THERMOKARST DEGRADATION OF POTENTIAL ICE-WEDGE POLYGONS INSIDE SCALLOPED DEPRESSIONS IN UTOPIA PLANITIA, MARS. A. Séjourné[1], F. Costard[1], A. Fedorov[2], J. Gargani[1], R. J. Soare[3] and C. Marmo[1]; [1]Univ. Paris-Sud XI, Laboratoire IDES, Orsay, France (antoine.sejourne@u-psud.fr) [2]Permafrost Institute, Yakutsk, Russia. [3]Dawson College, Montreal, Canada.

Introduction: An assemblage of possible periglacial landforms dots the landscape of western Utopia Planitia in the northern mid-latitudes of Mars. The landforms comprise flat-floored depressions with scalloped shapes [1-6]; spatially-associated patterned ground [2-4, 7]; and polygon-junctions pits [3, 8, 9]. In the last few years, several papers point to a thermokarst origin of the scalloped depressions, i.e. degradation of ground-ice [1-5]. Development of these depressions has been explained by two contrary models. The first one suggests a poleward expansion [2-3].; the second one suggests an equatorward expansion [4, 6].

Here, we describe new landforms resulting from the degradation of polygons on the pole-facing slopes of scalloped depressions. In order to understand the processes of degradation, we compare these landforms with active thermokarst landforms occurring along thermokarst lakes in Central Yakutia (Siberia).

Degradation of polygons on the pole-facing slopes of scalloped depressions:

Polygons (~6-10 m in diam.) occurring inside scalloped depressions are particularly interesting because they show two distinct morphologies. Some polygons exhibit small ridges on their margins, giving them a low-centered morphology (Lc) (Fig. 1a) [4]. They are analogous to thermal-contraction polygons of periglacial regions on Earth. Others have no marginal ridges, their polygon centers are higher than their sides, giving them a high-centered morphology (Hc) (Fig. 1a) [4]. There is a continuum in the change of morphology from Lc to Hc inside the scalloped depressions (Fig. 1a). Similarly to polygon evolution on Earth, the morphological evolution of these polygons could be the result of degradation of ground-ice.

Semicircular hollows of 0.5-1 km in diameter are observed on the pole-facing slopes of scalloped depressions (Fig. 1a) [4]. The semicircular hollows are surrounded by degraded Hc polygons. Associated with the hollows, cirque-shaped alcoves (~10 m diam.) at polygonal troughs (Fig. 1a) and failure cracks occur on the pole-facing scarp (Fig. 1a). Inside the semicircular hollows, small outcrops of Hc polygons and barely discernable polygons are observed (Fig. 1b). Some polygonal troughs on the scarp show alcoves with channel-like forms at their base (Fig. 1c) [4].

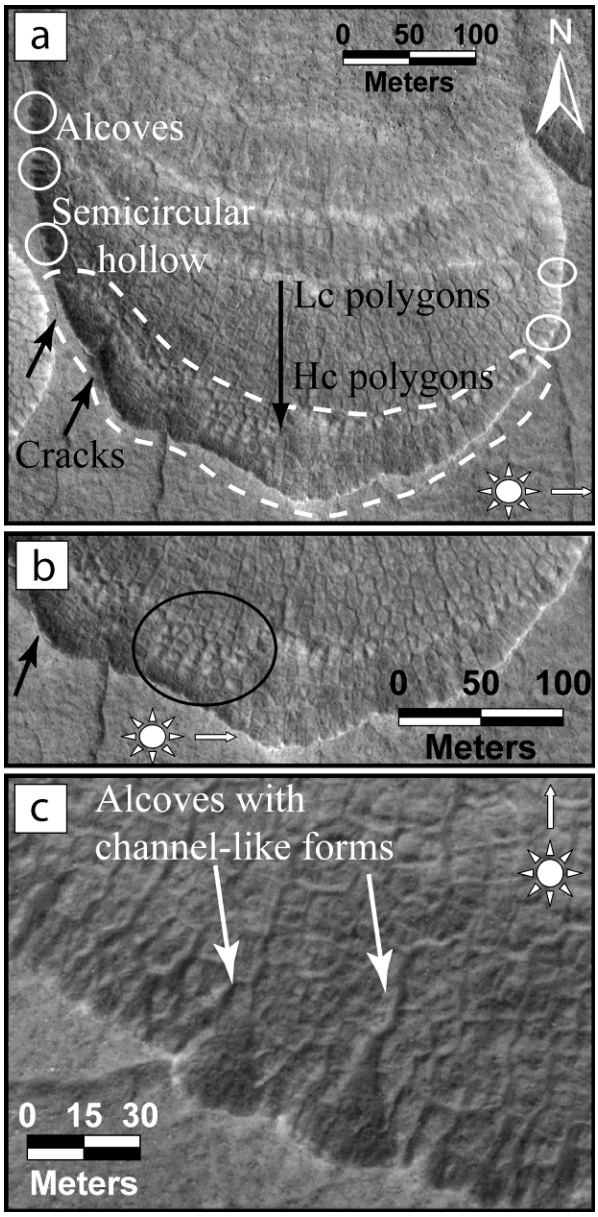

Fig. 1: Semicircular hollows (dashed line) and cirque-shaped alcoves (circle) around Hc polygons on pole-facing slopes of scalloped depressions (PSP_002439_2265).

Baydjarakhs and thermocirque along thermokarst lakes in Central Yakutia (Siberia):

In central Yakutia, the permafrost is ice-rich (60-80% of ice by volume) and has been extensively degraded by thermokarst processes [10]. The term ther-

mokarst denotes the processes of degradation of ground-ice due to thermal destabilization of permafrost [10-11]. Numerous flat-floored thermokarst lakes (~0.2-1 km in diam.) dot the landscape of Central Yakutia. They are the result of subsidence of the ground following the extensive thawing of ice-wedges polygons [10-11].

On the hill-slopes surrounding these thermokarst lakes, amphitheatrical hollows (thermocirque) (~10 m in diam.) could occur (Fig. 2) [10]. The localized thawing of ice-wedges polygons on the lakeside hill-slopes leads to formation of thaw gullies utilizing the polygonal troughs. The highly-degraded Hc polygons forming conical mounds are known as baydjarakhs (Fig. 2) [10]. Further thaw degrades successively the baydjarakhs leading to the formation of a thermocirque with steep scarp. Inside the thermocirques, different stages of degraded baydjarakhs are observed (Fig. 2). Thawing of ground-ice triggers landslides and mud-flows inducing the retreat of the scarp parallel to itself [10]. Ponding of water could occur in low areas of thermocirques, small gullies drain the water toward the lakes forming fan deposits.

Fig. 2: A thermocirque showing baydjarakhs near a thermokarst lake in Central Yakutia (Siberia).

An important and localized thermokarst degradation of polygons: In Utopia Planitia, the semicircular hollows inside scalloped depressions are reminiscent of thermocirques occurring inside thermokarst lakes on Earth. The Hc polygons surrounded by cirque-shaped alcoves on the scarp are similar to baydjarakhs of Siberia. The curved cracks associated with semicircular hollows indicate the subsidence and failures of the pole-facing scarps of depressions. The outcrops of preserved Hc polygons or residual polygons inside the semicircular hollows indicate a formation by downwearing and backwearing due to removal of ice.

From the comparison with terrestrial thermocirques, several geomorphologic differences arise. Inside semicircular hollows, no run-off features, mud-flows or fluvial-fan deposits are observed. The absence of thaw-related features point to a formation of semicircular hollows by sublimation of ground-ice. However, the channel-like forms on the pole-facing scarp raise questions (Fig. 1c). Although, they are not well developed (no fan deposits are observed) and only observed inside one depression, they may be indicative of highly localized and transient conditions under which thawing might have occurred.

Inside scalloped depressions, the thermokarst degradation originates at the polygonal troughs on the pole-facing scarp. Then, the polygons are successively degraded. Through observation of important degradation of polygons, we suggest that the polygons must have a substantial amount of ice. This could show that the polygons are potentially underlain by ice-wedges.

The relative fresh appearance and steepness of the scarp of semicircular hollows argue for a relatively recent degradation. To account for the exclusive occurrence of them on the pole-facing slope of depressions, degradation must have occurred during high obliquity periods of Mars. During high-obliquity periods (45°), pole-facing slopes receive more solar radiation in summer than equator-facing slopes [12].

Conclusion: Inside scalloped depressions, polygons are successively degraded by thermokarst processes forming highly degraded Hc polygons and then thermocirque-like hollows on their pole-facing slopes. The relatively recent degradation could be due to sublimation of ground-ice. However, localized and transient thaw might have occurred. The nearly complete degradation of the polygons argue for the presence of ice-wedge polygons inside the depressions.

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