EXAMINING SOIL CRUSTS AT JEZERO CRATER, MARS. E. M. Hausrath[1], C.T. Adcock[1], A. Bechtold[2], P. Beck[3], A. Brown[4], E.L. Cardarelli[5], N.A. Carman[1], A. Cousin[6], O. Forni[6], T.S.J. Gabriel[7], F. Gomez[8], Y. Goreva[5], J. Lasue[6], C. Legett[9], J.M. Madariaga[10], L. Mandon[11], G. Martinez[12], J. Martínez-Frías[13], T. McConnochie[14] P-Y. Meslin[6], M-P. Zorzano Mier[15], M.E. Minitti[16], G. Paar[17], S. Siljeström[18], M.E. Schmidt[19], S. Schroeder[20], M. Sephton[21], S. Shkolyar[22], S. K. Sharma[23], A. Steele[24], R. Sullivan[25], A. Udry[1], A. Vaughan[26], R.C. Wiens[9], the SuperCam team and the Regolith working group. [1]UNLV, Las Vegas, NV, US Elisabeth.Hausrath@unlv.edu, [2]Univ. of Vienna, Vienna, Austria; [3]Univ. Grenoble Alpes, CNRS, IPAG, France, [4]Plancius Research, Severna Park, MD, US [5]NASA JPL, Pasadena, CA, US [6]IRAP, Toulouse, France, [7]USGS Flagstaff, NM US, [8]CAB INTA, Madrid, Spain, [9]LANL, Los Alamos, NM, US, [10]Univ. of the Basque Country, Leioa, Spain [11]Univ. de Paris, Meudon, France, [12]LPI, Houston, TX, US, [13]IGEO, Madrid, Spain, [14]Univ. of Maryland, Greenbelt, MD, US [15]CAB, TA, Spain, [16]Framework, Silver Spring, MD, US, [17]Joanneum Research, Graz, Austria [18]RISE, Stockholm, Sweden [19]Brock Univ. St. Catharines, ON, CA [20]DLR, Berlin, Germany [21]Imperial College, London, UK [22]NASA GSFC, Greenbelt, MD, US [23]Univ Hawaii, Honolulu, HI, US [24]CIW, Washington, DC, US, [25]Cornell Univ., Ithaca, NY, US [26]ASU, Tempe, AZ, US

Introduction: Mars soils allow an investigation of the integrated history of the surface, including interactions with potential volatiles such as water that may result in crust formation (e.g., [1]). These soil crusts contribute to Mars geomorphology [2], and have important implications for future returned Mars samples and potential human exploration.

In arid environments on Earth such as the Atacama Desert, salty soil crusts form near the surface [3]. Multiple salts have also been detected on Mars, including Ca, Mg, Fe, and Na sulfates; chlorides; and perchlorates (e.g. [4]). When atmospheric humidity is sufficiently high, hygroscopic salts such as perchlorates and chlorides can absorb moisture from the air, deliquescing and forming brines that have been shown to form crusts in Mars analog regolith in laboratory experiments [5]. Rock surfaces at Jezero crater are also observed to have crusts with compositions similar to global Mars dust [6], such as on the PIXL target Naltsos (sol 125), and may be related to soil crusts.

Here we examine the prevalence of soil crusts at Jezero crater; the hydration of the soil surface; and the correlation of elemental compositions.

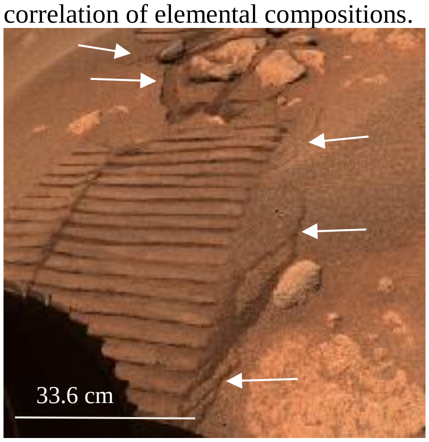

Fig. 1. Rear HazCam image of cracks (indicated with arrows) formed when the rover drove over the soil crust. Sols 278-280.

Methods: To examine the prevalence of soil crusts at Jezero crater, Rear HazCam images were examined from each rover stop from sol 9 through 291, and where Rear HazCam images did not contain evidence of crusts, NavCam images were also examined. These images allow examination of locations where the surface of the soil has been disturbed by the wheels and can display evidence of crust such as fracturing (Fig. 1). Images that did not show evidence of a crust do not necessarily indicate that a crust was not present – a crust might have not been disturbed in such a way that it was visible in Rear HazCam or NavCam images.

Repeated LIBS measurements in the same location form small excavation pits, allowing chemical variations in the top 1-2 mm of the soil [7] to be examined. To examine the composition of the soil crust, the hydrogen ICA score, which is a unitless measure of the hydrogen peak that can correspond to hydrogen content [8], was compared to elemental compositions as well as S and Cl scores. Large grains in the soil that would affect the results were removed based on a preliminary analysis. Averaged chemical data and H, S, and Cl scores, and shot-to-shot data were analyzed using Principal Component Analysis (PCA) in OriginPro.

Results and Discussion:

Prevalence of soil crusts at Jezero crater. Rear Hazcam/NavCam images revealed soil crusts at 37 of 75 locations, indicating their prevalence (Fig. 2).

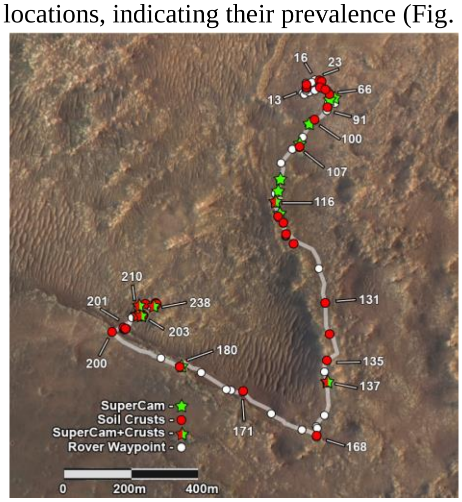

Fig. 2. The rover traverse indicating rover stops (white points), soil crusts (red points/half stars), and SuperCam soil analyses (stars).

Hydrated surfaces. An examination of the shot-to-shot data for soils indicates a characteristic increase in the H ICA score towards the surface (e.g. Fig. 3), with many soils displaying this trend. These measurements were all made during the daytime, and hydration may differ at night.

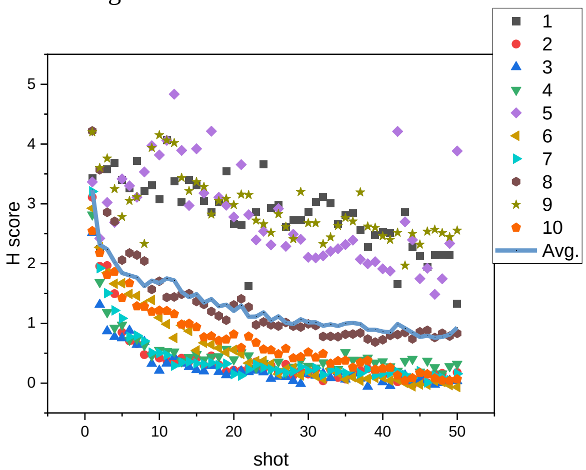

Fig. 3. *H score versus shot number (shot 1 is at the soil surface) for ten spots in the regolith target Chambares, showing scatter expected in soil [9], and an increase in H scores towards the surface.*

Correlation of elements. PCA analysis of the averaged shots for each point shows that H, Cl, and S are tightly correlated for the averaged soil shots, and that K_2O is also correlated (Fig. 4) indicating association of Cl, S, and K_2O with H. In addition, PCA analysis of the shot-to-shot data shows the correlation of cations with the H and S scores (e.g. Fig. 4). These results suggest the presence of hydrated salts that may be contributing to the formation of the soil crusts.

Conclusions and Future Work: Soil crusts on Mars are important for understanding both past surface processes, as well as the characteristics of the soil that future human explorers will interact with. Changes in atmospheric humidity through time impact the atmosphere-soil water cycle, and the potential use of hydrated soils for *In Situ* Resource Utilization. More work, including examination of additional crusts and rock coatings on Mars with additional techniques such as Infrared Spectroscopy and MastCam-Z [10], Earth and laboratory analogs, atmospheric measurements, and soil sampling for return to Earth, is needed to allow a comprehensive understanding of the soil crust-forming processes on Mars.

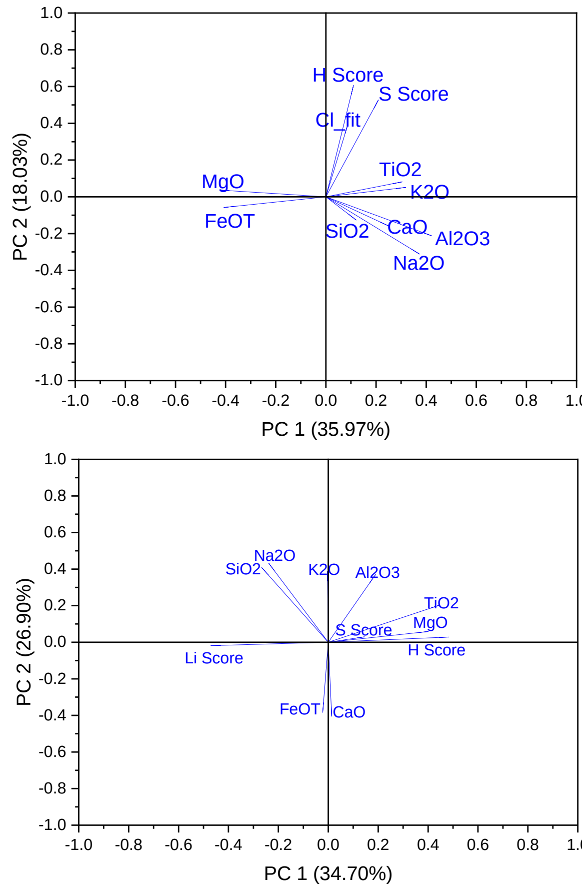

Fig. 4. *PCA analysis using OriginPro of the averaged shot data (top) and shot-to-shot data for Chambares point 2 (bottom). The averaged data (top) show the correlation of H, S, and Cl, with K_2O also correlated, and shot-to-shot data for Chambares point 2 (bottom) show the correlation of S with Mg and H, which suggests the potential presence of hydrated salts.*

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