THE FIRST 300 SOLS OF THE SHERLOC INVESTIGATION ON THE MARS 2020 ROVER. A. E. Murphy¹¹, L. W. Beegle¹, R. Bhartia¹.², W. Abbey¹, S. Asher³, E. Berger⁴.5.6, A. Burton⁴, S. Bykov³, E. Cardarelli¹, S. Cleggⁿ, P. Conrad³, L. DeFlores¹, K. S. Edgettゥ, B. Ehlmann¹⁰, A. Fox⁴, M. Fries⁴, J. Razzell Hollis¹, L. Kah¹¹, M. R. Kennedyゥ, C. Lee⁴, M. Minitti¹², R. Roppel³, E. L. Scheller¹⁰, S. Sharma¹, S. Shkolyar¹³.¹⁴, S. Siljeström¹⁵, C. Smith¹⁶, P. Sobron¹⊓, A. Steele³, K. Uckert¹, R. Wiens⊓, A. Williams¹³, K. Williford¹, B. Wogsland¹¹, R. A. Yingst¹ゥ, and the SHERLOC team. ¹Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA, 91109 (Luther.Beegle@jpl.nasa.gov), ²Photon Systems Inc., ³University of Pittsburgh, ⁴NASA Johnson Space Center, ⁵Texas State University, ⁶Jacobs JETS, ⁶Carnegie Institute Washington, ¬Los Alamos National Laboratory, ⁰Malin Space Science Systems, ¹⁰California Institute of Technology, ¹¹University of Tennessee-Knoxville, ¹²Framework, ¹³NASA Goddard, ¹⁴Blue Marble Space Institute of Science, ¹⁵RISE Research Institutes of Sweden, Stockholm, Sweden, ¹⁶Natural History Museum, London, ¹¬SETI Institute, ¹³University of Florida, ¹⁰Planetary Science Institute.

Introduction: During the first 300 sols on Mars, the Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals (SHERLOC) instrument has been used to analyze 5 rock abrasion patches during the 'Crater Floor Campaign' within Jezero crater. Abraded rock surfaces allow for the observation of rock and mineral textures by SHERLOC's imagers that are otherwise not visible on weathered rock surfaces. Observing abraded rock surfaces allows for micron-scale identification and spatial correlation between rock texture, minerals, and organics. SHERLOC's Raman spectra have been used to identify phosphates, sulfates, carbonates, perchlorates, olivine, and amorphous (glass-like) or microcrystalline silicate phase(s) (AMS). Fluorescence observed within abraded sample surfaces is usually spatially correlated with minerals. Within these detections, we have observed evidence of past water interaction with these rocks.

Background: The Mars2020 mission is NASA's latest flagship mission to Mars. The spacecraft launched in July 2020, and landed in Jezero crater on February 18, 2021 at the Octavia E. Butler Landing site. The rocks and sediments of Jezero crater are anticipated to have preserved records of past, potentially habitable environments. The mission is characterizing these environments by analyzing outcrop geochemistry, characterizing the presence and nature of organic molecules, and in environments with high preservation potential, searching for potential biosignatures.

SHERLOC is a robotic arm mounted instrument. SHERLOC combines imaging with UV resonance Raman and native deep UV fluorescence spectroscopy to identify potential biosignatures and understand the aqueous history of the Jezero Region [1]. WATSON (Wide Angle Topographic Sensor for Operations and eNgineering), a reflight of the Mars Hand Lens Imager (MAHLI) on the Curiosity rover is capable of color imaging over a wide range of resolutions (from infinity to 13.1 micron/pixel) and is used for both science and engineering. A second imager, the Autofocusing Contextual Imager (ACI), produces gray scale images at 10.1 micron/pixel resolution at a 48 mm range [1].

Results: As of Sol 300, we have explored 5 different abraded rock patches. Although other payload instruments (e.g., PIXL, SuperCam, MastCam-Z) may have observed the same targets (Fig. 1), we present here only the observations from SHERLOC.

The <u>Guillaumes</u> target (from the Roubion outcrop, Roubion member of the Máaz Fm) is dominated by Casulfate with patches of perchlorate. The presence of perchlorate indicates these rocks have undergone aqueous alteration and this material was either emplaced after being created in atmospheric processes, or is indigenous to the sample through processes described elsewhere [7,8].

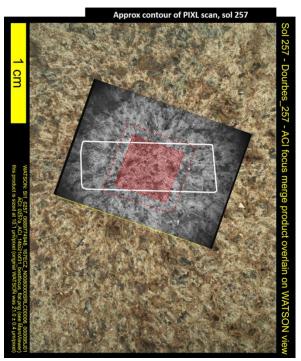


Fig. 1 Color WATSON image of the Dourbes abraded patch with the gray scale ACI overlay. The SHERLOC Survey scan is indicated by red dots, with the PIXL overlay in white.

The <u>Bellegarde</u> target (from the Rochette outcrop, Rochette member of the Máaz Fm) exhibits Raman

peaks that match hydrated Ca-sulfate, AMS, carbonate, and phosphate phases. Collocated 300 and 325 nm fluorescence spectral features with sulfate phases observed within the target may be aromatic ring organics [8].

The <u>Garde</u> target (from the Bastide outcrop, Bastide member of the Séítah Fm) is dominated by olivine and carbonate with AMS occurring in association with both mineral phases. This co-occurrence may indicate carbonation of the primary olivine via an aqueous alteration process, producing carbonate and AMS phases [8,9]. Localized 290 and 335 nm fluorescence spectral features are observed along the olivine and carbonate grain boundaries. Fluorescence spectral features along grain boundaries may be linked to the redistribution of organics during aqueous alteration whereby fluids altered minerals during diagenesis or metamorphism.

The <u>Dourbes</u> target (from the Brac outcrop, Bastide member of the Séítah Fm) (Fig. 1) is dominated by olivine and shows minor amounts of carbonate, hydrated Ca-sulfate, and AMS (Fig. 2). Fluorescence features (330-340 nm) are detected in discrete spots and do not appear to be associated with minerals.

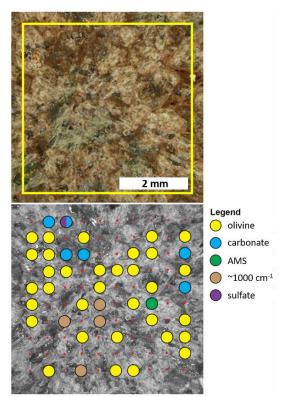


Fig. 2 WATSON image (left) of Dourbes target where yellow box denotes SHERLOC scan area (right). Gray scale ACI with mineral identification (see legend) overlay. Small red dots denote analyzed areas with currently unconfirmed mineral identification.

The <u>Quartier</u> target (from the Issole outcrop, Bastide member of the Séítah Fm) exhibits a large sulfate feature (white feature in Fig. 3), as well as carbonate, perchlorate, olivine and a fluorescence doublet at 290 and 330 nm; this fluorescence feature is very similar to the Bellegarde fluorescence doublet.

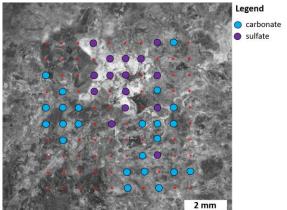


Fig. 3 Gray scale ACI with mineral identification (see legend) overlay in the Quartier target. Small red dots denote analyzed areas with currently unconfirmed mineral identification.

Summary: The presence of perchlorates (<u>Guillaumes</u>) and the association of amorphous/microcrystalline silicate with olivine/carbonate phases (<u>Garde</u>) suggests aqueous alteration of the rocks analyzed in the 'Crater Floor' geologic units including the Máaz Formation (mapped from orbit as Cf-fr) and Séítah Formation (mapped from orbit as Cf-f-1) in Jezero crater.

The *Perseverance* payload is equipped with complementary instruments so that mineral data collected (SHERLOC, SuperCam) may be compared to elemental data collected (SuperCam, PIXL) to better interpret the geologic history at Jezero crater and determine the site's potential for habitability. We continue to work with the other Mars2020 instrument teams to better interpret the aqueous history of these geologic units and connect fine-scale WATSON/ACI images and SHERLOC's Raman spectra to other rover- and orbital-derived data.

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References: [1] Beegle, L. W. et al. (2015) *IEEE*, 90, 1-11. Bhartia, R. et al. (2021) *Space Sci. Rev.*, 217, 58. [2] Abbey, W. J. et al. (2017) *Icarus*, 290, 201-214. [3] Sapers, H. et al. (2019) *Front. Microbiol.*, 10. [4] Razzell Hollis, J. et al. (2019) *App. Spec.*, in press. [5] Razzell Hollis, J. et al. (2020) submitted to Icarus. [6] Bhartia, R. et al. (2008) *App. Optics*, 62 (10). [7] Steele, A. et al. (2018) *Sci. Adv.*, 4. [8] Scheller, E. L. et al. (2022) LPSC. [9] Smith, B. et al. (2022) LPSC.