EPSC Abstracts,
Vol. 4, EPSC2009-260, 2009
European Planetary Science Congress,

Water on Mars – Constraining Volume to Time Relations

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Introduction

The localization of former potentially habitable zones on Mars is one of the main objectives of the HGF Alliance Program "Planetary Evolution and Life". It is not yet assured which environmental requirements, such as energy sources, nutrients and access to geological environments [e.g. 1], are indispensable for the evolution of life. However, it is unquestioned that liquid water is the primary environmental factor that is necessary for the origin of life. Thus, knowledge about the amount of water and its availability through time is essential for the geologic evolution and habitability of a planet. On Mars, water left its traces as geomorphological landforms. The detection and cataloguing of these features, the derivation of formation times based on the calculation of the required water volume for their formation provide significant information concerning the question "Where was water on Mars, when, and how much?". The goal of this study is to estimate the occurrence and amount of liquid water on Mars globally and with time.

Methodology

In this work we started to collect published studies of fluvial features on Mars and put the results into a data base. Fluvial features that are analysed here comprise outflow channels, valley networks, paleolakes, and alluvial fans/deltas. Important specifications and parameters include the location of the feature, its area and volume, the water discharge, formation time, age, its minimum time of presence, morphological characteristics, and the mineralogy. All information gained from the literature were collected and stored in a data base. In order to provide a complete set of data we will calculate and derive these parameters where ever these specifications are missing. In addition new topographic data from Mars Express are used to constrain the amount of water on the surface per unit time.

Paleolakes and Deltas

Many studies have considered possible paleolakes on Mars [e.g. 2,3,4] providing us a comprehensive dataset of proposed paleolakes and morphometric parameters (Fig. 1). Paleolakes might belong to the prominent regions for the evolution of life due to the long lasting occurrence of liquid water giving the geological context of life. Especially open-basin lakes provide strong evidence because water must have been present there long enough to erode an outlet into the basin boundary [2]. Furthermore, the occurrence of alluvial fans or deltas in a proposed paleolake provide evidence that water flew into a lacustrine basin and transported coarse- to fine-grained material that has accumulated close to the inlet channel [e.g. 4,5,6]. Comprehensive analyses concerning deltas and alluvial fans have been provided by [4] and [5]. The identification of possible paleolakes depends preferably on morphometric parameters such as the existence of a basin (mostly impact craters) or a topographic low featuring inlet channels, outlet channels and alluvial fans [2]. Furthermore, circular platform-like structures around a basin rim are supposed to represent fluvial terraces that were built by the action of waves in a standing body of water [5].

Valley networks

The presence of valley networks gives indication for the incision of flowing water into the bedrock and thus for a relative long-term presence of water at the respective localities. Especially the co-occurrence with hydrated mineral phases evidences the presence of liquid water long enough to be incorporated into the mineral structure [7]. Dendritic patterns are the most reliable features to indicate surface runoff-fed fluvial systems due to their analogy to terrestrial

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features [e.g. 4,8]. However, linear channels featuring a few, or lacking, tributaries might also represent fluvial channels which might be, for example, fed by ground water sapping [9, 10].

Outflow Channels

The water volume that has flooded the Martian outflow channels has been enormous [11]. It is generally accepted that this water has been released from the subsurface in zones of tectonic instability [e.g. 12]. Outflow channels have formed in episodic catastrophic events [12] and thus might indicate a shorter-term existence of liquid water in comparison to valley networks and paleolakes [e.g. 13, 14, 4]. However, the huge amount of water and the aerial extend of these sites of fluvial processes make outflow channels indispensable in a complete data base concerning water on Mars. Morphologically outflow channels can be identified by their broad anastomosing valleys structure having a low sinuosity and high width–depth ratios [11].

Current Status

The current status of this ongoing work is shown in figure 1. So far, 33 deltas/alluvial fans, 213 proposed paleolakes, 25 valley networks and 13 outflow channels have been entered to the catalogue. The acquisition of parameters mentioned above and the derivation of discharges and derived water volume is still ongoing [14].

First impressions of this summarizing compilation of fluvial features imply that Mars has several regions which might be proposed as formerly habitable due to the huge amount of locations representing liquid water activity. However quantitative estimates as proposed in [14] are needed to constrain the water time relation.

Acknowledgement:
This research has been partly supported by the Helmholtz Association through the research alliance 'Planetary Evolution and Life'.

References

[1] Wald, G. (1964) *Proceedings of the National Academy of Sciences* 52, 595–611. [2] Fassett, C.I. & Head, J.W. (2008) *Icarus* 198, 37-56. [3] Cabrol, N.A. & Grin, E.A. (1999) *Icarus* 142, 160-172. [4] Irwin, R.P et al. (2005) *JGR* 110, doi:10.1029/2005JE002460. [5] Ori, G.G. (2000) *JGR* 105, 17629-17642. [6] Pondrelli, M. et al. (2008) *Icarus*, *197*, 429-451. [7] Bishop, J.L. (2009) *LPSC XL,* abstract #2239. [8] Craddock, R.A. & Howard, A.D. (2002) *JGR* 107, doi:10.1029/2001JE001505. [9] Jaumann, R. et al. (2005) *GRL* 23, 16203. [10] Harrison, K.P. & Grim, R.E. (2005) *JGR* 110, doi: 10.1029/2005JE002455. [11] Wilson, L. et al. (2004) *JGR* 109, doi:10.1029/2004JE002281. [12] Baker, V.R. (2001) *Nature* 412, 228-236. [13] Tanaka, K.L., & Chapman, M.G. (1990) *JGR* 95(B9), 14,315–14,323.[14] Irwin, R. P. & Howard, A.D. (2002) JGR 107, doi:10.1029/2001JE001818. [14] Jaumann et al. (2009) *EPSL*, submitted.

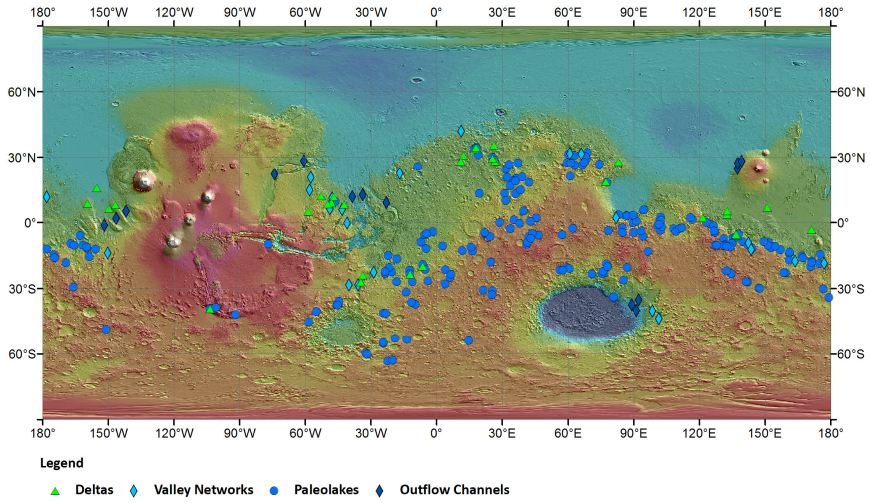

Figure 1: Current status of the catalogue of fluvial features on Mars