SUPERNOVA NANOPARTICLES ARE THE CARRIERS OF ^{54}Cr ANOMALIES IN PLANETARY MATERIALS

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Acid leachates and residues of primitive meteorites have revealed large variations in ^{54}Cr relative to terrestrial composition [1-9]. Despite two decades of extensive search, the nature of the carrier of ^{54}Cr excesses is still uncertain. Ion probes offer the opportunity to address directly this question by measuring $^{54}Cr/^{52}Cr$ ratios in individual grains [10-13].

We have measured the Cr isotopic composition of physical and chemical separates from the primitive carbonaceous chondrites Orgueil and Murchison. The colloidal fraction of Orgueil (median grain size of ~30 nm) shows the largest ^{54}Cr-excess ever measured in a bulk meteorite residue ($\varepsilon^{54}Cr=170$). This indicates that the carrier of ^{54}Cr-anomalies was efficiently concentrated by our procedure and that it must be very fine grained (<100 nm) [also see 3, 4]. In situ Cr isotopic analyses by NanoSIMS of the <200 nm nominal size fraction of Orgueil (median grain size 184 nm) revealed the presence of ^{54}Cr-rich nanoparticles ($^{54}Cr/^{52}Cr>3.6\times$solar). Heterogeneous distribution of these nanoparticles in the inner solar system is compatible with the variations in ^{54}Cr abundance measured in bulk meteorites and terrestrial planets. Because of their small size, no direct mineralogical characterization of the ^{54}Cr-rich grains could be performed. However, study by transmission electron microscopy shows that ^{54}Cr-rich grains are found in a fraction where the sole chromium-bearing grains are oxides, mostly nanospinels.

At the present time, we cannot tell which of type Ia and II supernovae produced the grains identified here, though the oxide mineralogy would favor condensation from a type II. This question can be addressed in the future by measuring the isotopic abundance of other neutron-rich isotopes, in particular ^{48}Ca [14,15], in the same grains. Study of these grains will shed new light on the nucleosynthesis of iron-group nuclei and the evolution of supernovae.

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