TESTING THE COMMON SOURCE HYPOTHESIS FOR CV AND CK CHONDRITES PARENT BODY USING Δ^{17}O-ε^{54}Cr ISOTOPE SYSTEMATICS. Q.-Z. Yin[1], M. E. Sanborn[1], and K. Ziegler[2] [1]Department of Earth and Planetary Sciences, University of California-Davis, Davis, CA, USA 95616 (E-mail: qyin@ucdavis.edu), [2]Institute of Meteoritics, University of New Mexico, Albuquerque, NM, USA.

Introduction: The potential for a common parent body or single reservoir for the CV and CK chondrites has been proposed based on similarities in their oxygen isotopic composition [1] and certain bulk geochemical constraints, such as abundances of lithophile or siderophile elements (e.g., Cr, Sc, Co, Ni, and Au) [1,2]. The similarities are strong enough that the two chondrite groups are sometimes referred to as the CV-CK clan [3]. The idea of a single parent body has been incorporated into petrologic and thermal models that utilize a single parent body with increasing degrees of metamorphism at deeper depths with CV chondrites near the surface and highly metamorphosed CK chondrites at depth [4]. While the oxygen isotopic and geochemical data do indicate strong similarities between the two groups, other isotopic evidence may indicate distinct sources related to their formation. The use of stable isotopes, specifically mass-independent nucleosynthetic anomalies in ^{54}Cr and ^{50}Ti, has been limited by the small number of samples that have been analyzed or uncertainties that were too large to distinguish CK from CV [5-7]. Oxygen has long been used as one parameter to try and associate different samples to a common source reservoir. However, recent use of adding a second parameter (e.g., Cr) has shown that oxygen alone is not always definitive in identifying a common source for two different meteorites (e.g., [8-10]).

Here, we report Cr isotopic compositions for three new CK chondrites (Northwest Africa (NWA) 6047, NWA 7461, and NWA 7704) and a new aliquot of CV chondrite (Allende). In addition to this new aliquot of Allende and CK chondrites, we have previously reported the Cr isotopic composition for a suite of CV-like and CK-like achondrites and separate aliquot of Allende [9-12] Combining these new isotopic measurements with previously analyzed samples, we test the genealogy of CK and CV chondrites.

Methods: Three CK chondrites ranging from petrographic grade 3 to 5 were prepared for isotopic analysis: NWA 6047 (CK3), NWA 7461 (CK4), and NWA 7704 (CK5) based on the classification and petrographic grades from the Meteoritical Bulletin descriptions. In addition, an aliquot of the CV3 chondrite Allende was also prepared. Homogenized powder was made from an interior chip of each sample that was visually inspected to ensure no fusion crust was present. An aliquot (~15-17 mg) of each sample was placed into a PTFE capsule that was sealed in a stainless steel Parr bomb jacket with a 3:1 mixture of HF: HNO_3. The Parr bombs were heated at 190°C for 96 hours. After complete dissolution, the bulk rock samples were processed through a 3-column chemistry procedure (see [13]) to separate Cr from all other matrix elements. The purified Cr fractions were analyzed on a Thermo *Triton Plus* thermal ionization mass spectrometer at UC Davis. Each W filament was loaded with 3 μg of Cr (four filaments per sample) and each sample was bracketed with the NIST SRM 979 Cr standard. All isotope ratios are reported as parts per 10,000 deviations from the measured SRM 979 composition.

Oxygen isotopic composition of NWA 6047, NWA 7461, and NWA 7704 were measured at the University of New Mexico. Samples were acid-washed to remove terrestrial contamination. Oxygen isotopes were measured using a Finnigan MAT 253 mass spectrometer combined with a CO_2 laser-assisted fluorination line.

Results and Discussion: The Cr isotopic composition for the CV3 Allende was ε^{54}Cr = +0.93 ± 0.10. This is indistinguishable from the other CV chondrites (Allende, Vigarano, and Leoville) for which Cr isotopic composition has been measured [5-7,11-12]. This consistency across a range of CV chondrites shows that the Cr isotopic composition is homogenous across the suite of CV chondrites analyzed thus far. The homogenous nature of the CV chondrite source reservoir extends to CV-like achondrites with both CV and CV-like achondrites exhibiting the same ε^{54}Cr within error [10-12].

Prior to this study, Cr isotopic measurements were reported in the CK4 Karoonda [5] and CK5 EET 92002 [6]. However, between those two CK chondrites there was a significant difference. For EET 92002, there was no excess in ε^{53}Cr, unlike any other carbonaceous chondrites and had the lowest ε^{54}Cr value of any carbonaceous chondrites [6], inconsistent with [5] or this study. The ε^{54}Cr of the CK chondrites measured in this study were +1.23 ± 0.09, +0.67 ± 0.11, and +0.71 ± 0.11 for NWA 6047, NWA 7461, and NWA 7704, respectively. NWA 6047, reported to be the least equilibrated at petrographic grade 3, has an ε^{54}Cr much higher than the CK4 or CK5 in this study or reported for Karoonda. The reported classification of NWA 6047 as a CK3 is limited to mineralogy characterization [14]. The oxygen isotopes measured here also deviate significantly from the Δ^{17}O typically seen in CK chondrites (Fig. 1). Previous studies of the CR chondrite group have shown a homogenous ε^{54}Cr across samples spanning a large range in Δ^{17}O and petrographic types [15]. As such, a difference in both ε^{54}Cr and Δ^{17}O for NWA 6047 points towards a non-cogenic relationship to the CK chondrites. NWA 6047 plots closer to the CM2 chondrites rather than the CK or CO chondrites (Fig. 1). CK3 meteorites are the smallest subgroup of CK meteorites comprising only around 10% of all CKs and NWA 6047 is the first sample classified as a CK3 with Cr isotope data. The exact provenance of NWA 6047 is still to be clarified, but the clear difference in both ε^{54}Cr and Δ^{17}O indicates that a separate source reservoir, with broadly similar mineralogy and bulk chemistry to CK chondrites, that underwent minimal thermal equilibration may exist.

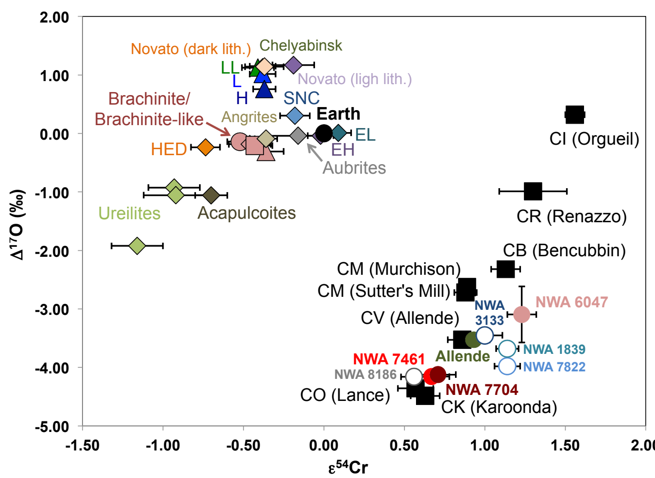

Figure 1. Composition of NWA 6047, NWA 7461, NWA 7704, Allende, and CV- and CK-like achondrites in Δ^{17}O-ε^{54}Cr isotope space. Carbonaceous achondrites are represented by open symbols. Literature data from [9,10,16] and references therein.

In contrast to the higher ε^{54}Cr of NWA 6047, the Cr isotopic composition for the other two CK chondrites analyzed, NWA 7461 and NWA 7704, are indistinguishable from Karoonda. In this particular study, the measured CKs and the CV Allende are marginally different outside of the uncertainties of the individual measurements. This is in contrast with earlier studies that showed CK and CV chondrites the same for ε^{54}Cr within error. With the increased number of samples, it is possible to calculate a weighted average of the CK and CV chondrite groups (Fig. 1). Calculating this average, the CK chondrites have an ε^{54}Cr of +0.66 ± 0.06 and CV chondrites +0.88 ± 0.06 (both 95% confidence level error). The decreased uncertainty of the weighted average shows a resolvable difference between the CK and CV chondrite groups, which is corroborated further by the offset in Δ^{17}O values.

The difference between CK and CV chondrites measured both in this study and the weighted average across literature data provide additional evidence that there is a distinct Cr isotopic composition for each group.

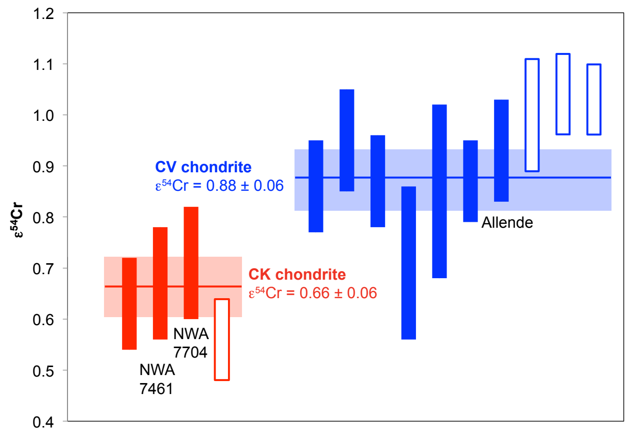

Figure 2. Weighted average of CK and CV chondrites calculated using Isoplot. Samples analyzed in this study are individually labeled with their sample name. All reference values are from [5-7,9,10]. Open symbols are for the carbonaceous achondrites reported in [9,10]. The shaded region indicates the 95% confidence interval of the weighted average (solid horizontal line) of the CK and CV chondrites only. Anomalous EET 92002 (CK5) [5] and NWA 6047 (CK3) from this study are not included in the average of CK chondrite group.

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