



Putative crater-floor pingos, paleolakes and periglacial landscapes in north Utopia Planitia, Mars.

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Pingos are perennial ice-cored (but non-glacial) hills or mounds. They evolve and persist only in continuous and deep permafrost, i.e. ground that is frozen for periods of no less than two years. In periglacial (or cold-climate, non-glacial) regions such as the Tuktoyaktuk Coastlands of northern Canada closed-system pingos originate where thermokarst lakes either have lost or are losing their water by drainage, evaporation or sublimation. Closed-system pingos form as a result of freeze-thaw cycling, permafrost aggradation and pore-water migration.

If closed-system pingos were identified on Mars, particularly on late Amazonian terrain at near-polar latitudes, this would point to boundary-conditions of pressure and temperature at or above the triple point of water having occurred much more recently and closer to the polar regions than many workers have thought possible.

In 2005, we found two crater-floor landscapes in northern Utopia Planitia with mounds that seemed to share a suite of morphological characteristics and landform associations with closed-system pingos on Earth (Soare et al. 2005). Since this study the HiRISE and CTX cameras on-board the Mars Reconnaissance Orbiter have provided better coverage and higher resolution images of the area, allowing us to refine our previous work. We have identified two additional craters with similar assemblages and have verified the absence of such assemblages in other craters across a circum-global longitudinal transect spanning 20 degrees ($\sim 52^\circ$ - 72° N) of latitude. This allows us to evaluate the closed-system pingo hypothesis anew. Interestingly, the four principal mound-bearing craters occur within a tight latitudinal band from $\sim 64^\circ$ - 71° N. This could be a marker of active albeit highly localised hydrological and freeze-thaw cycling.

Conway et al. (2011) have identified perennial ice-domes on impact-crater floors at latitudes ($\sim 70^\circ$ N) that are adjacent to the mound-bearing craters. They hypothesise that the ice domes are formed in these craters by the accumulation of ice precipitated from regional polar-winds laden with water vapour. Under slightly different obliquity solution these polar winds might have precipitated ice further to the south in those craters where the putative pingos are observed. Subsequently, were temperatures to have migrated close to 0° C the accumulated crater-ice could have thawed, forming endogenic paleolakes. El Maarry et al. (2010) suggest that the fracture geometry of some polygons on the floors of impact craters in northern Utopia Planitia points to an origin by desiccation, the end-stage of paleo-lake evolution.

Although we explore two non-periglacial mound-formation hypotheses, the periglacial hypothesis is shown to be more robust, encompassing geomorphological, stratigraphical and climatological observations, and is less subject to inconsistencies than the alternatives.

Conway S.J., et al. 2011. Climate-driven deposition of water ice and the formation of mounds in craters in Mars' North Polar Region. *Icarus* (in review)

El Maarry, M.R., et al. 2010. Crater Floor Polygons: Desiccation Patterns of Ancient Lakes on Mars? *Journal of Geophysical Research* 115, doi:10.1029/2010JE003609.

Soare R.J., et al. 2005. Possible pingos and a periglacial landscape in northwest Utopia Planitia *Icarus* 174, 373-382.