Evolution of early atmosphere on terrestrial planets after giant impact

KEIKO HAMANO*[1] AND YUTAKA ABE[1]
AND MASANORI ONISHI[2]

[1]Department of Earth and Planetary Science, The University of Tokyo, Japan.
*correspondance: keiko@eps.s.u-tokyo.ac.jp, ayutaka@eps.s.u-tokyo.ac.jp
[2]Department of Earth and Planetary Sciences, Kobe University, Japan. onishi@gfd-dennou.org

The recent theories of planet formation suggests that terrestrial planets would experience global melting due to giant impacts, i.e. the formation of a magma ocean[1]. Early atmosphere forms by degassing from the interior, wherease hydrodynamic escape could blow off the atmosphere during planetary solidification. If the atmosphere consists of greenhouse gases, the evolution of the atmosphere affects the thermal evolution of the magma ocean[2-5], which, in turn, contols the degassing rate.

Recently, we considered early coupled evolution of steam atmosphere and magma ocean, and investigated the thermal history and water budget on early terrestrial planets[6]. Our resuls suggest that two disparate types of planets develop during solidification, depending on their distance from their parent star: wet and potentially habitable planets like Earth, and dried-out planets like Venus. These two types of planets can also solidify over vastly different timescales, depending on the initial amount of water present.

Early terrestrial planets would have gaseous components other than water vapor during formation. Hydrogen is one of the candidates, as planets could capture nebula gas during formation, and also as it can be produced by chemical reaction between water and metallic iron, which could be scattered in the magma ocean on giant impact events. In this talk, we'd like to discuss contributions of hydrogen on early evolution of terrestrial planets.

[1] Genda, H., Hamano, K., & Abe, Y. *et al* Goldschmidt Conference 2014 (in this volume).[2] Matsui, T. & Abe, *Nature* **319**, 303–305 (1986). [3] Zahnle, K. J., Kasting, J. F. & Pollack, *J. B. Icarus* **74**, 62–97 (1988). [4] Elkins-Tanton, *Earth Planet. Sci. Lett.* **271**, 181–191 (2008). [5] Lebrun, T., Massol, H., Chassefière, E., Davaille, A., Marcq, E., & *et al Geophys. Res. Lett.* **118**, 1155-1176 (2013) [6] Hamano, K., Abe, Y. & Genda, H., *Nature*, **497**, 607-610 (2013).