INITIAL ANALYSIS OF THE OSIRIS-REx SAMPLE FROM ASTEROID BENNU: AN OVERVIEW OF THE PETROGRAPHY AND PETROLOGY.

H. C. Connolly Jr.[1,2,3], T. J. McCoy[4], S. S. Russell[5], D. S. Lauretta[3], and the OSIRIS-REx Sample Analysis Team. [1]Rowan University, Glassboro, NJ USA (connollyh@rowan.edu); [2]American Museum of Natural History, New York, NY USA; [3]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA; [4]National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; [5]Natural History Museum, London, UK.

Introduction: The Sample Return Capsule (SRC) of NASA's OSIRIS-REx spacecraft, containing pristine carbonaceous material from asteroid Bennu, landed in the Utah desert on September 24, 2023 [1,2]. By the end of the next day, the sample was safely stored in N_2 within a glovebox in the OSIRIS-REx cleanroom at NASA Johnson Space Center (JSC) [3]. A mass of 138 mg of material, known as the quick-look (QL) sample, was allocated on September 28 for immediate analysis [4,5]. By October 26, allocation of larger aggregate samples to Geographic Coordinators (GCs) for analysis and hypothesis testing began [4]. We present a high-level overview of the initial findings from these analyses and set up the related abstracts in this session.

Characterization of hand samples: Our data are based on observations of the bulk collection. Most particles are very dark in visible light, with one lithologic type containing many specular grains. A few particles are white, grey, or greyish green and may be a different lithology from the darker rocks. The morphologies of particles are strikingly like those of boulders observed on Bennu's surface [6,7], including breccias [8]. The major morphological types of particles are (i) angular with apparent layering and/or stepped structures with or without linear features; (ii) angular with smooth surfaces; (iii) hummocky or cauliflower-like; and (iv) flat to tabular.

3-D structure: The 3-D structure of some particles was analyzed by XCT to provide key petrographic data [7] and will be used to guide cutting of larger particles.

Mineral phases: To date, data from QL and GC analyses are based on whole particles or polished sections of a size range from fine (<100 µm) to coarse (500-5000 µm). The <u>major phases</u> [5] are phyllosilicates (serpentine + smectite). <u>Minor phases</u> [3] include oxides (magnetite); sulfides (pyrrhotite + pentlandite + sphalerite + Cu-rich + alabandite); and carbonates [5,8]. <u>Trace phases</u> [5] include anhydrous silicates [9]; phosphates [5,10]; phosphides [11]; oxides; halides; and carbonaceous matter [12].

Overall petrography: Our observations show that Bennu samples experienced a high degree of pervasive aqueous alteration, with interparticle variations in extent, within Bennu's parent body. Serpentine and smectite are mostly intermixed throughout all samples in either massive or fibrous forms, the former rich in fine sulfides. Magnetite is abundant either as isolated grains or as framboids and is also found concentrated in distinct regions mimicking or replacing veins. Sulfide abundance and habit vary and include large pyrrhotites exhibiting euhedral shapes, or cross-sections through such forms, and fine dispersed anhedral particles. Carbonates are dispersed as individual particles or as concentrations and often found as assemblages with magnetite and/or pyrrhotites with interparticle variations in overall abundance. Tantalizingly, we observe vugs partially filled with fibrous phyllosilicates, frequently with magnetites found with at least a pair of pyrrhotites in a 'V' pattern that may have replaced a previous phase assemblage. Trace phases appear randomly distributed and may not be present in every particle. A surprise are phosphates, which appear as isolated particles, euhedral to anhedral, and as possible veins or as surface coating (possible former veins) on abraded surfaces. These may be more abundant as we process more sample. No non-carbonaceous chondrite material, obvious protolith rock, definitive chondrules or CAIs, or clear evidence of major shock have been found. Evidence of space weathering is observed [13].

Implications: Our data support the hypotheses that at least two lithological types exist on Bennu and that its parent body was geologically active, potentially with multiple aqueous alteration events with evolving fluid(s) (e.g. pH, Eh, activities) during early metamorphism. For aqueous alteration to have occurred, water was needed, and thus Bennu's parent body formed beyond the snow line where ice and rock were accreted together.

Acknowledgments: Supported by NASA under Contract NNM10AA11C.

References: [1] Lauretta et al. (2017) *Space Sci /Rev, 212,* 925-984. [2] Lauretta and Connolly et al. (2023) AGU. [3] Righter et al. (2023) *MAPS, 58,* 572-590. [4] Lauretta et al. (2023) *arXiv [astro-ph.EP]* 2308.11794. [5] Zega et al. (2024) this conf. [5] Jawin et al. (2023) *JGR Planets, 128*, e2023JE008019. [6] Ishimaru et al. (2024) this conf. [7] McCoy et al. (2024) this conf. [8] Libourel et al. (2024) this conf. [9] Russell et al. (2024) this conf. [10] Barnes et al. (2024) this conf. [11] Smith et al. (2024) this conf. [12] Nguyen et al. (2024) this conf. [13] Thompson et al. (2024) this conf.