

Hypervelocity impacts on carbonaceous asteroids analogue materials

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1. Introduction

Two on-going sample return space missions, Hayabusa2 and OSIRIS-REx are orbiting and characterising two near-Earth asteroids, (162173) Ryugu and (101955) Bennu respectively. Initial ground-based observations and preliminary mission data indicate that the composition of these small objects is similar to the CM or CI meteorites [1-4]. However, their mechanical properties appear to be different [5,6]. How does this weak materials respond to impacts? What type of regolith is produced during micrometeoroid bombardment? Will we expect to find exogenous materials embedded on the weak surfaces of Bennu and Ryugu?

2. Materials

In our work we used as targets to hypervelocity impact experiments, asteroid analogue materials with mineralogy similar to the CM meteorites. Specifically, the CM2 regolith simulant is a close mineralogical match to the Murchison CM2 carbonaceous chondrite meteorite. Since one of the aims of the project was to examine qualitatively the produced regolith after impact events, we used as inclusions glass beads for an easier examination. The samples were produced and casted at the Exolith Lab of the University of central Florida. Samples were also mechanically tested at the 3SR Lab in Grenoble, where the compressive stress and tensile strength were measured.

3. Experiments

In order to study the response of the CM-like asteroid analogue material to collisions with small projectiles, at typical impact speeds occurring in the asteroid Main Belt, we performed a series of laboratory hypervelocity impact experiments. We used the facilities of the Impact Lab of the University of Kent in the UK. The

main instrument used here is a 2-stage light-gas gun (LGG), which can achieve speeds up to 7.5 km/s. Targets were the squared blocks of CM analogues with dimensions 9.5 cm x 9.5 cm and 4.4 cm thickness, while as projectile we used stainless steel of different diameters. In these experiments we measured the depth and diameter of the craters, the quality of the ejecta and the state of the inclusions. In particular we wanted to test a part of the hypothesis that on materials with inclusions, impacts produce mainly multiminerale fragments, whereas thermal cracking, as a slower process produces monomineralic.



Figure 1: Impact crater on a CM2 asteroid analogue sample.

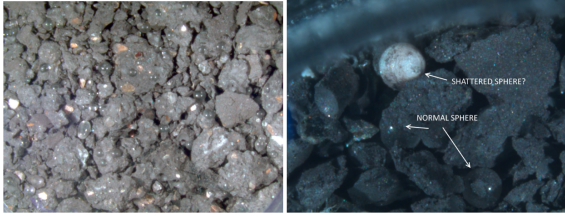


Figure 2: Ejecta of a CM2 asteroid analogue sample.

4. Conclusions & Implications

Combining the mechanical properties of the asteroid analogues and the impact results, we predict that the impact shockwave dissipates very rapidly in such a soft material, therefore one would expect to see also monomineralic fragments. In addition, we predict that there should be exogenous material implanted on the surface of those NEAs, coming from other parts of the inner-Main Belt [7,8].

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