DETAILED CHLORIDE MAPPING IN TERRA SIRENUM, MARS. E. M. Harrington, B. B. Bultel, A. M. Krzesińska and S. Werner, The University of Oslo, Centre for Earth Evolution and Dynamics (CEED) Postbox 1028 Blindern, N-0315 Oslo Norway (e.m.harrington@geo.uio.no)

Introduction: Chloride deposits were identified in hundreds of exposures across the surface of Mars [1,2]. Because these deposits are found in Noachian and Hesperian era terrains [2,3] they are important source of information on ancient Martian water. The origin of the deposits is, however, not fully known. The leading hypotheses regarding formation of chlorides include surface water evaporation and concentrations of hydrothermal brines [2], but other explanations may include marine seepage or ion exchange from mixing waters [4]. Although paleolakes represent evaporated bodies of standing water, there does not appear to be much correlation between paleolakes and chloride evaporite deposits [5].

Uncertainties regarding the formation of chloride deposits come partly from the challenges in interpretation of remote-sensing data. Previous works described the method of characterizing chloride deposits using decorrelation stretch (DCS) THEMIS images [6]. Although this method allows identification of deposits, and mapping at the THEMIS IR scale (100 m/pixel) previous works focused on creating rough regions of interest for comparative analysis (Fig. 1a), rather than detailed mapping. Intricate geomorphological analyses are therefore difficult. To fill this gap, our study expands on the work done by Osterloo et al. [1,2] by performing more detailed mapping of chloride deposits in Terra Sirenum, Mars at the THEMIS IR scale (100 m/pixel) (Fig. 1b). We also characterize morphological and albedo differences across chloride deposits using CTX and HiRISE data [7,8]. Mapping confirms chloride deposits occur as high-relief inverted channels and low-relief, irregularly shaped basins.

Methods: We performed detailed mapping of chlorides using THEMIS DCS colour composite images as previously described. Chlorides are prominent in all standard THEMIS DCS composites, appearing blue (8/7/5), green (9/6/4), and brownish (6/4/2) (Fig. 2). We find the strongest signature in the 8/7/5 composites. We use images available through JMARS [8], and processed new composites using the ISIS program. We measured relief using the HRSC/MOLA DEM [10,11], and salt bed thicknesses using HiRISE DTMs.

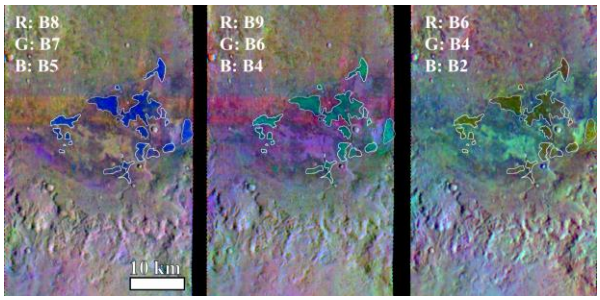

Figure 1: Chloride deposits discovered by Osterloo et al. (2008), now mapped in finer resolution (white outline). Chlorides mapped using DCS THEMIS colour composites, indicated in top left of each image (THEMIS: I33877002).

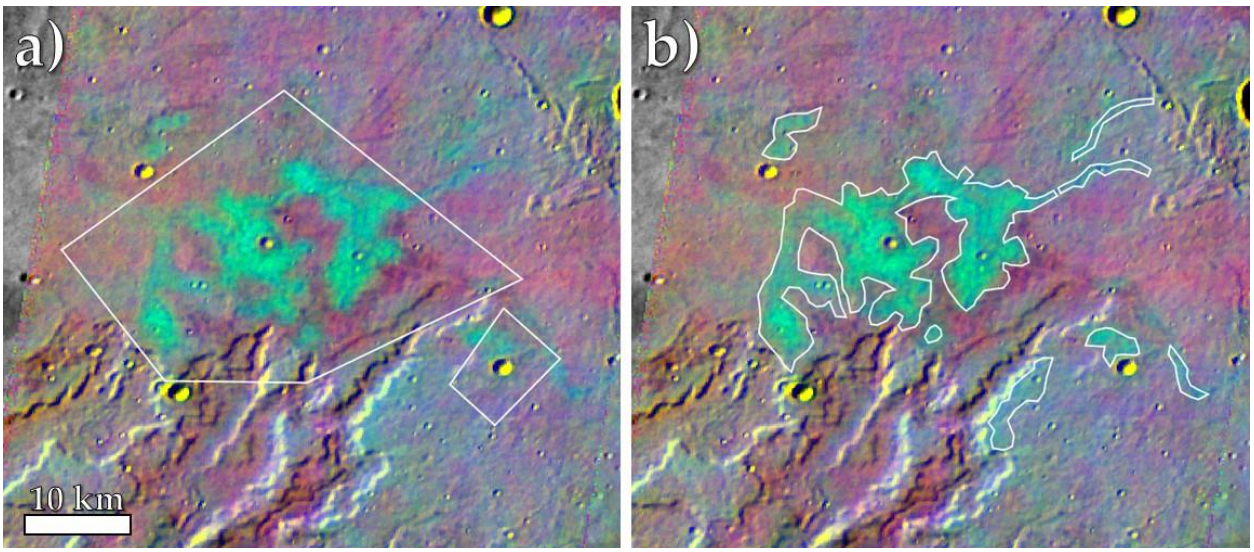

Figure 1: THEMIS DCS (9/6/4) image highlights chlorides in green. a) white outlines in show previous chloride survey [1,2]. b) Smaller channels are resolvable when mapping is performed at the THEMIS-IR (~100 m/pixel) scale (THEMIS: I41988002).

Mapping Outcomes: We have produced a more detailed map of chloride exposures in Terra Sirenum, Mars. The map will be publicly available as shapefile upon its publication. We find that chloride exposures are found equally within and outside of Eridania Basin, the largest known paleolake on Mars. The detailed mapping also confirms the diverse salt morphologies as observed in previous works [2]. Some chloride deposits are found in irregularly shaped depressions. Other chloride exposures are on small topographic highs. The highs are narrow, long, and sinuous in shape, like inverted channels. Nearly all chloride deposits appear bright in CTX and HRSC images.

In typical, low-relief basin settings, chlorides appear in distinct stratigraphic layers which can be correlated across outcrops (Fig. 3). These frequently occur in geologic windows where chlorides have been exhumed, which is also consistent with the literature [2]. We measured the thickness of salt beds using HiRISE DTMs and found that most salt exposures in eastern Terra Sirenum contain salt layers 2.5 m – 4 m thick, ranging up to 8 m thick. Some salt beds appear to contain internal bedsets, which are not easily resolvable even at the HiRISE scale (Fig. 4).

Discussion and Conclusions: Chloride deposits are forming distinctive stratigraphic layers in the Terra Sirenum Noachian highlands. Given the soft and soluble nature of chlorides, it is unclear why chloride-rich channels have been lithified and preserved.

The presence of bedsets within salt layers indicates episodic precipitation. In some places there are thin dark beds between salt layers, which would indicate switches from salt precipitation (very low energy) to sand or mud deposition (low to medium energy). It is plausible that "thicker" 2.5-8 m salt beds seen in inverted channels and laterally extensive layers are also made up of multiple smaller bedsets that are not visible at HiRISE resolution.

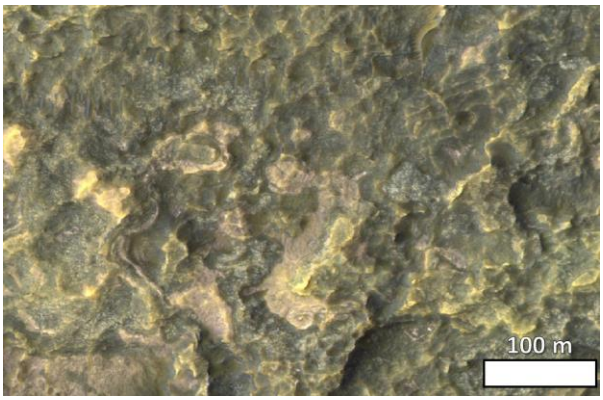

Figure 3: HiRISE IRB image (ESP_057898_1480) showing a chloride-rich unit (pink) stratigraphically positioned above a dark green/grey unit and below a brighter yellow caprock. The area is highly eroded, showing that the chloride unit is laterally expansive across multiple outcrops.

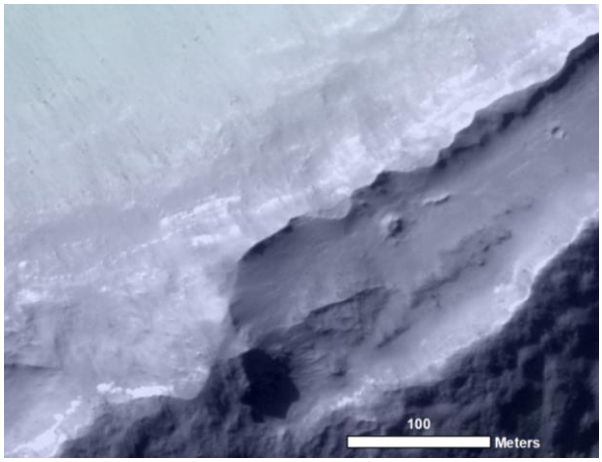

Figure 4: Inside a crater rim and wall. High to low is bottom-right to top-left (purple to blue). The bright layers inside the crater wall are chloride rich. They appear to be forming multiple smaller bedsets (ESP_017243_1465).

Future Work: Closer examination of chloride deposits across Terra Sirenum opens new questions and opportunities for further research into chloride formation on Mars. We are particularly interested in the stratigraphic context of the layered salt units. Measuring their thicknesses, compositions, and geologic contacts can provide insight into past water bodies on Mars.

Acknowledgments: Thank you to Catherine Neish and Catheryn Ryan at UWO for helpful discussions regarding the progress of this research.

References: [1] Osterloo, M. et al. (2008) *Science, 319(5870),* 1651-1654. [2] Osterloo, M. M., et al. (2010) *JGR: Planets, 115(E10).* [4] Warren, J. K. (2006) *Springer Science & Business Media* [5] Harrington, E. M. et al. (2020) *34th NGWM* Abstract P-16.5 [6] Gillespie et al. (1986) *Remote Sens. Environ., 20,* 209–235 [7] Malin et al. (2007) *JGR : Planets, 112(E5).* [8] McEwen et al. (2007) *JGR : Planets, 112(E5)*. [9] Christensen et al. (2009) *AGUFM IN22A-06*. [10] Lemoine, F. G. et al. (2001) *JGR : Planets, 106(E10)*. [11] Neukum, G. A. Jaumann, R. (2004) *Mars Express: The Scientific Payload, 1240,* 17-35.