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A comparative study of the distribution of Towada-Hchinohe pyroclastic flow and the estimations from simple physical models

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Towada-Hachinohe pyroclastic flow erupted about 13,000 years ago and formed Towada caldera. In the northern Tohoku district of Japan it distributed widely, propagated to about 65km at the northern area from caldera and about 100km at the south, and its distribution is described by Nakagawa(1972), Hayakawa(1985), Doi(1993) and so on. Adachi(2004MS) divided its deposits into two types ,one that shows a typical occurrence of valley pond deposit, and another that deposits topographical heights or distal away area. In this report, the present author researched its northern distribution, made the estimation of the distribution from simple physical models and compared it from its actual distribution.

Energy line model that proposed by Hsu(1975) applied proclastic flows as the model estimating the distribution, Kaneko and Kamata(1992) enhanced it in three dimensions, and called that energy cone model. In this study, the present author used this model and calculated frictional angle F and column collapse altitude H. The results ,when F is put with 3.43 degree angle and H is put with 4300m, the estimated distribution is the best fit to the actual distribution. But there is the difference of distance about 30km between northern and southern direction in the actual distribution. In the northern area, the flow propagated much shorter than the estimated distance. It is because that Energy cone model which is apllied from particle dynamics adapted to the Hachinohe pyroclastic flows deposits which deposited topographic height or distal away area from dilute pyroclastic flows. So the present author researched the northern distribution area, from Kamikita plain to Shimokita peninsular, and examined the model available for dilute pyroclastic flows.

The present author newly found that a few millimeter pumice clasts, which contain hornblende crystals in the weathering volcanic ash layer. Because there is no layer that contains hornblende crystals around here, the present author judged it Towada-Hachinohe pyroclastic flow deposit. So the distribution known extended to 10km north.

The present author attempted to estimate the run-out distance for northern and southern directions, using the model of Busik and Woods (1996) discussing about the dynamics and thermodynamics of large scale ash flow. Busik and Woods (1996) proposed the equation for the correlation between eruption rate and run-out distance, xf=x0+(V/Ws)ln((1-n0)Ta/n0(T-Ta)) where xf is the run-out distance, x0 is the caldera radius, V is the volumetric flux, W is the cannel width, s is the average fall speed, n0 is the initial gas mass fraction, T is the temperature of the ambient air, T is the temperature of the material.. Here from the analysis of Towada-Hachinohe pyroclastic flow deposits, x0 is put with 5.5km, W is put with 8.4km and 4.3km for northern and southern area respectively, s is put with 1m/s, T is put with 573K, Ta is put with 273K. n0 is put with the value between 0.02 and 0.4. When n0 is given, the initial flow density B0 is determined.

In order to satisfy the actual run-out distance 75km and 100km for northern and southern area respectively, given that value, V took the value from minimum 1km3/s to maximum 23km3/s. Eruption rate Mf is shown by the product of V and B0. So when n0=0.2, Mf took the minimum value 10^10kg/s, when n0=0.4, Mf took the maximum value 3.5*10^10kg/s. Total mass is about 50*10^12kg estimated (Adachi 2004MS), so duration time t took minimum value 1.4*10^3 seconds, maximum value 5.0*10^3 seconds.