

Evidence of recent flows of liquid water on the surface of Mars

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SCIENTIFIC



ENVIRONMENTAL

SUMMARY

Dr Colman Gallagher, UCD School of Geography, and Open University planetary science researcher Dr Matthew Balme have identified eskers emerging from a degraded glacier in the Phlegra Montes region of Mars. Eskers, originally an Irish word meaning ridge or elevation, are ridges of sediment similar to a dried-out river bed, which form only by sustained flows of liquid water underneath a glacier.

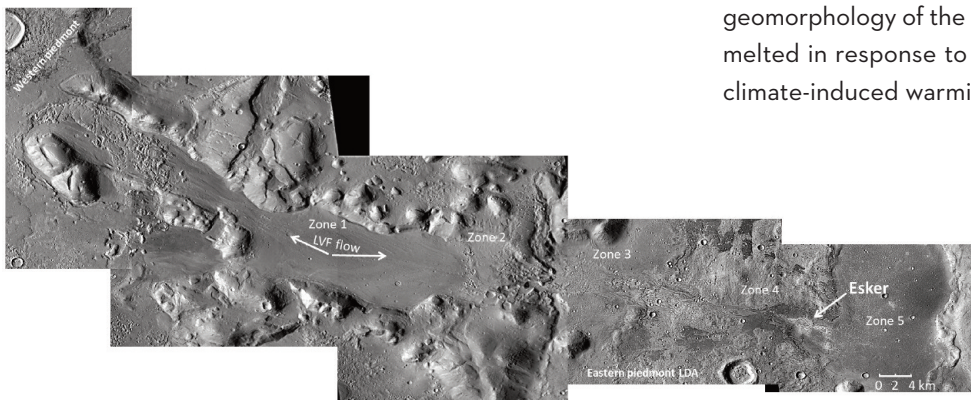
Eskers on Mars are important, as they indicate the melting of glacial ice. Finding another type of environment where liquid water can occur is important in the whole 'life on Mars' question, as it provides yet more evidence for habitability in the recent past.

This research contributes important insights from Mars to our understanding of the complex relationships governing the melting of Earth's most sensitive glacial systems.

DESCRIPTION

Dr Gallagher's research contributes towards advancing our understanding of climate on Mars, through studying the characteristics, origin, and development of features of its frozen surface, which includes glaciers, permafrost and ice caps. Mars is very cold and dry. Although near-surface ice is plentiful, liquid water is very rare. Low environmental temperatures inhibit melting; any meltwater evaporates rapidly. However, several icy landscapes on Mars bear the hallmarks of thaw and meltwater flows. In this context, Dr Gallagher made the first definitive observations of two key landform assemblages.

The first were hillslopes patterned by intricate accumulations of frost-shattered, size-sorted rocky debris incised by water-carved gullies. He also made the first definitive identification of an esker on Mars that was still physically linked with its parent glacier. According to their age, and judged against Earth analogues, the patterned hillslopes reflect the thaw of permafrost, liquefaction of overlying slopes and the emergence of significant thaw-water flows as a consequence of past climate warming on Mars. The eskers are unequivocal evidence of glacial meltwater production, but prevailing climatological and glaciological theory predict that Martian glaciers cannot produce significant meltwater. Instead, the contextual geomorphology of the eskers suggests that their parent glacier melted in response to locally enhanced geothermal heat, not climate-induced warming.



Composite of several images, captured by Context Camera (CTX) aboard the NASA Mars Reconnaissance Orbiter, showing the first esker system on Mars still physically associated with its parent glacier (LVF). The esker discovery was made by Dr Colman Gallagher and announced in Gallagher and Balme (2015). Image: NASA/MSSS.

Hence, these are important new insights to the production of water from the Martian cryosphere through both climatic and non-climatic drivers. Mars climate theory is probably broadly correct but Dr Gallagher's observations provide a rationale both for differentiating between geomorphological indicators of climatic and non-climatic environmental change on Mars and building on insights from Earth into the importance of geothermally-induced cryosphere destabilisation as an amplifier of climate change.

These findings contribute important insights back from Mars to our understanding of the complex relationships governing the melting of Earth's most sensitive glacial systems, in Antarctica and Greenland. These systems are particularly sensitive because they respond both to climatic warming and to regionally elevated levels of geothermal heating. Meltwater produced at their surfaces by increasing atmospheric temperatures is entering these glaciers through crevasses and pipe-like conduits and then combining at the base of the glaciers with geothermally generated subglacial meltwater. The increasing amount of meltwater reduces friction at the base of these glaciers, allowing them to slide more rapidly to the ocean and contribute to global rises in sea level. On both planets, therefore, we are beginning to see the special significance of the planetary cryosphere in maintaining environmental stability and also driving significant environmental change.

DETAILS OF THE IMPACT

Resonating with that international research impact, Dr Gallagher's esker discovery was widely publicised, with coverage by [RTE](#), [The Irish Times](#), [The Irish Examiner](#), the Irish Daily Mail, the Irish Sun and international outlets such as Bloomberg. The research has been widely tweeted and publicised on many international science websites.

The paper is in the top 5 % of all research outputs scored by Altmetric (the bibliometric service used by ScienceDirect). It has been viewed over 6,000 times and downloaded over 700 times since its release in October 2015. The paper has been widely read throughout Europe, the USA and China. International interest in the paper has resulted in Dr Gallagher's invitation to address the Subglacial Landform and Terrain Morphometry, Genesis, and Glaciological Significance session (CR4.4/GM10.6) and Planetary Geomorphology session (GM7.1/PS9.3) of the European Geosciences Union (2016) General Assembly in Vienna.

RESEARCH REFERENCES

C Gallagher, MR Balme, SJ Conway, PM Grindrod (2011). Sorted clastic stripes, lobes and associated gullies in high-latitude craters on Mars: Landforms indicative of very recent, polycyclic ground-ice thaw and liquid flows, *Icarus*, 211, 1, 458-471. DOI:10.1016/j.icarus.2010.09.010

Colman Gallagher and Matthew Balme (2015). Eskers in a complete, wet-based glacial system in the Phlegra Montes region, Mars, *Earth and Planetary Science Letters*, 431, 96-109. DOI:10.1016/j.epsl.2015.09.023