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Chromium and Titanium isotopic anomalies in Al-rich chondrules from CV chondrites

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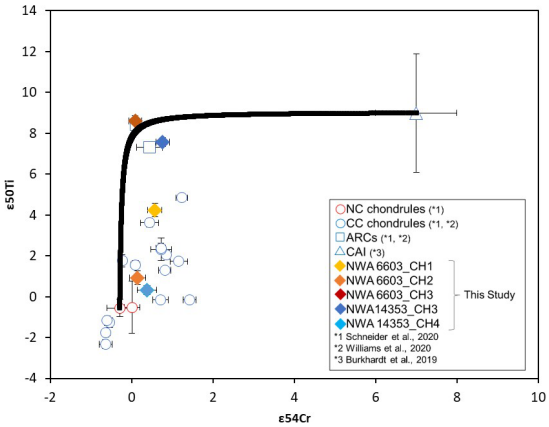

Recent high-precision isotopic measurements of Cr and Ti enabled a new classification of chondrites: carbonaceous chondrites (CCs) and non-carbonaceous chondrites (NCs) (Warren, 2011; Kleine et al., 2020). This classification is referred to as the 'isotopic dichotomy' of meteorites, suggesting that the origins of the parent bodies of CCs and NCs are spatiotemporally distinct. In contrast, the isotopic ratios of Cr and Ti in chondrules from CCs (hereafter CC chondrules) showed large variations that exceeded the range of those of bulk CCs, whereas chondrules from NCs (hereafter NC chondrules) had isotopic compositions consistent with those of bulk NC chondrites (e.g., Schneider et al., 2020). Decoding the origin of CC chondrules is key for understanding material transport and mixing processes in the early Solar System. Among the CC chondrules for which the isotopic ratios have been measured in previous studies, Al-rich chondrules (ARCs) are unique in their isotopic composition. ARCs are more Al-rich than Mg-rich chondrules that can be commonly found in CCs, which have characteristics of both Mg-rich chondrules and CAIs in terms of mineral composition. ARCs are important materials for elucidating the mixing process between the CAIs and NCs. However, as ARCs are a rare constituent of meteorites, there are very few examples of isotope ratio measurements in previous studies.

In this study, we examined three ARCs found in thick sections of NWA 6603 (CVox3) and two in NWA 14353 (CVred3). After a detailed mineral description of the ARCs, we sampled them with a microdrill device to determine the elemental abundances using TQ-ICP-MS, and the isotopic compositions of Cr (ε^{54}Cr) and Ti (ε^{50}Ti) using TIMS and MC-ICP-MS, respectively. The ε^{54}Cr values of the five ARCs are similar to those in Mg-rich CC-chondrules (Fig. 1). In contrast, the ε^{50}Ti values in ARCs show a large variation ranging from 0.34±0.22 to 8.60±0.25, suggesting the varying contribution of CAIs to individual ARCs. On the other hand, the variation of ε^{54}Cr cannot be solely explained th3 mixing of NC-chondrules and CAIs, which requires additional processes including the mixing of AOAs and/or secondary alteration on the parent body.