# Te stable isotopic constraints on the nature of late accretion

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Late accretion, or late veneer, is defined as the addition of broadly chondritic material to Earth's mantle after core formation ceased. However, the origin and nature of the late-accreted material remains controversial. Nucleosynthetic Ru isotope anomalies for meteorites indicate that this material was most similar to enstatite and distinct from carbonaceous chondrites [1], consistent with prior conclusions based on the Os isotope composition of Earth's mantle [2]. By contrast, the Se/Te ratio of Earth's mantle is similar to that of volatile-rich carbonaceous chondrites, and distinct from enstatite and ordinary chondrites [3], suggesting that the late veneer contained some material from carbonaceous chondrites.

To resolve these disparate observations, and to better constrain the nature and origin of the late-accreted material, we obtained mass-dependent Te isotopic data for terrestrial samples and a comprehensive set of chondrites. Tellurium stable isotope variations may arise as a result of nebular processes, leading to distinct isotopic compositions among chondrites, which allow to distinguish between different chondrite groups as potential sources of the late veneer. To this end, we developed a $^{123}$Te-$^{125}$Te double spike method for the precise measurements of Te isotope variations by multi-collector ICP-MS. The Te stable isotopic composition of the bulk silicate Earth was precisely defined by analyses of several peridotites, which have been well-characterized in previous studies [*e.g.,* 3]. Samples from the major chondrite classes display a range in Te isotopic compositions, and combined with their Se/Te ratios only some carbonaceous chondrite group overlap with the composition determined for the Earth's mantle in this study. Our new data therefore indicate that the late veneer cannot have solely consisted of enstatite chondrite-like material, but also included volatile-rich carbonaceous chondrite-like material. When combined with the Ru and Os isotopic evidence for an enstatite chondrite-like composition of the late veneer, our new Te isotopic data indicate that the late accretionary assemblage was a mixture of volatile-rich carbonaceous and volatile-poor non-carbonaceous material.

**References:** [1] Fischer-Gödde M. and Kleine T. (2017) *Nature, 541,* 525–527. [2] Meisel T. et al. (2001) *GCA, 65,* 1311–1323. [3] Wang Z. and Becker H. (2013) *Nature, 499,* 328–331.