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Early evolution of Venus and Earth constrained by the reproduction of measured Ar, Ne isotope and K/U elemental ratios

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Abstract

We show that the measured present day atmospheric Ar, Ne isotope ratios and elemental K/U ratios measured for Venus and Earth can be reproduced by a combination of EUV-driven hydrodynamic hydrogen escape and impacts happening during accretion. We find that both protoplanets formed within the solar nebula and accreted large enough masses able to capture thin hydrogen envelopes, which were then lost within a few 10s of million years after disk dispersal. We further show that early Venus was surrounded by a denser primordial hydrogen-dominated atmosphere compared to a less massive proto-Earth that accreted its final mass by pre-fractionated dry impactors and about two percent carbonaceous chondrites after the thin primordial hydrogen envelope was lost. Our results agree with hafnium-wolfram isotope chronometric evidence that favors a fast accretion scenario of the Earth with a late Moon-forming impact. We conclude with a discussion on the implications of these findings in relation to planetary evolution of terrestrial exoplanets and their potential habitability.

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