ADVANCED CURATION ACTIVITIES AT NASA: IMPLICATIONS FOR ASTROBIOLOGICAL STUDIES OF FUTURE SAMPLE COLLECTIONS F. M. McCubbin, C. A. Evans, M. D. Fries, A. D. Harrington, A. B. Regberg, C. J. Snead, R. A. Zeigler, NASA Johnson Space Center, 2101 NASA Parkway, Mail Code XI2, Houston, TX 77058. francis.m.mccubbin@nasa.gov.

Introduction: The Astromaterials Acquisition and Curation Office (henceforth referred to herein as NASA Curation Office) at NASA Johnson Space Center (JSC) is responsible for curating all of NASA's extraterrestrial samples. Under the governing document, NASA Policy Directive (NPD) 7100.10F JSC is charged with curation of all extraterrestrial material under NASA control, including future NASA missions. The Directive goes on to define Curation as including documentation, preservation, preparation, and distribution of samples for research, education, and public outreach. Here we briefly describe NASA's astromaterials collections and our ongoing efforts related to enhancing the utility of our current collections as well as our efforts to prepare for future sample return missions. We collectively refer to these efforts as advanced curation.

NASA Curation: The NASA Curation Office presently curates nine different astromaterials collections: (1) Apollo samples, (2) Luna samples, (3) Antarctic meteorites, (4) Cosmic dust particles, (5) Microparticle Impact Collection [formerly called Space Exposed Hardware], (6) Genesis solar wind atoms, (7) Stardust comet Wild-2 particles, (8) Stardust interstellar particles, and (9) Hayabusa asteroid Itokawa particles.

In addition, the next missions bringing samples to JSC are Hayabusa 2/ asteroid Ryugu and OSIRIS-Rex/ asteroid Bennu, in 2021 and 2023, respectively. We currently house contamination knowledge (CK) witness plates for OSIRIS-REx, and we will soon begin curating CK witness plates for the Mars 2020 mission, which is going to collect and cache martian samples for possible future return to Earth.

To ensure that we are keeping the samples as pristine as possible, we routinely monitor the cleanliness of our clean rooms and infrastructure systems. This monitoring includes measurements of inorganic and organic contamination in processing cabinets [1-2] and weekly airborne particle counts in most labs. Each delivery of LN_2 is monitored for contaminants, and the stable isotope composition of the gaseous N_2 is measured monthly. The quality of our UPW system is monitored daily.

Advanced Curation: The NASA Curation Office plans for the requirements of future collections in an "Advanced Curation" program. Advanced Curation is tasked with developing procedures, technology, and data sets necessary for curating new types of collections as envisioned by NASA exploration goals. Here we review the advanced curation efforts we plan to make that will be directly relevant to astrobiological studies of future sample collections that could be returned from habitable worlds within our Solar System.

As each new sample collection is returned, new facilities are added to accommodate them. In addition to organic and inorganic cleanliness monitoring and cleaning, we are preparing to undertake a comprehensive study of the microbial ecology of our current clean labs and astromaterials collections. This activity will define the baseline of microbial contamination in our labs, and it will provide us with a benchmark with which to compare and test the biological cleaning protocols that we will develop. This activity will have particular relevance to the astrobiology sample science community, and it provides a unique environment to look for extremophiles capable of surviving in clean room environments [3-4]. The microbial assessment of our collections will also provide critical inputs to toxicological assessments of astromaterials dusts because the presence of lipopolysaccharides or endotoxins can exacerbate and even outpace pulmonary responses to the physicochemical properties of dust [5-6]. Consequently, toxicological studies to understand the contribution to astronaut health burdens due to exposure to astromaterials dust require the use of samples that are not contaminated by microbes.

Concluding Remarks: The return of every extraterrestrial sample is a scientific investment, and the curation facilities and personnel are the primary managers of that investment. Our primary goals are to maintain the integrity of the samples and ensure that the samples are distributed for scientific study in a fair, timely, and responsible manner. It is only through the long-term stability and support of curation facilities, coupled with the infusion of technological advances realized through new advanced curation initiatives that the maximum returns on that scientific investment are achieved. In the coming decades, sample return missions will increase in their complexity with respect to sample storage and sample handling requirements as we set our sights on astrobiologically significant targets for sample return. Our advanced curation efforts today ensure we will be poised to curate and handle these samples upon return.

References: [1] Calaway, M.J., et al., (2014) NASA TP-2014-217393, July 1, pp. 108. [2] Allen, C. et al., (2011) Chemie Der Erde-Geochemistry, 71, 1-20. [3] Ghosh, S. et al., (2010) Astrobiology, 10, 325-335. [4] La Duc, M., et al., (2014) Astrobiology, 14, 15-23. [5] Degobbi, C., et al. (2011) Aerobiologia. 27: 97. [6] Hirohisa T. et al., (2002) Am J Respir Crit Care Med Vol 165. pp 1329–1335.