TRACE ELEMENT ABUNDANCES IN CHONDRULES FROM KNYAHINYA (L/LL5) AND OUZINA (R4)

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Introduction and Analytical Methods: Previously we discussed the trace element geochemistry of non-porphyritic objects in unequilibrated ordinary chondrites (UOC) [1] as well as in some carbonaceous chondrites [2]. Here we present some bulk trace element analyses of non-porphyritic objects in the EOC Knyahinya and the R chondrite Ouzina. For trace element analysis we used a VG Plasma Quad II+S ICP-MS with a 266 nm Q-switched Nd-YAG laser following procedures of [3], except that we used a wide beam (~ 40 µm) for bulk sampling.

Results: Trace element (TE) abundances in individual objects in *Knyahinya* are all fractionated with respect to CI. Normalized REE abundances are between 0.1 and 2 x CI, all have a positive Eu anomaly and La < Lu, refractory TE (Nb, Ta, U, Th, Ca, Sc, Hf, Zr) > HREE and medium volatile elements (MVE) Sr, Ba, Mn, V and Cr are at 1 - 2 x CI (~ HREE). A few exceptions have very low REE contents (Sm ~ 0.1 x CI) with high Eu (~ 1 x CI) and low Ca, Sc, Hf and Zr abundances (between 0.6 and 1.2 x CI). One BO chondrule is exceptional because it contains a large apatite.

Ouzina objects also have fractionated normalized TE patterns with REE at 0.8 – 8 x CI, La < Lu but no or very small +/- Eu anomalies. Most refractory TE have abundances ~ HREEs (Nb, Ta, U, Th, Zr, Hf) and the MVE Sr, Ba, Mn, V and Cr have abundances < HREE and decrease with increasing volatility. Exception is OZ8, a BO chondrule with unfractionated refractory TE + Sr + Ba and fractionated MVE abundances. Knyahinya and Ouzina objects have strongly fractionated Rb/Cs ratios (up to 10 x CI) and are surprisingly rich in W (0.1 – 0.7 x CI in Knyahinya and 0.9 – 2 x CI in Ouzina) – despite their very low metal contents.

Discussion: In contrast to bulk trace element abundance patterns of fine-grained and BO objects from UOC and CC [1,2,4,5], which usually are relatively flat with or without some abundance anomalies, the patterns of objects in Knyahinya (EOC) and Ouzina (R4) indicate a more complicated genesis likely due to late stage equilibration processes [e.g., 6]. The depletion trend of LREE with respect to HREE and high-field-strength elements (HFSE) apparently documents varying degrees of elemental transport into an external REE sink [e.g., 7] and restricted mobility of most refractory TE. Apparently, REE are mobile, HFSE are not and therefore have high abundances in the objects. MVE (some are ol/px-compatible) tend to have equilibrated, unfractionated abundances in Knyahinya and only slightly fractionated ones in Ouzina objects. The fractionate Rb/Cs ratio implies low original VE contents and restricted mobility of the large Cs ion. Abundance pattern trends in objects of the two chondrites are broadly similar, which suggests a similar evolution history for objects of the EOC and the R4 chondrites. Lack of an Eu anomaly and the high abundance of W in Ouzina objects apparently reflect processing under fairly oxidizing conditions.

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References: [1] Engler et al. 2003a 34th LPSC, #1689. [2] Engler et al. 2003b *MAPS* 38:A86. [3] Jenner et al. 1993 *GCA* 57:5099-5103. [4] Grossman and Wasson 1983 *GCA* 47 :759-771. [5] Kurat et al. 1985 16th LPSC, 471-472. [6] Kurat 1988 *Phil. Trans. R. Soc. Lond.* A 325 :459-482. [7] Rambaldi et al. 1981 *EPSL* 56:107.