EXPERIMENTAL SIMULATIONS OF MARTIAN GULLIES USING $MgSO_4$ BRINE SOLUTION

Brett Addison[1,2], Vincent Chevrier[2], and John Dixon[2,3]

[1]Department of Physics and Space Sciences, Florida Institute of Technology, Melbourne, FL 32901; [2]Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR 72701; [3]Department of Geosciences, University of Arkansas, Fayetteville, AR 72701

Introduction

Gullies are an indicator of past or present day fluvial activity on the surface of Mars. They have been found in areas with surface temperatures below the freezing point of liquid H_2O thus brine solutions have been proposed as a formation mechanism [1]. To test this hypothesis, we performed a series of flume experiments to recreate gullies as seen on Mars using $MgSO_4$ solution at ambient temperature and pressure [2]. FTIR spectral analysis was preformed on gully samples to determine if sulfates are detectable on the surface and/or subsurface of gullies.

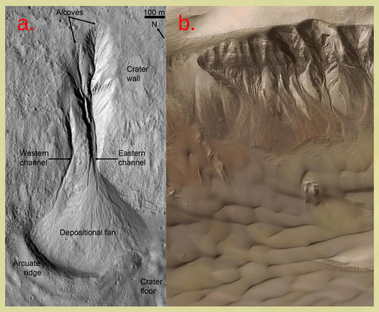

Fig. 1: a. Typical Martian gully showing morphology. b. Shows gullies on hillslope.

Experimental procedures

- Simulations run in a 1x1.5 m^2 flume filled with medium to fine grain size sand (500-600 µm) (Fig. 2).
- Slope angle of flume: 16 ± 2 degrees.
- $MgSO_4$ solution: 5-10 wt%.
- 5 mm hose runs from bottom of 6 L bucket to a rotameter.
- Solution released just below the sand surface.
- Volume flow rates: 1262 ± 126 mL min^{-1}.
- FTIR spectra taken of dry gully samples (24 hours after gully experiment) and compared to epsomite.

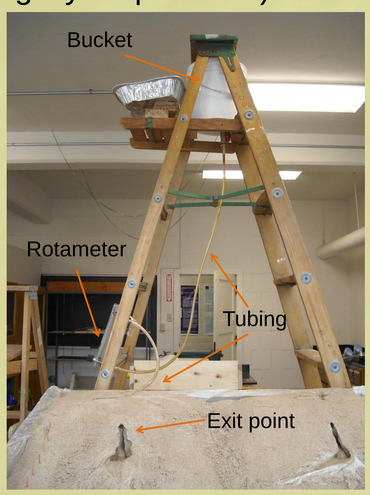

Fig. 2: Experimental set up used to create gullies.

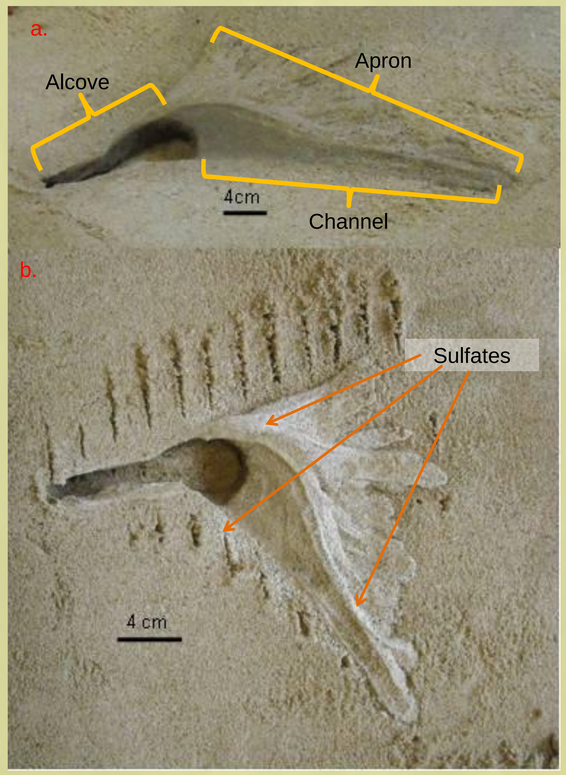

Fig. 3: a. Gully morphology created using ~ 736 mL of solution. b. Same gully left to dry for 48 hours resulting in the formation of sulfates (white material) on the surface of the apron.

Fig. 4: Gully morphology created using ~ 947 mL of solution.

Experimental results

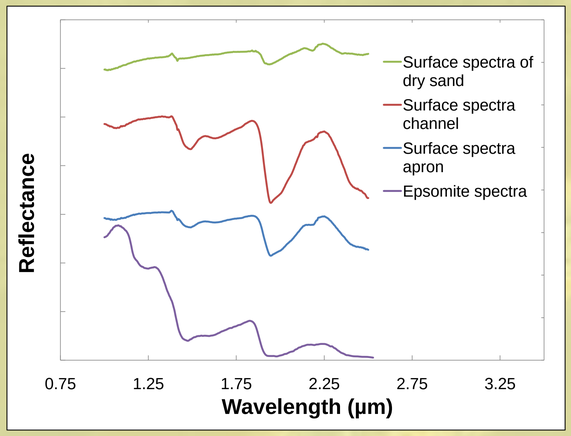

Fig. 5: FTIR surface spectra plot showing epsomite present on the surface of gully channel and apron.

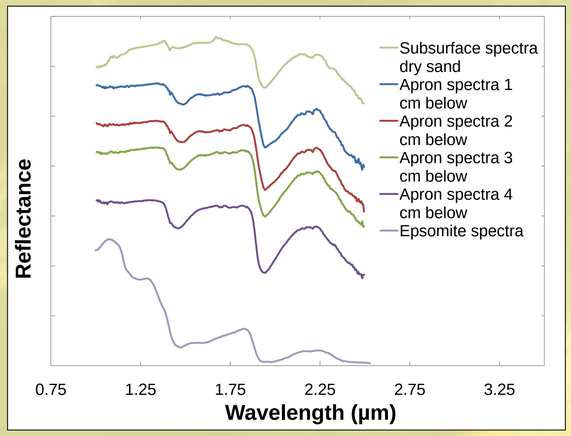

Fig. 6: FTIR subsurface spectra plot of the apron showing epsomite is detected.

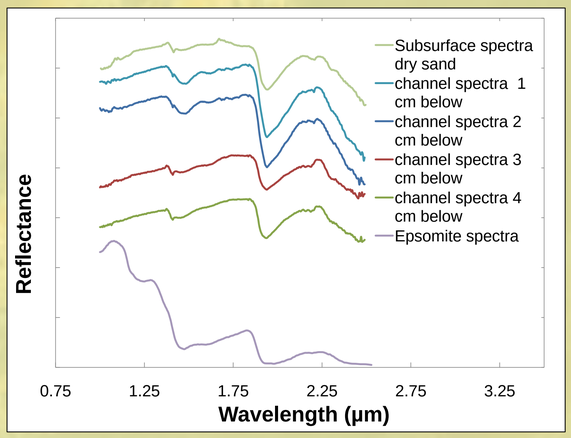

Fig. 7: FTIR subsurface spectra plot of the channel showing epsomite detected down to 2 cm.

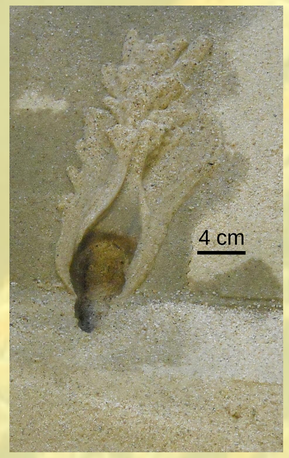

Fig. 8: Gully morphology created using ~ 1500 mL of solution with a somewhat long and narrow apron.

Discussion

- Three gully segments (alcove, channel, and apron) were recreated as seen on Mars with similar features observed by previous studies [3] (Fig. 1(a,b), 3(a,b), 4, and 8).
- Epsomite ($MgSO_4.7H_2O$) seen on surface of gullies (apron mainly as white material) and detected by FTIR probe both on the surface and below the surface (Fig. 5, 6, and 7).
- Amount of epsomite detected has not been quantified.
- FTIR didn't detect epsomite below 2 cm under channel (Fig. 7).
- Results indicate sulfates should be detected on the surface and subsurface of Martian gullies.
- Sulfates detected on Martian surface by orbiters and landers, none have been found near gullies [4].
- Possible explanations: low resolution, covered up, and/or removed from gullies.

Conclusions

- Experiments using brine solution can successfully recreate gully segments as seen on Mars.
- FTIR spectra detected epsomite on the surface and subsurface of gullies.
- Epsomite infiltrates further below apron than channel.

Acknowledgements

We would like to thank Walter Graupner (Laboratory Manager of the Space Center) for his technical assistance.

References

[1] Anderson, Dale T. and et al., 2002. Cold Springs in permafrost on Earth and Mars: Journal of Geoplysical Research, v. 107 (E3), p. 5015- 5021. [2] Coleman, K.A. and et al., 2008, Experimental simulation of Martian gully forms: Planetary and Space Sciences, v. 57, p. 711-716. [3] Malin, M.C. and Edgett, K. S., 2000, Evidence for recent ground water seepage and surface runoff on Mars: Science, v. 288, n. 5475, p. 2330-2336. [4] Chipera, Steve J. and Vaniman, David T., 2007, Experimental stability of magnesium sulfate hydrates that may be present on Mars: Geochimica et cosmochimica acta, v. 71, p. 241-250.