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EXTREME EVAPORATION RECORDED BY COLORLESS HIBONITE–CORUNDUM GRAINS FROM MURCHISON

X. Yang[1,2,3], Y. Zheng[1,2], J. Greer[1,4], A. M. Davis[1,2,5], M. Zhang[6], N. T. Kita[6], G. R. Huss[7], A. N. Krot[7], K. Nagashima[7], H. Busemann[8], C. Maden[8], and P. R. Heck[1,2*], [1]Robert A. Pritzker Center for Meteoritics and Polar Studies, Negaunee Integrative Research Center, The Field Museum of Natural History, Chicago, USA (* prheck@fieldmuseum.org); [2]Department of the Geophysical Sciences and Chicago Center for Cosmochemistry, The University of Chicago, Chicago, IL, USA; [3]Max Planck Institute for Solar System Research, Göttingen, Germany; [4]Chalmers University of Technology, Sweden; [5]Enrico Fermi Institute, The University of Chicago, USA; [6]WiscSIMS, University of Wisconsin–Madison, USA; [7]University of Hawai'i at Mānoa, USA; [8]ETH Zurich, Switzerland.

Introduction: Protoplanetary disks experience episodic heating events such as accretion outbursts, shocks, and magnetic activity that can raise temperatures far above equilibrium values [1]. Early in the solar nebula's history, such conditions produced calcium-aluminum-rich inclusions (CAIs). It remains unclear whether CAI-level thermal processing persisted during later stages of disk evolution. Here we investigate **c**olorless **hi**bonite–**c**orundum grains (CHIC grains) from the CM chondrite Murchison [2, 3], a new population of refractory oxide grains, to constrain their thermal history and chronology and to evaluate whether they record late CAI-level heating.

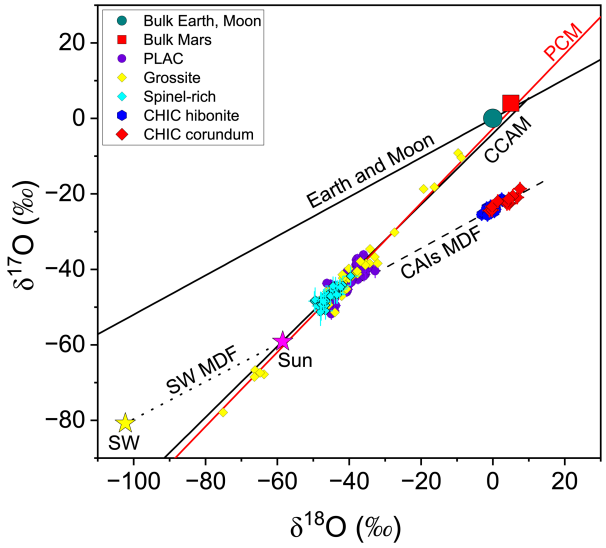


Fig. 1. Oxygen three-isotope diagram for analyzed refractory oxides. Hibonite and corundum grains have $\Delta^{17}O \approx -24‰$ and span a relatively broad range in $\delta^{18}O$ (from approximately –3‰ to +7‰). PLAC = platy large hibonite crystal [6]. Blue data points are spinel-rich CAIs from primitive chondrites [12], representing possible precursors of CHIC grains. Grossite data are from [13]. SW = solar wind [14].

Materials and Methods: CHIC grains were extracted from Murchison (FMNH ME 2644 #23.20) and characterized by scanning electron microscopy and energy-dispersive spectroscopy (SEM/EDS) [4]. Typical hibonites from Murchison are blue and contain minor TiO_2 and MgO at the wt% level [5–6]. In contrast, CHIC grains are colorless and have TiO_2 and MgO below the detection limit of ~0.1 wt%. We analyzed 29 CHIC grains by secondary ion mass spectrometry (SIMS) for their O, Al-Mg, Ca, and Ti isotopes, and measured noble gases in selected grains also by mass spectrometry.

Results and discussion: CHIC grains show large mass-dependent fractionation in O, Ca, and Ti isotopes (e.g. Fig. 1), while retaining CAI-like $\Delta^{17}O$ values of approximately –24‰ and showing no resolved nucleosynthetic anomalies in $\delta^{50}Ti$ or $\delta^{48}Ca$ within the uncertainties. These features indicate that CHIC grains are strongly evaporated residues derived from CAI-like precursors. The Ca isotope fractionation with F_{Ca} of 10‰ implies ~70% Ca loss, and evaporation modeling suggests that the precursors could be spinel-rich REE Group II CAIs [7]. All analyzed grains define an external Al–Mg isochron with initial $(^{26}Al/^{27}Al)_0 = (3.48 \pm 0.08) \times 10^{-6}$, corresponding to 2.81 ± 0.02 Ma after canonical CAI formation. Noble gas measurements show no resolvable pre-accretion ^{21}Ne excesses, distinguishing CHIC grains from early-formed ^{26}Al-poor hibonites irradiated by strong solar cosmic rays [8]. Evaporation models and experimental constraints indicate temperatures above ~2050 °C and rapid evaporation [9, 10], without significant isotopic exchange with the surrounding nebular gas [11]. Although an early origin during incomplete nebular ^{26}Al homogenization cannot be fully excluded, all these isotopic features are consistent with that CHIC grains are residues of typical CAI-like precursors that experienced brief and intense reheating ~2.8 Ma after CAI formation. Such events were likely rare or poorly preserved, but they indicate that strong evaporation continued during later protoplanetary disk evolution.

References: [1] Connolly Jr H. C. et al. (2006) *Meteorites and the early solar system II:* 383–397. [2] Yang X. et al. (2024a) *MetSoc* Abstract #6357. [3] Yang X. (2024) *Goldschmidt*. [4] Korsmeyer J. M. (2025) *University of Chicago*, PhD thesis. [5] Berry A. J. et al. (2017) *Chem. Geol.* 466: 32–40. [6] Kööp L. et al. (2016) *GCA* 189:70–95. [7] Ivanova M. A. (2021) *GCA* 296: 97–116. [8] Yang X. (2025) *University of Chicago*, PhD thesis. [9] Floss C. et al. (1998) *GCA* 33:191-206. [10] Mendybaev R. A. et al. (2021) *GCA* 292:557–576. [11] Yamamoto D. et al. (2021) *GCA* 312:108–120. [12] Bodénan J.-.D. et al. (2014) *EPSL* 401:327–336. [13] Krot A. N. et al. (2020) *Sci. Adv.* Eaay2724. [14] McKeegan K. D. et al. (2011) *Science* 332:1528–1532.