

## The origin of Earth's volatiles

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The final stage of accretion is thought by some to be the addition of a late veneer that provided the (post core and Moon formation) mantle and crust inventory of both highly siderophile elements (gold, platinum etc) and volatiles such as water, carbon and nitrogen. Isotopic and relative elemental abundances of Earth's highly volatile elements (noble gases, H, C, N) provide evidence of a series of Solar, chondritic and cometary additions punctuated by major differential losses. If chondritic materials are assumed to be the primary starting materials for most of the volatiles in the terrestrial planets then there has been extremely strong (up to 2 orders of magnitude) depletion in  $^1\text{H}$ ,  $^{12}\text{C}$ ,  $^{14}\text{N}$  and  $^{130}\text{Xe}$  relative to  $^{20}\text{Ne}$ ,  $^{36}\text{Ar}$  and  $^{84}\text{Kr}$ . Indeed carbon and nitrogen are the most depleted elements in the silicate Earth reflecting core formation or losses to space. A major fraction (>70%) of Earth's hydrogen (water) budget appears to be earlier than any putative late veneer. Furthermore, the evidence of isotopic similarity between the Moon and silicate Earth is inconsistent with the idea of a large (1 to 5%) veneer as has recently been proposed.