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Analytical approach to constraining siderophile element genetics of late-stage terrestrial accretion

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Earth formed from the sequential addition of Solar System-derived bodies sourced from various heliocentric distances. The silicate Earth, however, has been mixed for over 4.5 billion years via differentiation and convective stirring, which would have attenuated original discrete chemical fingerprints inherited from Earth's building blocks. Genetic (i.e., mass independent nucleosynthetic) Mo and Ru isotope variations in bulk meteorites, however, may serve as sensitive tracers to identify specific types of building blocks that may have left a record in the mantle. The modern Bulk Silicate Earth (BSE) Mo and Ru isotopic estimates provide cumulative yet complementary genetic information about Earth's building blocks. The dominant proportion of Mo in the BSE was likely established during the final 10 to 20 % of Earth's accretion, possibly coincident with final stages of core segregation. Whereas Ru was likely predominantly set during the final 0.5 to 1 % of Earth's accretion (i.e., late accretion). Constraining, to high precision, the Mo and Ru BSE estimate is required to identify the dominant genetic signature of material accreted during and following core formation. Furthermore, discovery of anomalous Mo and/or Ru isotopic compositions of mantle domains would pinpoint the genetic components of late-stage building blocks. Both tasks require high precision mass spectrometric methods using thermal ionization mass spectrometry (TIMS) or inductively coupled plasma mass spectrometry (ICP-MS).

We will report on recent advancements in the resolution of analytical challenges associated with TIMS and ICP-MS high precision Mo and Ru isotopic measurements. A newly developed multidynamic Mo measurement method addresses issues present at <15 ppm in static TIMS and ICP-MS datasets. New data from modern and Eoarchean samples are used to report a more accurate and precise BSE Mo isotopic estimate and constrain if there was a change in genetics during late-stage accretion. Resultant compositions are interpreted in the context of new numerical mixing models to constrain the genetic signatures of Earth's late-stage building blocks.