EVIDENCE AND ARGUMENTS FOR AN EARLY MARTIAN OCEAN .

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The possibility that a large ocean once occupied the northern plains of Mars is based largely on the work of Parker et al. (1987, 1989, 1993), who identified evidence in high-resolution Viking Orbiter images of a series of nested levels – which they interpreted as shorelines – located along the highland/lowland boundary. The highest and oldest of these was called the ‘Arabian Level’ and is believed to date back to the Late Noachian.

In the much higher resolution (~0.2 - 20 m/pixel) MOC, HiRise and HRSC images, the Arabian Level exhibits evidence of terracing (potentially indicative of wave-cut erosion); however, the lower, younger levels/’shorelines’ do not. The interior plains encompassed by these lower levels include vast expanses of cold-climate landforms, such as polygonal ground and pingos, a relationship that is consistent with either an initially warm, but progressively cooling, marine environment – or initial conditions that were cold from the outset. In either case, the flow-front-like morphologies associated with the lower levels may have resulted from ice-shoving due to short-lived transgressive events caused by later episodes of outflow channel activity around the northern plains (Parker et al., 2012).

The combination of high-resolution orbiter images with MOLA gridded topography has enabled the compilation of regional and global maps of the proposed shorelines. Apparent discrepancies between the absolute elevation of one of these proposed shorelines with the perimeter of an equipotential surface was cited as a potential serious weaknesses of the paleo-ocean hypothesis (Carr and Head, 2003). However, improved shoreline maps, based on the recent influx of new, higher-resolution images, combined with recognition of the potential impact of polar wander on the post-ocean deformation of shorelines (Perron et al., 2007) have helped resolve much of this disagreement.

Additional support for the ocean hypothesis comes from: (1) recent studies of the geographic distribution of Martian valley networks which appear consistent with the former presence of an ocean in the northern plains (Luo and Stepinski, 2009; Di Achille and Hynek, 2010) and (2) the recent MARSIS discovery of anomalously low near-subsurface dielectric values within the northern plains region interior to the proposed shorelines (Mouginot et al., 2011). These low dielectric values are consistent with either a thick (□100 m) deposit of high porosity sediment or a large volumetric content of water ice (or some combination of the two).

The survival of a frozen relic of an ancient ocean is an expected consequence of the burial or ocean ice by eolian sediments and volcanics, that may have preserved the ocean ice to the present day. While atmospheric sublimation may have depleted the original ice in the shallow subsurface, the presence of a geothermal gradient and the process of thermal vapor diffusion (Clifford, 1993) may continue to offset this loss by the thermal redistribution of surviving ice from greater depth.

This conclusion is consistent with the growing geomorphic and topographic evidence for the former existence of a northern ocean and with the geomorphic and radar evidence that a substantial relic of that body may continue to survive as massive ice deposits within the northern plains.