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Atmospheric noble gas isotope ratios and bulk K/U as a constraint on the early evolution of the Earth

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While Earth was accumulating mass within the solar nebular the protoplanet also captured a significant hydrogen dominated atmosphere by picking up gas from the circumstellar disk during the formation of the Solar System. This primordial atmosphere was then quickly lost by hydrodynamic escape after the disk dissipated. After a short but efficient boil-off phase the EUV-driven hydrodynamic flow of H-atoms dragged heavier elements with it at different rates, leading to changes in their isotopic and elemental ratios which is reflected in the present-day atmospheric noble gas isotope and elemental ratios of Earth (and also of Venus). Depending on the disk lifetime and the initial composition, the ^{36}Ar/^{38}Ar, ^{20}Ne/^{22}Ne and bulk K/U ratios observed on the Earth, can be best explained if the Sun was born between a weakly and moderately active star and if Earth had grown to ~53-58% of its current mass by the time the nebula gas dissipated approximately 3.5 Myr after formation of the Sun. The present-day atmospheric Ar and Ne isotope ratios can be reproduced best if the post-nebula impactors contained ~5% weakly depleted carbonaceous chondritic material and ~95% enstatite chondrites that are strongly depleted in Ar, Ne and moderately volatile elements like potassium. If higher amounts of carbonaceous chondrites were involved in early Earth's accretion, then the present atmospheric Ar and Ne ratios can only be reproduced if the involved carbonaceous chondritic post-nebula material was highly depleted in these noble gases and/or was primarily delivered as long as the primordial atmosphere was yet escaping. If Earth would have grown to masses >75% of its final mass, it might not have been able to lose its primordial hydrogen atmosphere, and might have ended up being inhabitable.