Mars ISRU Reconnaissance and Experimentation (MIREX) mission at Mawrth Vallis Jones Mays[1], [1]NASA SEES intern, 77030, (Jonesmays2@gmail.com)

Introduction: With the reviewed interest in space exploration and several proposed missions to Mars by private and public entities, there is a growing need to test new ISRU technologies for future human habitation on other celestial bodies. In this paper, an analog rover mission to Mars will be presented to test the feasibility of ISRU technologies that will be useful for future crewed missions. The main objectives of this mission to mars are to (O1) establish the potential for long term habitability on Mars, (O2) assess the current Martian climate/medical concerns, (O3) identify the mineral composition of the local regolith, and (O4) search for biosignatures of past life on the red planet.

Landing Site Selection: With regards to the landing site, it was selected based on its accessibility, natural resources, potential for finding signs of life, and usefulness for testing new ISRU processes. Furthermore, data from instruments such as CRISM, HRSC, MOLA, OMEGA, TES were used to compare the potential landing sites to the criteria above. In the end, Mawrth Vallis (23.986N, 341.049E) was selected as the processed site for this mission. Research has shown that Mawrth Vallis was a valley that was formed by water erosion caused by ancient floods.[2] Due to this site's formation, data collected from the instruments above supports that it is an excellent place to complete objective (O3) since its clay soil could have preserved the biosignatures of past life. In addition, this site has a relatively high concentration of many minerals such as igneous rocks, phyllosilicates, sulfates, and hydrous minerals that could be used for ISRU purposes.

Themis DCS/ TES DCS Map of Mawrth Vallis ISRU Targets with OMEGA Hydrous Mineral Detections

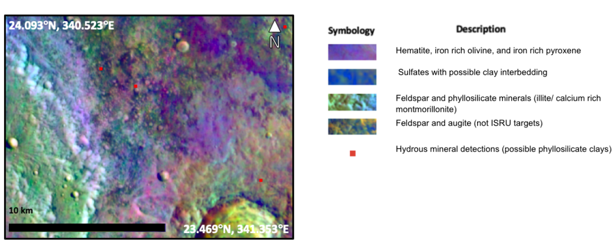

Figure 1. *THEMIS DCS / TES DCS and OMEGA data integrated and interpreted [1] using Java Mission-planning and Analysis for Remote Sensing version 5 software (2020)*

Instrument Selection: For this mission, instruments were chosen based on their ability to survive the Martian climate and complete the objectives explained in the introduction. The table below displays the devices selected, their capabilities, and the mission objectives that they complete.

Table 1. *Displays each instrument used along with its function, capability, and the objective it completes.*

Instrument & Function	**Capability**	**Objective completed**
REMS: "measures atmospheric pressure, temperature, humidity, winds, plus ultraviolet radiation levels." [5]	An operating temperature range of -130c to +70c [5] Maximum of three hours of operation per sol [5]	(O1) & (O2)
SuperCam: measures the mineralogy, chemistry, and molecular composition [4]	Uses Laser-induced Breakdown Spectroscopy [4] Raman, Time-Resolved Fluorescence, and Visible and Infrared Reflectance Spectroscopy [4] color remote micro-imager [4]	(O3) & (O4)
3D Printer: uses martian regolith and a binder in order to 3D printer relativity small structures [1]	10 x 10 x 10cm max sample volume 200mm per second max print speed [1] Monitors the effects of mars on the printed sutures	(O1)
Sabatier Reactor: uses the chemical equation with the help of a catalyst to produce methane and water from hydrogen and carbon dioxide. ($CO_2 + 4H_2 > CH_4 + 2H_2O$) [3]	Size 8in long and 1in in diameter [3] Working temp 240-450 C [3] Intake gas ratio 3.5 H to 5.5 CO2 [3] Vibration tested [3]	(O1)

Rover Traverse: The rover for this proposed mission will be landing in the eclipse shown in Figure 2 at (23.986N, 341.049E) to maximize the number of exciting sites it will be able to visit during its lifetime. In total, this mission involves 704.41 hours of roving and 26 to 34 days of simple analysis at the proposed sites. In the end, these statistics do not account for the many stops the rover might make on the way to its sampling sites.

Map of Rover Traverse

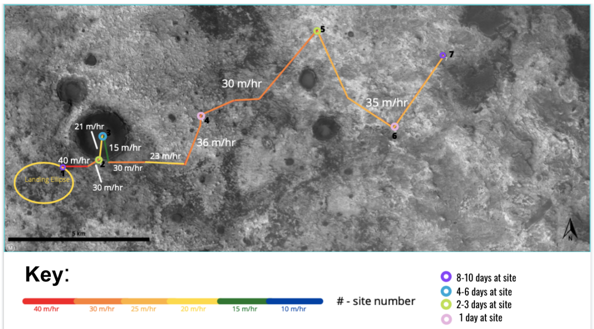

Figure 2*. Map of rover traverse on terrain with sampling sites. Furthermore, this was created using Java Mission-planning and Analysis for Remote Sensing version 5 software (2020)*

Table 1*. Displays each sampling site that the rover will visit and the objectives each site will address*

Rover site	**Objectives & Instruments**
Site 1: (23.986, 341.049) Time: 8-10 Days	Study gypsum, olivine, and phyllosilicates *Instruments:* SuperCam, 3D Printer.
Site 2: (23.991, 341.073) Time: 2-3 Days	Identify mineralogical differences between the valley and the crater. *Instruments:* SuperCam
Site 3: (24.007, 341.076) Time: 4-6 Days	Scan for biosignatures, perchlorates and make a mineralogical map. *Instruments*: SuperCam
Site 4: (24.02, 341.14) Time: 1 Day	Record weather conditions, small mineral analysis map. *Instruments:* SuperCam, REMS
Stie 5: (24.076, 341.217) Time: 2-3 Day	Record weather conditions and create a detailed mineral composition analysis map. *Instruments:* SuperCam, REMS.
Site 6: (24.0127, 341.2666) Time: 1 Day	Record weather conditions and create a detailed mineral composition analysis map. *Instruments:* SuperCam, REMS.
Site 7: (24.06, 341.3) Time: 8-10 Day	Search for biosignatures near the delta, extract water from hydrous minerals, and study basalt. *Instruments:* SuperCam, Sabatier, 3D Printer.

Conclusion: This mission in Mawrth Vallis aims to test ISRU technologies that will be used for future crewed missions to Mars. Furthermore, this will primarily be done by the Rems, Supercam, 3d printer, and Sabatier reactor devices on the rover as it traverses through the valley.

Acknowledgments: All figures and tables were made using data collected by the CRISM, HRSC, MOLA, OMEGA, or TES satellites. In addition, this data was processed and displayed using Java Mission-planning and Analysis for Remote Sensing version 5 software (2020).

References: [1] 3D Printing Industry. (2020, May 15). *The Delta WASP 3MT CONCRETE 3D printer - technical specifications and pricing*. 3D Printing Industry. https://3dprintingindustry.com/news/the-delta-wasp-3mt-concrete-3d-printer-technical-specifications-and-pricing-171741/ [2] Gross, L., Carter, J., Poulet, F., Loizeau, D., Bishop, J., Horgan, B., & Michalski, J. (n.d.). *MAWRTH VALLIS -AN AUSPICIOUS DESTINATION FOR THE ESA AND NASA 2020*. Retrieved August 5, 2021, from https://www.hou.usra.edu/meetings/lpsc2017/pdf/2194.pdf [3] Junaedi, C., Hawley, K., Walsh, D., Roychoudhury, S., Abney, M., & Perry, J. (n.d.). *Compact and Lightweight Sabatier Reactor for Carbon Dioxide Reduction*. https://ntrs.nasa.gov/api/citations/20120016419/downloads/20120016419.pdf [4] mars.nasa.gov. (n.d.). *SuperCam for Scientists*. Mars.nasa.gov. Retrieved August 5, 2021, from https://mars.nasa.gov/mars2020/spacecraft/instruments/supercam/for-scientists/ [5] mars.nasa.gov. (2019). *REMS | Instruments – NASA's Mars Exploration Program*. NASA's Mars Exploration Program. https://mars.nasa.gov/msl/spacecraft/instruments/rems/