The Tharsis and Elysium corridor: A marker for an internally active Mars?

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The paradigm of an ancient warm, wet, and dynamically active Mars, transitioning into a cold, dry, and internally dead planet has persisted up until recent in spite of published Viking-based geologic maps, which indicate geologic and hydrologic activity into the youngest part of the history of Mars, the Late Amazonian epoch. This paradigm is shifting to a water-enriched, still possibly internally active planet, based on a collection of geologic, hydrologic, topographic, and elemental evidences obtained by the Viking, Mars Global Surveyor (MGS), Odyssey, and Mars Express missions. A collection of diverse information unfolds this possibility, including: (1) stratigraphically young rock materials such as pristine lava flows with few, if any, superposed impact craters, (2) tectonic features that cut stratigraphically young materials, such as fractures, faults, graben, and pit crater chains, (3) features with possible aqueous origin such as structurally-controlled channels that dissect stratigraphically young materials and anastomosing-patterned slope streaks on hillslopes, (4) elevated elemental abundances, such as hydrogen and chlorine, and (5) methane, all of which occur in regions that reportedly record ancient, middle planet, and geologically recent magmatic, tectonic, and hydrologic activity. Specifically, parts of Tharsis, Elysium, and the region that straddles the two volcanic provinces, collectively referred to here as the Elysium/Tharsis corridor, unfolds a potentially internally active Mars.

Results from recent Mars missions and their implication to possible life

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The Mars Opportunity and Spirit rover missions, Mars Express, Mars Odyssey, and Mars Global Surveyor have revolutionaized our view of Mars. No scientist has faced these data with prior ideas well intact. While the orbiting missions have provided global and regional views of ice distribution in the shallow crust, topography,geology, and geochemistry, as well as aspects of local geology and geomorphology, the rover missions have provided critical ground truth that lend confidence to the global observations and add critical details not discernable from orbit. Most critically, the rovers have provided close-up chemical and petrologic data that elucidate important enviornmental conditions at two points in geologic time and space. It is evident from these orbital and rover data that Mars, like Earth, is a "water world," but it is one where most of the water has been locked as solid ice for most of Martian history. There were periods and places on the surface where liquid water was abundant for geologically significant periods of time. We see it in the landforms and in the chemistry and mineralogy. Limited rover-based ground truth points toward highly acidic, highly saline, and probably very cold brines as the depositional agent in Meridiani Planum and as a rock-altering agent in Gusev Crater. The rover data are consistent with a an interpretation that Mars is analogous to a global acid-mine waste site. Many aspects of Martian geology, geochemistry, and mineralogy--right down to the red color of Mars-- can be explained within the context of this aqueous acid model. Orbiter observations of very young water-related landforms indicate a surprising geologic recency of some aqueous activity. However, in retrospect, considerations of multicomponent solid-liquid-gas phase equilibria suggest that aqueous acid brines still are active at shallow levels and potentially even at the surface of Mars. Whether life ever could have originated or evolved there is an important unanswered question, but one which should bear very strongly on our exploration strategy. Recent Mars Express observations of methane are consistent with the past or present existence of methanogenic life; however, abiogenic formation of methane also is possible. In sum, we have answered long-standing questions about whether Mars was icy or wet; it was and still is both.