

Cross-sectional observation of crater formation process under low-gravity by quarter-space method

*Masato Kiuchi¹, Takaya Okamoto², Yuuya Nagaashi³, Yukari Yamaguchi⁴, Sunao Hasegawa¹, Akiko Nakamura⁴

1. Japan aerospace exploration agency, Institute of space and astronautical science, 2. Planetary Exploration Research Center, Chiba Institute of Technology, 3. Graduate School of Science, Tohoku University, 4. Graduate School of Science, Kobe University

It is important to understand a crater formation process under low gravity to estimate the surface properties and the evolutionary processes of asteroids. Several studies have investigated the effect of gravity on crater diameter for low velocity to high velocity (1 m s^{-1} to 6.6 km s^{-1}) impacts: the crater diameter was shown to be proportional to $-0.165 \sim -0.19$ power of the gravitational acceleration in the low and high gravity range (Gault and Wedekind, 1977; Schmidt and Housen, 1987; Cintala et al., 1989; Kiuchi et al., 2019). On the other hand, the gravitational dependence of the crater diameter was hardly observed for granular targets with significant cohesion, and the crater diameters were determined by the target strength (Kiuchi et al., 2021, JpGU). In these experiments, the crater formation process was mainly observed from the upward of the target surface, and little information on the crater depth was obtained. In order to understand the detailed crater formation process under low gravity, it is necessary to observe not only the crater diameter but also the cross-sectional growth of the crater cavity.

We have developed an experimental apparatus for cross-sectional observation of the crater formation process in reduced gravity by a quarter-space method. We assembled a simple drop tower in the vacuum chamber of a two-stage vertical light-gas gun at the Institute of Space and Astronautical Science (ISAS), Japan, to conduct high-velocity impact experiments in reduced gravity (Kiuchi et al., 2021, JpGU). We vertically partitioned an inner space of a box-shaped container with an acrylic plate. One partitioned space was filled with target materials, and a digital video camera and a light source were placed in another space. A projectile was impacted vertically near the partition plate, and the temporal growth of the crater cavity was observed through the acrylic plate. We used four types of target materials; quartz sand with a representative diameter of $425 \text{ }\mu\text{m}$, glass beads with a representative diameter of $220 \text{ }\mu\text{m}$, fine glass beads with a representative diameter of $44 \text{ }\mu\text{m}$, and fused alumina particles with a representative diameter of $40 \text{ }\mu\text{m}$. A glass sphere with a diameter of 1 mm was impacted at a velocity of 1.2 km s^{-1} . We will present the effect of gravity on the growth process of the crater cavity for each target.

Keywords: impact crater, low gravity, quarter-space method