MAPPING THE NORTHERN PLAINS OF MARS: ORIGINS, EVOLUTION AND RESPONSE TO CLIMATE CHANGE – A NEW OVERVIEW OF RECENT ICE-RELATED LANDFORMS IN UTOPIA PLANITIA. 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., Kereszturi, A., Orgel, C., Platz, T., Ramsdale, J.D., Reiss, D., Skinner, J.A., Jr., Van Gasselt, S.; (1) [(1)]Univ. Paris-Sud XI, Laboratoire GEOPS, Orsay, France. [(2)]ING PAN. [(3)] Department of Geography, Durham University, Durham, UK.

Introduction: An International Space Science Institute (ISSI) team project has been convened to study the northern plain of Mars. It uses geomorphological mapping to compare ice-related landforms in the three northern plains basins: Acidalia Planitia, Arcadia Planitia, and Utopia Planitia. The main science questions this project aims to answer are:

1) "What is the distribution of ice-related landforms in the northern plains, and can it be related to distinct latitude bands or different geological or geomorphological units?"

2) "What is the relationship between the latitude dependent mantle (LDM) and (i) landforms indicative of ground ice, and (ii) other geological units in the northern plains?"

3) "What are the distributions and associations of recent landforms thought to be indicative of thaw of ice or snow?"

The combination of improved spatial resolution with near-continuous coverage (e.g. CTX images of 6 m/pixel cover ~ 90% of the surface of Mars as of December 2014 [1]) increases the time required to analyze the data. Many of the landforms we were interested in (e.g. dozen meter-scale polygons), could only be identified in CTX images viewed at 1:10,000 or 1:20,000 scale and therefore too small to be represented on regional maps. This becomes problematic when attempting regional or global-scale studies of meter-scale landforms. However, we needed to map the distribution of such landforms across very large continuous latitudinal swath in the Acidalia, Arcadia, and Utopia areas (see results [2-3]). Rather than traditional mapping with points, lines and polygons, we used a grid "tick box" approach to efficiently determine where specific landforms (see [4] for details). Here, we describe our mapping in Utopia Planitia.

Interest of Utopia Planitia: Western Utopia Planitia (UP) shows an assemblage of possible periglacial landforms: scalloped depressions [5-10]; spatially associated small-sized polygons [6-11]; polygon-junction pits [7, 12]. There seems to be a general agreement that these relatively recent landscape features are indicative of a permafrost that is probably ice-rich [8]. However, the Gamma Ray Spectrometer detected only a small percentage of water-equivalent hydrogen (4 % wt of ice) content in the near-surface of UP (depth < 1 m) [13] but ground-ice is predicted to be stable at these latitudes at depth > 1 m [14]. Interestingly, UP lies in the area of the young latitude-dependent mantle thought to have been emplaced during obliquity variations of Mars [15].

Questions concerning the distribution of periglacial landforms and characteristics of the ice-rich permafrost in UP remain unanswered.

Landform type	***Description***
Small Mounds	High albedo dome-like forms of 50-100m in diam. often in clusters
Large Mounds	High albedo mounds of 0.3-3km in diam. with low dome-like features and summital pits
Thumbprint Terrain	Ridges and chains of cones with an arcuate shape
Viscous flow features (VFFs)	Comprises lineated valley and concentric crater fill (CCF), and lobate debris aprons
km scale polygons	High centred polygons of 1-5 km in diam.
Scalloped depressions	Coalesced thermokarst-like depressions with concentric bands
100m scale polygons	Polygons of 100 m in diam. That are found in association with scalloped depressions
Pits	Thermokarst-like pits at the junction of 100 m polygons or along cracks inside km impact craters
Basket ball terrains	Etched terrain, includes linear, wrinkled and basketball sub-types
Dunes	Dune fields

Tableau 1 : Ice-related landforms mapped in the grid mapping in UP

Method: We conducted a geomorphological study of all landforms in UP along a strip from 25°N to 75°N latitude of 250 km wide (Fig. 1). The goals are to: (i)

map the geographical distribution of the ice-related landforms; (ii) identify their association with subtly-expressed geological units and; (iii) discuss the climatic modifications of the ice-rich permafrost in UP. Our work combines a study with CTX (5-6 m/pixel) and MOLA, supported by higher resolution HiRISE (25 cm/pixel) and a comparison with analogous landforms on Earth. The mapping strips were divided into grid of squares for each study area, each approximately 20×20 km [4].

Results: 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).

Our mapping shows that the scalloped depressions, pits and 100 m polygons occur over a broader area than previously shown (from 40°N to 65°N on Fig. 1). Coalesced scalloped depressions of several km in diameter are concentrated near 50°N. Different impact craters are observed with CCFs (see [16] for details). We also observed that the thumbprint terrains, high-albedo mounds of different diameter (see [17] for details) and km-scale polygons are mostly seen in the southern UP (from 30°N to 40°N on Fig. 1).

Conclusion: This work improves significantly the knowledge of the distribution of the ice-related landforms in western Utopia Planitia. Assemblages of ice-related landforms are used as indicators of the geomorphological evolution of the landscape of UP. Grid mapping provides an efficient and scalable approach to collecting data on large quantities of small landforms over large areas.

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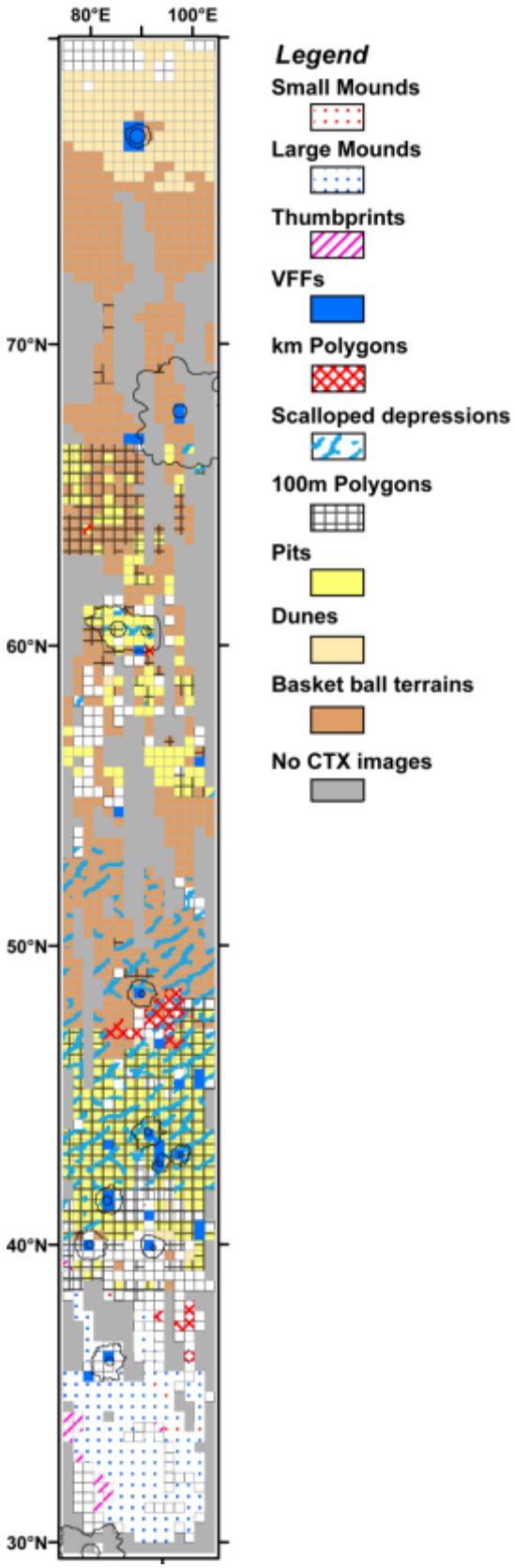

Figure 1 : Geomorphological grid mapping results in western Utopia Planitia