PERIGLACIAL POLYGON FIELDS ON DEVON ISLAND, HIGH ARCTIC, AS POSSIBLE ANALOGS FOR HIGH-LATITUDE POLYGONAL TERRAIN ON MARS: IMPLICATIONS FOR PHOENIX.

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Summary

A quantitative study of a variety of periglacial polygon fields on Devon Island, High Arctic, reveals a correlation between polygon relief and maximum particle size. If polygons at Phoenix candidate landing sites on Mars are analoguous, coarse blocky terrain at those sites might also imply hazardous polygon relief.

Introduction

Phoenix, the first Mars Scout mission, will launch in August 2007 and is targeted to land on Mars in May 2008 between 65°N and 72°N [1]. A commonly observed terrain feature at high latitudes on Mars (>40°N or S) is *polygonal terrain* of the type shown in Figure 1 [2] [3]. MOC narrow-angle images reveal an abundance of such polygonal terrain in the Phoenix candidate landing site areas. On Earth, morphologically similar (in shape and in scale) polygonal terrain can be found in cold climate regions where this type of terrain is generally described as a form of *periglacial patterned ground* [4] [5].

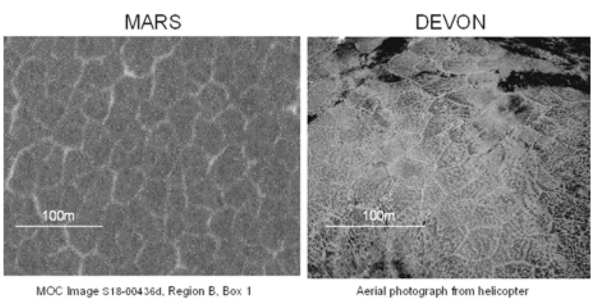

Fig.1: Polygonal terrain on Mars in a candidate Phoenix landing site region (left – NASA/JPL/MSSS) and morphologic analogs from Devon Island, High Arctic (right – Haughton-Mars Project 2006).

This Study

We report here on preliminary results from a quantitative field survey of a variety of periglacial polygonal terrain located in the vicinity of the 20 km-diameter Haughton Crater, Devon Island, High Arctic (75°N, 89°W). The site has been the subject of extensive Moon and Mars analog studies under the auspices of the Haughton-Mars Project since 1997 [6]. The main motivations behind the present study are to: 1) investigate the morphometric characteristics of periglacial polygons in the polar desert of the High Arctic (Devon Island as a starting point) and 2) examine what implications these characteristics might have for the safety of Phoenix if it were to land in an area presenting analogous features.

Methods

The study area comprised rocky plateau tops and silty outwash plains located within a 15 km range from the Haughton-Mars Project Research Station. (HMP RS) at 75^o 25.95' N, 89^o 51.754' W. The study area included portions of the interior of Haughton Crater. The nine polygon sites selected for our investigation were chosen from photogrammetric aerial photography data for their similarity in polygon shape and polygon scale to the polygonal features observed in the Phoenix canadiate landing site areas. Only the fields with the largest polygons (10 to tens of meters across typically) were considered on Devon, as they are the only ones that present polygon scales approaching those of the smallest polygons seen at the Phoenix canadidate sites. During subsequent Devon polygon visits by land vehicles (ATVs) and helicopter, the following polygon characteristics were systematically measured or noted: diameter, shape, joint depth, joint width, material sorting, dominant particle size, maximum particle size, terrain moisture, dominant lithology(ies), and general geologic context [7].

Results

From the observation of our nine different sites with large polygons, we noted that such polygons may present very different ranges in particle sizes (wide and narrow ranges), different dominant particle sizes (silt, sand, cobbles, submeter-sized blocks), different dominant particle compositions (dolomite, limestone, impact breccia, glacial till), and different shapes (angular polygons, ovals, irregular, raised, flat, etc.). Polygon particles may be spatially sorted (generally coarser grains on the outer edges) or not at all.

Of greatest potential significance for Phoenix, we noted a correlation between the relief of polygons (elevation difference between the center of a polygon and the center of its peripheral joint) and granulometry: polygon relief is observed to increase roughly linearly with maximum particle size (Fig.2). The large periglacial polygons on Devon involving the coarsest materials (up to 2 m blocks) present the greatest relief (up to 1.5 m) over lateral distance scales of less than a few tens of meters or so.

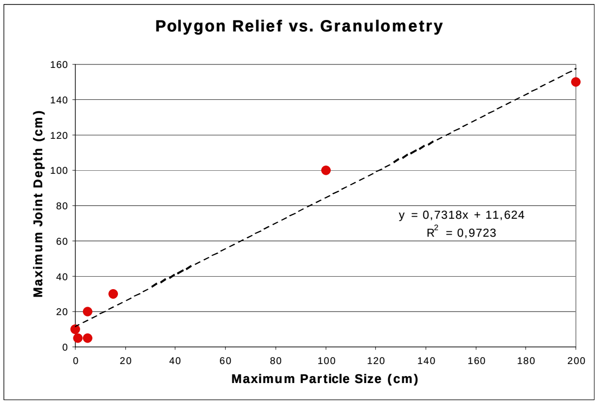

Fig.2: For the Devon Island periglacial polygon fields we have studied to date, a correlation is noted between polygon relief (maximum joint depths) and granulometry (maximum particle size).

Discussion

If (note this important condition) the Phoenix site polygons are analogous to the the large polygons examined on Devon, then a similar correlation might exist between maximum block size and polygon relief at the Phoenix sites on Mars. Phoenix site polygons might display a range of reliefs depending on the maximum particle sizes involved, hence the importance of assessing what this maximum particle size is. If coarse material is present, a landing hazard might be presented not only from the presence of large blocks directly, but possibly also from steep slopes at the scale of the lander associated with high polygon relief.

Recent data from the Mars Reconnaissance Orbiter (MRO) indicate that several of the candidate landing sites considered for Phoenix are proving to be excessively blocky. The present study suggests that avoiding such blocky areas is not only a good idea in terms of avoiding landing directly on blocks, but possibly also in terms of minimizing Phoenix's chances of encountering steep slopes on local (Phoenix sized) scales.

Our results highlight both the value and the limitations of analog studies. Until features on Earth and on Mars that are morphologic analogs of each other are actually proven to be genetically analogous, interpretations of their similarities and differences will remain fraught with an important caveat: they might look similar but they could have unrelated origins. In the present case, the lessons learned from the Arctic are intended to help make informed engineering decisions regarding the selection of a sound landing site for the Phoenix mission. It is therefore important to note that, in regards to Mars, our results are suggestive, but not conclusive.

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