Dynamics of ballistic projectiles based on Trashcano experiment

*Saruta Shusaku[1], Kae Tsunematsu[1], Isao Motoyama[1]

1. Yamagata University

Ballistic projectiles ejected during explosive eruptions are centimeter to meter- sized volcanic pyroclasts that follow ballistic trajectory. Generally, these dynamics are studied by computer modellings and observations of actual eruptions. We applied the eruption simulation experiment which is known as the Trashcano experiment to investigate the relationship between the eruption velocity and the size of projectiles, and the effects of the gas.

The Trashcano experiment is an eruption simulation experiment which produces an explosion using the abrupt vaporization of liquid nitrogen. In our case, plastic balls and three-dimensional models of volcanic blocks were used to imitate ejecta. Their movement were observed by two high-speed cameras. We reconstructed trajectories of ejecta in three dimensions based on obtained high-speed images. The velocity of ejecta were calculated based on those trajectories and the ejection velocity of them were estimated by extrapolating the velocity curve.

The plot of the ejecta momentum (mv where m is the mass of the ejecta and v is the velocity) against the cross-sectional area of ejecta shows an upward linear trend. This implies that the ejection velocity depends on the cross-sectional area of the ejecta because the cross-sectional area receives the pressure which is equivalent to the force per unit area affecting during the time step Δt ($P = mv/\Delta tA$)). We interpreted this trend as meaning that the time step Δt of each ejecta is equal, and the ejection velocity depends on the cross-sectional area of the ejecta.

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