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Exploring the preservation of 182W anomalies with mantle convection models

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The μ-composition of 182W, expressed in parts per million, exhibits significant positive and negative deviations from a standard reference composition in mantle-derived rocks. These variations have been attributed to a combination of three processes: late accretion, silicate–silicate differentiation, and core–mantle interaction. To evaluate this hypothesis, we employ a multiphase fluid dynamics model to simulate mantle evolution under each scenario individually and in combination.

Our objective is to reproduce the μ182W evolution of the bulk silicate Earth (BSE; crust + mantle) over 4.5 billion years. Previous studies constrain the BSE to evolve from an initial value of approximately +25 ppm to a present-day value near 0 ppm.

Our simulations show that multiple combinations of the three processes can yield a BSE μ182W evolution consistent with these constraints. We further investigate the efficiency of mantle mixing through time for each scenario. The spatial distribution of both positive and negative 182W anomalies within the mantle evolves through time and may strongly influence their likelihood of being sampled at Earth's surface. This temporal and spatial variability provides additional constraints to better link 182W anomalies preserved in the rock record and the chemical state of the deep interior.