Hypervelocity impacts on carbonaceous asteroids analogue materials.

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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 these 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?

Materials: We used as targets to hypervelocity impact experiments, asteroid analogue materials with minaralogy 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 ex- amine 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.

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. The main instrument used here is a 2-stage light-gas gun (LGG), which can achieve speeds up to 7.5 km/s. Tar- gets 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 multimineralic fragments, whereas thermal cracking, as a slower process produces monomineralic.

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].

Acknowledgements: This work was supported by the BONUS QUALITÉ RECHERCHE Lagrange (BQR), France 2017 and partially by the ANR ORIGINS, France (ANR-18-CE31-0014). The work of C.A. was supported by the French National Research Agency under the project ''Investissements d'Avenir'' UCAJEDI with the reference number ANR-15-IDEX-01. This work was supported by the Programme National de Planétologie (PNP), France of CNRS/INSU, co-funded by CNES, France and by the program ''Flash!'' supported by Crédits Scientifiques Inditatifs (CSI), France of the Université Nice Sophia Antipolis. D.B. and C.S. were supported by the NASA, USA Solar System Exploration Research Virtual Institute cooperative agreement number NNA14AB05A to the Center for Lunar and Asteroid Surface Science. Authors would like to thank C. Pompeo from the CSTB (Grenoble) for his help with the measurement of the thermal properties. The laboratory 3SR is part of the LabEx Tec 21, supported by the project ''Investissements d'Avenir, France'' with the reference number ANR-11-LABX-0030.

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