

## **Earth's volatile accretion as told by Cd, Bi, Sb and Tl core–mantle distribution**

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The timing and origin of volatile elements accretion on Earth has been and continues to be key questions, despite intense research scrutiny. Two end-member scenarios are usually proposed in which (1) volatile elements were delivered during the main phase of Earth's accretion and underwent subsequent core–mantle differentiation, or (2) Earth accreted from largely dry and volatile-depleted material, with late addition of volatile-rich material after differentiation. Studying the behavior of elements that are both volatile and siderophile in a metal–silicate equilibrium can help discriminate between those two scenarios by deconvolving the effect of siderophile processes such as the Earth's differentiation from the effect of volatile processes. We report high-pressure and high-temperature metal–silicate equilibrium experiments that are used to trace the behavior of four moderately volatile and siderophile elements: Cd, Bi, Sb and Tl. Experiments were performed between 2 and 20 GPa, from 1700 to 2600 K and additional recent diamond-anvil cell experiments were added to our dataset (45–51 GPa). Our results indicate that Cd, Bi, Sb and Tl partitioning coefficients are largely controlled by changes in temperature, pressure,  $fO_2$  and the S content of the metal phase. The pressure effect on Tl and Bi partitioning is measured for the first time and improves significantly the knowledge of Bi and Tl behaviour during core formation. Core formation modelling was used to reconcile the experimental data with observed abundances for different accretion scenarios. Homogeneous accretion with full core–mantle equilibration induces a massive segregation of Bi, Sb and Tl in the core, preventing reproduction of observed present-day mantle abundances. We find that a scenario in which the volatile elements are accreted in the last 10–20% of the Earth's accretion is the most suitable accretion process that is able to explain the abundances of Cd, Bi, Sb and Tl in Earth's mantle. Partial core–mantle equilibration is necessary to reproduce Bi and Tl abundances. These observations corroborate a growing wealth of evidence in support of this schematic heterogeneous accretion pathway.