GRID MAPPING OF ICE-RELATED LANDFORMS IN UTOPIA PLANITIA ON MARS: DISTRIBUTION AND STRATIGRAPHY OF ICE-RICH DEPOSITS. Séjourné[(1)], A. (antoine.sejourne@u-psud.fr), Costard[(1)], F., Losiak[(2)], A., Swirad[(3)], Z. M., Balme, M.R., Conway, S. J., Gallagher, C., Hauber, E., Johnsson, A.E., Orgel, C., Platz, T., Ramsdale, J.D., Reiss, D., Skinner, J.A., Jr., Van Gasselt, S.; [(1)]Univ. Paris-Sud XI, Laboratoire GEOPS, Orsay, France. [(2)]Institute of Geological Sciences, PAN, Wroclaw, Poland. [(3)] Department of Geography, Durham University, Durham, UK.

Introduction: The northern plains of Mars, topographically lower than the "cratered highlands" of the southern hemisphere, comprise several large overlapping basins that are filled by sediments. Different ice-related landforms demonstrated the presence of ground-ice even at mid-latitudes (Table 1) [e.g., 1-2]. However, there is no consensus about the nature of ground ice and formation of the planetary permafrost. The spatial distributions of ice-related landform at broad-scale and control by regional geology or climate is still not constrained. Improving the geological context of the northern plains will help constrain outstanding questions about martian geological evolution.

An International Space Science Institute team project has been convened to study ice-related landforms in targeted areas in the northern plain of Mars: Acidalia Planitia, Arcadia Planitia, and Utopia Planitia [3-4]. Here, we describe our mapping of western Utopia Planitia along a strip from 25°N to 75°N latitude of 250 km wide. The goals are to: (i) map the geographical distribution of the surface ice-related landforms; (ii) identify their association with subtly-expressed geological units and; (iii) discuss what the distribution tell us about the ice-content, sediment types and environmental evolution in UP.

Landforms	Description
Mantled deposits	Areas subdued by a deposit over several kilometers
Textured terrains	Rubble piles (20 m in diam.) forming a basketball surface
Viscous flow features	Lineated valley and concentric crater fill and lobate debris aprons of glacial origin
Scalloped depressions	Coalesced thermokarst depressions of 0.5-30 km in diam.
Small-sized polygons	Thermal contraction polygons of 30-100 m in diam.
Pits	Thermokarst pits (30-100 m in diam.) at the junction of the 100 m polygons
High albedo mounds	High albedo dome of 0.5-5 km in diam. with summital pit of mud or volcanic origin
km scale polygons	High centred polygons of 1-5 km in diam. of dessication origin
Thumbprint Terrain	Ridges and chains of cones with an arcuate shape of mud or volcanic origin

Table 1. Landforms mapped in the grid mapping

Grid mapping strategy: Rather than traditional mapping with points, lines and polygons, we used a grid "tick box" approach to efficiently determine distribution of specific landforms by using grid of squares for each study area, each approximately 20×20 km [5]. Over the region, ice-related landforms were identified and recorded as being either "present", "dominant", or "absent" in each sub-grid square displayed in a Cassini projection (Table 1). The end result of the mapping is a "raster" showing the distribution of the various different types of landforms across the whole strip providing a digital geomorphological map (Fig. 1).

Distribution: Based on their correlated distribution at regional scale but also at local scale where they are associated, three assemblages of landforms can be defined. 1) The mantled deposits and the textured surface are associated at regional scale between ~47°N and 78°N and as well at local scale where the surface of the mantled deposits is textured (Fig. 1). This assemblage of landforms and the correlated smoothing of small-scale topography are interpreted to be indicative of the young latitude dependent mantle [e.g., 2].

2) The scalloped depressions, pits and 100 m polygons occur over a broader area than previously shown (from 40°N to 48°N; Fig. 1). The scalloped depressions, pits and 100 m polygons are spatially associated at local scale because pits cross-cut polygons that are degraded by scallops. Their distribution corresponds to an ice-rich permafrost like on Earth [e.g., 6-7].

3) The thumbprint terrains, high-albedo mounds and km-scale polygons are mostly seen in the south (30°-40°N; Fig. 1). The km polygons are buried in the north (latitudes >45°N). Collectively this assemblage of landforms were interpreted as mud flows from diapirism or compaction [e.g., 8-9].

The three assemblages are not correlated with geological units but rather with the latitude. In contrary, the Viscous flow features and gullies are only observed

inside impact craters (concentric crater fills) and have no preferential distribution.

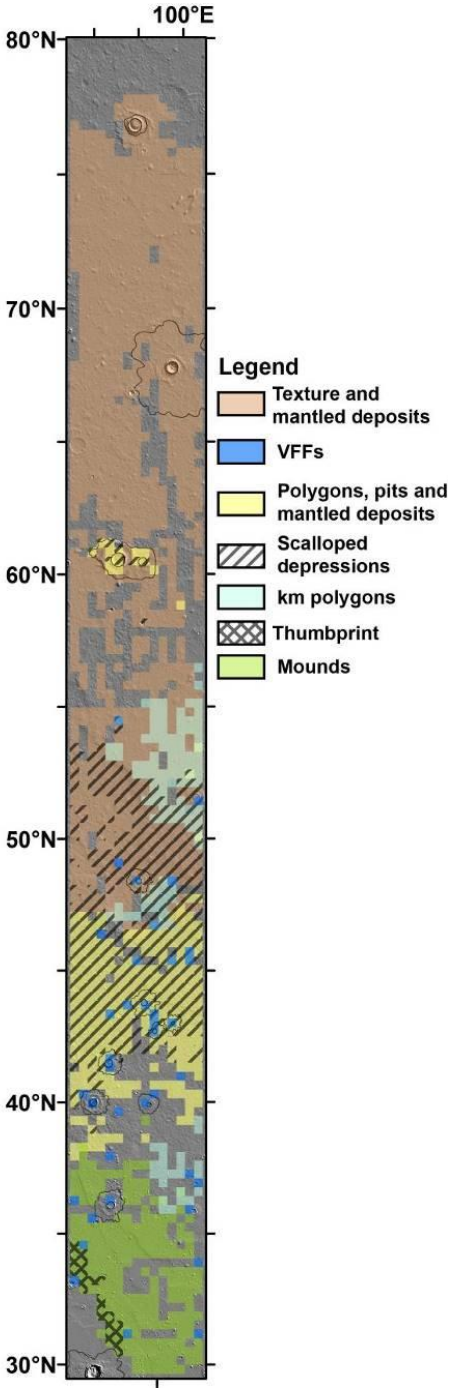

Figure 1: Geomorphological grid mapping in Utopia Planitia

Stratigraphy: From the definition of assemblage of landforms, stratigraphical relationship was investigated in order to distinguish the different sedimentary deposits. No noticeable difference in topography or overlapping of deposits were observed between the two assemblages of ice-related landforms at about 48°N.

Over the area of the assemblage of landforms indicative of ice-rich permafrost, the 100 m polygons are present over the surface continuously until its southern limit at about 38°N (Fig. 2). The southern limit of the polygonized surface takes the form of a deposit with clear gently-sloping limits whithout scallops suggesting no degradation (Fig. 2). The deposit covers a surface that is lower in altitude that contains high albedo mounds of the third assemblage of landforms. Therefore, the ice-rich permafrost assemblage of landforms is correlated with a deposit forming the permafrost. The estimated thickness of the deposit is about 20-30 m based on different MOLA laser tracks along the limit. This in agreement with a loess-like deposition [10] and ice-rich content [7, 11].

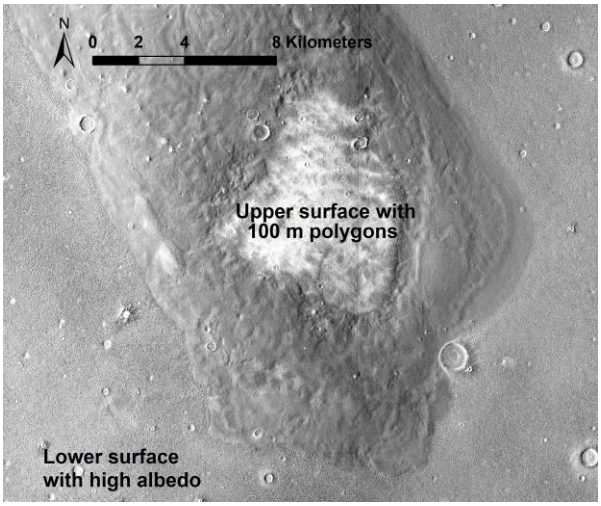

Figure 2: Limit of the ice-rich permafrost assemblage

Conclusion: Based on their spatial association at regional and local scale, there are three different assemblages of landforms in Utopia Planitia. Their distribution is related to latitude rather than topography or geological units. We found that the assemblage of landforms indicative of ice rich permafrost is associated with an ice-rich deposit of 20 m in thickness. Grid mapping provides an efficient and scalable approach to map small landforms over large areas.

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