AN ASTEROID REGOLITH SIMULANT FOR HYDRATED CARBONACEOUS CHONDRITE LITHOLOGIES (HCCL-1).

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Introduction: Simulants of extraterrestrial lithologies are commonly used in testing equipment designed to collect samples or to otherwise interact with them *in situ*. The OSIRIS-Rex mission will sample the surface regolith of 101955 Bennu, a dark (presumed carbonaceous), low density, near-Earth asteroid[1, 2]. The mission's TAGSAM sampling device is being tested on a variety of stimulants including one designed to represent the physical and magnetic properties of the ungrouped Tagish Lake meteorite[3] which was recovered with relatively little weathering[4]. (presumed to be broadly representative of strongly altered carbonaceous chondrite lithologies (e.g., CI, CM).

Simulant Qualities and Manufacture: The HCCL-1 design attempts to simulate the density, porosity, strength, elastic and magnetic properties to be encountered on Bennu. The chosen constituents crudely replicate Tagish Lake mineralogy, so HCCL-1 probably also roughly simulates other material properties.

Components. HCCL-1 contains four fine-grained components with volume proportions as follows: 85% saponite (mixed Na, Mg); 10% magnetite; 5% charcoal; trace India ink. All components are commercially obtainable.

Manufacture. Components are dry mixed then wet mixed in water; mixing with the minimum necessary amount of water minimizes drying time (the longest process step). Checking internal stimulant structure on "polished" surfaces in multiple lots indicates that textural brecciation can occur in wetter mixes requiring care in preparation. After drying, lumps are crushed with a press at up to ~200 psi to produce more realistic clast shapes.

Physical Properties: Measured simulant densities (multiple lots) range from 1.65 to 1.8 gcm^{-3}, grain densities 2.65-2.7 gcm^{-3}, and microporosities 34–40% are comparable to those of Tagish Lake[4]. Seismic velocities and strengths are typical of porous, weak rocks such as claystones: V_p 1.46-1.59 kms^{-1}; V_s 1.0-1.05 kms^{-1}. Preliminary uniaxial compression failure strengths are 22-37 MPa. HCCL-1 is sufficiently homogenous that all size particles are magnetically attracted. The Bennu surface regolith is expected to be (at least in part) a loose aggregate with high macroporosity. Measurements in HCCL-1 aggregate require partial compaction to transmit sufficient energy for signal detection, resulting in measured V_p at least as low as ~0.4 kms^{-1}. However, even lower V_p of ~0.1 kms^{-1} are expected for Bennu regolith based upon in situ lunar regolith and laboratory proxy aggregate measurements[5,6]. Linear extrapolation of the simulant laboratory seismic data yields a V_p geometric mean of 0.13 km/s (in simulant with ~50% macroporosity) consistent with the lunar regolith.

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