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Nucleosynthetic isotopic anomalies of Ti and Cr in fine-grained CAIs from the Allende meteorite

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Nucleosynthetic isotopic anomalies shown in meteorites suggest that the protosolar disk had a heterogeneous isotopic composition. Especially, isotopic anomalies of ε^{50}Ti and ε^{54}Cr (representing 10^4 times relative deviation from a standard material) have been used to discuss the isotopic dichotomy of bulk meteorite compositions [1], providing a clue to the origin of the Solar System materials. Calcium-aluminum-rich inclusions (CAIs) in chondrites are the oldest materials in the Solar System. Their constituent minerals suggest that CAIs were formed by direct condensation from nebular gas with a solar composition [2]. Recent studies found differences in isotopic ratios for several elements between coarse-grained CAIs (CGs) that underwent remelting and fine-grained CAIs (FGs) that did not remelt [3-4]. However, reports on ε^{54}Cr in CAIs are currently limited [5], especially for those in FGs.

In this study, Ti and Cr isotope ratios of eight FGs from the Allende meteorite were measured by MC-ICP-MS and TIMS, respectively. The obtained ε^{50}Ti and ε^{54}Cr values ranged from 5.7 to 11.6 and from 0.43 to 10.1, respectively. The ε^{50}Ti values are consistent with those of previous studies [3], whereas the ε^{54}Cr values are variable compared to those of reported CGs [6]. The correlation between the ε^{54}Cr and ε^{53}Cr suggests that the relatively low ε^{54}Cr value is due to contamination from the matrix material. However, the ε^{54}Cr values of some FGs obtained are higher than the representative value of ε^{54}Cr = 7±1 for CGs and AOAs [5], which has been used in various calculations of CAI mixing models [7]. The variable isotopic ratios of FGs are consistent with the fact that the bulk isotopic ratios of the NCs and CCs cannot be explained by mixing with CGs and CI chondrites (Fig.1), suggesting that the FG isotopic compositions influence the bulk meteorite composition significantly.

[1] Kleine et al. (2020) *Space Sci Rev.* 216, 1. [2] Yoneda and Grossman (1995) *GCA*, 59, 3413. [3] Davis et al. (2018) *GCA*, 221, 275. [4] Masuda and Yokoyama (2023) *GCA*, 345, 50. [5] Trinquier (2008) *GCA*, 72, 5146. [6] Bogdanovski et al. (2002) *LPSC abst*. 33, 1802. [7] Williams et al. (2020). *PNAS*, 117, 23426.

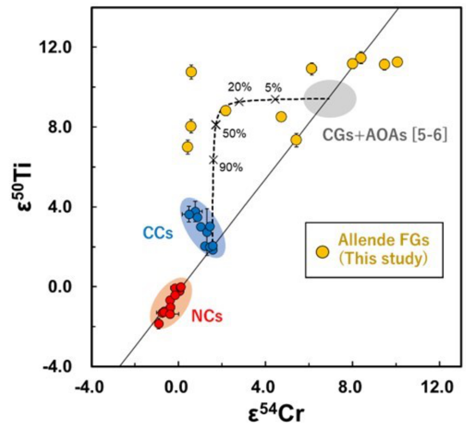

Figure 1 Diagram of ε^{50}Ti versus ε^{54}Cr for FGs obtained in this study. Also shown are those of carbonaceous and non-carbonaceous meteorites, and CAI and AOAs previously reported [1,5,6]. The black solid line represents the correlation line defined by NCs, CIs, and CAIs in [5]. The black dashed line represents an example of a two-component mixing model estimating the effect of Ti and Cr between CAIs and CI chondrites [5] (labels indicate the percentage of CI chondrites in the mixture).