Impact cratering of porous targets in the strength dominated regime

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Most of small solar system bodies are porous, that means, the bulk density of the bodies is smaller than those of the component materials of the bodies. The response of porous bodies to impact depends not only on porosity but also on other physical properties. An S-type asteroid Itokawa was shown to be a rubble-pile, a re-accumulated body, and has macroporosity of 40% by Hayabusa's exploration. When impacted, such a body is expected to behave as granular targets in the laboratory, for which, gravity largely plays a role. A C-type asteroid Mathilde is also a body explored by a space mission, NEAR Shoemaker. The bulk density 1300 kg m^{-3} of this body shows that the macroporosity is about 40% if we exclude possibility of ice in the interior. Although the expected porosity is similar to Itokawa, Mathilde has a distinct appearance. Large craters of diameters comparable to the diameter of the asteroid co-exist. Why large craters can co-exist and the body was not disrupted and dispersed is probably because of the porosity that effectively attenuates the shock wave via compaction. Blocks were not observed on the surface of this body, while ejecta blocks are common on other small bodies in the vicinity of craters (e.g., on Martian moon, Phobos) and even wide spread on the surface (e.g., on asteroid Eros). The observational evidence shows that impact processes on Mathilde were not simple granular, but compaction, or in other words, strength that resists compaction, played a role. Because primordial small bodies would have been very porous, impact process of porous bodies associated with compaction is of importance in the collisional evolution of porous primitive bodies.

Laboratory impact experiments of porous targets in the strength regime have been performed using different materials, such as sintered-glass bead targets, gypsum targets, natural porous rocks, and blocks of chondrites. In some of previous experiments, spatial extent and the degree of compaction were observed using transmission X-ray imaging or SEM. Crater diameter data can be compiled using conventional cratering scaling (Holsapple, 1993) with an empirical modification for porosity, while depth data cannot be compiled in the same manner. The results including those in literatures and some new ones of a set of impact experiments which were focused on using porous projectiles will be reviewed and presented with a discussion in terms of possible scaling for application to primitive small bodies.