



HAL
open science

Introduction to the Current and recent landscape evolution on Mars special issue

Richard Soare, Susan J. Conway, Jean-Pierre Williams

► To cite this version:

Richard Soare, Susan J. Conway, Jean-Pierre Williams. Introduction to the Current and recent landscape evolution on Mars special issue. *Icarus*, 2020, 342, 10.1016/j.icarus.2020.113715. insu-03663843

HAL Id: insu-03663843

<https://insu.hal.science/insu-03663843>

Submitted on 8 Dec 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Editorial

Introduction to the Current and recent landscape evolution on Mars special issue

Richard Soare^{a,*}, Susan Conway^b, Jean-Pierre Williams^c

a Dawson College, Montreal, PQ, Canada

b CNRS UMR 6112 Laboratoire de Planétologie et Géodynamique, Nantes, France

c University of California, Los Angeles, California, United States

* Corresponding author.

E-mail address: rsoare@dawsoncollege.qc.ca (R. Soare).

The early views of Mars, derived of the Mariner and Viking missions, hinted at a surface environment that was invariably cold, extremely dry (at least in the relatively-recent past), low in atmospheric pressure and, largely, inanimate. Repeat orbital observations combined with the collection of in situ data have revealed a contrary geological facet. Mars is unrelentingly in flux, it seems, at temporal and geological scales ranging from micro- to macro- and, bi-hemispherically, at polar and non-polar latitudes.

The Late Mars Workshop was held on 1–2 October 2018 at the Lunar and Planetary Institute in Houston, Texas. By means of oral and poster presentations, participants shared their observations, interpretations and findings. The articles that comprise this special issue grew out of that workshop.

Fanara et al. (2020) report active mass-wasting at the north-polar margins; here, dry avalanches and block falls reveal layering that is remarkably diverse and climatologically insightful. The high northern-latitudes, specifically in the region radial to the Phoenix lander (68.2°N, 234.3°E), also draw the attention of Noe Dobrea et al. (2020). They look at the rim-morphologies of small (<km-scale) impact-craters and find that the cavities of these craters have been filled, compared to larger ones, and that most of these craters lack ejecta blocks. From the second observation they infer the presence of an unconsolidated and possibly ice-rich layer comprising 20–30 m of depth. Similarly, the fulcrum of Roback et al.'s (2020) attention is a small (km-scale) impact crater within the Meroe Patera dunefield (~7.3°N, 67.7°E). Contrasting the actual to the hypothesized volume of sand fill within the crater and its dune-free shadow, they identify a substantial gap between the two values. They infer sand leakage over time by the work of wind and, importantly, propose that the sand-retention competences of impact-craters are over-estimated, at least at this one site.

Portyankina et al. (2020) focus on the south pole and describe the possible formation pathway of “araneiforms”, landscape features seemingly unique to Mars. The araneiforms, are thought to be the work of multiple, if not ongoing eruptions of cold CO₂ gas. They comprise radially-converging systems of branching troughs with fractal properties which, for the first time, are evaluated using techniques typically reserved for the study of rivers on Earth.

Alongside the work of Fanara et al., two other sets of contributors discuss mass wasting and block falls. Thomas et al. (2020) evaluate the influence of sulfate-rich sediments on slope-side erosion where neither water nor CO₂ are mobile agents. They find that erosion rates are significantly higher, albeit highly localised, when mass wasting co-occurs with the presence of these sediments. Tesson et al. (2020) report that crater-slopes at the mid and equatorial latitudes show a higher frequency of rock falls on north-south facets than on west-east ones. They hypothesise that solar-induced thermal

stress plays a more important role than the phase transitions of H₂O or CO₂ in a) rock breakdown; and, b) the preconditioning of rock-fall slopes, under recent or current boundary-conditions at the low latitudes studied by them.

Soare et al. (2020) explore the mid-latitudes of Utopia Planitia (~35–50°N; ~80–115°E). They describe possible ice-rich landscapes punctuated by pingo-like mounds. The latter, in turn, are embedded in polygonised thermokarstic-structures. Soare et al. also present new crater-frequency distribution data that questions whether these landscapes, often associated with recent variances of obliquity and associated spin/orbital parameters, are older than has been thought hitherto.

Gastineau et al. (2020) contrapose small-scale lobate features on Mars, primarily found on crater walls, with solifluction lobes and zebra stripes on Earth. Curiously, the two terrestrial analogues diverge markedly in their geographical and climatological referents. On Earth, solifluction is rooted in periglacial landscapes where the freeze-thaw cycling of water is commonplace; by contrast, the zebra-stripes referenced by Gastineau et al. are observed in the hyper-arid Atacama Desert.

Primm et al. (2020) address questions concerning the metastability of liquids on Mars under current boundary conditions at or near the surface of Mars. They consider the effects of magnesium and sodium chloride brines on this metastability and suggest that the eutectic temperature of each brine depends on the maximum temperatures reached before freezing. This could be an important variable to consider when evaluating the liquid or non-liquid composition of RSLs, for example.

Since the turn of the century, discussion about millenarian-scale variances of surface temperature, pressure and humidity of Mars have been linked to increases or decreases in obliquity and, as noted above, of other spin/orbital parameters. Mischna and Piqueux (2020) propose an obliquity-driven cycle of surface evolution that drives variability in surface thermal inertia, and suggest that the potential for liquid water at the surface rises with time following large, positive excursions in Mars' obliquity. Currently, obliquity is and has been stagnant for 300 ky, thermal inertia is low and, they argue, the likelihood of water being observed at least artefactually at the surface is high.

Thematically, this collection of articles highlights the extent to which the Late Amazonian Epoch has borne witness to revisions of the Martian surface and near-surface that are wide-ranging, diverse, dynamic and, in some instances, current.

References

Fanara, L., Gwinner, K., Hauber, E., Oberst, J., 2020. Present-day erosion rate of north polar scarps on Mars due to active mass wasting. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113434>.

icarus.2019.113434.

Gastineau, R., Conway, S.J., Johnsson, A., Eichel, J., Mangold, N., Grindrod, P.M., Izouierdo, T., 2020. Small-scale lobate hillslope features on Mars: a comparative 3D morphological study with terrestrial solifluction lobes and zebra stripe lobes. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113606>.

Mischna, M.A., Piqueux, S., 2020. The role of atmospheric pressure on Mars surface properties and early Mars climate modeling. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113496>.

icarus.2019.113496.

Noe Dobrea, E.Z., Stoker, C.R., Berman, D.C., McKay, C.P., Davila, A.F., 2020. Crater morphology and evolution at the Phoenix landing site: insights into timing of modern geological processes and subsurface ice. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113534>.

Portyankina, G., Hansen, C.J., Aye, K.-M., 2020. How Martian araneiforms get their shapes: morphological analysis and diffusion-limited aggregation model for polar surface erosion. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.02.032>.

Primm, K.M., Stillman, D.E., Michaels, T.I., 2020. Investigating the hysteretic behavior of Mars-relevant chlorides. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.06.003>.

Roback, K.P., Runyon, K.D., Avouac, J.P., 2020. Craters as sand traps: dynamics, history and morphology of modern sand transport in an active Martian dune field. *Icarus*. <https://doi.org/10.1016/j.icarus.2020.113642>.

Soare, R.J., Conway, S.J., Williams, J.-P., Gallagher, C., McKeown, L.E., 2020. Possible (closed system) pingo and ice-wedge/thermokarst complexes at the mid latitudes of Utopia Planitia, Mars. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.03.010>.

Tesson, P.-A., Conway, S.J., Mangold, N., Ciazela, J., Lewis, S.R., Mège, D., 2020. Evidence for thermal-stress-induced rockfalls on Mars impact crater slopes. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113503>.

Thomas, M.F., McEwen, A.S., Dundas, C.M., 2020. Present-day mass wasting in sulfate-rich sediments in the equatorial regions of Mars. *Icarus*. <https://doi.org/10.1016/j.icarus.2019.113566>.