THE CHEMISTRY OF MARTIAN WATER AFTER ~3GYR OF PLANETARY EVOLUTION.

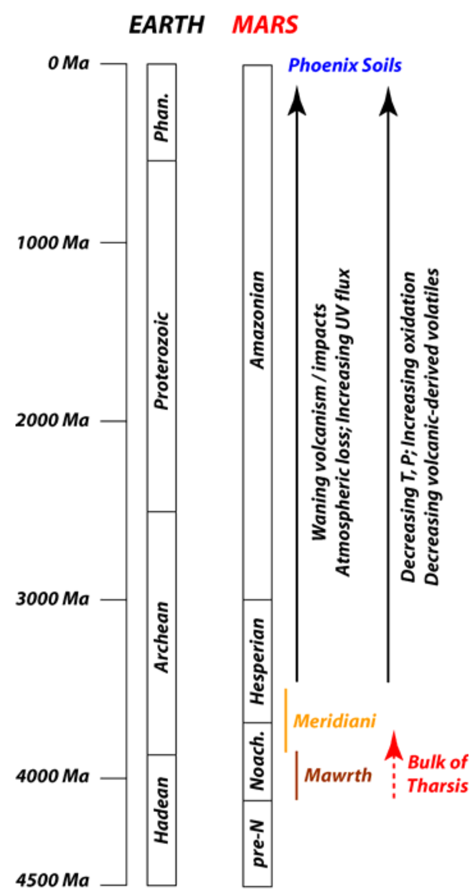
N. J. Tosca, Department of Organismic & Evolutionary Biology, Harvard University, Cambridge, MA 02138 ntosca@fas.harvard.edu

Introduction: Our present knowledge of water on Mars is biased toward the ancient sulfate- and phyllosilicate-bearing sedimentary record – the product of liquid water's larger role in concert with vigorous sedimentary processes [1]. But the unfamiliar chemistry and mineralogy uncovered by the Phoenix Lander reflect physical and chemical processes of a different climate – one that has resulted from billions of years of planetary evolution. When comparing orbital and *in-situ* evidence for liquid water on ancient Mars to the geologically recent Phoenix landing site, it seems important to ask: *What changed over time? And how did large scale planetary evolution change water's chemistry as well as its role in shaping surface mineralogy?*

Water on ancient Mars: The weight of available evidence for liquid water on Mars rests largely in Noachian and Hesperian aged materials [1-3]. Ancient outcrops containing weathering products & chemical precipitates show that water was at times abundant on early Mars. At the same time, geomorphologic and mineralogical constraints suggest that even on ancient Mars the presence of liquid water may have been episodic and of limited persistence on a global scale [4].

Major influences on aqueous chemistry through time: Impacts and volcanism were the hallmarks of late-Noachian/early-Hesperian climates [5]. What the early/mid-Noachian phyllosilicate-bearing materials reflect of the ancient atmosphere is still not clear. However, late Noachian valley networks and the increasing role of volcanism do argue for at least a transient atmosphere and a geochemistry influenced by volcanic-derived volatiles (e.g., SO_4) [6].

In contrast, Amazonian climates saw waning volcanism and impacts, in addition to large-scale atmospheric loss [5]. Where and when H_2O was present during this time, it was largely in the form of ice and snow-pack, with glaciation driven largely by orbital parameters [7]. During these episodes there may have been regional melting, but meltwater chemistry would have been influenced by a thin atmosphere depleted in most volatile constituents except for CO_2. Redox conditions were undoubtedly more aggressive in post-Noachian climates owing to increased UV flux and Fe photolysis [8], as well as other photochemical products that may have been more efficiently cycled into the youngest regolith. Despite the cyclic nature of recent Amazonian climates, episodes of liquid water may have been individually short-lived; geologically young weathering products are scarce and, where they are present, are diagenetically immature [4].



In comparison to our increasing knowledge of ancient martian environments, the Phoenix results are exotic and unfamiliar. At the same time, the increased importance of atmospherically-driven chemical cycles, evolving redox conditions, waning volcanism and seasonally driven processes in the late Amazonian are all likely to have played a role in forming and modifying Phoenix soils. The importance of such processes appears to be consistent with our knowledge of large-scale planetary change and expected influences on aqueous chemistry.

References: [1] McLennan, S. & Grotzinger, J. (2008) in, *The Martian Surface*, Cambridge. [2] Squyres, S., *et al*. (2004) *Science*, 306, 1709. [3] Mustard, J., *et al*. (2008) *Nature*, 454, 305. [4] Tosca, N. & Knoll, A. (*in press*) *EPSL*. [5] Carr, M. (2007) *The Surface of Mars*, Cambridge. [6] Bibring, J.-P. (2006) *Science* 312, 400. [7] Head, J. *et al*. (2005) *Nature*, 434, 346. [8] Burns, R. (1993) *GCA*, 57, 4555.