“WET” PERIGLACIAL PROCESSES, GROUND ICE AND A REVISION OF THE NEAR-SURFACE STRATIGRAPHY IN UTOPIA PLANITIA, MARS. R.J. Soare¹, G.D. Pearce² and A. Séjourné³; ¹Dept. of Geography, Dawson College, 3040 Sherbrooke St. W., Montreal, Quebec, Canada H3Z 1A4 (rsoare@dawsoncollege.qc.ca); ²Dept. of Earth Sciences, Univ. of Western Ontario, London, Ontario, Canada N6A 5B7; ³UMR CNRS IDES - Bât 509, Univ. Paris-Sud XI - 91400 Orsay, France.

Introduction: Recent Mars Global Climate Models have suggested that a dusty icy-mantle could have formed in southern Utopia Planitia (UP) by means of atmospheric deposition during the very late Amazonian period, perhaps < ~10myr [1-2]. Astapus Colles (ABa) is a geological unit located in this hypothesized area of accumulation - that is thought to comprise such as mantle [3].

In the main, the ABa drapes three geological units: 1. the early to late-Hesperian UP plains unit (HBUv); 2. the early Amazonian Vastitas Borealis interior unit (ABvI) and 3. marginal unit (ABvM) [3] (Fig. 1).

Numerous landforms whose shape, size and geological characteristics are consistent with the presence of surface/near-surface ground ice (and its formation/modification by “wet” periglacial processes [pp]) or with the occurrence of surface/near-surface ice sheets/remnants (and their formation/modification by “dry” glacial processes [gp]) have been identified in the ABa region: [pp] shallow (sometimes scalloped) depressions that are tens of metres deep and lack raised rims [e.g.,4-7], small-sized polygonal patterned-ground [e.g.,4-7] and polygon-trough/junction pits [7,9]; [gp] concentric crater-fill [e.g.,10-14], lobate debris-aprons [e.g.,10-14] and intra-crater (sub-kilometre) stratified mounds [15-16]. Generally, researchers have assumed that these landforms occur within the same geological unit, the ABa [3,5,7].

Figure 1: Map of geological units in southern Utopia Planitia, adapted from [3] and modified from [6,17-18]. The red circles indicate the distribution of MOC images containing scalloped depressions, small-sized polygons and polygon-junction pits within and around the ABa region.

In our recent work we mapped the distribution of the putative periglacial features in the ABa region (Fig. 1). We found that (a) the periglacial landscape stretches beyond the margins of the ABa and (b) is visible within the ABa region in those places where the icy mantle has ablated. Together, these observations point to two possible scenarios. An older, previously unidentified periglacial unit (UPU) underlies the more youthful and uniformly glacial ABa [17-18] and overlies the three regional basement-units; or, the periglacial features are a product of landscape modification within the upper metres of the underlying basement units.

In either case, the origin and evolution of the periglacial landscape assumes the antecedent presence of ground ice. Moreover, we propose that ground-ice emplacement must be the result of “wet” periglacial processes. These processes involve stable liquid-water at or near the regolith surface, penetration and saturation of the regolith by this water and, subsequently, freeze-thaw cycling. Based on our evaluation of the near-surface stratigraphy in areas where the periglacial landscape is most expressive, we also propose that these “wet” processes modified the near-surface regolith to tens of metres of depth.

Two countervailing hypotheses: Latterly, questions concerning the genesis and evolution of the putative periglacial-landscape in southern UP have been debated hotly; there have been two principal foci: the shallow depressions and the small-sized polygons. Here we evaluate this debate, as the first step towards proposing ground-ice emplacement based on “wet” or thaw-related processes.

Five key characteristics shown by the Martian depressions and by terrestrial alasines (drained or evaporated thermokarst lakes) have been cited as evidence of ground ice and its modification by thaw conditions: 1. inner benches or tiers (possible markers of liquid H2O having been evacuated or lost episodically); 2. orthogonally-oriented polygons on the floors and walls of the depressions (indicating the slow loss of liquid H2O and, on Earth, often associated with the occurrence of inner benches); 3. relatively shallow floors (measuring no more than tens of metres of depth) and the absence of raised rims (pointing to a origin that could be lacustrine but certainly not impact-related); 4. the scalloped-shape itself (synonymous with coalescing and/or receding thermokarst lakes and fields of alasines in terrestrial periglacial environments); and, 5. stratigraphically, the depressions share the regional landscape with small-sized polygons and polygon
of the scallped depressions in southern UP (dotted with small-sized polygons) present a cross-section of ice-rich and periglacially modified regolith to depth, then unconformities, slump pockets (where the ice has sublimated) or separate lag and ice horizons, ought to be discernable. Herefore, none of these traits have been observed. Third, the near-surface stratigraphy of southern UP [17-18] shows that a glacial mantle (the ABa) overlies a periglacial landscape (PUPU), not vice versa.

We suggest that the most plausible mechanism for emplacing ground ice to depth and for producing conditions consistent with the formation of the landscape assemblage identified by us is by (a) the saturation and (b) the in situ freezing of liquid H2O. As these assumptions do not require the occurrence of a consolidated and fairly uniform body of near-surface ice overlain by a lag, there is no expectation of unconformities or of sorting in the near-surface regolith.

**Discussion:** Regardless of whether one believes that thaw-related or sublimation based processes have formed the enigmatic features of southern UP, questions concerning the origin of the substrate can be answered more plausibly by the occurrence of ground ice (emplaced and modified by freeze-thaw cycles) than by a hypothesis comprising buried ice, sublimation and a surficial lag. 1. The regional stratigraphy is inconsistent with the top-down ordering of dusty lag and dust-free ice. 2. The lag assumption is deficient of observed geological evidence. 3. The only known terrestrial analogues of the periglacial landscape identified by us occurs in ice-rich and “wet” permafrost environments such as the Tuktoyaktuk Coastlands.