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Patterned ground as an indicator of periglacial activity in and around Lomonosov Crater, Mars

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A survey of the northern plains of Mars has been conducted to catalogue the distribution of possible periglacial landforms across several large study areas in Acidalia, Utopia and Arcadia Planitiae.. Several hundred HiRISE and CTX images have been surveyed, looking for features indicative of a periglacial environment; patterned ground, solifluction features and scalloped depressions.

Non-sorted patterned ground is fairly common across the Northern Plains of Mars where nets of fracture polygons are common at mid to high latitudes. These features are most likely the result of contraction cracking due to temperature changes. The occurrence of fracture polygons is in keeping with the cold, dry environment of Mars. Analogous features on Earth are found in some of the coldest and driest regions of the planet. However other types of patterned ground, such as sorted circles and stripes, tend to occur in warmer and wetter environments as sorted patterned ground is the result of the repeated freezing and thawing of the permafrost active layer. These features require the action of liquid water during the warmer months of the year and are characteristic of a periglacial environment. Such features would not be expected to be as common on Mars, where the surface temperature is only warm enough for water to exist in a liquid state for short periods of time in isolated areas which receive high levels of insolation.

Prior studies (e.g. Gallagher et al., 2011, Icarus.) have observed features which appear to be morphologically similar to sorted patterned ground. It is possible that unusual sites where boulders appear organised into stripes and networks could be analogous to these terrestrial periglacial features. Determining where such features occur on Mars could have important implications for understanding the martian environment.

Lomonosov Crater, located at 64.9 degrees N, 9.3 degrees W in the northern reaches of Acidalia Planitia, is a 150 km diameter crater surrounded by the low-lying Martian Northern Plains. Large swathes of boulder covered ground, both within the crater and on the surrounding plains, exhibit possible organisation which could represent sorted patterned ground. A large number of sites containing discontinuous nets of boulders are found both in the crater and around it. There are also possible sorted stripes on the crater walls of both Lomonosov and a small unnamed crater to the north east. However the lack of any other putative periglacial landforms in the area means that it is impossible to be certain that these structures formed through periglacial processes rather than the boulder-clustering mechanism proposed by Orloff et al., (2011, JGR).

If these features are periglacial in origin they could provide a geomorphic marker for locations where water has frequently thawed and refrozen within geologically recent time, where liquid water is playing an active role in shaping the Martian environment. This would have implications both for defining the environments in which life could exist and for resource utilization on future manned missions to Mars.