Layered Deposits of Arabia Terra and Meridiani Planum: Keys to the Habitability of Ancient Mars

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Understanding the habitability of ancient Mars is a key goal in the exploration of that planet. Evidence for conditions favorable to early life must be sought in ancient sedimentary rocks, such as those of Arabia Terra and Meridiani Planum.

Arabia Terra, the northernmost extension of the ancient highlands, is dominated by cratered plains and minor ridged units. These plains extend south into the adjacent Meridiani Planum. The Opportunity rover landed in northern Meridiani, close to the border with Arabia.

High resolution MOC images reveal extensive layered sequences across much of the Arabia and Meridiani region. These layers have been interpreted as eroded remnants of sedimentary rock deposits (Edgett, 2005). The layered sequences are concentrated in the SW quadrant of Arabia and in northern Meridiani.

Preliminary mapping by Edgett (2005) distinguished four large scale layered sequences in the Arabia and Meridiani region. These have dimensions of hundreds to more than 1,000 km. MOLA altimetry shows that each of the sequences can attain a thickness of 200 to 400 m, with a total thickness greater than 1 km. The sequences are generally flat lying, with regional slopes of a few degrees. Much finer layering is evident within a number of craters.

The plains and ridged units of the Arabia and Meridiani region were originally mapped as Noachian based on crater statistics, particularly the number of large craters (Scott and Carr, 1978). The layered sequences in the current study postdate many, but not all, of these large craters. The layered sequences have partially or totally filled a number of craters with diameters ranging from 20 to over 50 km.

The topmost layered sequence, as well as the lower two sequences, have intermediate thermal inertia, as derived from THEMIS, indicative of moderate induration. The TES spectra from the lower sequences include features indicative of basalt. Some areas of the topmost sequence, which includes the Opportunity landing site, have TES spectra dominated by hematite. Just below this topmost sequence lies a sequence with higher thermal inertia, indicative of more indurated or coarser grained material. The TES spectra of this sequence lack distinctive mineral features, and the rocks may be obscured by a thin coating of dust.

The layers have been extensively eroded. The uppermost sequences are characterized by deeply scalloped boundaries. Filled craters have been partially exhumed. Finely layered deposits within craters have been strongly dissected. Landforms uniquely attributable to wind erosion are rare, but erosive styles and geomorphology characteristic of water and possibly ice are present.

The layered sequences in Arabia Terra and Meridiani Planum likely reflect an epoch when the planet was much more habitable than it is today. Several areas in these layered sequences are under intensive study as candidate landing sites for the 2009 Mars Science Laboratory.