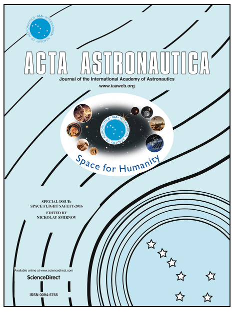
Accepted Manuscript



Shallow transient liquid water environments on present-day mars, and their implications for life

Eriita G. Jones

PII: S0094-5765(17)31745-9

DOI: 10.1016/j.actaastro.2018.02.027

Reference: AA 6722

To appear in: *Acta Astronautica*

Received Date: 29 November 2017

Revised Date: 18 February 2018

Accepted Date: 21 February 2018

Please cite this article as: E.G. Jones, Shallow transient liquid water environments on present-day mars, and their implications for life, *Acta Astronautica* (2018), doi: 10.1016/j.actaastro.2018.02.027.

IAC-17.A1.6.4x36883

Shallow transient liquid water environments on present-day Mars, and their implications for life.

Eriita G. Jones[a],*

[a] *School of IT and Mathematical Sciences, University of South Australia, Adelaide,* eriita.jones@unisa.edu.au
* Corresponding Author

Abstract

The identification and characterisation of subsurface liquid water environments on Mars are of high scientific interest. Such environments have the potential to support microbial life, and, more broadly, to develop our understanding of the habitability of planets and moons beyond Earth. Given our current state of knowledge of life on Earth, three pre-requisites are necessary for an environment to be considered 'habitable' and therefore capable of supporting terrestrial-like life: energy, biogenic elements, and liquid water with a sufficiently high water activity. The surface of Mars today is predominately cold and dry, and any liquid water exposed to the atmosphere will vaporise or freeze on timescales of hours to days. These conditions have likely persisted for much of the last 10 million years, and perhaps longer. Despite this, briny liquid water flows (Recurrent Slope Linea) have been observed in a number of locations in the present-day. This review examines evidence from the Phoenix Lander (2008) and the Mars Science Laboratory (2012-current), to assess the occurrence of habitable conditions in the shallow Martian regolith. It will be argued that shallow, transient, liquid water brines are potentially habitable by microbial life, are likely a widespread occurrence on Mars, and that future exploration aimed at finding present-day habitable conditions and potential biology should 'follow the salt'.
Keywords: (astrobiology, habitability, Mars, Curiosity, Phoenix, extremophiles)

1. Introduction & Background

All known active life requires liquid water. This observation, and the remarkable adaptations shown by life in even the most inhospitable environments where liquid water is available, has guided the search for life on other planets. For terrestrial-like life to exist in the harsh conditions that dominate the surfaces of other rocky planets, our current understanding suggests that minimum fundamental requirements of liquid water, nutrients, and a gradient in chemical energy must be met. Within our solar system, Mars is a strong candidate for hospitable environments able to support life due to the reservoirs of water within its crust and the strong likelihood of liquid water at the surface and in the shallow subsurface. In the present-day, and throughout the past 500 Ma [1], the martian surface is dominated by sub-zero temperatures, and a thin atmosphere below the triple point of water, which causes any exposed water to enter the vapour or solid phase. Considerable attention is given to the likelihood of past habitable conditions on Mars within the Noachian epoch (> 3.7 Ga), during which period long-term standing liquid water was present and extensive liquid water erosion of the surface occurred (e.g. [2]–[5]). For example, observations of nodular silica structures by Mars Exploration Rover Spirit suggest the occurrence of hydrothermal springs and habitable conditions, and have a potentially biogenic origin [6]. Observations at Gale Crater by Curiosity suggest a past habitable fluvio-lacustrine environment [7], with available biogenic elements for life, and a duration of hundreds to potentially tens-of-thousands of years [7]. Limited attention however is given to the extent of habitable environments under the inhospitable conditions that dominate Mars in the present day. In recent years, multiple orbital observations have indicated that despite the low temperatures and atmospheric pressures, liquid water is able to accumulate seasonally in sufficient volume to influence surface features (see review by [8]). For example, linear flow features at the equator termed Recurrent Slope Linear (RSLs) are active in the spring and summer and have been spectrally identified as liquid brine flows from the hydrated salt deposits which remain when the liquid water has evaporated [9]. A number of crater-wall gully systems have become 're-activated' with new flows occurring carving new channels and transporting materials from upslope [10], [11]. Dark streaks that form, and have been observed to grow, on dusty equatorial slopes, are consistent with transient brine accumulation [12]. These observations are supported by laboratory work and theoretical modelling which indicate that present-day Mars can host short-term liquid water environments in the shallow soil within a number of geologic settings (e.g. [13]–[15]). Despite their low volume and short duration, the bio-relevance of modern liquid water environments should not be overlooked. Identifying current liquid water and current/recent habitability on Mars are priorities of the Mars Exploration Program Analysis Group [16], ESA's Geobiology and