PREFERENTIAL DISTRIBUTION OF ICE-WEDGE POLYGONS IN RELATION TO REGOLITH PROPERTIES (UTOPIA PLANITIA, MARS). M. Philippe[1], S. J. Conway[1], R. J. Soare[2], L. E. Mc Keown[3]. [1]Laboratoire de Planétologie et Géodynamique, CNRS UMR 6112, University of Nantes, France (*philippe.meven@gmail.com*). [2]Geography Department, Dawson College, Montreal, Qc, Canada. [3]School of Physical Sciences, Open University, Milton Keynes, UK.

Introduction: In places where the ground is cemented by ice, sharp drops of temperature below 0°C can cause the ground to contract and fracture. Eventually, the resulting thermal-contraction cracks can form polygonal networks at the surface. On Earth, ice [1], sand [2] or a combination of both can aggrade within these thermal-contraction cracks. This aggradation uplifts the overlying sediment and causes the polygon margins to show elevations that are relatively higher than those of the polygon centres, forming low-centered polygons (LCPs). When the infilling material degrades, the elevation of the margins reduces relative to that of the centre, forming high-centered polygons (HCPs). Polygons with no elevation difference between their centre and margins can be defined as flat-centered polygons (FCPs). On Mars, polygonally-patterned ground that expresses all of these morphologies is commonly found at the mid- to high-latitudes and is proposed to be the result of the thermal contraction of ice-cemented ground [3], but whether it is underlain by sand or ice wedges is debated.

The degradation state of terrestrial ice wedge polygons is known to depend on ambient temperature conditions, where mean rises of temperature cause them to melt and hence the margins to lower to form HCPs where there were once LCPs. On Mars, increases in annual (or longer) mean surface temperature, or decrease in average humidity [4] could induce ice sublimation causing LCP to degrade to HCP. In contrast, the degradation state of sand wedges should not depend on ambient temperature/humidity conditions, because sand is not volatile. On Mars, the mean annual temperature decreases poleward, and ground ice stability also increases towards the pole [5]. We identified an increase in LCP-to-HCP ratio for the polygons in Utopia Planitia, Mars (40°-50° N, 110°-125° E), which we used as evidence to support their origin as ice-wedge polygons [6]. We noticed during this study that polygons of all types concentrate on a "bright unit", i.e. having a high radiant temperature, in THEMIS daytime infrared (IR) imagery. This unit has a sinuous pattern in planview (Fig. 1).

Here, we present the first results of a study that aims to find out how (and which) regolith properties might favour polygon formation. We will focus on thermal properties (i.e. thermal inertia), material type, grain size and porosity of the regolith - factors we identified as potentially influencing ice wedge formation, and that can be studied with available remote sensing data. The first step is a study of this bright unit in Utopia Planitia (46°-50° N, 110°-125°E; Fig. 1).

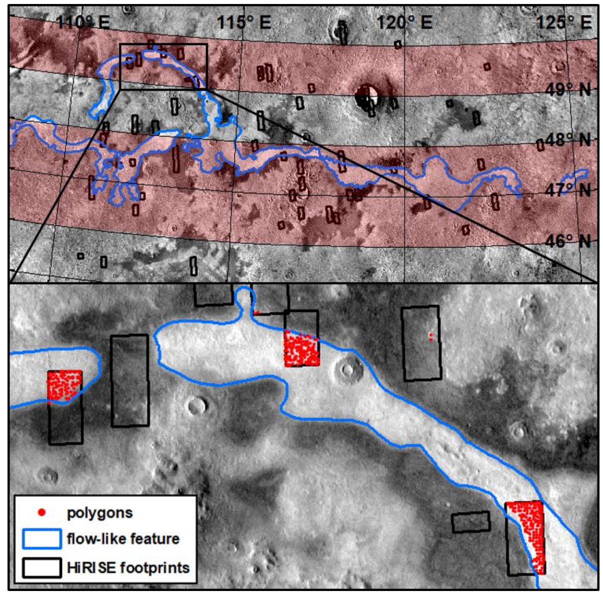

Figure 1: the study zone (highlighted in red, top panel) with the bright unit outlined in blue and HiRISE footprints in black. 48°-49°N does not have any HiRISE images located on the bright unit, and is excluded from the statistics. On bottom panel, note how the polygons (red points) are preferentially located on this terrain. Background image: THEMIS global day-IR mosaic (THEMIS team/Arizona State University).

Method: We used a grid-based mapping approach [7] on 42 HiRISE images. They were gridded in 500x500 m squares. The presence or absence of each polygon type (LCP, HCP, FCP) was noted in each square when at least five polygons were present. Based on the global THEMIS daytime IR mosaic, we mapped the extent of the bright unit (Fig. 1). We then calculated two parameters: the percentage of polygonisation (i.e. the percentage of squares that have polygons, no matter the type), and the LCP/HCP ratio (i.e. the ratio of the number of squares with LCPs to the number of squares with HCPs), for both the bright unit, and the study zone excluding the bright unit (the "surrounding terrains"). We also compared the thermal inertia of the bright unit and the surrounding terrains, based on the THEMIS qualitative thermal inertia mosaic. We did not use the quantitative mosaic because there was too much variation across the study area caused by e.g. season of acquisition or atmospheric corrections, to be exploitable. We made these calculations only for the latitudinal ranges where HiRISE data are available on the bright unit (i.e. ≥ 46° < 47°, ≥ 47° < 48° and ≥ 49° < 50°).

Results: The bright unit shows a high percentage of polygonisation (~ 89%, Fig.2a) and a higher LCP/HCP ratio (~ 0.24, Fig.2b) relative to the surrounding terrains (respectively ~ 50% and ~ 0.15). The average thermal inertia of the bright unit cannot be distinguished from that of the surrounding terrains based on the scatter in the data. The THEMIS mosaic used here only covers ~ 62 % of the study zone, but we consider it sufficient to give a good indication of the thermal inertia.

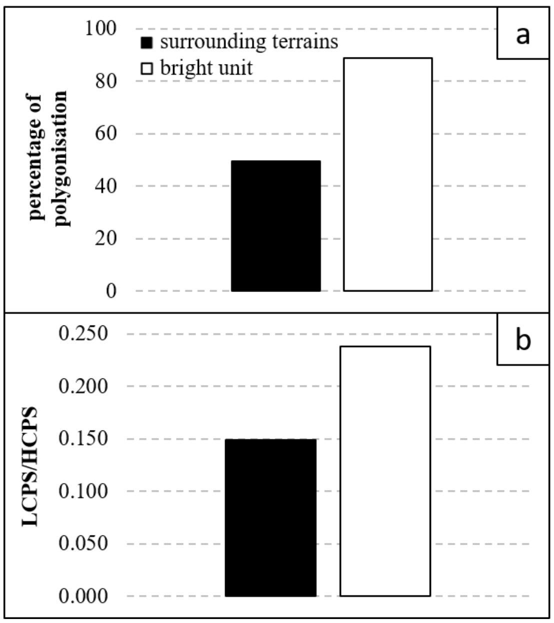

*Figure 2: comparison of the percentage of polygonisation (**a**) and the LCP/HCP ratio (**b**) between the surrounding terrains and the bright unit.*

Discussion: Polygons of our study zone (proposed to be underlain by ice-wedges [6,8]) are concentrated in this bright unit. The unit also has more LCPs than the surrounding terrains. It is therefore likely that this terrain has (or had) particular properties that favour(ed) both development and preservation of subsurface water ice, properties that are not expressed by the surrounding terrains. The thermal inertia of this bright unit is similar to that of the surrounding terrains, hence the thermal inertia of the bright unit is not acting to favour development and preservation of ground ice. Other aspects of the regolith composition (e.g. porosity, grain size, type of material), are probably at play, which is supported by the brightness of the unit in THEMIS day-IR imagery. Therefore, we suggest that the spatial distribution and morphology of polygons could be used to identify particular regolith compositions – whose exact properties are yet to be defined. Our study zone is located at the terminus of Hrad Vallis, which originates from the northwestern flank of Elysium Mons. The units in this area have been suggested to include a massive unit of volcanoclastic flows generated by magma/volatile interactions [9], or large lacustrine or oceanic deposits [10,11]. The origin of Hrad Vallis itself is debated, e.g. formation by lava flows [12], phreatomagmatism [13], or both mudflows and lava flows [14]. From our preliminary results, a lava flow origin for the bright unit is unlikely, considering the poor capacity of basaltic rocks to favour ground ice development (i.e. low porosity and frost susceptibility). Mudflows, or flows/airfalls of ash or fine volcanoclastic material, are better candidates for favouring the development of ground ice.

Future work: We will extend the mapping zone to the whole of the bright unit and examine its detailed morphology, and its composition using other spectral data, such as CRISM, OMEGA and other THEMIS products. We will then broaden the study to other extensively polygonised areas in the martian mid-latitudes, in order to obtain similar data on possible relations between polygon distribution/morphology and regolith composition.

Conclusions: Polygon density and type can provide insights into the propensity of the regolith to preserve ground ice and therefore give information on its geological origin. We have identified a unit in Utopia Planitia where polygons are dense and are preferentially low-centred in morphology, which is more consistent with a lahar or fine-volcanoclastic origin for this unit than a basaltic lava flow.

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