Results from Joint NASA/ESA Field Trials Simulating International Missions to a Lunar/Mars Base

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Drilling on the Moon and Mars in human Exploration (DOMMEX) and EuroGeoMoonMars

What is it?

- A collaboration between NASA DOMMEX, EuroGeoMars, Intl. Mars Society
- Crew simulations of 2 week duration using Mars Desert Research Station
- 7 missions in 2009-2010 with having a mix of national origins, gender, age, & experience levels.

Objectives of Analog Research Activity and of Each Crew:

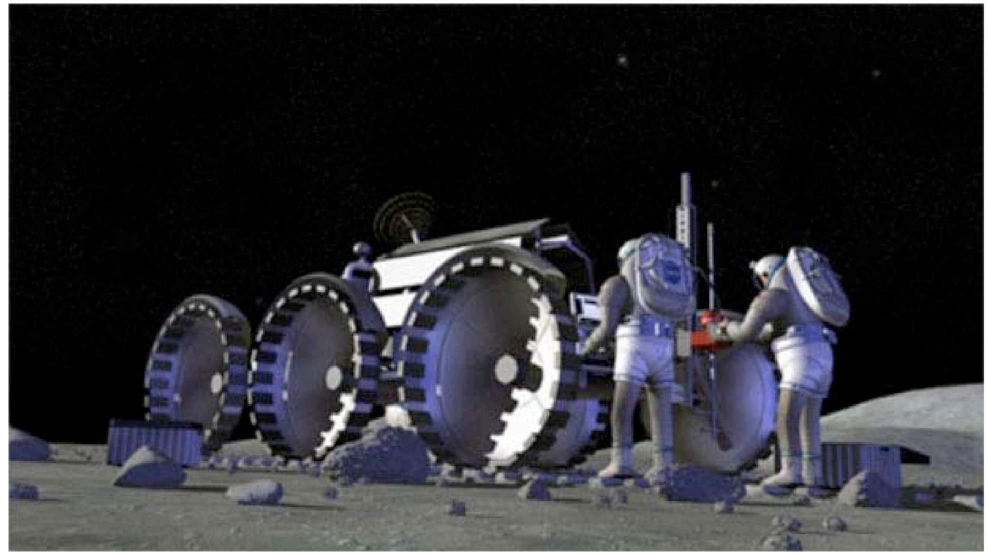
1) Science Research: field science investigations with geology, geochemistry, biology, and astronomy

2) Technology demonstration: sets of flight prototype instruments and robotic systems were deployed, tested and assessed.

3) Operations: evaluations of crew time, man-machine interfaces, food and mood, human factors.

4) Education, outreach, communications and public relations aspects

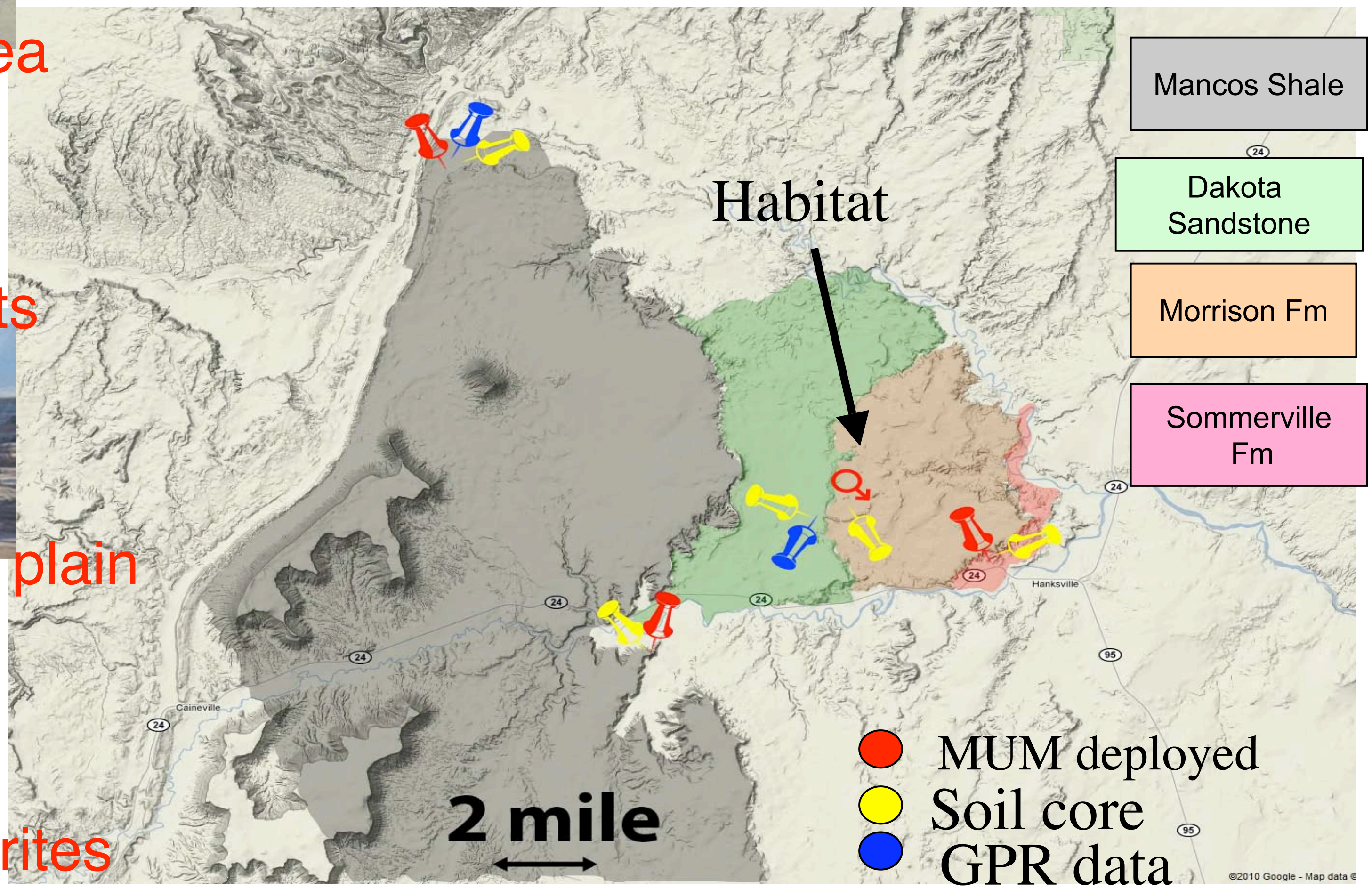
Why Drill on the Moon and Mars?



Drilling and subsurface sample acquisition is a key science activity for robotic precursor missions and human exploration on both the Moon and Mars. Regolith core samples are among the most valuable science products of Apollo. On Mars, drilling is needed to get to the most biologically interesting samples.

DOMMEX mission objectives focus on subsurface investigations and sample collection, and test subsurface access technologies

DOMMEX Activity map



Science Tasks Exploration Phase

- Explore major geologic units in the base area
- Choose and characterize candidate sites for drilling, soil sampling, and geophysics experiments

Sampling phase Activities: Soil cores collected and analyzed with TERRA field XRD

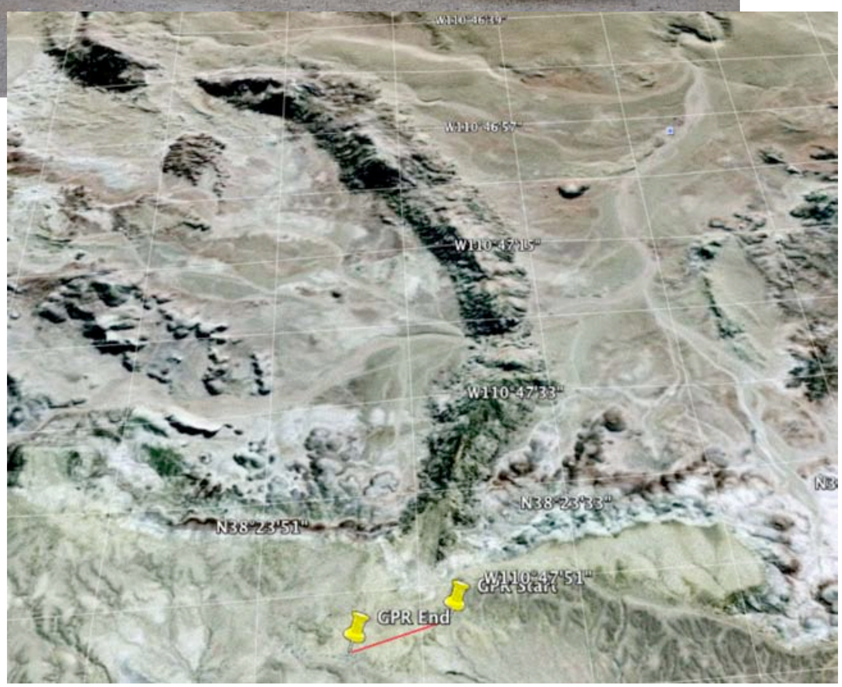
- Soil cores were collected from each geological unit using a manual impact soil corer and aseptic techniques.
- Mineral analysis was performed with TERRA (in Xitu™) portable XRD instrument, a commercial grade prototype of the MSL CHEMIN instrument.
- Biological analysis (DNA extraction) was also performed in the habitat and samples were prepared for subsequent analysis upon return to “earth”.

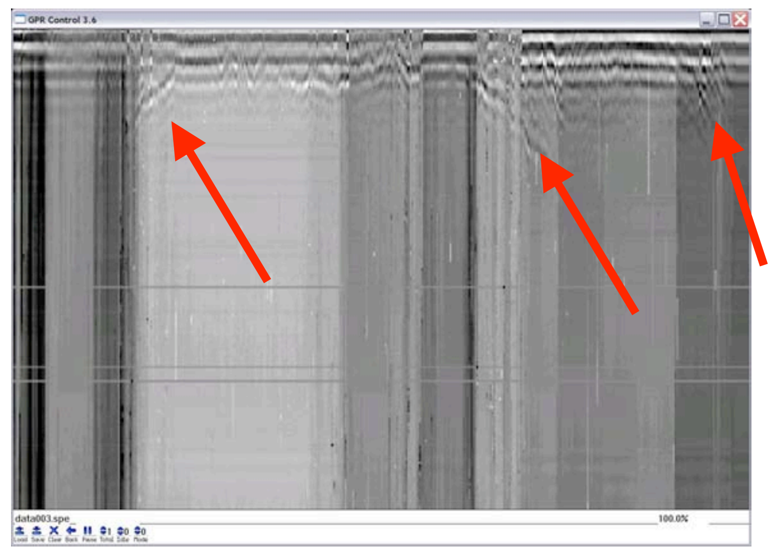
Soil cores collected with penetrometer to 1m depth

XRD analysis in field and hab with Terra XRD

Biological sample analysis in the habitat

Activity: Geophysical survey of buried inverted channel with CRUX Experimental GPR System





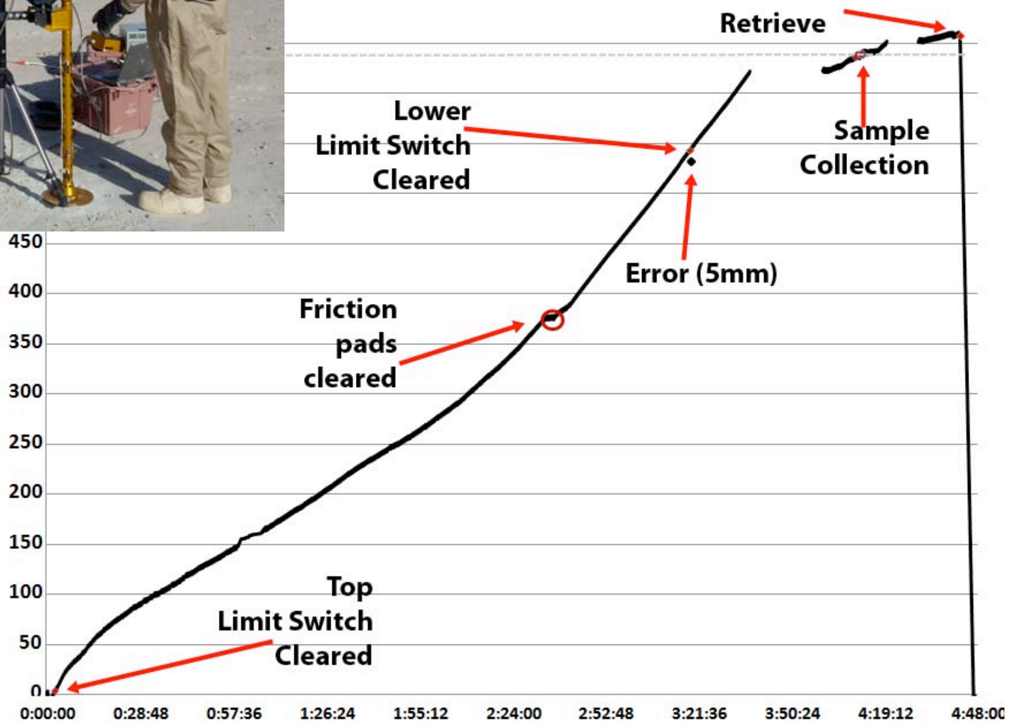
Human explorers are far superior to robots for drilling

Normal vertical drilling

Horizontal drilling

Angled drilling

Technology Testing Activities

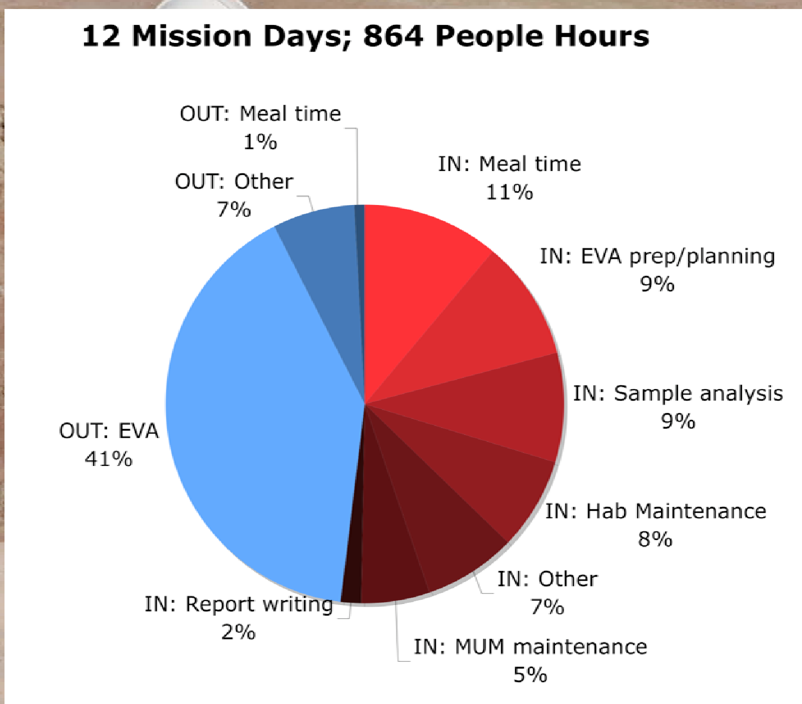


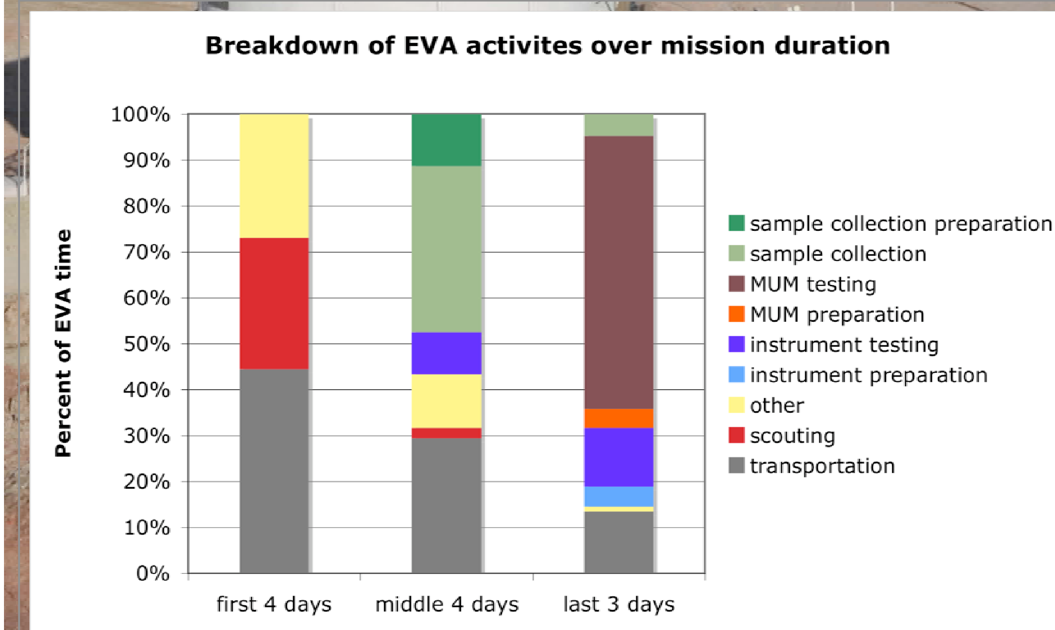
• Deploy and test MUM prototype soil penetrometer and sample collection system in 4 different types of soils

Operational Assessment

Detailed time records kept of all activities performed
Analysis shows time allocation for different activities and phases of mission

See poster by Messeri and Stoker for more details





Multicultural and Educational Aspects

Denmark
Grad Student

France
Airforce
Cadets

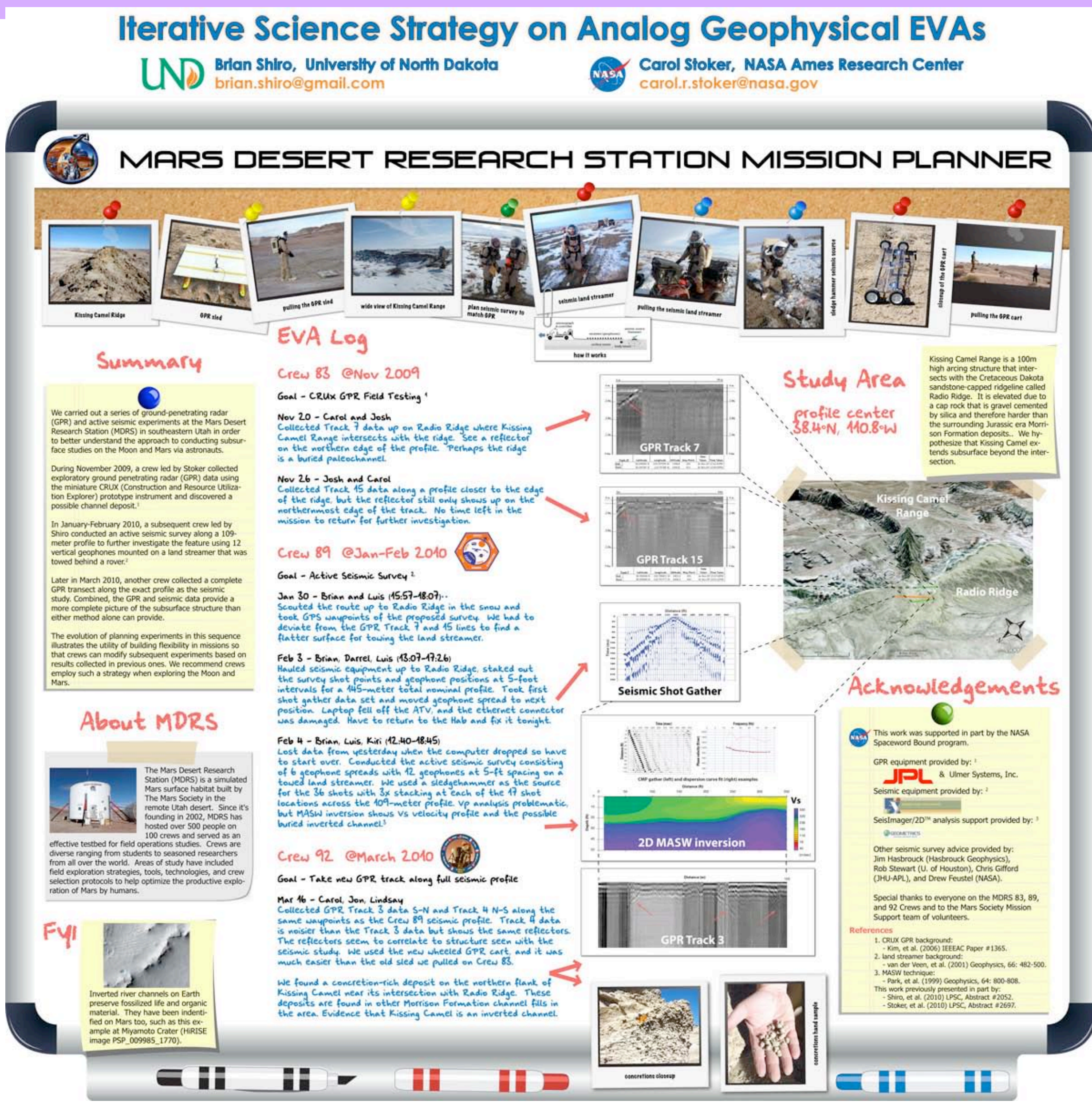
Australia
professor

NASA/US
researcher

• Education: These mission simulations are an important way to train and engage students. In addition to students in this crew, 4 follow up missions with student crews performed in this field season at MDRS. These included 1 US student crew, 1 European student crew, and 2 mixed US+ Euro crews.

All student crew members were required to present papers at technical meetings. See Student poster session (here) for some of the results, including Messeri and Stoker, Shiro and Stoker, and Wilhelm et al. European students are presenting at COSPAR, ILEWG, and EGU.

Activities from a base naturally allows for iteration and refinement



See poster by Shiro and Stoker for illustrative example

Conclusions

• Mission simulations at MDRS is a highly cost effective way to simulate mission scenarios end-to-end.

• International crew mix was successful and no interpersonal or communication problems resulted. Instead, it was bonding experience.

• Mixing students with senior scientists worked well on many levels. Analog mission activity has high value for training and inspiring the next generation.

• Astronaut towed Ground Penetrating Radar successfully identified a subsurface channel deposit. Previous attempts to use this instrument towed by a robot were unsuccessful due to electronic noise interference.

• Astronaut operated drill was highly portable, light, and speedy compared to any comparable robotic system. Even though this is not a flight prototype, it is representative of the type of field portable drilling systems envisioned for astronauts.

Acknowledgements:

- The DOMMEX project is supported with funds from the NASA Moon and Mars Analogs Program.
- Eurpoean student participants in DOMMEX field campaigns and other missions were organized and funded by the ILEWG EuroMoonMars mission activity led by Dr. Bernard Foing.
- NASA Spaceward bound supported student participants at MDRS.
- The CRUX GPR was provided by Sam Kim(JPL) and colleagues. For further information on this instrument see S.S. Kim et al., IEEEAC paper #1365, Version 2, Updated Nov. 10, 2005.
- The Terra XRD and assistance interpreting the results are provided by David Blake (NASA ARC).
- The Mars Desert Research Station is provided by the Mars Society. Logistics for this campaign were supported by Artemis Westinberg and a dedicated team of Mars Society volunteers.