

Study of porosity change of simulated chondrite materials by impact experiments

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Primordial small bodies formed by the aggregation of matrix and chondrules have a porous structure that depends on the matrix fraction. Compression due to self-gravity alone is not sufficient for the reduction of porosity from those of the primordial small bodies to the porosity of chondrites [1, 2]. In addition to thermal evolution and aqueous alteration, compression by impact is considered to be a factor of porosity reduction. In a previous study, analogue materials of chondrite parent body consisting of dust and beads sealed in a cylindrical vessel was compressed by an impact of an aluminum cylinder to examine the degree of compaction due to impact [1]. In this study, we investigate the porosity change during the crater formation and material ejection process by impact on the surface of the chondrite parent body.

Samples were prepared by mixing 1.5 μm irregularly shaped silica particles and 4.3 μm fly-ash as matrix simulants, and glass beads of 220 μm in diameter as chondrules, adding water to the mixture, compressing the mixture at 7 -10 kPa, and then drying the mixture at 50 °C. The volume ratio of glass beads was 13% (Sample A) and 35% (Sample B). The porosity after drying was 62% (Sample A) and 38% (Sample B), respectively.

For these samples, SUS and aluminum spheres 3.2 mm in diameter were impacted at a speed of 4.5 km/s using a two-stage light gas-gun at the Institute of Space and Astronautical Science (ISAS). Flash X-ray transmission images were acquired at several timings during 6 ~ 3000 μs after the impact. In all samples, the growth of the crater cavity over time was captured. In Sample A, a compacted layer was formed just below the cavity, and it was observed that the compacted layer expanded after a lapse of time from the impact. It is considered that the porosity of the compacted layer depends on the distance from the impact point. However, assuming that it is constant for simplicity, the average porosity of the compacted layer was calculated to be 23 ~ 54%. On the other hand, in the sample B, the compacted layer could not be detected. This is considered to be because the spatial resolution and S/N of the flash X-ray image were not sufficient to capture the change in the porosity.

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[1] Beitz, et al., Icarus 225, 558-569, 2013.

[2] Omura, T. and Nakamura, A. M. Planetary Science Journal, accepted.

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