Mars and Earth - distinct inner Solar System products

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Terrestrial planets provide Solar System insights into the evolution of accretion, core-mantle and crust-mantle differentiation, and surface processes. Similarities and differences between the Earth and Mars made the former habitable and the other inhospitable to uninhabitable. Here we com-pare compositional models for Mars and the Earth to reveal their shared and distinctive properties. Terrestrial planets accreted more high-temperature materials and are depleted in the moderately volatile elements as compared to chondritic asteroids, with the Earth being more depleted than Mars. These compositional properties resulted from nebular chemical fractionation processes, not post-accretionary losses of moderately volatile elements. In agreement with Wänke and Dreibus (1988), Mars' accretion occurred under nearly uniform oxidizing conditions in the presence of a nebular disk, whereas Earth's accretion likely initially occurred under reducing conditions followed by additions of more oxidizing materials. Growth of the Earth occurred during and post-nebular disk's lifetime. Mars' lower Mg# in the mantle reflects a more oxidizing core formation condition than that of the Earth's, leading to Mars' smaller core size and an absence of nominally lithophile elements (e.g., V, Cr and Mn) in its core. Early loss of its dynamo is consistent with Mars having quickly spent its primordial heat (i.e., heat of accretion and core formation), leading to a low sur-face heat flow and a planetary engine driven by its radioactive elements (planetary Urey number ~0.9). These observations may also explains the absence of plate tectonics on Mars even in the presence of surface water early in its history.

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