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The Distribution of Possible Periglacial Landforms on the Northern Martian Plains

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Abstract

A survey of HiRISE images of medium sized craters across areas of Acidalia, Arcadia and Utopia Planitia was conducted. The locations of putative periglacial landforms were recorded and their latitudinal distribution examined. Fracture polygons are ubiquitous across the area surveyed. Possible sorted polygons were located at several sites between 36-74 °N. Lobate structures were found between 32-68 °N, but only at very few sites. This suggests that possible periglacial landforms occur over a wider latitudinal range than previously thought.

1. Introduction

Periglacial landscapes are found in cold climate environments on Earth where the freezing and thawing of the permafrost active layer occurs on a seasonal cycle. A variety of distinctive landforms such as sorted circles, thermokarst depressions and solifluction lobes are typical of periglacial environments [1].

It has been proposed that a variety of features on the northern plains of Mars have a similar morphology to terrestrial periglacial landforms [e.g. 2]. If these features formed by the same processes, this would suggest that thawing of water-ice has occurred in the geologically recent past.

Two possible hypotheses for the formation of these landforms were proposed by [2]: (i) These putative periglacial landforms formed during past periods of higher obliquity [3] when the martian climate may have been more conducive to the production of liquid water from ice. In this case the features observed in HiRISE and CTX images could be relic landforms undergoing degradation. (ii) It is also possible that these landforms formed under present-day temperature and pressure conditions if the significant concentrations of salts such as magnesium perchlorate were present such that the freezing point of water was depressed, allowing thawing to occur. Such salts were detected at the phoenix landing site [4] and other 'cryobrines' with similarly low eutectic temperature could also allow periglacial processes on Mars [5].

2. Survey

A survey has been conducted to locate putative periglacial landforms across the northern plains. 361 HiRISE images of the walls and floors of >1 km diameter craters were examined, covering regions of Acidalia, Utopia and Arcadia Planitia across latitudes between 30 and 80° N. A variety of landforms including fracture polygons, clastic polygons, clastic stripes and rubble piles, lobate structures, gullies and scalloped depressions were recorded.

3. Results

The overall results are shown in table 1. Individual feature-classes are discussed below.

Scalloped depressions and gullies: Scalloped depressions and gullies have a similar latitude range, and are frequently found south of 60 °N. Similar features to the scalloped depressions of Utopia Planitia have been observed in both Acidalia and Arcadia Planitia, but are not found over such a wide range of latitudes in Acidalia, as they are in Arcadia and Utopia.

Sorted landforms: Possible sorted landforms (stripes, polygons etc.) can be found as far south as 40° N and as far north as 70° N but most are found between 45-65° N. Lobate structures were found in a few isolated locations over a wider range of latitudes than suggested by [2].

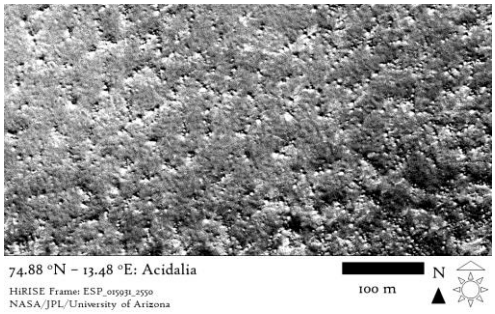

Figure 1: *Possible sorted polygons near a high latitude crater.*

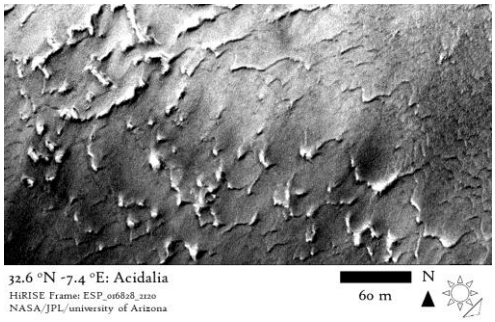

Figure 2: Lobate structures in a low latitude crater interior.

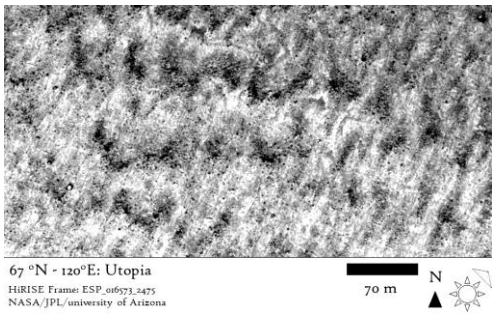

Figure 3: Clastic lobes on high latitude crater wall.

4. Summary and Conclusions

In conclusion, features similar in morphology to terrestrial periglacial landforms can be found across all three northern plains regions. Fracture polygons are ubiquitous across the areas surveyed, while features arguably more likely to be indicative of thawing of water or brine are also present. Scalloped depressions and gullies are common while putative sorted structures are much scarcer. Lobate structures are only found in a few sites. However these features are not concentrated at high latitudes as previously thought [2] but occur as far south as 32.6 °N. None of the features identified can be said to be periglacial with certainty, but all have morphological similarities to features common in periglacial environments on Earth.

Acknowledgements

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References

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	Acidalia, 60 images		Arcadia, 175 images		Utopia, 126 images	
Landform	# Feature	Range (°N)	# Feature	Range (°N)	# Feature	Range (°N)
Fracture Polygons	45	30-77	90	32-74	69	31-70
Sorted Polygons	13	37-74	17	36-73	17	40-68
Sorted Stripes	2	53-61	6	34-64	3	46-64
Rubble Piles	7	43-75	5	36-73	0	N/A
Lobate Structures	5	32-54	5	38-68	4	35-67
Scalloped Depressions	11	30-52	27	64-74	36	40-67
Gullies	19	31-53	10	32-59	40	30-67

Table 1: Distribution of possible periglacial landforms on the martian northern plains.