THERMOCHEMICALLY MASS-BALANCED EARTH AND METEORITES

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Masses and densities of equilibrium condensates in a gas of solar composition (Si, Al, Mg, Fe, Ca, Na, K, Ti, Ni, C, H, O, S, N) have been matched with masses and densities of Mercury and Earth. For Mercury a close match occurs at a temperature around 1575 K and a pressure of $10^{-2}$ bar. Earth is calculated to be a mixture of a high-temperature component and a low-temperature component. The high-temperature component is identified as the condensate assemblage forming at a temperature of 1453 K and a pressure of $10^{-2}$ bar.

Compositionally this component was a mixture of FeNi (24% by mass) and silicates (38.91%). The remaining masses 8% FeS for the core and 29.01% for the mantle were provided by the low-temperature component which was compositionally similar to CI chondrite equilibrated below 621 K, the condensation temperature of FeS. A primitive core (24%) and a primitive lower mantle formed through homogeneous accretion at high temperature. As this material was undergoing differentiation, the low-temperature component was arriving at the top contributing FeS to the core and paving the way to the formation of the mantle by mixing of the low-temperature and high-temperature silicates.

Compositions of chondrites are shown to be related to a mixing of CI chondritic material with material left over after the formation of the high-temperature condensates. Starting from a mixture of the residuals from the high-temperature component and CI chondrite, the modal mineralogy and mineral compositions of equilibrated chondrites have been simulated at a pressure of 1 bar under variable redox (H/O) conditions and temperature.