Ag isotope variations in the Earth

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The short-lived radionuclide ^{107}Pd decays to ^{107}Ag with a half-life of 6.5 Myrs. Pd is more siderophile than Ag and therefore partitions more strongly into the core thereby allowing this system to place chronological constraints on core formation processes.

Preliminary results on terrestrial samples revealed Ag isotopic variations on the order of –1.1ε to 5.3ε (relative to the SRM 978a standard) for ore samples and slightly smaller variations for basalts from the Hawaiian volcanoes Kilauea and Mauna Loa (Hauri et al., 1999). Basalts from Mauna Loa have been shown to have radiogenic ^{186}Os, from the decay of ^{190}Pt, which may be a signature of core-mantle interaction on the Earth (Brandon et al., 1998). These basalts are therefore promising samples to search for Ag isotopic anomalies due to the extinct nuclide ^{107}Pd. However, this task requires precise and accurate Ag isotopic measurements, which has proven difficult because Ag has only two naturally occurring isotopes that can easily experience mass fractionation during chemical processing and analysis (Carlson et al., 2001, Woodland et al. 2003). We have improved the chemical separation procedure in order to obtain a better separation of Ag from Ti. This is essential for basalt analyses because of matrix effects related to Ti during ICP analysis. First results for the Steens Mtn. flood basalt CH83-55 yield an average Ag isotopic composition of -1.6 ± 1.6 ε, indistinguishable from the SRM 978a standard. Analyses of a more comprehensive set of Hawaiian basalts and chondrites are underway. We also reanalyzed the native Ag metals derived from globally distributed ores and previously investigated with a VG Plasma 54-30. The new measurements, performed with an Axiom, confirm the previously reported Ag isotopic variations in the range of –1.1ε to 5.3ε.

References

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Timing, mechanisms and conditions of terrestrial planet accretion and early differentiation

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Over the past few years there have been major advances in our understanding of both the timescales and processes of terrestrial planet accretion, primarily as a result of ^{182}Hf-^{182}W chronometry. The accretion of Mars would appear to have been extraordinarily fast, providing evidence of runaway growth. The current best estimates for some martian reservoirs would imply that they formed within the first 1 or 2 million years of the solar system. Mars differentiation appears incomplete and lacks the uniform and well-mixed W depletion found on Earth. Although accretion may have been rapid the timescales for early metal segregation in the source for Nakhla for example could be more than 20 Myrs. In contrast, the final stage of Earth accretion – the Moon-forming collision (or Giant Impact) between the Earth and another planet "Theia", took place 40 to 50 million years after the start of the solar system. Comparisons between the results of ^{182}Hf-^{182}W chronometry and more traditional systems like $^{235/238}$U-$^{207/206}$Pb indicate that the models used to define these timescales are over-simplified. With the age of the Moon well-constrained the W isotopic data for the Earth provide evidence for minor amounts of incomplete mixing during accretion. For example, the degree of equilibration of W between the core of Theia and the silicate Earth during the Moon-forming Giant Impact could have been as little as ~30%. This cannot explain the discrepancy between Hf-W and U-Pb timescales. A change in U/Pb in the silicate Earth during accretion and differentiation is the best explanation. However, the mechanism for this is unclear.