Mapping Rover Routes and Hydrous Soil Locations on the Mars Desert Research Station. D. K. Weiss[1], N. S. Levine[1], E. K. Beutel[1], N. De Munster[2], L. G. Barajas[3], K. Wynne[4], A. Stien[5], C. Runyon[1], [1]Geology and Environmental Geosciences, College of Charleston, Charleston, SC, United States (dkweiss@g.cofc.edu), [2]IT Teaching Center, CVO Waregem, Waregem, Belgium, [3]Advanced Robotics Group, Manufacturing Systems Research Laboratory, General Motors Global R&D, Warren, MI, United States, [4]Department of Neuroscience, University of Texas Medical Branch, Galveston, TX, United States, , [5]Edutainment Department, Technopolis, Mechelen, Belgium.

Introduction: Most comprehensive human-engaged Mars mission-proposals suggest the use of robotic exploration of the planet surface to augment human activity where human exploration is limited by capability and resources [1]. Robotic exploration combined with human field work during a manned mission to Mars is important in resource acquisition; especially in locating water.

During such a mission, a rover is likely to be controlled by a ground crew on the surface of Mars with imperceptible communications delay; therefore, the rover could cover much more ground and execute more tasks compared to Earth-controlled Mars rover missions. Rover travel is constrained by surface geology and terrain gradient [2].

Long term water supply is a concern for future missions seeking a prolonged stay on Mars. Since locating a subsurface or hydrothermal water source cannot be assured, it is imperative that the astronauts have the ability to generate their own water through effective and reliable means. A sustained human presence on the surface of Mars will require onsite synthesis of water by the astronauts. Generating water by freeing it from Mars' regolith through heating has been proposed [1]. Using soils with higher water content would be more productive for water acquisition; therefore, the water content of soils should be determined before the soils are excavated.

Mars Desert Research Station (MDRS): The Mars Desert Research station is a two closed crew simulation in Utah with the goal of enhancing understanding for future Mars surface operations.

Mapping at MDRS: This project seeks to create maps to show trafficability potential on Mars. The maps illustrate: 1) the area over which rovers can travel without significant risk of overturning due to excessively high slope gradient; 2) locations of loose soil in which a rover could become trapped; 3) places where the soil strength is sufficient to support the rover with low risk of initiating a localized rockslide which could flip or damage the rover; 4) water content of the soils; 5) hydrous mineral deposit locations based on reflectance spectra with an absorption minimum at 2.2 μm.

The proposed combination of remote sensing, human testing, and rover route mapping could be critical to water acquisition and exploration on the surface of Mars.

Methodology: We report on a two-week Mars Desert Research Station (MDRS) crew 109 rotation where satellite imagery and ground-based observations were combined to create a map of potential rover exploration routes for the area surrounding the MDRS habitat. Routes to hydrous mineral deposits were also mapped. The goal of this project is to simulate data sets available for the Martian surface as part of a comprehensive Mars mission feasibility study. Satellite imagery, topographic maps, and computer-based analyses were used to optimize rover routes. Field data relevant to engineering properties of the soils were collected (see Fig. 3) to provide ground truth information to the remotely sensed data. Cone penetrometer testing (a blow-count test, see Fig. 2), site aerial photography (see Fig. 1), and sample collection for sieving were conducted during Extra Vehicular Activities (EVAs) to produce detailed maps showing the most efficient and lowest risk rover routes based on soil strength data derived from soil density and compaction regression curves.

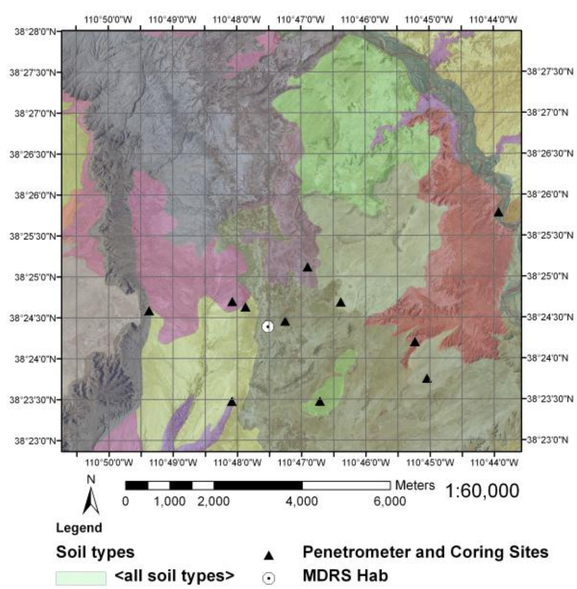

Figure 1: Different soils and penetrometer and coring sites.

Figure 2: Crew conducts blowcount test with the cone penetrometer

Figure 3: Crew departs the Hab on an EVA to a cone penetrometer and coring site.

Results and Conclusions: Levels of water content in most types of soils surrounding the habitat in a 100 km^2 vicinity were determined and integrated with the rover route-map. Linking the available routes with high-water-content soils is critically important given that the device which collects water from the Martian soils is likely to be a rover-like vehicle with travel and payload limitations based on terrain topography and geology (see Fig 4). Generating a map showing rover-accessible high-water-content soils near habitats on Mars will increase productivity of water collection. Mapping viable rover routes and soil properties will permit robotic and human exploration for water in the soils of Utah to be used as a model and test-bed for future soil studies on Mars.

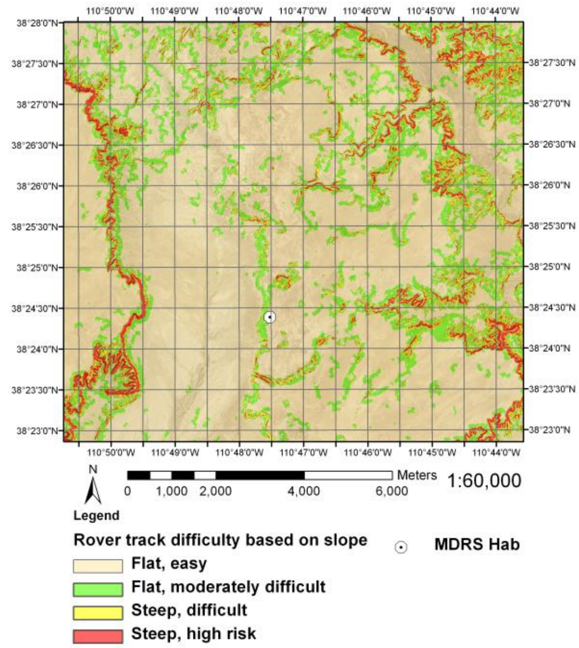

Figure 4: Early results illustrate rover track difficulty based on slope.

References:
[1] Zubrin, R. and Wagner, R.. *The Case for Mars*. 1996. New York: The Free Press.
[2] Kereszturi A. Geologic field work on Mars: Distance and time issues during surface exploration. 2011. Acta Astronautica 68,1686-1701.

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