THE MARS PLATE-TECTONIC-BASEMENT HYPOTHESIS.

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Introduction: The Hadean-age-equivalent (> 4.0 Ga) Martian basement complex has heretofore been difficult to characterize. This is due to extensive modification by the Late Heavy Bombardment and subsequent impacts, as well as chemical alteration of the primary rocks (including weathering rinds, clay minerals, Al/Fe oxides/hydroxides, sulfates, and evaporite deposits). Obscuration of a felsic basement includes erosion of the terrain predominantly through wind and water activity, as well pervasive mantling by wind- (e.g., aeolian), water- (e.g., fluvial, alluvial, colluvial, glacial, periglacial), and volcanic- (airfall deposits, lava flows materials, fine-grained volcanic spherules transported by wind) related materials. Tharsis, dominant in the geologic, hydrologic, and climatic records of Mars since its embryonic development nearly 4.0 Ga. [1-2], has been a primary supplier of basaltic materials.

Yet, unlike the Hadean rocks that have been obliterated on Earth, the Hadean-age-equivalent ancient Martian basement is still preserved. This is because an Earth-like phase of Mars, including an active dynamo and hypothesized plate tectonism [3-14], terminated sufficiently early in its evolutional stage [1] to archive early Mars rocks, early solar system history, and possibly evidence of early life.

Such a hypothesized basement record, including plate tectonism that terminated sometime following the demise of the dynamo, which occurred prior to the ~ 4.0 Ga Hellas impact event [15], is referred to here as the Mars plate-tectonic-basement hypothesis (MPTB).

MPTB is based on geological mapping investigations and related syntheses of new data from landers and orbiting spacecraft. It is supported by a systematic, spatial arrangement of landforms, referred to as the Claritas subduction zone region that is strikingly similar to the plate-tectonic-modified landscapes of the western US that resulted from plate migration and subduction, including the subduction of the denser mafic Farallon Plate beneath the lighter felsic North American Plate (**Fig. 1**).

Further corroborating MPTB are the diagnostic features of rugged mountainous terrain of the Claritas

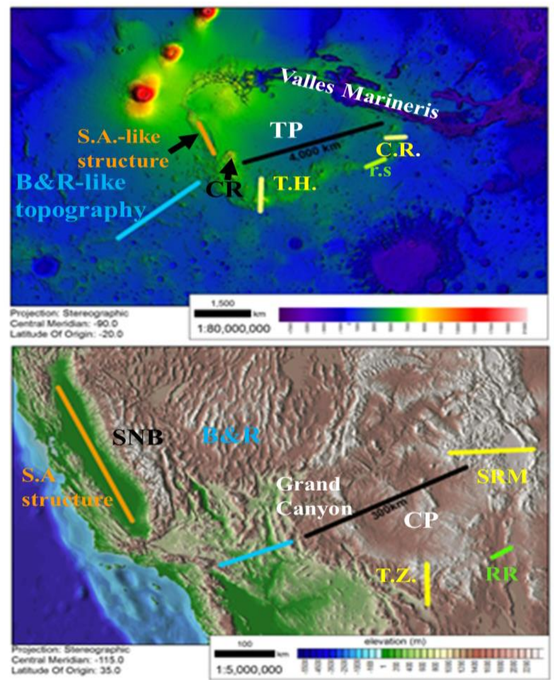

Figure 1. Shows two colorized topographic shaded relief maps: Claritas subduction region (top) and the southwestern US (bottom). Line colors are matched across maps highlighting similar structures and spatial arrangement.

Claritas subduction region includes the Thaumasia Plateau and depressed central part (TP; black line generally representative of its width) with mountainous terrain along its eastern and southern margins, the Coprates rise (C.R., yellow line) and the Thaumasia highlands (T.H.) mountain ranges, respectively, an unnamed rift system (r.s.; green line) marking the gap between the former two mountain ranges at the southeast corner of the plateau, Basin & Range-like topography (B&R; blue line) to the southwest and west of the plateau, and a San Andreas-like structure (S.A.; orange line) along the western margin of the plateau with massive promontories near the structure's northwest and southeast margins, the latter being the Claritas rise (CR), as well as deformation along the structure's eastern margin.

Western US region includes the Colorado Plateau and depressed central part (CP; black line) with mountainous terrain along its eastern and southern margins, the Southern Rocky Mountains (SRM; yellow line) and Transition Zone (T.Z.; yellow line), respectively, the Rio Grande Rift (RR; green line) marking the gap between the former two mountainous terrains, the Basin & Range (B&R, blue line) to the southwest and west of the plateau, the San Andreas-related Great Valley (S.A. structure; orange line) along the western margin of the B & R with massive Sierra Nevada Batholith (SNB) along its eastern margin and the San Andreas fault along its western margin.

subduction region, exemplified at the Claritas rise and surroundings, estimated to be > 4.0 Ga [4] including:

(1) Baikal-rift-like structures observed in Claritas rise, a large promontory that forms the northwest part of the Thaumasia highlands mountain range [16-17].

(2) Bouguer gravity lows of the Hadean-age-equivalent Claritas subduction region, consistent with the less dense, older, highly deformed felsic continental crustal materials at compressional plate margins of Earth (e.g. Himalaya, Andes, and Japan). Granite accumulations, for example, distinctly accumulate at subduction zones. On the other hand, the generally younger and denser mafic oceanic crust of Earth is characterized by high Bouguer gravity, as do the Hawaiian shield volcanoes and Ontong Java igneous plateau. Similarly, the lava flows sourcing from Syria Planum and the Tharsis Montes that embay and partly bury the rugged mountainous terrain of the Claritas subduction region generally along its eastern and western margins, respectively, have relatively high Bouguer gravity values. Similar to orogenic complexes of Earth, the low gravity of mountainous terrain of the Claritas subduction region is consistent with deep crustal roots and/or low-density materials.

(3) Mars Odyssey Gamma Ray Spectroscopy-based identification of elemental concentrations [18] consistent with a felsic basement compared to the basaltic lava flows materials that embay the western and eastern margins of the mountainous terrain of Claritas rise and surroundings. These are sourced from the Tharsis Montes and Syria Planum, respectively.

(4) CRISM-based identification of a diversity of minerals including the largest extent of serpentine [19], yet identified on Mars, along the northern structural front of Claritas rise in contact with carbonate, consistent with structurally-controlled occurrences of serpentine mélanges of Earth exemplified in the Altai Mountains of the India-Asia collisional orogenic complex [20]. As a diagnostic indicator of orogenic complexes of Earth, ductile materials, produced along the margin of the subducting hydrated slabs with increasing temperatures and pressures, are eventually squeezed back towards the surface of Earth through subduction zone-related basement structures, and thus occur as long serpentine-mélange belts (with lengths that can reach over a 1000 km and widths less a 2 km).

(5) Candidate olistostromes distinctly visible within steeply dipping beds of a prominent ridge near the northeast margin of Claritas rise. Terrestrial counterparts mark submarine flows (turbidites) emplaced towards the trench often comprising blocks of part of the orogenic complex including those oceanic materials composing the accretionary complex (e.g., Ocean Plate Stratigraphy commonly composed of Mid Ocean Ridge (MOR) basalt, chert, hemipelagic sediment, and trench turbidite deposits representative of the conveyor belt as it moves from the MOR to the trench [21]). An ocean along the northern front of the Thaumasia highlands is possible if Tharsis is removed.

(6) Candidate accretionary complex with structural expression similar to that of Earth counterparts such as one mapped San Francisco [22]; though, detailed mineralogy confirming stack packages along thrust faults is necessary for confirmation. A key index of accretionary complex development is the Pacific-type Japanese Orogenic Complex [23-25].

Conclusion: The systematic, spatial arrangement of structures, in a manner analogous to that of the western US, and the abovementioned diagnostic indicators of a terrestrial-like orogenic complex all point to a Hadean-age-equivalent phase of plate tectonism on Mars. These and additional evidence support the MPTB hypothesis and have important implications for a new era of geologic investigation and reconnaissance, as well as for potential environmental information about early Mars, solar system, and possibly life, compiled through subduction processes.

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