Evolution of Surface Water Reservoirs on Mars: Constraints from Hydrogen Isotopes in Martian Meteorites

T. USUI[1]*, H. KUROKAWA[2] AND M. SATO[3]

[1]Dept. of Earth and Planet. Sci., Tokyo Institute of Technology, Meguro, Tokyo 152-8551 Japan (*correspondence: tomohirousui@geo.titech.ac.jp)
[2]Dept. of Physics, Nagoya Univ., Nagoya, Aichi 464-8602, Japan
[3]Dept. of Environmental Changes, Kyushu Univ., Fukuoka 819-0395, Japan

Martian surface morphology implies that Mars was once warm enough to maintain persistent liquid water on its surface [1]. While the high D/H ratios (~5000 per mil) of the current martian atmosphere suggest that significant water has been lost from the surface during the martian history, the timing, the processes, and the amount of the water loss have been poorly constrained [2]. Recent technical developments of ion-microprobe analysis of martian meteorites have provided accurate estimation of hydrogen isotope compositions (D/H) of martian water reservoirs at the time when the meteorites formed [3, 4]. Based on the D/H datasets from martian meteorites, this study estimates the amounts of water loss due to atmospheric escape and demonsrates that water loss during pre-Noachian was more significant than in the rest of the martian history. Combining our results with geological and geomorphological evidence for ancient oceans, we propose a possibility that there should be undetected subsurface water/ice of much greater extent than the collective amounts of "visible"current water inventory. Our study further implies that, because such large water inventory automatically calls for significant water loss that cannot be explained by oxygen escape models [5, 6], unknown mechanisms that effectively consume the remaining excess oxygen should be required.

[1] Head *et al* (1999) *Science* **286**, 2134-2137 [2] Jakosky and Phillips (2001) *Nature* **412**, 237-244 [3] Usui *et al* (2012) *EPSL* **357–358**, 119-129 [4] Greenwood *et al* (2008) **35**, L05203 [5] Terada *et al* (2009) *Astrobiology* **9**, 55-70 [6] Lammer *et al* (2003) *Internatl. J. Astrobiol.* **2**, 195-202