THARSIS-TRIGGERED FLOOD INUNDATIONS OF THE LOWLANDS OF MARS. Alberto G. Fairén[1,2], James M. Dohm[3], Victor R. Baker[3,4], Miguel A. de Pablo[2,5], Javier Ruiz[6], Justin C. Ferris[7], Robert C. Anderson[8]. [1]Centro de Biología Molecular, Universidad Autónoma de Madrid, 28049 Cantoblanco, Madrid, Spain, agfairen@cbm.uam.es; [2]Seminar on Planetary Sciences, Universidad Complutense de Madrid, 28040 Madrid, Spain; [3]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ, 85721; [4]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ; [5]Escuela Superior de Ciencias Experimentales y Tecnología, Universidad Rey Juan Carlos, 28933 Móstoles, Madrid, Spain; [6]Departamento de Geodinámica, Universidad Complutense de Madrid, 28040 Madrid, Spain; [7]U.S. Geological Survey, Denver, CO 80225; [8]Jet Propulsion Laboratory, Pasadena, CA.

Summary: Throughout the recorded history of Mars, liquid water has distinctly shaped its landscape, including the prominent circum-Chryse and the northwestern slope valleys outflow channel systems [1], and the extremely flat northern plains topography at the distal reaches of these outflow channel systems. Paleotopographic reconstructions of the Tharsis magmatic complex reveal the existence of an Europe-sized Noachian drainage basin and subsequent aquifer system in eastern Tharsis. This basin is proposed to source the magmatic-triggered outburst floods that sculpted the circum-Chryse and NSVs outflow channel systems [1], entrained boulders, rock, and sediment during passage, and ponded to form sequentially through time various hypothesized oceans, seas, and lakes in the northern plains [2,3,4,5], and glaciers and rock glaciers and lacustrine environments such as in the southern hemisphere [6]. The floodwaters decreased in volume with time due to inadequate groundwater recharge of the Tharsis aquifer system.

Basing on the ideas of episodic greenhouse atmosphere and water stability on the lowlands of Mars [3], a conceptual scheme for water evolution and associated geomorphologic features on the northern plains can be proposed. This model highlights Tharsis-triggered flood inundations and their direct impact on shaping the northern plains, as well as making possible the existence of fossil and/or extant life. Martian topography, as observed from the Mars Orbiter Laser Altimeter, corresponds well to these ancient flood inundations, including the approximated shorelines that have been proposed for the northern plains [2]. Stratigraphy, geomorphology, and topography record at least three main stages for water evolution on Mars. First, a great Noachian /Early Hesperian northern plains ocean [7] (related to stages 1-3 of Tharsis development [1]), best portrayed by the martian dichotomy boundary, but in Arabia Terra, where the initial shoreline might have been as far south as Sinus Meridani [8]; and so forming an almost equipotential line [9] western Arabia, and northeast Arabia, Elysium and Amazonis that we name Contact 0, which is also consistent with the location of the boundary in crustal thickness dichotomy, as deduced from topography and gravity data [10] and with the locus of debouch of almost every Noachian valley network on Arabia [8,11]. After a transient dry period, a Late Hesperian sea (related to stage 4 of Tharsis development [1]) would have extended over the deeper areas in the lowlands inset within the boundary of the first great ocean, and so portrayed by Contact 2 [2,5]. And a number of widely distributed minor lakes may represent a reduced Late Hesperian sea, or ponded waters in the deepest reaches of the northern plains [4], related to minor Tharsis (stage 5) [e.g., 1,12] and Elysium [13] induced Amazonian flooding. Our coastal evolution model is summarized in Figure 1.

Potential related biological evolution: Possible biologic evolution throughout the resulting different climatic and hydrologic conditions would account for very distinct metabolic pathways for hypothesized organisms capable of surviving and perhaps evolving in each aqueous environment, those that existed in the dry and cold periods between the flood inundations, and those organisms that could survive both extremes. Terrestrial microbiota, chemolithotrophic and heterotrophic bacteria, provide exciting analogues for such potential extremophile existence in Mars, especially where long-lived, magmatic-driven hydrothermal activity is indicated [14]. Such Martian environments and related materials and life forms may have been excavated to the surface by catastrophic outflows making targets readily available for sampling and in-deep analyses.

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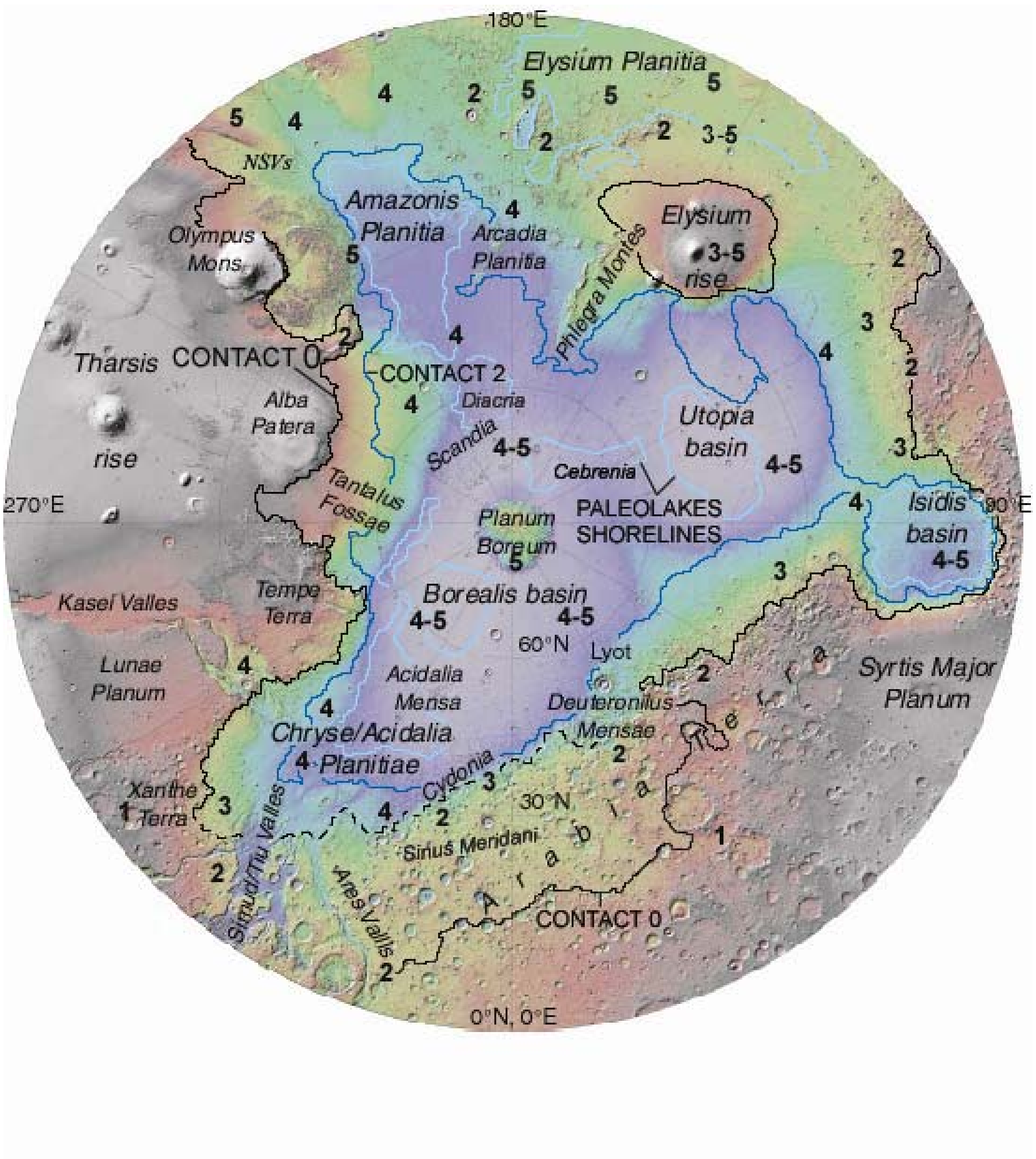

Figure 1. Topographic shaded relief map of the northern hemisphere of Mars constructed from MOLA data [15], showing major geographic features of the northern hemisphere. Marked are Contact 0 (black line), Contact 1 (martian dichotomy boundary, dashed-black line), Contact 2 (dark blue line) and paleolakes (light blue line). Stage information (numbers [1]) is correlative with geologic mapping. Polar stereographic projection, scale varies with latitude.