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The Depth of the Cryosphere and the Presence of Groundwater on Present-Day Mars: Revised Estimates and Implications.

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It has been estimated that, at the time of peak outflow channel activity, ~2-3 Gya, Mars possess a planetary inventory of water equivalent to a global ocean 0.5–1 km deep (M. Carr, Icarus. 68, 187, 1986). Because this peak post-dates the period when the most efficient mechanisms of planetary water loss (impact erosion and hydrodynamic escape) are thought to be active (>4 Gya), the bulk of this water is likely to still suvive as in the PLD and in the subsurface, as ground ice and groundwater.

How much groundwater survives on Mars today depends on the relative size of the planetary inventory of H2O vs. the pore volume of the cryosphere (that region of the crust where the temperature remains below freezing). If the planetary inventory exceeds what can be stored as ice within the cryosphere, then the excess will exist as a groundwater, saturating the lowermost porous regions of the crust. Previous best estimates of mean global heat flow, crustal thermal conductivity, and freezing-point depression, suggested that the nominal depth of the cryosphere varied from ~2.5 km at the equator to ~6.5 km at the poles, with the natural heteorgenity of the crust expected to give rise to significant (±50%) local variations (Clifford (JGR 98, 10973, 1993).

Here we revisit these previousr estimates, examining the potential consequences and implications of our evolving understanding of crustal heat flow, thermal conductivity and the effects of groundwater composition on freezing-point depression – as deduced from recent Mars' surface, orbital, and Earth-based investigations. We conclude that the present day cryosphere may be up to twice as deep as previously thought, raising questions about the continued survival of subpermafrost groundwater -— as a once large inventory may have been cold-trapped into the thickening cryosphere, as the planet's internal heat flow declined with time.

If groundwater does continue to persist on Mars, the locations that are likely to provide the best opportunity for its detection are those that combine low latitude (minimizing the thickness of frozen ground) and low elevation (minimizing the depth to a water table in hydrostatic equilibrium). The results of MARSIS radar soundings obtained over several of these areas will be discussed.