Geomorphological view of the aqueous history of Mars and candidates of current habitable environments

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Ancient Mars is now considered to have had an environment similar to that of Earth. This is often discussed in terms of the existence of large bodies of water, a wide range of surface oxidation states, an active dynamo and associated magnetic field, magmatism and tectonism including mountain building and basin formation, and a variety of chemical components that are potential building blocks of life. Similar to Earth, ancient Mars had hydrological cycling among atmosphere, ocean, and landmass (southern cratered highlands). Endogenic activities continued until recently, and recent water-related geological features indicate the prolonged existence of aquifer systems, where habitable environments may exist for a significant period. Occasional releases of volatiles from such aquifer systems may ultimately account for Curiosity rover detecting methane in the Gale crater and inconclusive results obtained with metabolism-detection instruments onboard Viking landers. Unequivocal evidence of the existence of subsurface aquifers or extant endogenic activity is, however, still lacking possibly due to the existence of homogeneous regolith materials covering the surface of Mars. Besides, even if a habitable environment exists at depth, accessing the environment with a spacecraft (either a lander or a rover) has been challenging because such an environment is generally thought to exist more than several kilometers below the Martian surface. Recent findings of a recurring slope lineae (RSL) point to traces of possible seasonal liquid water flows along slopes, findings that are likely to change the above prevailing view; some of these features might result from the partial discharges from an aquifer. In other words, RSLs might provide a natural bridge between a subsurface aquifer and the surface accessible by a rover. Thus, subsurface structures near such features are prime targets to be explored by future missions. Once the presence of groundwater is confirmed, especially an aquifer, mapping and characterizing the distribution of subsurface water would significantly help address the ever-important question of whether life exists on Mars.

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