GRS AS A TEST FOR THE MEGAOUTFLO HYPOTHESIS.

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Introduction: Based on diverse evidence, the MEGAOUTFLO hypothesis [1,2] genetically links: (1) endogenic releases, largely focused at Tharsis since the Noachian, and to a lesser extent, Elysium since the Hesperian [3,4]; (2) floods that carved the large outflow channels [5] and possible spring-fed activity [4], distributing water and rock materials from the southern cratered highlands (including deep-seated, ancient crustal materials) to the northern lowland plains forming lakes [6] and oceans [1,7-9]; and (3) possible transient climatic perturbations [1], including glacial activity [10] (Fig. 1).

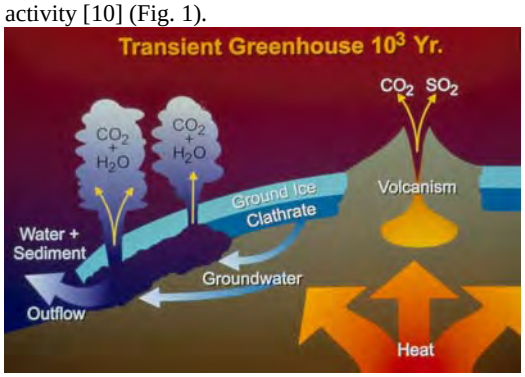

Fig. 1. MEGAOUTFLO genetically links endogenic-driven release of heat and volatiles, floods, ponding of water and sediments in the northern plains, and transient climate perturbation [1,2].

Based on stratigraphy, topography, and geomorphology, the inundation history of the northern plains has been recently reported to have included at least one great Noachian-Early Hesperian northern plains ocean covering approximately 1/3 of the planet's surface, a Late Hesperian sea inset within the margin of the high water marks of the previous ocean, and a number of widely distributed minor lakes that may represent a reduced Late Hesperian sea, or ponded waters in the deepest reaches of the northern plains [11] (Fig. 2). In addition to water and rock materials, elements such as Potassium (K), Thorium (Th), and Iron (Fe) may have been leached from highland materials and concentrated in the lowlands, since at least part of this recorded aqueous history included acidic conditions [12]. Such conditions, which were initially hypothesized to precipitate jarosite and inhibit carbonates from forming at and near the surface of Mars [13] (bearing into question the long-standing argument: "no carbonates, no oceans"), was later confirmed by the Mars Exploration Rover, Opportunity [14]. Mars Orbiter Laser Altimeter (MOLA)-based results [15,16] combine with the Gamma Ray Spectrometer (GRS) instrument identification of element abundance distributions to test whether oceans and lakes occupied the northern plains and the hypothesis that links the geologic, paleohydrologic, and paleoclimatic histories, MEGAOUTFLO.

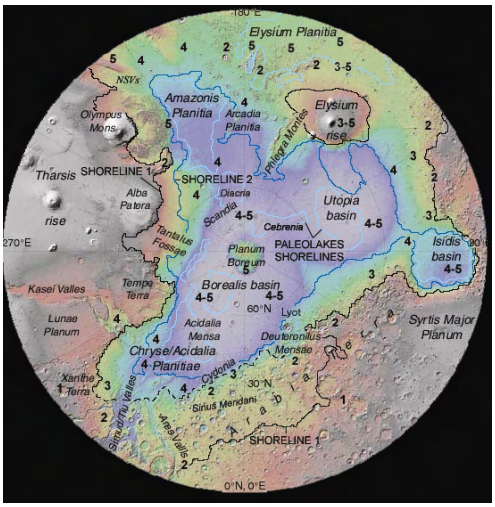

Fig. 2. Based on [11], topographic shaded relief map of the northern hemispere of Mars constructed from Mars Orbiter Laser Altimeter (MOLA) data showing major geographic features of the northern hemisphere, including three major basins (Borealis basin = Vastitas Borealis, Utopia basin = Utopia Planitia, Isidis basin = Isidis Planitia). Also shown are Revised Shoreline 1 (RS1; black line), Shoreline 1 (dashed-black line) and Shoreline 2 (dark blue line), which are largely based on [8,9, 15-18]; paleolakes (light blue line), based on [6]; and Stage information (numbers) that reflects the geologic mapping of [4] and correlative with Stage information of [3,19]. Polar Stereographic projection; scale varies with latitude; modified from [20,21].

GRS: A Test for the MEGAOUTFLO Hypothesis: Coupled with other lines of evidence, GRS-based data (sampling rock materials up to tens of centimeters depth) adds to the assessment of the MEGAOUTFLO hypothesis [1,2], having a significant bearing on the long-standing argument of whether lakes and oceans occupied the northern plains. In order to perform the GRS-based assessment, the following steps were taken: (1) placing shoreline information [e.g., 6,8,9,11,15-18] on a MOLA map for regional GRS summing (Fig.3); (2) formatting shoreline regions (e.g., Fig.4) as bit maps [e.g.,22,23], (3) adding shoreline regions to routine whole mission, CO_2 frost-free summing and analysis [e.g., 22,23], and (4) performing spatial and temporal investigation of variation among common elements (e.g., Fig.5), which includes Student's T-test statistical analysis.

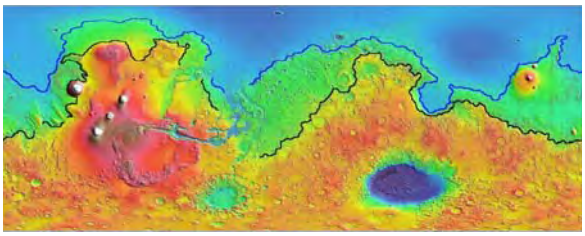

Fig.3. Shoreline information [6,8,9,11,15-18] placed on MOLA data prepared for regional GRS summing.

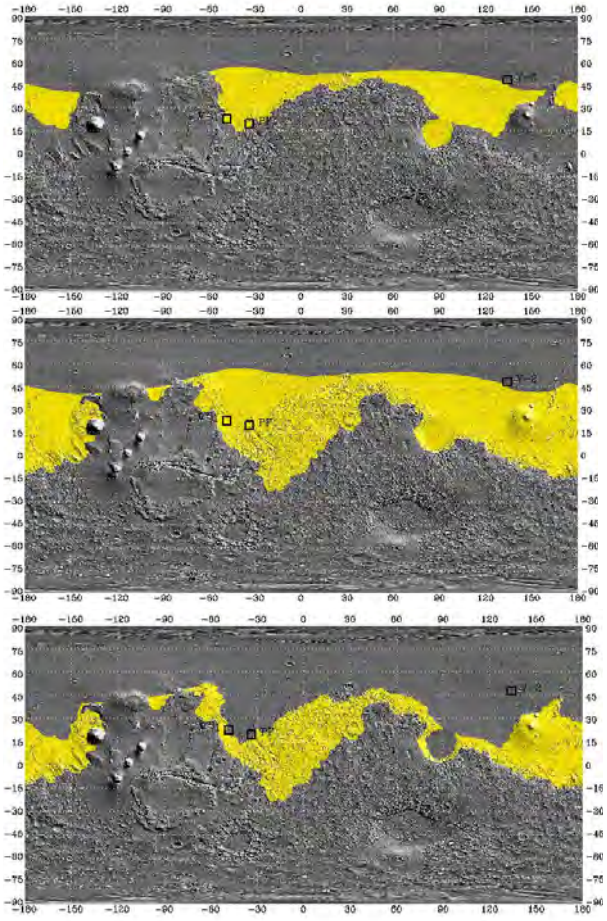

Fig.4. Based mainly on [8,9,11,15-18], yellow regions on MOLA shaded relief maps denote: (top) region below putative shoreline 2, (middle) region below inferred shorelines 1 and 2. Other regions for analysis included region above interpreted shoreline 2, region above putative shoreline 1, and region outside the transitional region.

Conclusion: Coupled with MGS-TES, Pathfinder, and Viking IRTM datasets, the elemental information may be explained by inherent variations in igneous rocks and by variations in the extent of aqueous alteration [24,25]. On the other hand, when coupled with other lines of evidence, which includes Viking data [e.g., 1,2,6,7,8,9,17,18] and recent results from the Mars Orbiter Laser Altimeter (MOLA) instrument of Mars Global Surveyor [11,15,16], GRS elemental information is consistent with lakes and oceans that once occupied the northern plains of Mars and the MEGAOUTFLO hypothesis. A comparison among the geology, topography, paleohydrology, and GRS-based elemental information will be presented at the conference.

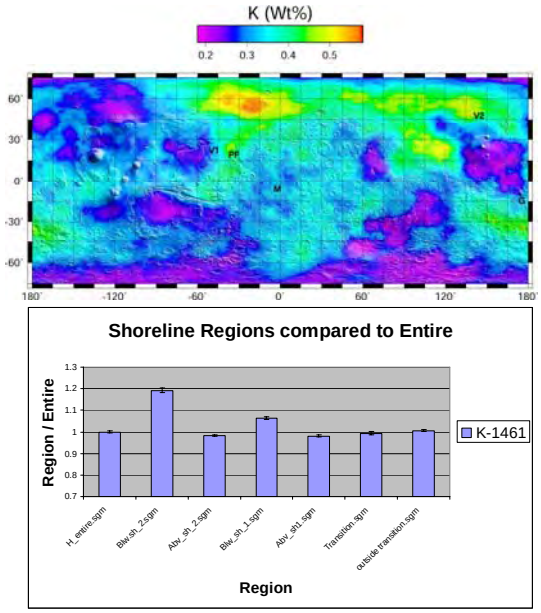

Fig 5. GRS-based elemental map information showing K abundance (top) and associated histograms (bottom) within 1-sigma error showing shoreline regions compared to the rest of the sampled region (referred to as the belly band; see [21,22]). Note that elevated K abundances in the northern plains, which includes the Vastitas Borealis Formation hypothesized to have been emplaced by aqueous process [4]. On the other hand, K abundance is low where Tharsis and Elysium volcanics have been mapped [4,20].

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