REASSESSING MARS' GLOBAL OCEAN SHORELINES. S. F. Sholes[1,2], D. R. Montgomery[1], and D. C. Catling[1,2], [1]Dept. of Earth and Space Sciences, Box 351310, University of Washington, Seattle, WA (sfsholes@uw.edu), [2]Astrobiology Program, Box 351580, University of Washington, Seattle, WA.

Introduction: It has long been proposed that the northern plains of Mars may represent a basin where discharge from the large outflow channels may have pooled [e.g. 1-2]. However, the hypothesis of a large ocean has yet to be satisfactorily reconciled with climate models and water inventory assessments [3-4].

Support proposed for liquid water oceans includes hypothesized paleoshoreline features. Observations of contacts that encircle portions of the northern plains have been interpreted as paleoshorelines for different ocean stands. Two primary levels have been traced to near-complete closure around the northern plains: the Arabia Level, which roughly follows the topographic dichotomy, and the Deuteronilus Level, which largely follows the southern boundary of the Hesperian-aged Vastitas Borealis Formation (VBF).

However, two problems with interpreting these features as true paleoshorelines are: 1) the mapped shorelines show a wide variance in their elevations, which is at odds with an expected equipotential surface [5]; 2) the features have continuously been found to have no obvious or unambiguous consistency with a coastal origin [e.g. 5-8].

True polar wander and crustal flexure have been proposed to explain the contacts' current topographic state [e.g. 9]. However, little work has been done to reexamine the proposed shorelines using the plethora of high-resolution data now available from the *Mars Reconnaissance Orbiter*.

Here, we address both problems by 1) summarizing and quantifying the issues with the mapped shorelines and 2) reinvestigating specific locations that have been proposed as possible coastal landforms and assessing their candidacy based on the now available very-high resolution HiRISE imagery and stereo-imaged-derived topographic data.

Shoreline Locations: The original mapped contacts were done free-hand on low-resolution Viking images [1-2], which invariably led to their misidentification and misplacement [8]. This has led to observed ~0.6 km and ~2.5 km ranges in elevation within the Deuteronilus and Arabia Levels respectively [5].

This misplacement is further compounded due to the absence of standard shapefiles corresponding to contact locations, leading to relatively low-quality digitization of published figures. Fig. 1 captures a snapshot of the large offset seen between the two contacts locally in west Deuteronilus Mensae. The historically used shapefiles from [5], datamined from [10, their Fig. 6], are

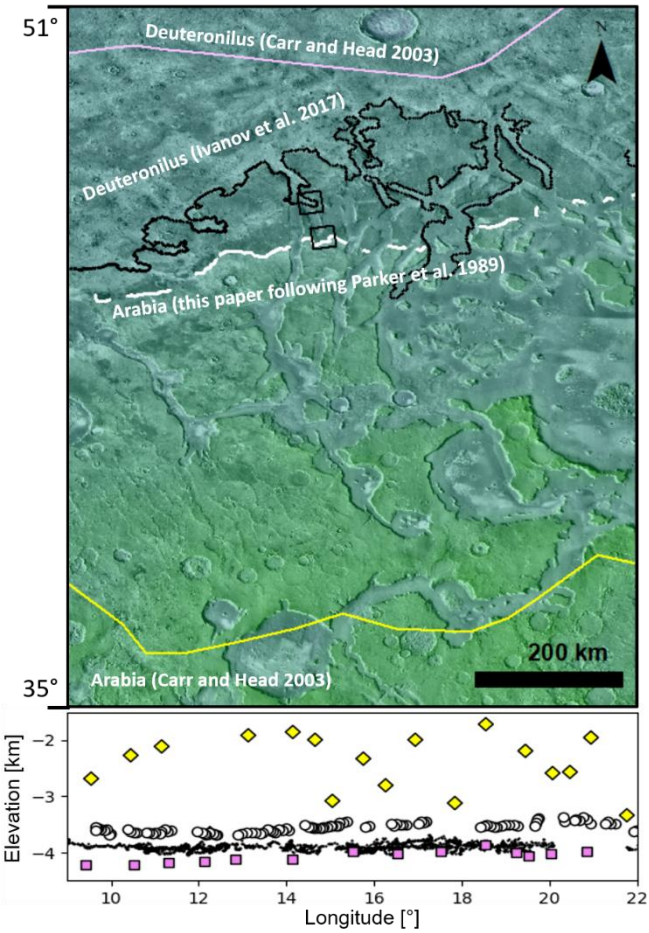

Fig. 1: Different locations according to different authors of the same proposed ocean levels contacts in west Deuteronilus Mensae. Mappings have large variance in locations (top) and elevation (bottom). Arabia [5] is in yellow, Arabia [this paper, from 1] in white, Deuteronilus [5] in purple, and Deuteronilus [11] as black dots. THEMIS-IR Day Mosaic with MOLA colorized elevation.

shown in yellow (Arabia) and purple (Deuteronilus). Detailed remapping of the prominent Deuteronilus Level by [11] is shown in black. Here, we also present our remapping of the local Arabia Level based on the original boundary (as described by [1]) in white.

Remapping of the Deuteronilus Level found two distinct regional levels with decile elevation differences of ~180 m and ~270 m and a modeled geoid accounting for true polar wander is able to explain the disparity [11]. However, the Arabia Level has had no such detailed remapping, largely in part due to the changing morphologies along track, sometimes diffuse nature, and accumulation of material obscuring the contact. Through our remapping, we find the Arabia Level (based off the tonal

boundary in THEMIS-IR Day) is at an average elevation of -3,560 m with a decile range of 200 m. Compare this with the local mean elevation of -2,430 m with a decile range of 1,300 m from the datamined version [5]. This is consistent with descriptions of other unpublished remapping efforts, which suggest a potential ~2 km offset due to misidentification of the Arabia Level near Apollinaris Patera [12].

Shoreline Characterization: We identified 40 locations cited in the peer-reviewed literature as potential candidates for ocean paleoshorelines. All have CTX coverage of ~6 m/px, and 22 have HiRISE coverage (0.25-0.5 m/px). We use the paleoshoreline identification toolkit established in [8] to assess the features. Fig. 2 shows typical morphological expressions of the two contacts (Deuteronilus – lobate, Arabia – tonal).

As with other studies, we find no obvious or unambiguous evidence to support a paleoshoreline interpretation. Rather, the origins of the features plausibly fall into other categories: glacial, mass wasting, volcanic, regional collapse, outflow channels, unit boundaries, tectonic, deltaic/alluvial fan, and lobate flows.

Conclusions: Caution must be used when examining the putative paleoshorelines. The Arabia Level is so poorly mapped that we find mean elevations off by >1 km in Deuteronilus Mensae. The Deuteronilus Level is more thoroughly mapped, but consists of lobate flow-front deposits. These deposits may be consistent with an ice and debris covered ocean [12], but may also be the result of volcanic, glacial, or subaerial catastrophic flood deposits [11].

In addition to their locations, morphologies in the high-resolution imagery show little to no consistency with a shoreline hypothesis. For example, many of the stepped massifs believed to be wave-cut terraces are more likely the result of collapse of the highland terrain [13] with overlapping aprons, varying elevations, and tilts in opposite directions. Mass wasting events create features that resemble strandlines, narrow terraces, or stacked ridges. However, HiRISE reveals the features as highly discontinuous with bifurcations. Ridges previously interpreted as spits or tombolos connecting islands, cross-cut massifs, are highly sinuous, and have various orientations that are more consistent with volcanic processes than coastal deposition.

Overall, we reiterate the conclusions of [5], that the margins of the lowland boundaries (paleoshorelines) offer little to no support for an ocean. This does not preclude the existence of an ancient ocean, but more compelling evidence is required to support such an interpretation. Putative tsunami deposits [14] and deltas [15] are other hypothesized evidence for an ocean, but these features were beyond the scope of the present study.

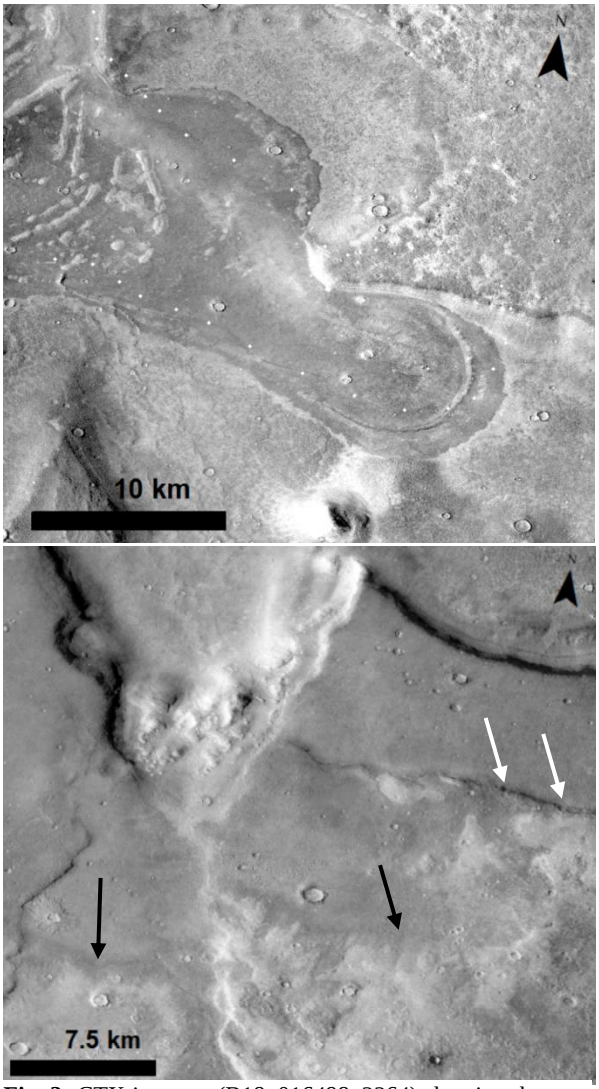

Fig. 2: CTX imagery (B18_016498_2264) showing the general features of the Deuteronilus level (top) and the Arabia level (bottom) within Mamers Valles (black boxes in Fig. 1). Deuteronilus is marked by dark-toned lobate flow fronts while Arabia is most visibly seen as a tonal contrast (black arrows) in THEMIS-IR Day images (overlaid onto bottom CTX image). White arrows indicate escarpment also used to define the Arabia level.

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