RARE EARTH ELEMENTS AND O-Al-Mg ISOTOPE SYSTEMATICS FROM A >200 µm CORUNDUM GRAIN IN A CAI OF THE CK3 CHONDRITE NORTHWEST AFRICA 4964.

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Introduction: Corundum (Al_2O_3) is one of the first minerals predicted to condense from a gas of solar composition at pressures $<10^{-3}$ atm [1,2]. However, because it reacts with the cooling solar gas to form hibonite—and later grossite and melilite—corundum is rarely found in meteorites. Since corundum represents such an early formed phase, it is critical for our understanding of possible ^{26}Al heterogeneity in the protoplanetary disk and the evolution of its O-isotopic reservoir(s) (e.g., [3]). In this work, we present a very large (>200 µm) corundum grain from the CAI "Homer" [4] of the CK chondrite Northwest Africa 4964 which was investigated by measuring its chemical compositions, including rare earth elements (REE) contents, and the O and Al-Mg isotope systematics.

Results: Next to many small corundum grains (Fig. 1a, figure from [4]), the CAI "Homer" contains a very large single corundum grain of >200 µm length and 50 µm width (Fig. 1b). REE concentrations of the sample were measured by LA-ICP-MS (spotsize: 10µm and 40µm). Multiple elements were below detection limit in the corundum, and the combined results are shown Fig. 2. The light REEs are mostly depleted compared to those of the bulk CAI measurement and the surrounding material (mixture of plagioclase ($An_{32\text{-}95}$), Fe-rich spinel, and ilmenite). However, the heavy REEs exhibit a group II pattern similar to that of the bulk CAI "Homer" with the exception of a notable difference in Yb. This condensation pattern is well known from CAIs [5] and also from Na-Al-rich chondrules [6]. The O-isotopes of the grain plot with $\delta^{17}O = -3.93$ ‰ and $\delta^{18}O = -0.69$ ‰ directly in the field of CK chondrites next to the CO-CK-CM-Line. The Al-Mg isotopic data create a well-defined line with a slope of 3.15×10^{-6} which is significantly shallower than the canonical value of 5.23×10^{-5} [8].

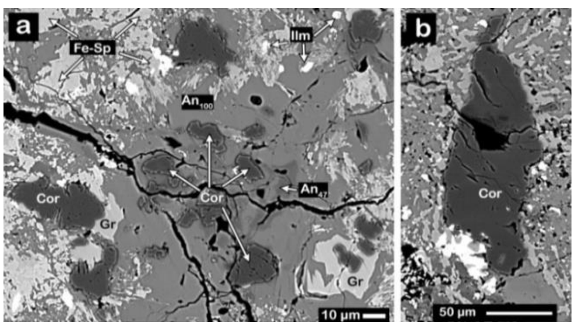

Figure 1: a) small corundum (Cor) grains intergrown with grossular (Gr) and Fe-rich spinel (Fe-Sp) and enclosed by anorthitic plagioclase (An). b) The large corundum grain with the surrounding material consisting of plagiclase, Fe-Sp, and ilmenite.

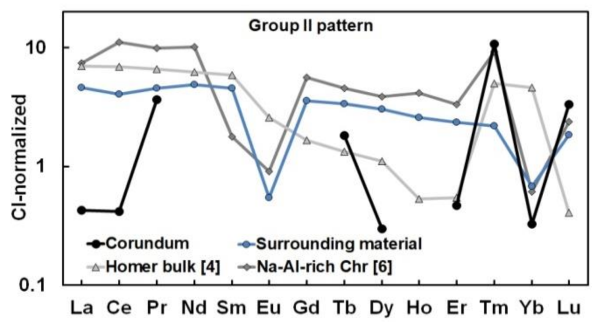

Figure 2: REEs of the corundum normalized to CI [7] indicating a group II pattern and similar to "Homer" bulk from [4]. Also sown are REE pattens of the surrounding material and a Na-Al-rich chondrule from [6]

Discussion and Conclusion: The group II REE pattern reveals a condensation origin of the corundum grain, showing that it was not formed during a later melting process. As corundum is one of the first oxides formed in a cooling gas of solar composition, it is of special interest when establishing relationships between O and Al-Mg isotopic systematics. However, Al-Mg work on the corundum grain indicates a significantly lower $^{26}Al/^{27}Al_{initial}$ than the canonical CAI value. Whereas a non-canonical value in a CAI could be caused by initial ^{26}Al heterogeneity in the CAI forming region, it could also be caused by secondary alteration processes. First, O isotopes of the corundum are indistinguishable from that of bulk CK chondrites, possibly pointing to alteration resetting the O-isotope composition on the parent body. Secondly, as the calculated initial $^{26}Al/^{27}Al$ of 3.15×10^{-6} (~3 Ma after CAIs) fits within the formation age of chondrules [e.g. 9 and references therein], it is likely that the Al-Mg and O isotopic systems are indicative of a heating event during chondrule formation and/or by thermal metamorphism on the CK parent body. Regardless of the origin of the disturbance, it does not appear that the O and Al-Mg isotopes in this very large corundum grain are useable for determining any potential links between the two isotopic systems.

References: [1] Grossman L. (1972) *Geochimica et Cosmochimica Acta* 36:597-619. [2] Yoneda S. and Grossman L. (1995) *Geochimica et Cosmochimica Acta* 59:3413-3444. [3] Makide K. et al. (2011). The Astrophysical Journal Letters 733:L31. [4] Shollenberger Q. et al. (2018) *Geochimica et Cosmochimica Acta* 228:62-80. [5] Mason B. and Martin P. M. (1977) *Smithsonian Contribution to the Earth Sciences* 19, 84-95. [6] Ebert S. and Bischoff A. (2016) *Geochimica et Cosmochimica Acta* 177:182-204. [7] Barrat J.-A. et al. (2012) *Geochimica et Cosmochimica Acta* 83:79-92. [8] Jacobsen B. et al. (2008) *Earth and Planetary Science Letters* 272:353-364. [9] Pape J. et al. (2019) *Geochimica et Cosmochimica Acta* 244:416-436.