History and Current Inventory of Water on Mars

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The geology and geomorphology of Mars provide clear evidence for the presence of liquid water on its surface during the Noachian and Hesperien eras (i.e., >3 Ga). In contrast to the ancient watery environment, today the surface of Mars is relatively dry. The current desert-like surface conditions, however, do not necessarily indicate a lack of surface or near-surface water/ice. In fact, massive deposits of ground ice and/or icy sediments have been proposed based on subsurface radar sounder observations. Hence, accurate knowledge of both the evolution of the distribution of water and of the global water inventory is crucial to our understanding of the evolution of the climate and near-surface environments and the potential habitability of Mars.

This study presents insights from hydrogen isotopes for the interactive evolution of Martian water reservoirs. Based on in situ hydrogen isotope analyses of Martian meteorites, we reported convincing evidence that the Martian mantle has retained a primordial hydrogen isotope composition similar to water on Earth. Using our one-reservoir atmospheric escape model (Kurokawaet al. 2014) and new D/H data (500-1000‰ at 4 Ga), we obtained water inventory lower-and upper-bounds (81-270 mGEL, global equivalent layer) at 4 Ga. The calculated range of water inventory at 4 Ga is distinctly lower than the geological estimates based on the volumes of paleo-oceans (e.g., ~550 mGEL [Di Achille& Hynek, 2010]). This difference supports our hypothesis (Usui et al. 2015) that a part of Noachian surface water has been sequestered underground over geologic time and is a source of the intermediate D/H reservoir.

References

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