# Constraints on the origin of a type B CAI from the Vigarano $CV3_{red}$ chondrite

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Calcium-aluminum-rich inclusions (CAIs) preserve records of processes and conditions in the earliest, high-temperature stages of Solar System evolution [1]. We conducted a coordinated study of mineralogy, petrology, microstructures, and O and Al-Mg isotopic compositions of a type B CAI from the Vigarano $CV3_{red}$ chondrite. The CAI was examined by scanning electron microscope, electron microprobe, transmission electron microscope combined with focused ion beam sample preparation technique, and NanoSIMS.

The CAI examined from Vigarano is a 1,200 x 750 µm fragment of a type B CAI. The CAI consists of a grossmanite core and a melilite mantle partially surrounded by a Wark-Lovering (WL) rim and an olivine-rich accretionary rim. The core grossmanite is compositionally heterogeneous with ~16-21 wt% $Al_2O_3$ and ~7-17 wt% $TiO_2$. The melilite mantle, ~250-450 $\mu$m in size, is reversely zoned grading outwards from $Åk_{\sim 60}$ at the interface with the core to $Åk_{<1}$ in contact with the WL rim. Euhedral spinel occurs in the core and mantle, and is nearly pure $MgAl_2O_4$ with FeO <0.1 wt%. Combined with O and Al-Mg isotope measurements [2,3], the textures and compositions of the CAI suggest that it crystallized from a melt that had experienced some evaporation in multiple distinct oxygen isotopic reservoirs. Additionally, the core is surrounded by a thin layer of Al-Ti-rich pyroxene with local areas of perovskite-melilite-Al-Ti-rich pyroxene symplectite, indicative of a later stage of short-lived, incomplete reactions between the core and mantle. Perovskite displays (101) twinning, consistent with relatively slow cooling rates (<50°C/hour) [4]. Collectively, these observations imply that the CAI formed by multi-stage high-temperature processes under highly dynamic conditions.

**References:** [1] MacPherson (2014) Treatise on Geo-chemistry II pp.139-179. [2] Needham et al. (2015) 78th MetSoc abstract #5014. [3] Needham et al. (2015) 46th LPSC abstract #2865. [4] Keller and Buseck (1991) AM 79, 73-79.