ASTROBIOLOGICAL POTENTIAL OF ROCKS ACQUIRED BY THE PERSEVERANCE ROVER IN JEZERO CRATER, MARS

T. Bosak[1], D. L. Shuster[2], B. P. Weiss[1], S. Siljeström[3], L. Mayhew[4], E. L. Scheller[1], J. Simon[5], K. Hickman-Lewis[6], K. Stack[7], K. A. Farley[7], J. Bell III[8], K. Benison[9], A. Brown[10], C. D. K. Herd[11], M. B. Madsen[12], J. Nunez[13], S. Sharma[14], A. Steele[15], M. Wadhwa[8], A. Williams[16]

[1]Massachusetts Institute of Technology, Cambridge, MA, tbosak@mit.edu, [2] University of California, Berkeley, Berkeley, CA, [3] RISE Research Institutes of Sweden, Stockholm, Sweden, [4] University of Colorado Boulder, Boulder, CO, [5]NASA Johnson Space Center, Houston, TX, [6] The Natural History Museum, London, UK and 2) Dipartimento BiGeA, Università di Bologna, Bologna, Italy, [7] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [8]Arizona State University, Tempe, AZ, [9]West Virginia University, Morgantown, WV, [10] Plancius Research, MD, [11] University of Alberta, Edmonton, AB, Canada, [12] University of Copenhagen, Copenhagen, Denmark, [13] Applied Physics Laboratory, Baltimore, MD, [14] University of Hawaii, HI, [15] Carnegie Institution for Science, Washington, DC, [16] University of Florida, Gainesville, FL

Introduction: The scientific community has prioritized the return of Martian rock samples with known geologic context for more than a decade (Beatty et al., 2019). Thus, the main objectives of the Perseverance rover mission on Mars include identifying past habitable environments, collecting rocks that are likely to preserve biosignatures and using the rover's instruments to look for potential biosignatures in these rocks (Farley et al., 2020). Here, we present an overview of the bedrock samples collected by the Perseverance rover in Jezero crater to date and discuss the potential of the sampled materials to address astrobiological questions upon sample return to Earth.

Sample collection and documentation: In its four campaigns, Perseverance explored Jezero crater and drilled eight rock samples from the igneous crater floor (Simon et al., 2023) and twelve aqueously deposited sedimentary rocks from the western sediment fan in Jezero and its margin. The collected rock cores are pencil-sized and oriented in the absolute Martian geographic coordinates (Weiss et al., in press). Initial Reports document the sample lithologies and compositions, their geologic and stratigraphic context, and rationale for sampling and are available publicly at the NASA Planetary Data System at https://pds-geosciences.wustl.edu/missions/mars2020/returned_sample_science.html

Geological context and compositions: All sampled rocks have a well-constrained geologic context (Stack et al., submitted) and known chemical compositions. The samples from the crater floor are igneous and range from olivine cumulate to a basalt and basaltic andesite; all aqueously altered (Simon et al., 2023). Perseverance encountered aqueously deposited sedimentary rocks at the front, top and margin of the western Jezero fan and collected a suite composed of six sandstones, a sulfate-rich mudstone, a sulfate-rich sandstone and a sand-pebble conglomerate. All sandstones are hydrated, contain Fe/Mg carbonates, aqueously altered olivine and pyroxene and a variety of minor phases such as Fe-Ti and Fe-Cr oxides, phosphate minerals and zircon/baddeleyite. Sandstones from the fan top and margin contain both Fe/Mg carbonates and hydrated silica. The sulfate-rich mudstone and sandstone from the fan front contain clay minerals and up to 20 wt% SO_3 in hydrated Mg/Fe sulfates and numerous anhydrite veins and grains. Organic signals were not confidently detected in any of the analyzed rocks, which indicates organic concentrations below ~ 0.1 wt% (Scheller et al., 2023) and necessitates organic analyses of returned samples.

Return sample science and astrobiology potential: Upon return to Earth, the collected materials could be analyzed to address major outstanding questions in the history of Martian habitability, volatiles and climate. Carbonates, sulfates, clay minerals and hydrated silica in sedimentary rocks could be examined for the presence of organic compounds and potential textural biosignatures. Water, carbon and other volatiles in all samples would provide insights into when and how Mars lost its water and its CO_2-rich atmosphere. Sulfate- and clay-rich mudstones have the highest astrobiological potential due to the fine grain size, the abundance of clay minerals that may preserve organic compounds and precipitated minerals that could preserve fluid inclusions (Benison et al., in review). Geochronology and paleomagnetic studies could use the igneous rocks as well as the detrital grains and iron oxide minerals in the collected sandstones and the sand-pebble conglomerate to constrain the time when the water flowed and deposited sediments in Jezero fan, when minerals such as carbonate precipitated, and how Martian dynamo, climate and habitability co-evolved.

References:

Beatty, D. et al., (2019) *MaPS*, *54*, S3-S152.
Benison, K. et al. (submitted) *JGR Planets.*
Farley, K.A. et al. (2020) *SSR*, *216*, 1-41.
Scheller et al. (2023) AGU, *Abstract #* 1293635.
Simon et al. (2023) *JGR Planets*, *128*, e2022JE007474.
Stack et al. (submitted) *JGR Planets.*
Weiss et al., (in press) *ESS.*