^{53}Mn-^{53}Cr SYSTEMATICS OF R-CHONDRITE NWA 753. K. Jogo[1], C-Y. Shih[2], Y. D. Reese[3], and L. E. Nyquist[4], [1]Department of Earth and Planetary Science, Kyushu University, 6-10-1 Hakozaki, Fukuoka 812-8581, Japan, kaori@geo.kyushu-u.ac.jp, [2]Mail Code JE-23, ESCG/Jacobs Sverdrup, P.O. Box 58477, Houston, TX 77258-8477, chi-yu.shih1@jsc.nasa.gov, [3]Mail Code JE-23, ESCG/Muniz Engineering, Houston, TX 77058, young.reese1@jsc.nasa.gov, [4]Mail Code KR, NASA Johnson Space Center, Houston, TX 77058-3696, laurence.e.nyquist@nasa.gov.

Introduction: Chondrules and chondrites are interpreted as objects formed in the early solar system, and it is important to study them in order to elucidate the evolution of the early solar system. Here, we report the study of the Mn-Cr systematics of the R-Chondrite NWA753 and compare the results to previously determined chondrite data. The goal was to determine Cr isotopic and age variations among chondrite groups with different O-isotope signatures. The ^{53}Mn-^{53}Cr method as applied to individual chondrules [1] or bulk chondrites [2] is based on the assumption that ^{53}Mn was initially homogeneously distributed in that portion the solar nebula where the chondrules and/or chondrites formed. However, different groups of chondrites formed from regions of different O-isotope compositions. So, different types of chondrites also may have had different initial ^{53}Mn abundances and/or Cr isotopic compositions. Thus, it is important to determine the Cr isotopic sytematics among chondrites from chondrite groups. We are studying CO-chondrite ALH83108 and Tagish Lake in addition to R-Chondrite NWA753. These meterorites have very distinct O-isotope compositions (Figure 1).

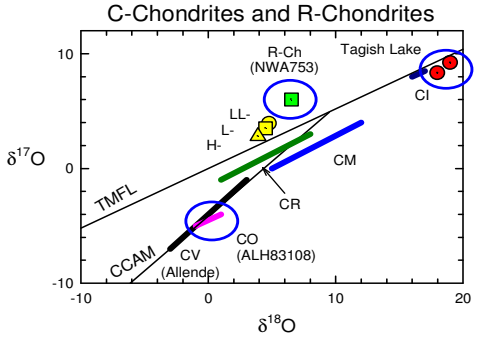

Figure 1. Comparison of O-isotope composition of R-chondrite NWA 753 to those of other chondrite groups.

Samples, Analytical Procedures, and Results: NWA 753 is a rare Rumuruti-type chondrite (R 3.9). A thin slab of the chondrite, weighing ~650 mg, was kindly allocated to us by T. Nakamura for this study. The sample is brownish and contains many small (<1mm diameter) white chondrules. The sample was cleaned in ethyl alcohol and sonicated for 10 minutes. Then we broke the sample and picked out ~ 110 mg "clean" chips for the Mn-Cr study. In order to eliminate possible post-crystallization, pre- or terrestrial, contamination, one bulk rock sample was further cleaned by washing in 2N HCl with sonication for 10 minutes, producing the whole rock residue (WR(r)) and leachate (WR(l)). Another bulk rock sample (WR) was not washed with HCl. The chromiums for these samples were separated using the chemical procedures described in [1]. The ^{53}Cr/^{52}Cr and ^{54}Cr/^{52}Cr isotopic measurements, normalized to ^{50}Cr/^{52}Cr =0.0518585, were made on a Finnigan-MAT 261 multi-collector mass spectrometer. Multiple (6-13) runs were obtained for each sample. The $\varepsilon(^{53}Cr)$ and $\varepsilon(^{54}Cr)$ values (deviations in 10^4 of sample ^{53}Cr/^{52}Cr and ^{54}Cr/^{52}Cr relative to their respective standard ^{53}Cr/^{52}Cr and ^{54}Cr/^{52}Cr values) were calculated. Using the Williamson program to regress sets of $\varepsilon(^{53}Cr)$ and their corresponding $\varepsilon(^{54}Cr)$ data, we obtained $\varepsilon(^{53}Cr)$ values, readjusted to $\varepsilon(^{54}Cr)=0$, for each sample of NWA 753. The Mn and Cr concentrations were made on an aliquot (~10%) of the sample solution by ICP-MS. The results are given in Table 1.

Table 1. Mn-Cr Analytical Results for NWA 753

Sample[a]	^{55}Mn/^{52}Cr[b,c]	$\varepsilon(^{53}Cr)$[c,d]
R-chondrite :		
NWA753 WR	0.709±0.036	0.39±0.10
NWA753 WR(r)	0.707±0.036	0.31±0.08
NWA753 WR(l)	2.90±0.15	0.25±0.11
	Wtd avg =	0.32±0.05

[a]WR=whole rock, r=acid-washed residues, l=acid leachates.
[b]Mn and Cr Determined by ICP-MS (analyst C.M. Kuo of Wyle Labs.), ±~5%.
[c]Uncertainties correspond to last figures and represent $\pm2\sigma_m$ error limits.
[d]ε-values calculated relative to standard ^{53}Cr/^{52}Cr runs
[e]Uncertainties correspond to last figures and represent $\pm2\sigma_p$ error limits.

Mn-Cr internal isochron for NWA 753: The ε^{53}Cr and ^{55}Mn/^{52}Cr data for three samples (solid diamonds) of NWA 753 are shown in Figure 2. The unwashed (WR) and acid-washed (WR(r)) bulk samples contain most of the Cr and appear to have slightly higher ε^{53}Cr than the leachate WR(l), which contains only ~15% of the bulk Cr. However, all three samples have the same ε^{53}Cr within analytical uncertainties despite a 3-fold variation in ^{55}Mn/^{52}Cr between the whole rock and leachate samples. These samples do not show the old age (dotted isochron) defined by fayaltic olivine grains in NWA 753 [3]. However, our leachate sample may contain some desert alteration products, commonly found in desert meteorites, and

which may have compromised its Cr isotopic composition. Further studies will be needed. We tentatively assign the weighted mean value $\varepsilon^{53}Cr=+0.32\pm0.05$ to NWA 753. This value is virtually the same as +0.31±0.08 for the acid-washed bulk sample.

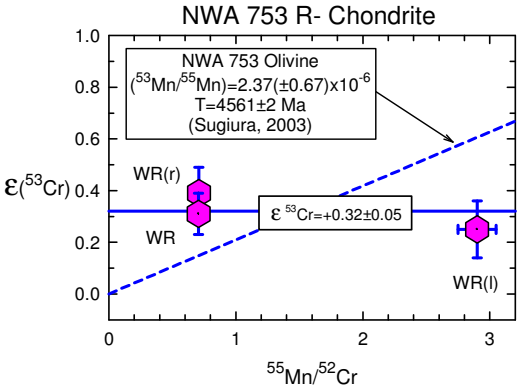

Figure 2. Mn-Cr isochron plot for NWA 753.

Possible O-Cr isotopic correlations: Figure 3 compares $\varepsilon^{53}Cr$ for NWA 753 to values for L and LL-chondrites [1] plotted against $\Delta^{17}O$ for these chondrite groups. There is a hint of a small negative trend of $\varepsilon^{53}Cr$ with $\Delta^{17}O$. In principle, analyses of O-chondrites could verify whether this trend extends to negative values $\Delta^{17}O$. There are multiple reasons why such a trend might exist: (a) All the chondrites could have formed at the same time, but Mn/Cr was lower in R-chondrites; (b) R-chondrites could have formed late, after some ^{53}Mn had decayed; (c) ^{53}Mn might have been heterogeneously distributed within the early solar system.

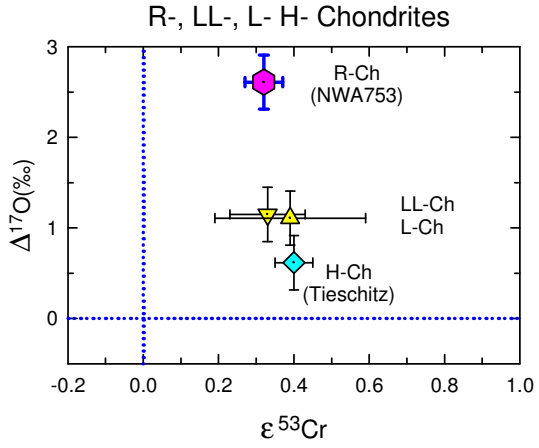

Figure 3. $\Delta^{17}O$ vs. $\varepsilon^{53}Cr$ for R-, L-, LL-, and H- chondrites

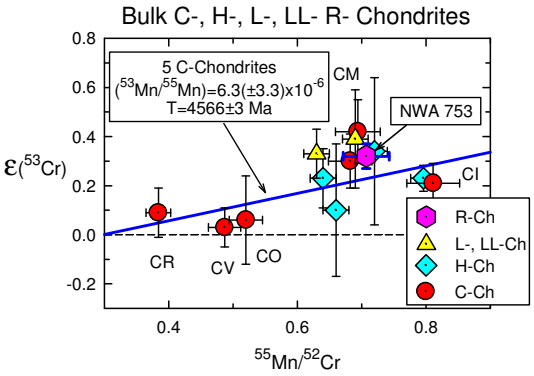

Fig. 4. $\varepsilon(^{53}Cr)$ *vs.* $^{55}Mn/^{52}Cr$ evolution diagram for bulk C, H, L, LL and R chondrites.

Figure 4 shows Mn-Cr isotopic data from the JSC laboratory for C-chondrites and the L-, LL-, and H-chondrites for which averaged data are shown in Figure 3. Five bulk carbonaceous chondrites satisfy and isochron relationship for initial $(^{53}Mn/^{55}Mn)_I$ ratio of $(6.3 \pm 3.3) \times 10^{-6}$ and $\varepsilon(^{53}Cr)_I = -0.17 \pm 0.18$. This result appears to be within error limits of initial $(^{53}Mn/^{55}Mn)_I = (8.5 \pm 1.5) \times 10^{-6}$ and $\varepsilon(^{53}Cr)_I = -0.21$ for carbonaceous chondrites reported by [4]. H-chondrite data plots near the carbonaceous chondrite isochron. The carbonaceous chondrite isochron implies an absolute age T_{LEW}= 4566±3 Ma when compared to $(^{53}Mn/^{55}Mn)_I = 1.44\pm0.07 \times 10^{-6}$ for Lewis Cliff 86010 (LEW) [5], and a 4558 Ma age for LEW [6].

Conclusions: The ~4566 Ma age for C-chondrites agrees with the CAI age reported by [7] and widely accepted as the age of the solar system. Also, the L-chondrite Mn-Cr data lie above the C-chondrite isochron at the same Mn/Cr ratio as for R-, and H- chondrites. Both observations suggest either higher initial ^{53}Mn abundance; i.e, an initially heterogeneous distribution of ^{53}Mn in the early solar system [8], or variations in initial Cr-isotopic compositions, possibly correlated to O-isotope variations.

Acknowledgements: This research was sponsored by the LPI Summer Internship Program. Financial support for analyses at the Johnson Space Center was provided by NASA RTOP 344-31 to L. E. Nyquist.

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