Core composition, and the origins of Earth's water and carbon

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Our planet is characterized by life, and the origins of Earth's water and carbon have been of great interest in earth and planetary science. Recent planet formation theories proposed that extensive amount of water, possibly tens to hundreds ocean mass of water, may have accreted to proto-Earth. Nevertheless, the Earth sequestrated most of water (hydrogen) and carbon into the metallic core, leaving little in the silicate mantle and on the surface. In order to better understand the core and bulk Earth abundances of water (hydrogen) and carbon, we have recently determined their metal/silicate partition coefficients, D_H and D_C, simultaneously under high pressures and temperatures, corresponding to typical conditions of Earth's core formation. Experiments demonstrate that both D_H and D_C diminish in the presence of carbon and hydrogen, respectively, indicating their strong interactions. With these partitioning data, we found ~1–3 wt% H_2O and ~0.2–0.6 wt% C in Earth's building blocks, which match those of non-carbonaceous chondrites when considering their original water abundances. While such H_2O and C contents also overlap with the lower bounds of their concentrations in carbonaceous chondrites, the non-carbonaceous chondritic materials origin of the Earth building blocks is consistent with isotopic compositions. Modelling the multi-stage core formation further suggests that water and carbon were delivered in a late stage of Earth accretion rather than from the beginning. The delivery only in the final stage (last <10%) is also unlikely in the present models.