Evolution of H_2-H_2O atmospheres and magma oceans

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Terrestrial planets, like Earth, have been considered to have experienced a global melting due to giant impacts. Early atmospheres would form through degassing from the interior, and its blanketing effects would be essential to radiative heat balance at the planetary surface. Several groups have been working on a coupled evolution of early atmosphere and a magma ocean, focusing on oxidizing atmospheres consisting of H_2O and CO_2, while recent geochemical studies suggest that Earth's building blocks would have comprised a large fraction of enstatite-chondrite like materials, implying that early atmosphere might have contained some amount of reducing gases, like H_2.

Based on numerical modelling, we report that addition of H_2 enhances the thermal blanketing and has a role to prolong a magma ocean state longer. This is an opposite effect to addition of CO_2 [1]. Considering a mass of water comparable to the total inventory of the modern Earth and initial oxygen fugacity higher than ΔIW-2, Earth could have solidified in less than 10 Myr after the last giant impact. We will also discuss implications on early surface environments, planetary oxidation by giant impacts due to a preferential loss of H_2, and the materials which formed the Moon based on a scenario proposed by Karato (2014)[2].

[1] E. Marcq et al., Geophys. Res. Planets, 122, 1539–1553, (2017)

[2] S. Karato, Proc. Jpn. Acad., Ser. B 90 (2014)