Highly Siderophile Elements in H Chondrites

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Chondritic Meteorites and H Chondrites

- Chondrites are stony, undifferentiated rocks from the early solar system
- Chondrites are "cosmic aggregates" formed of previously unrelated components
- Chondrites typically contain chondrules, silicate matrices, and refractory inclusions and metal grains

HSEs strongly partition into iron metal over silicates
Metalsilicate concentration ratio (D-value) > 100 for all HSE
Abundance ratios of HSEs in metal relative to silicates constrains the extent of metal-silicate equilibration for various rock types and metamorphic grades

Purpose
Assessing the extent of HSE equilibration between metal and silicate in H Chondrites
• The goal is to measure HSE abundance in H4, H5, and H6 chondrites and to assess whether equilibration occurred for any of the metamorphic grades
• HSE abundances in metal and silicates in H5 and H6 chondrites have not been previously measured
• With limited silicate data, a good indicator of equilibration would be a trend of increasing HSE concentration in metals with increasing metamorphic grade

• Will compare Re-Os data to a primordial ~4.57 Ga isochron from Horan et al. (2009) in figure 4 in order to assess potential open system behavior.

Analytical Methods
Phase 1: Sample Processing
-Crush sample and purify it using magnetic separation in order to obtain distinct silicate, coarse-grained metal, and fine-grained metal from each sample.

Phase 2: Isotope Dilution chemistry for Osmium
-Samples are dissolved by aqua regia(2:1 mixture of HNO3 to HCl) in sealed Pyrex tubes while being heated at 240 °C over night.
-They are separated using CCL4 in a centrifuge tube, and vigorously shaken to ensure that the oxidized OsO4 is separated from the rest of the HSEs.
-Next, the CCL4 is mixed with HBr and heated to reduce the OsO4 and isolate the Os. The CCL4 is removed, now devoid of Os, and the HBr is dried to a small amount (40 uL) and prepared for micro distillation.
-Cr2O72- ( Dichromate) is used to oxidize the Os once more, where it will collect and be reduced in a 15 µL drop of HBr. It is dried until it is a powder.

Phase 3: TIMS analysis for Osmium

Hypothesis
A) Increasing thermal metamorphic grade in H chondrites will correlate with increasing concentration ratios in metal relative to silicate approaching or exceeding the D value of 100 that we expect to see for equilibrated HSEs. I predict that H4 chondrites will not be equilibrated, (metal/silicate<10) and H6 chondrites will be equilibrated (metal/silicates>10).

B) Fine-grained metals (<150µm) will have a higher concentration of HSEs than coarse-grained metals (>150µm) relative to silicates. This phenomenon has been observed in previous studies of metal grains in chondrites (Rambaldi et al. 1997) and Campbell and Humayun (2003).

Proof of concept comparing this study to Horan et. al.(2009)

Phases: 1: Sample Processing
2: Isotope Dilution for Osmium
3: TIMS analysis for Osmium

Highly Siderophile Elements
Rhenium (Re), Osmium (Os), Iridium (Ir), Ruthenium (Ru), Platinum (Pt) and Palladium (Pd)

Source
Collector Array, 8 Faraday Cups
Magnet
Preliminary Data

Figure 5: Graph of 187Re/188Os vs 187Os/188Os for Ochansk, an H4 Chondrite, with reference isochron calculated from iron meteorite data to 4.57 Ga. Assumed initial 187Os/188Os composition of 0.99517. The decay constant (J) = 1.666E-10 ± 1 u. Top plot shows per mil deviation of Os from reference line.

Figure 4: Comparison of elemental abundances in C1 carbonaceous chondrites and the solar photosphere demonstrates an approximate 1:1 correlation. Solar atmosphere elemental abundances are derived using spectroscopy.

Figure 3: Comparison of elemental abundances in metal and silicates in H5 and H6 chondrites has not been previously measured.

Figure 2: Speckled C1 Carbonaceous Chondrites

Figure 1: From Woods (2003), this illustrates the higher metamorphic grade H chondrites as having originated at a deeper (hotter) location within the parent body than H3 and H4 chondrites. Temperature and pressure are greater within the parent body than are the surface. Thin sections demonstrate the high degree of recrystallization in H6 relative to H4.


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