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Exploring Past and Present-Day Habitable Environments in the Martian Subsurface

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Today, liquid water is not thermodynamically stable at the surface of Mars due to the low temperature and pressure conditions. However, liquid groundwater may still exist in the Martian subsurface [1, 2].

In this study, we use fully dynamical 3D thermal evolution models [3] to calculate the depth at which favorable conditions for liquid water are present, assuming that a global subsurface cryosphere exists on Mars today.

Some of the most important parameters that affect the depth of liquid water are the spatial variations of crustal thickness and crustal thermal conductivity, since the crust has a lower thermal conductivity compared to that of the mantle and thickness variations can shift the groundwater table locally closer to the surface. The amount and distribution of heat sources, and the presence of mantle plumes, can introduce additional perturbations to the depth of groundwater. The surface temperature distribution and the presence of salts and clathrate hydrates considerably affect the depth and locations where subsurface liquid water may be stable. Hydrated magnesium (Mg) and calcium (Ca) perchlorate salts, whose presence has been suggested at various locations on Mars [4], may significantly reduce the melting point of water ice. In addition to thick regolith layers, clathrate hydrates, if present in the subsurface, would provide an insulating effect reducing the crustal thermal conductivity at least locally [e.g., 5].

Our results suggest that the Martian subsurface has had, and still has, the potential to enable deep environments with stable liquid groundwater. Combined with the analysis of geomorphological features at the Martian surface such as outflow channels, valley networks, deltas [6], sedimentary deposits [7], hydrated minerals [8], cementation [9], mineral veins containing, e.g., manganese oxides that require water [10], and maps of subsurface water ice [11], our models could deliver valuable estimates of the depth of liquid groundwater on past and present-day Mars providing key knowledge on the planet dynamics, evolution, and astrobiological potential.

References: [1] Clifford et al., 2010, JGR, 115(E7); [2] Stamenković V. et al., 2019, Nat. Astron., 3(2); [3] Plesa A.-C. et al., 2018, GRL, 45(22); [4] Leshin L. et al., 2013, Science, 341; [5] Kargel J. et al. 2007, Geology, 35(11); [6] Fassett C. & Head J., 2008, Icarus, 198(1); [7] McLennan S. et al., 2019, Annu. Rev. Earth Planet. Sci., 47; [8] Ehlmann B. & Edwards C., 2016, Annu. Rev. Earth Planet. Sci., 42; [9] McLennan S. et al., 2005, EPSl, 240(1); [10] Lanza N. et al., 2016, GRL, 43; [11] Piqueux S. et al., 2019, GRL, 46.

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