A Mission Outline For The Future Of ISRU and Martian Geology Royce Jacobs, SEES NASA Intern, roycejacobs10@hotmail.com, 5 Birchwood Drive, Medford, NJ 08055

Introduction: Mawrth Vallis is an interesting area on Mars because of it's interesting mineralogy and potential for ISRU. A mission to bring next-generation ISRU modules could revolutionize our understanding of the challenges of colonizing Mars and further our understanding of Martian history. This mission has been planned with the use of satellite data. This data helps not only to point out geologically interesting areas but also helps to plan a safe traverse path for a rover.

Site Mineralogy: Mawrth Vallis has a diverse mineralogy consisting mostly of four distinct categories. The first category is Ferrous minerals such as hematite and iron rich olivine and pyroxene. Next is Sulfates. These rocks are indicators that Mars once had large bodies of water.[1] The third category is feldspar and phyllosilicate minerals. The fourth category is feldspar and augite. This fourth category of minerals are important ISRU targets.

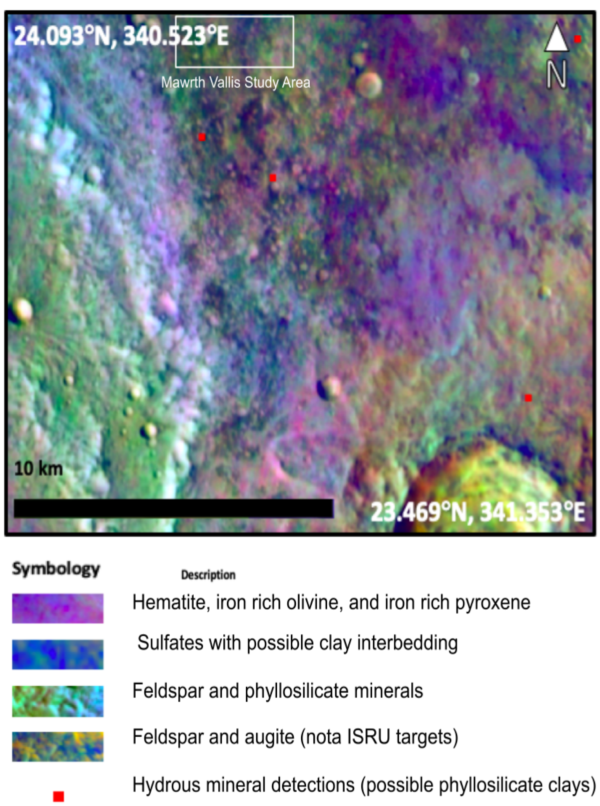

Figure 1. *A mineralogical map of the study site.*

Instrument Selection: The four instruments that we selected were Rover Environmental Monitoring Station (REMS), SuperCam, a 3D printer, and a Sabatier Reactor. The REMS instrument was chosen because it is very versatile and can mesure many of the ambient conditions around the rover. SuperCam was chosen because it can use VISIR spectroscopy to characterize mineralogy. The 3D printer uses minerals from the martian surface to make cement and 3D print structures. Finally, the Sabatier Reactor can convert carbon dioxide and hydrogen to methane and water. [2]

Site Selection: Sites were chosen based on their accessibility, scientific interest, and ISRU potential. Site 1 was chosen because of the high concentrations of olivine and gypsum. Site 2 was chosen because of mineralogical differences between the creator and the surrounding area. Site 3 was chosen because of the interesting meteorology. Site 4 was chosen because it was a safe place to stop to perform weather and atmospheric analysis. Site 5 was chosen because of interesting mineralogy. Site 6 was chosen because it was a safe place to stop to perform weather and atmospheric analysis. Site 7 was chosen because it has the best conditions and mineralogy to 3D print a structure.

***Table 1**. Site Coordinates and Time at each site Mars.*

Site #	Site Coordinates	Time at Site (days)
1	23.986, 341.049	8-10
2	23.991, 341.073	2-3
3	24.007, 341.076	4-6
4	24.02, 341.14	1
5	24.076, 341.217	2-3
6	24.0127, 341.2666	1
7	24.06, 341.3	8-10

Site Activities: At site 1, the viability for 3D printing with the olivine and gypsum at this site will be evaluated. In addition, there will be a study of phyllosilicate deposits to scan for biosignatures. At site 2, the mineralogical differences between the valley, and the crater will be investigated. At side 3, a scan for biosignatures and perchlorates will be conducted. At site 4, the atmospheric weather conditions will be studied along with making a small mineralogical map of the area. At site 5, a detailed mineral composition analysis map will be made. At site 6, the atmospheric weather conditions will again be studied along with making a small mineralogical map of the area. Finally, at site 7, a search for biosignatures near delta will be conducted. The rover will also attempt to extract water from hydrous minerals. The final plan for the rover will be to print a 3D structure at this site.

Rover Traverse: There are many challenges to using a rover on Mars. By careful route and site selection, many dangers can be avoided. Sites 1 and 2 are on the edge of a crater so care must be taken to avoid lips and larger crater ejecta.. Site 3 is in a crater. This means that the rover must drive slowly and carefully to avoid slipping down, getting stuck on a lip, or hitting a substantial bolder. Getting out of the crater also presents challenges such as steep slopes and getting stuck in sand dunes along with all the other normal difficulties. Traversing to the rest of the sites will mean avoiding the many hills and ridges along the way as well as large boulders that may not be easily identified from orbit.

Rover Traverse Time	Time (hrs)	Distance (km)
Site 1-2	43.83 hrs	2.52 km
Site 2-3	44.285 hrs	1.3 km
Site 3-4	209.865 hrs	4.41 km
Site 4-5	185 hrs	5.55 km
Site 5-6	140 hrs	4.9 km
Site 6-7	81.43 hrs	2.85 km
Total	704.41 hrs	21.53 km

Table 2. Traverse distances and times.

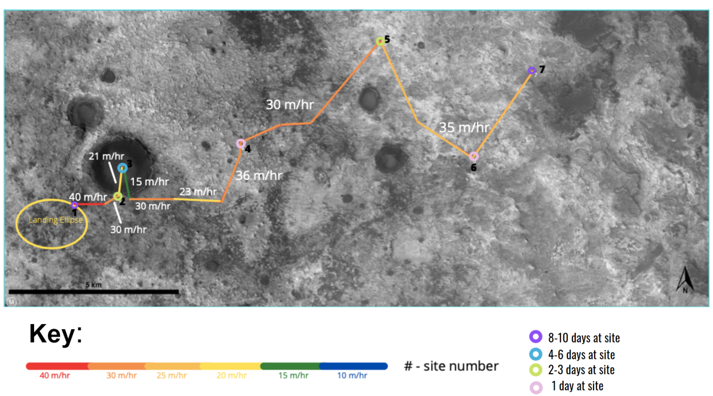

Figure 2. *The traverse path over the rover with the average traverse speed.*

Conclusion: Mawrth Vallis has interesting and varied mineralogy that can be safely traversed by a rover. Much can be learned by the use of a REMS instrument as well as a SuperCam on a rover in this area. In addition, Mawrth Vallis is an excellent place to test the revolutionary technology of 3D printing a structure on Mars. Finally, promising samples could be taken along the way for use in the sabatier reactor.

Acknowledgments: JMARs and satellite imagery from the instruments CRISM, HRSC, MOLA, OMEGA, HIRISE, and TES were used to make the rover traverse path and geologic map.

References:

[1] Lewis, James, et al. “Sulfate Minerals: A Problem for the Detection of Organic Compounds on Mars?.” Astrobiology, 2015, Mar 1,

[2] Gómez-Elvira, J., et al. "REMS: The environmental sensor suite for the Mars Science Laboratory rover." Space science reviews 170.1 (2012): 583-640.