

## CHROMIUM ISOTOPIC COMPOSITIONS OF SOME CHONDRITES

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Studies of isotopic anomalies in meteorites have contributed significantly to our understanding of the early history of the solar system [*e.g.*, 1]. The isolation, identification and isotopic analysis of presolar grains in primitive meteorites has been highlight of meteoritic science in recent years [*e.g.*, 2] and also become significant developing subdiscipline of astronomy providing primary data on stellar and supernova nucleosynthesis [*e.g.*, 3]. We have continued detail analysis of primitive meteorites particularly acid residue fractions from them. It is because acid residues are little suffered from metamorphism due to secondary heating and shock; so they would contain the component which retains some informations on the early evolution of the solar system and on the processes of nucleosynthesis in the pre-solar stage. In this paper, we present Cr isotopic data for some chondritic meteorites and discuss the implications of the data from the viewpoint of the evolution of the solar system.

The chondritic meteorites used in this work are (1) Allende (CV3) from Chihuahua, Mexico, (2) Murchison (CM2) from Victoria, Australia, (3) Nuevo Mercurio (H5) from Zacatecas, Mexico, (4) La Criolla (L6) from Entre Rios Province, Argentina, (5) Qingzhen (EH3) from Guizhou, China. These kinds of chondrites were disaggregated by using the freeze-thaw method with liquid nitrogen. They were dissolved by alternating treatments with several kinds of acids such as 6N HCl and 10N HF. The acid residue samples were decomposed in sealed polytetrafluoroethylene (PTFE: Teflon) vessels by a microwave dissolution method with more strong mixed acids. From these solubilized residue samples as well as acid soluble fraction, Cr was separated by precipitation in the chemical form of Cr(OH)<sub>3</sub>; and then passed twice through column packed with anion exchange resin (Biorad AG1 X8). The procedure was basically based on Lee and Tera's work [4].

Cr isotopic analyses were performed by a VG 354 thermal ionization mass spectrometer (TIMS) with a single Faraday collector. Samples were loaded on a zone-refined (99.995%) outgassed V-shaped Re single filament with silica gel and boric acid as an activator. Adequate prebaking was required to reduce interferences from molecular ions. Isotopes from possible interfering elements Ti, V and Fe were monitored at <sup>49</sup>Ti/<sup>51</sup>V and <sup>57</sup>Fe. No Ti or V interferences have been detected. However, small Fe signals were not negligible with the increase of filament temperature. Therefore, we corrected isobaric interferences by <sup>54</sup>Fe/<sup>57</sup>Fe=2.622222, (<sup>50</sup>Ti/<sup>49</sup>Ti=0.969150 and <sup>50</sup>V/<sup>51</sup>V=0.002406). Isotopic measurements were carried out in peak jumping mode. Isotope ratios were normalized to <sup>50</sup>Cr/<sup>52</sup>Cr=0.051859 [5] and mass fractionation was corrected using an exponential law.

Cr isotopic compositions of some chondritic meteorites measured in this work are shown in Fig. 1 as the deviations from the grand means of the standards. On the whole, remarkable isotopic anomalies far beyond experimental errors could not be detected, but one noticeable result is that the enrichment of <sup>54</sup>Cr/<sup>52</sup>Cr relative to normal value was detected in a specimen of Qingzhen acid soluble fraction, though in case of acid residues of Qingzhen, accurate data could not be obtained unfortunately. Moreover,  $\epsilon^{54}\text{Cr}$  and  $\epsilon^{53}\text{Cr}$  are inversely correlated as a whole, and acid residues have larger  $\epsilon^{54}\text{Cr}$  and smaller  $\epsilon^{53}\text{Cr}$  values than acid soluble in Allende and Murchison. In Qingzhen acid soluble fraction which showed some excess of <sup>54</sup>Cr/<sup>52</sup>Cr, slight deficit of <sup>53</sup>Cr/<sup>52</sup>Cr relative to normal value were also shown. And, in acid residues of equilibrated ordinary chondrites such as La Criolla and Nuevo Mercurio, remarkable isotopic anomalies far beyond experimental errors could not be detected.

Cr isotopic result of Qingzhen sample may show that <sup>54</sup>Cr heterogeneity due to the stage of stellar nucleosynthesis has remained in enstatite chondrite which formed in the reducing environment of the solar system as well as carbonaceous chondrite which formed in the oxidizing environment. But it is premature to mention that Qingzhen sample has anomalous Cr at this point only from these data shown in Fig. 1 because the reproducibilities of the data are not necessarily good.

Cr isotopic compositions of only acid residue samples in this work are shown in Fig. 2 along with that of other published work by Allegre's group so far. Acid residue samples have so low Mn contents that the effects of <sup>53</sup>Mn decay to  $\epsilon^{53}\text{Cr}$  values are too low. So, we regarded these samples much suitable to survey  $\epsilon^{53}\text{Cr}$  and  $\epsilon^{54}\text{Cr}$  correlations at the formation stage. At the bottom of this figure, <sup>53</sup>Mn/<sup>55</sup>Mn ratio in case of assuming solar abundances of the elements is shown. It represents the relative time scale for Cr isotopic homogenization from the viewpoint of the evolution of high-temperature condensate. That is, relative condensation age of each sample assuming that Cr condense as high-temperature minerals from homogeneous nebula is shown in Fig. 2. Here, zero point at <sup>53</sup>Mn/<sup>55</sup>Mn

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ratio is set up as 0.385; the value is the mean of  $\epsilon^{53}\text{Cr}$  values of bulk CI chondrite (Orgueil, Ivuna) measured by Rotaru *et al.* [6].

Acid residue samples have generally negative  $\epsilon^{53}\text{Cr}$  and positive  $\epsilon^{54}\text{Cr}$ . But the degree is larger in acid residues of primitive carbonaceous chondrites such as Murchison and Allende. And in acid residues of equilibrated ordinary chondrites such as La Criolla and Nuevo Mercurio,  $\epsilon^{53}\text{Cr}$  and  $\epsilon^{54}\text{Cr}$  values are close to that of bulk meteorites. The tendency can be interpreted to be shown that the high condensate which was formed earlier stage contained more exotic  $^{54}\text{Cr}$  assuming that the variations of  $^{53}\text{Cr}$  are due to the decay of  $^{53}\text{Mn}$  in the nebula. In addition, it suggests that the homogenization of Cr isotope proceeded with the elapse of time and terminated within relative short time scale as less than 2-3 Ma. On the other hand, the tendency that the samples which show large  $\epsilon^{54}\text{Cr}$  and small  $\epsilon^{53}\text{Cr}$  can be also interpreted that early high-temperature condensate contains the component which was strongly influenced by s-process nucleosynthesis from AGB star.

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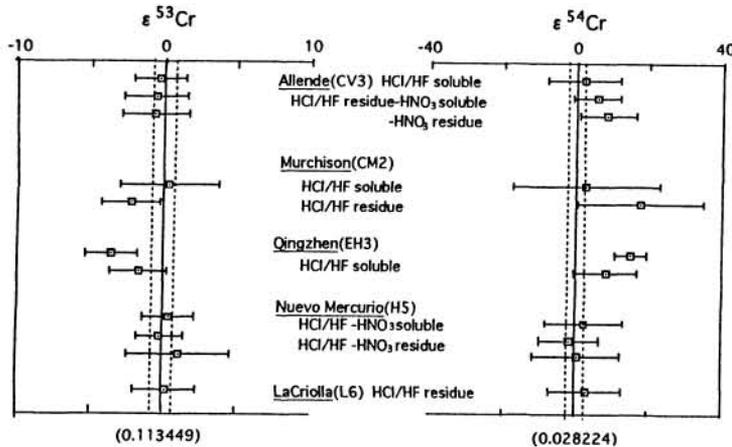


Fig. 1 Cr isotopic compositions of some chondrites.

All isotopic ratios are corrected for mass fractionation by normalization to  $^{50}\text{Cr}/^{52}\text{Cr}=0.051859$  (Shields *et al.*, 1966) using exponential law. Errors given are two standard errors of the mean. Dotted lines indicate the range of uncertainties for "Normals" at 95% confidence limit.

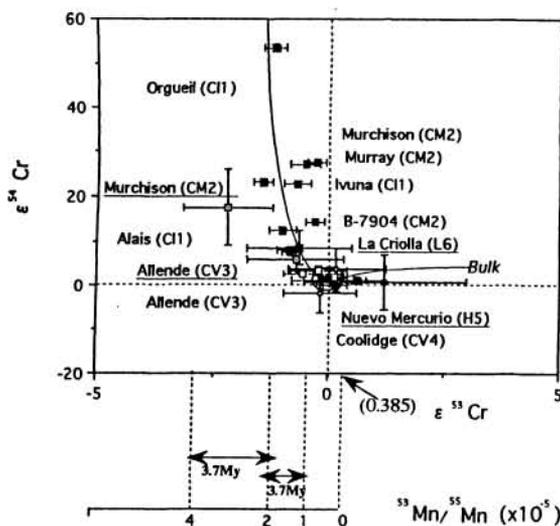


Fig. 2  $\epsilon^{53}\text{Cr}$  versus  $\epsilon^{54}\text{Cr}$  plots of acid (HCl/HF) residue samples in this work and fraction 5 (refractory phases) of some carbonaceous chondrites based on the data of Rotaru *et al.* (1992) and Birck & Allegre (1988). And, for reference,  $^{53}\text{Mn}/^{55}\text{Mn}$  ratio assuming solar abundances of the elements is shown and it also represents the relative time scale for the evolution of high-temperature condensate.