. Difference in logT/Area^1/2 plot

There is a tendency that becomes 1 or 2 straight lines if it plots logarithm of thickness (logT) versus area^1/2 (Pyle, 1989). The method of estimating the volume by using this feature is widely used (Fierstein and Nathenson, 1992). Many of pyroclastic fall deposits are shown by two straight lines on the logT/Area^1/2 plot. The volume estimated from the 1st straight line near the source defines V1 and the volume estimated from the 1st and 2nd straight line defines V2. The value of V2/V1 was range from 1.3 to 7.2 and the average value was 3.8 when 14 examples of pyroclastic fall deposit were examined. On the other hand, pyroclastic fall deposits to which the volumes were estimated by crystal method are practically shown by only one straight lines on the logT/Area^1/2 plot.

3. Cause in which difference of volume estimate happens

Many of pyroclastic fall deposits are shown by two straight lines on the logT/Area^1/2 plot. Moreover, it is not thought that pyroclastic fall deposits to which the volumes were estimated by crystal method were abnormal. Therefore, if pyroclastic fall deposits to which the volumes were estimated by crystal method can also measure the thickness far from enough, the possibility to be shown by two straight lines on the logT/Area^1/2 plot is high. The mean value of V2/V1 is 3.8, and this is almost corresponding to the result of crystal method indicating about 2-4 times the value compared with the estimate of isopach map and extrapolation method. It will be necessary to estimate the volume of pyroclastic fall deposits that are shown by two straight lines on the logT/Area^1/2 plot by crystal method.