Sample curation in support of the OSIRIS-REx asteroid sample return mission

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The OSIRIS-REx asteroid sample return mission launched to asteroid Bennu Sept. 8, 2016. The spacecraft will arrive at Bennu in late 2019, orbit and map the asteroid, and perform a touch and go (TAG) sampling maneuver in July 2020. After sample is stowed and confirmed the spacecraft will return to Earth, and the sample return capsule (SRC) will land in Utah in September 2023. Samples will be recovered from Utah [2] and then transported and stored in a new sample cleanroom at NASA Johnson Space Center in Houston [3]. The materials curated for the mission are described here.

a) Materials Archive and Witness Plate Collection: The SRC and TAGSAM were built between March 2014 and Summer of 2015, and instruments (OTES,OVIRS, OLA, OCAMS, REXIS) were integrated from Summer 2015 until May 2016. A total of 395 items were received for the materials archive at NASA-JSC, with archiving finishing ~30 days after launch (with the final archived items being related to launch operations)[4]. The materials fall into several general categories including metals (stainless steel, aluminum, titanium alloys, brass and BeCu alloy), epoxies, paints, polymers, lubricants, non-volatile-residue samples (NVR), sapphire, and various miscellaneous materials. All through the ATLO process (from March 2015 until late August 2016) contamination knowledge witness plates (Si wafer and Al foil) were deployed in the various cleanrooms in Denver and KSC to provide an additional record of particle counts and volatiles that is archived for current and future scientific studies. These plates were deployed in roughly monthly increments with each unit containing 4 Si wafers and 4 Al foils. We archived 128 individual witness plates (64 Si wafers and 64 Al foils); one of each witness plate (Si and Al) was analyzed immediately by the science team after archiving, while the remaining 3 of each are archived indefinitely. Information about each material archived is stored in an extensive database at NASA-JSC, and key summary information for each will be presented in an online catalog.

b) Bulk Asteroid sample: The Touch and Go Sampling Mechanism (TAGSAM) head will contain up to 1.5 kg of asteroid material. Upon return to Earth, the TAGSAM head with the sample canister will be subjected to a nitrogen purge and then opened in a nitrogen cabinet in Houston. Once the TAGSAM head is removed from the canister, it will be dis-assembled slowly and carefully under nitrogen until the sample can be removed for processing in a dedicated nitrogen glovebox. Bennu surface samples are expected to be sub-cm sized, based on thermal infrared and radar polarization ratio measurements [1]. The upper limit on material collected by the TAGSAM head is ~2 cm. Therefore, we will be prepared to handle, subdivide, and characterize materials of a wide grain size (from ~10 μm to 2 cm), and for both organic (UV fluorescence) and inorganic (SEM, FTIR, optical) properties. Representative portions of the bulk sample will be prepared for JAXA (0.5 %; see also [5]) and Canadian Space Agency (4%), with the remaining divided between the science team (<25%) and archived for future studies (NASA) (>75%).

c) Contact Pad samples: The base of the TAGSAM head contains 24 contact pads that are designed to trap the upper surface layer of material and thus offer an opportunity to study asteroid samples that have resided at the very top surface of the regolith. Asteroid material is trapped on the pads in spring steel Velcro hooks, and material will have to be removed from these pads by curation specialists in the lab.

d) Hardware: Some canister and SRC hardware items will contain information that will be important to understanding the collected samples, including the canister gas filter, temperature strips, flight witness plates, and the TAGSAM and canister parts that might have adhering dust grains.

Some challenges remaining for both bulk sample and contact pad samples include: i) working with intermediate size range (200 to 500 μm) samples – a size range NASA has not previously worked in such detail; ii) techniques for removal of contact pad material from the spring steel hooks, iii) static electrical effects of dust sized particles during sample handling and curation is likely to be significant, and iv) the TAGSAM head and associated canister hardware will undoubtedly be coated with fine adhering dust grains from Bennu. In the case of collection of a large bulk sample mass, the adhering dust grains may be of lower priority. If a small sample mass is returned, the adhering dust may attain a higher priority, so recovery of adhering dust grains is an additional challenge to consider. In the year leading up to sample return we plan a variety of sample handling rehearsals that will enables the curation team to be prepared for many new aspects posed by this sample suite.

References: [1] Lauretta, D.S. et al. (2017) Space Science Reviews, in press. [2] Pace, L. et al. (2017) this meeting. [3] Zeigler, R. et al. (2017) this meeting. [4] Dworkin, J. et al. (2017) Space Science Reviews, in press. [5] Nakamura-Messenger, K. et al., this meeting.