Terrestrial volatile abundances reflect different fates during giant impacts

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A chondritic heritage for terrestrial volatiles is at odds with non-chondritic bulk Earth N/H, C/H, Cl/F, Br/F and mantle He/Ne ratios. If a water ocean existed at the surface, atmospheric loss during a giant impact is enhanced but the ocean is largely retained. During a giant impact, H is retained in the ocean, while C and N are preferentially lost. Some inorganic C is dissolved in the ocean and retained. Atmospheric loss may therefore explain the strong N/H and moderate C/H bulk Earth depletions. This explanation implies that significant amounts of volatiles predate the late veneer, as the terrestrial N/H is lower than chondrites by 80%. F is highly soluble in magma compared to Cl and Br, which are highly soluble in water. Partial loss of an ocean during a giant impact therefore lowers the terrestrial Cl/F and Br/F. He is more soluble in magma than Ne, so atmospheric loss and magma ocean outgassing raise the mantle He/Ne ratio. The high upper mantle He/Ne ratio implies multiple episodes of atmospheric loss and magma ocean outgassing. Primitive plumes, however, retain solar-like He/Ne ratios indicating a deep mantle reservoir that may have survived complete melting during the later giant impacts.