Cr AND O ISOTOPES LINK IVA IRONS AND LL CHONDRITES

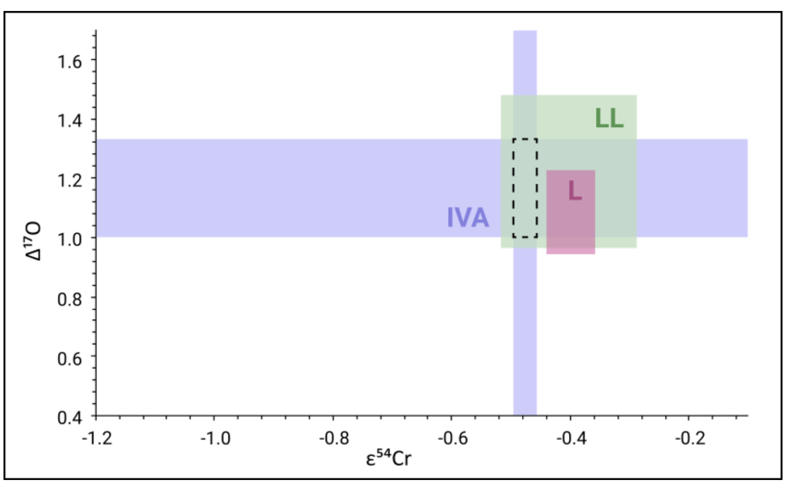
Aryavart Anand[1], Jonas Pape[2], Klaus Mezger[1], and Beda Hofmann[1,3], [1]Institut für Geologie, Universität Bern, Baltzerstrasse 1+3, 3012 Bern, Switzerland (aryavart.anand@geo.unibe.ch), [2]Institut für Planetologie, Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, [3]Naturhistorisches Museum Bern, Bernastrasse 15, CH-3005, Bern, Switzerland.

Introduction: Different magmatic iron meteorite groups are thought to sample the core of distinct parent bodies that experienced large-scale chemical fractionation, most notably metal-silicate melt separation. Combined Cr and O isotope data provide a means for identifying a possible genetic relationship among an iron meteorite group representing the core and a stony meteorite group representing the undifferentiated counterpart of a parent body or a body that formed from the same reservoir as the core material represented by iron meteorites. Previous studies have attempted to make such connections and indicated similarity within a ε^{54}Cr vs. Δ^{17}O space between IIIAB irons, main group pallasites and HEDs [1, 2], IIE irons and H chondrites [3], and Eagle Station pallasite and CV chondrites [4]. A similarity in ε^{54}Cr and Δ^{17}O isotopic composition between IVA irons and L/LL ordinary chondrites was also observed based on silicate inclusions from Steinbach and São Joao Nepomuceno meteorites [5]. The present study provides additional data on this association based on ε^{54}Cr values obtained from chromite ($FeCr_2O_4$) or daubréelite ($FeCr_2S_4$) inclusions in magmatic iron meteorites. Chromite and daubréelite are the two main carrier phases of Cr in these meteorites. A particular advantage of measuring ε^{54}Cr on these minerals is their very low Fe/Cr ratios of typically around ~0.5. As a consequence cosmogenic contributions of ^{54}Cr produced by galactic cosmic ray exposure from Fe are negligible; hence no correction for spallogenic Cr is required [6].

Samples and Methods: Two meteorite samples, Duchesne and Yanhuitlan were analyzed from the IVA iron meteorite group for Cr isotope compositions. A chromite or daubréelite fraction was obtained from each whole-rock sample. After mineral digestion and chemical purification, Cr isotopes were measured on a Triton™ Plus TIMS at the University of Bern. Δ^{17}O data for IVA and L/LL and ^{54}Cr data for L/LL chondrites are compiled from the literature [7,8,9,10,11].

Results and Discussion: Duchesne and Yanhuitlan daubréelite/chromite inclusions display a well-defined ε^{54}Cr with a mean value of -0.48 ± 0.02. Combined with the mean Δ^{17}O isotope data for IVA irons, these irons show a clear overlap with the LL ordinary chondrites when plotted on a ε^{54}Cr vs. Δ^{17}O diagram (Fig.1). Such an overlap suggests that both are derived from a common isotope reservoir with the same O-Cr isotope composition and are therefore genetically related. This reservoir exsisted within 1 Ma after the birth of the solar system (CAI formation) as indicated by chromite/daubréelite model ages in IVA iron meteorites, inferred as the time of core formation in their parent body [12]. The reservoir was also the source of planetesimal formation at least up to 3 Ma as indicated by the accretion of the ordinary chondrites parent bodies constrained by the chondrule formation interval [13] and the onset of metamorphism on the chondrite parent bodies [14]. This implies that planetesimal accretion within this reservoir spans an interval of at least 3 Ma and planetary accretion and differentiation was contemporaneous with chondrule formation. In some regions of the evolving solar system disk, planetesimals existed while others were still at the dust-gas stage.

Figure 1: Δ^{17}O-ε^{54}Cr diagram of IVA irons and LL/L ordinary chondrites.



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