Origin and early evolution of the terrestrial atmosphere: implications for the age of the Moon, the rate of continental crust growth, and the evolution of the young Sun

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We are investigating the origin and evolution of the terrestrial atmosphere at different timescales using noble gases (on-going ERC contract NOGAT). Terrestrial volatiles originated mainly from two types of cosmochemical reservoirs, the protosolar nebula, presumably from an H_2-rich atmosphere in equilibrium with molten silicates (within a few Ma after CAIs), and an evolved reservoir which also sourced asteroidal material. The analysis of samples of the Archean (3.5-3.0 Ga) atmosphere trapped in chemical sediments, namely barite and hydrothermal quartz, shows that : (i) the Xe isotope composition of the Archean atmosphere was intermediate between chondritic and modern air, showing long-term Xe isotope fractionation and loss of atmospheric Xe, presumably due to interaction of Xe with enhanced VUV light flux from the young Sun. The Xe loss-corrected I-Pu-Xe age of the atmosphere is 30-50 Ma, which may also sign the time of the Moon-forming impact (Pujol et al., *EPSL* 308, 298, 2011; Marty, *EPSL* 313-314, 56, 2012); (ii) the $^{40}Ar/^{36}Ar$ ratio of the Archean atmosphere was 143±24, implying formation of 80±10 % of felsic crust between 3.8 Ga and 2.5 Ga and accounting for the first global glaciations towards the end of the Archean eon (Pujol et al., *Nature* 498, 87, 2013); and (iii) the Archean atmospheric P_{N2} and $\delta^{15}N$ were comparable to the modern values, suggesting that the terrestrial magnetic field was already shielding the top of the atmosphere (>50% of present-day magnetic field) 3.5 Ga ago (Marty et al., *Science* 342, 101, 2013).

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