

**CHROMIUM ISOTOPIC DIVERSITY IN MAJOR MINERALS OF CARBONACEOUS CHONDRITES;** M. Rotaru, J.L. Birck, and C.J. Allegre, Laboratoire de Géochimie, IPG, 4, place Jussieu, 75252 Paris Cedex 05.

Previous investigations of the Cr isotopic ratios in separates from carbonaceous chondrites (CC) have shown widespread isotopic anomalies (1,2). The most striking effects have been found for the least metamorphosed meteorites: the C1s Orgueil and Alais. The principal result is that C1s and C2s contain no significant amount of normal Cr and that the mean solar composition results from the mixing of at least two Cr isotopic components, both of which are clearly different from solar composition: one depleted in  $^{54}\text{Cr}$  and one enriched in  $^{54}\text{Cr}$  (2). Additional effects exist for  $^{53}\text{Cr}$ . They appear to be related to in situ  $^{53}\text{Mn}$  decay (3). We have observed a clear decrease in the magnitude of the variability of the Cr isotopic anomalies between the major carriers of Cr within individual CC, which is correlated with the metamorphic grade of the CC. In C3-C4 chondrites the homogenization is almost complete.  $^{53}\text{Cr}$  excesses due to  $^{53}\text{Mn}$  decay which postdate the rehomogenization are still present in the later meteorite groups.

C1 meteorites are almost exclusively composed of matrix materials: submicron mineral phases including phyllosilicates, sulfates, etc..., for which a mechanical separation would be extremely difficult. A stepwise dissolution of a bulk powdered sample has been shown to discriminate against the different mineral microphases necessary to uncover major isotopic heterogeneities of Cr within the samples. However some mineral phases may be accessible to separation. Magnetite in C1 chondrites can be separated according to its magnetic properties. In contrast, C2s contain a wider variety of distinct crystals which may be physically separated. Renazzo contains metal grains of sufficient size to be individually analyzed. In this metal Cr is one of the main components (6) which is compatible with the primitive origin for this metal (4).

We report here Cr isotopic data obtained on such separates. In addition, to address the extent of variation of Cr isotopic behaviour within each class of CC and between classes, we report further data on additional CCs, as obtained by our usual stepwise dissolution procedure.

### RESULTS and DISCUSSION:

**Orgueil Magnetite:** The magnetite was separated following the procedure of Jeffery and Anders (5). The purity of the mineral has been controlled with an electron microprobe. Before dissolution in  $\text{HF}+\text{HCl}$ , the mineral grains were washed with dilute acetic and nitric acid. The data are plotted in Figure 1. An excess of  $72.4 \pm 0.5 \text{ ‰}$  is found for the  $^{54}\text{Cr}/^{52}\text{Cr}$  ratio.  $^{53}\text{Cr}$  displays an excess of only  $1.25 \pm 0.24 \text{ ‰}$ . This pattern is similar to that of the  $\text{HCl}+\text{HF}$  (step L4) dissolution step obtained by our procedure on powders of bulk samples (2). The magnetite thus constitutes one of the major carriers of the isotopic component enriched in  $^{54}\text{Cr}$ . The question whether the magnetite constitutes the unique carrier of this component is yet not settled. However, the fact that the L4 fraction has a small deficit in  $^{53}\text{Cr}$ , while magnetite exhibits a clearly resolved excess for this isotope, argues in favour of several mineral carriers for the  $^{54}\text{Cr}$  excess. Magnetite probably contained significant amounts of  $^{53}\text{Mn}$ : in situ decay resulted in the observed  $^{53}\text{Cr}$  excess. An additional argument in favour of at least one other  $^{54}\text{Cr}$  mineral carrier is given by the larger excess observed in step L4 than for the magnetite; stepwise dissolution does not usually perfectly discriminate between the different mineral phases, tending to introduce some procedural isotopic rehomogenization. If a separated mineral phase like magnetite were the only carrier of the  $^{54}\text{Cr}$  component, it would display the largest excess, thereby constituting one of the end members of mixing within the meteorite. This is not observed. The nature of the other carrier is an open question, but it may also well be magnetite: although the recovery of the magnetite with the separation procedure is estimated to be better than 80%, some magnetite, especially fine grained material, may be lost. This material may carry significant amounts of Cr enriched in  $^{54}\text{Cr}$ .

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**Ivuna:** Ivuna is a C1 similar to Orgueil. The isotopic data are similar for  $^{54}\text{Cr}$  and  $^{53}\text{Cr}$  in these two cc. The  $^{54}\text{Cr}$  isotopic pattern is plotted in Figure 2 in comparison to Orgueil. The magnitude of the  $^{54}\text{Cr}$  isotopic heterogeneity is smaller by about 20% than that observed for Orgueil, situating Ivuna between Alais and Orgueil in the range of isotopic heterogeneity. However this difference between Orgueil and Ivuna may be smaller than it appears, since different aliquots of the sample powder of Orgueil exhibit maximum values reached by  $^{54}\text{Cr}$  in step L4 which differ by as much as 14%. This variability could indicate intrinsic heterogeneity of the sample, but it is more likely a result of the procedure used for the dissolution of the sample: see the discussion above.

**Renazzo:** One metal particle in the mm size range was extracted and investigated using the electron probe (6). The Cr rich composition may be an indication of a primordial origin (4). An aliquot of powder of bulk matrix was also submitted to the stepwise dissolution procedure. The data are quoted in the table and the  $^{54}\text{Cr}$  effects plotted in Figure 2. The magnitude of the isotopic heterogeneity is nearly 3 times less than in CM2s (2). The material constituting this meteorite has undergone clearly stronger metamorphism than the other C2s analysed so far (2). Nevertheless  $^{54}\text{Cr}$  deficits are still observed in the first dissolution steps which is not the case for the C3s. The Renazzo metal particle gives data of poorer than usual precision: the isotopic pattern is compatible with normal composition within experimental errors. Metal does not appear to carry an isotopic component lying outside the range of values obtained by stepwise dissolution.

## CONCLUSION:

The variability of the Cr isotopic pattern for Ivuna obtained by stepwise dissolution locates this meteorite in between Orgueil and Alais in the metamorphic grade scale within the C1 meteorites. In contrast, the CR2 Renazzo exhibits Cr isotopic heterogeneity about 3 times lower than the CM2s Murchison and Murray (2). The separated mineral phases: the magnetite of Orgueil and a metal particle extracted from Renazzo display anomalies within the range of values already found using the stepwise dissolution procedures.

**REFERENCES:** [1] M. Rotaru et al. (1989) LPSC XX, 924. [2] M. Rotaru et al. (1990) LPSC XXI, 1037. [3] J.L. Birck et al. (1990) Abstr. 53<sup>rd</sup> Met. Soc. Meet. Perth, 8. [4] L. Grossman & E. Olsen (1974) G.C.A. 38,173. [5] P.M. Jeffery & E. Anders (1970) G.C.A. 34, 1175. [6] B. Zanda et al. This Volume.

	$^{53}\text{Cr}/^{52}\text{Cr}$	$^{54}\text{Cr}/^{52}\text{Cr}$
IVUNA WR	$0,15 \pm 0,26$	$-0,07 \pm 0,57$
IVUNA 1	$4,13 \pm 2,03$	$-2,83 \pm 3,86$
IVUNA 2	$0,42 \pm 0,24$	$-7,62 \pm 0,53$
IVUNA 3	$0,06 \pm 0,26$	$-5,55 \pm 0,53$
IVUNA 4	$-0,82 \pm 0,18$	$79,56 \pm 0,39$
IVUNA 5	$-0,68 \pm 0,29$	$22,73 \pm 0,64$
RENAZZO WR	$0,10 \pm 0,28$	$2,05 \pm 0,64$
RENAZZO 1	$0,90 \pm 0,30$	$-0,2 \pm 0,60$
RENAZZO 2	$0,12 \pm 0,15$	$-2,09 \pm 0,34$
RENAZZO 3	$0,14 \pm 0,20$	$-3,97 \pm 0,46$
RENAZZO 4	$0,28 \pm 0,24$	$6,21 \pm 0,60$
Metal RM9	$0,35 \pm 1,35$	$2,65 \pm 2,84$
ORG magn L4	$1,25 \pm 0,24$	$72,37 \pm 0,53$

Data are quoted in deviations from terrestrial standard, in part per 10000.

