EARLY OSIRIS-REx MISSION RESULTS FROM STANDARD AND WET CHEMISTRY PYROLYSIS OF SAMPLES RETURNED FROM ASTEROID BENNU. A. Mojarro[1,2,*], J. C. Aponte[2], J. P. Dworkin[2], D. P. Glavin[2], J. E. Elsila[2], H. C. Connolly Jr[3,4,5], and D. S. Lauretta[4]. [1]NASA Postdoctoral Program, Oak Ridge Associated Universities, Oak Ridge, TN, USA, [2]NASA Goddard Space Flight Center (GSFC), Greenbelt, MD, USA, [3]Rowan University, Glassboro, NJ, USA, [4]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA, [5]American Museum of Natural History, New York, NY, USA. *E-mail: angel.mojarro@nasa.gov

Introduction: On September 24, 2023, samples collected from the B-type carbonaceous asteroid Bennu by NASA's OSIRIS-REx mission returned materials to Earth expected to have recorded the chemical evolution of the early solar system. One hypothesis in the OSIRIS-REx Sample Analysis Plan states that Bennu likely contains a diverse suite of prebiotically relevant compounds (e.g., amino acids and nucleobases) which may have been delivered by meteorites to the early Earth (and perhaps elsewhere) and contributed to the origins of life [1]. The goal is to understand the abiotic formation and secondary alteration (e.g., aqueous, thermal) of organic compounds in parent bodies through the coordinated analysis of returned samples [1]. Here we present early mission results from pyrolysis–gas chromatography–triple-quadrupole mass spectrometry (*py*-GC-QqQ-MS) used to characterize Bennu's bulk organic composition.

Samples: Fines discovered on the return-capsule avionics deck during the "quick-look" (QL) stage of sample analysis (OREX-500002-0) and an aggregate sample from within the Touch-and-Go Sample Acquisition Mechanism (TAGSAM) (OREX-800031-0) consisting of fine- to intermediate-sized particles of distinct lithologies were distributed for coordinated organics analysis [2, 3, 4]. Two ~1 mg subsamples were collected from each parent aggregate sample for standard pyrolysis at 600°C to target insoluble organic matter [5] and wet chemistry pyrolysis at 250°C in the presence of a silylation reagent to derivatize and detect soluble organic matter [6]. Analyses were conducted in parallel with similar quantities of the Murchison carbonaceous chondrite along with procedural and reagent blanks.

Methods: Pyrolysis was conducted on a CDS 6200 pyroprobe interfaced to a Thermo TRACE 1600 GC with 30 m Rtx-5ms column coupled to a TSQ 9610 MS operated in simultaneous multiple reaction monitoring (MRM) and full scan (50-500 *m*/*z*) modes. Samples for wet chemistry pyrolysis were first incubated offline with 5 µL N-tert-butyldimethylsilyl-N-methyltrifluoroacetamide (MTBSTFA) with N,N-dimethylformamide (DMF) (4:1, v/v) in a capped 2 mL vial on a heating block at 85 °C for 1 hr, passively cooled to room temperature, then transferred into the pyroprobe. The MS scanned for MRM transitions targeting silylated amino acids and N-heterocycles. Compound identification was conducted via comparison with retention time and three MRM transitions of standards.

Results & Discussion: Standard pyrolysis of the QL fines primarily revealed 1-4 ring polycyclic aromatic hydrocarbons (PAHs) and S-, O-, and N-containing compounds. Detections included benzene, naphthalene, anthracene, phenanthrene, fluoranthene, and pyrene along with their C_1 up to C_5 alkylated species characteristic of meteoritic samples like Murchison [5]. In contrast, the TAGSAM aggregate displayed a lower naphthalene signal than Murchison, no detection of 3-4 ring PAHs, and traces of O- and N-compounds. The molecular distribution of C_1-C_4 alkylbenzenes and alkylthiophenes remained comparable to QL and Murchison.

Wet chemistry pyrolysis identified silylated amino acids and N-heterocycles in both QL and TAGSAM samples. Detections included glycine, alanine, leucine, isoleucine, valine, methionine, aspartic acid, proline, serine, threonine, phenylalanine, pyroglutamic & glutamic acid, asparagine, imidazole, isocytosine, 5-methylcytosine, cytosine, 2- & 4-imidazole carboxylic acid, uracil, thymine (5-methyluracil), and 1- & 6-methyluracil. Results from QL displayed quantitation signals more than 100x relative to the co-analyzed Murchison for alanine and glycine. TAGSAM responses were either comparable or slightly below those detected in Murchison.

Future pyrolysis experiments on distinct lithologies, rather than aggregate samples, will help address the degree and significance of chemical heterogeneity observed here. Early results indicate Bennu holds many of the building blocks of life, including amino acids [2] and nucleobases, and may provide new insights to our origins. This is important because exogenous delivery of organics synthesized within the early solar system may represent a significant source of prebiotic compounds to planetary surfaces [7].

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