

REFRACTORY INCLUSIONS IN AN UNUSUAL CARBONACEOUS CHONDRITE, NWA 1465.

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Introduction. NWA 1465 is classified as an anomalous CV3 [1]. It is petrologically similar to the reduced subgroup of CV3s but its bulk oxygen isotopic composition plots on the CR line [2]. We investigated the refractory inclusion population found in a polished thin section of the meteorite. The section, made from the fragment shown in [2] and provided by S. Kambach, a collector, has a 6 mm-long zone rich in blue refractory inclusions visible to the naked eye. This area alone contains over 20 inclusions, and we have identified 120 CAIs, from ~30 - ~600 μm across, in 120 mm^2 of the section. Except for four small, completely rimmed CAIs, all are unrimmed or partially rimmed fragments. The meteorite exhibits a foliation like that of Leoville.

Observations. Eighty-one of the inclusion fragments we found are melilite-rich; 14 of these contain hibonite. As in the reduced CV3s and the CRs, melilite is virtually unaltered, but unlike CRs, no grossite-bearing inclusions are present. The most common (32 of 120) of the 16 assemblages in the NWA inclusion fragments is melilite (mel)-spinel (sp), followed by sp-pyroxene (23); mel-sp-perovskite (pv) (18); mel-sp-anorthite (11); and, notably, 7 mel-sp-pv-hibonite (hib)-fassaite (fass) inclusions, in which the latter three Ti-rich phases are commonly intimately intergrown, and some of the fass reaches the most Ti-rich (~21 wt% $\text{TiO}_2 + \text{Ti}_2\text{O}_3$), MgO-poor (~2 wt%) compositions that we are aware of. It has $^{27}\text{Al}/^{24}\text{Mg}$ as high as 17, $\text{Al}/\text{Si} > 1$, and $\text{Ti}^{3+}/\text{Ti}^{\text{tot}}$ mostly ~0.55 to ~0.75, coexisting with mel ($\text{\AA}k_5$). In one of these samples fass has 1-2 wt% Sc_2O_3 . Hibonite occurs as small, Ti-rich (7-9 wt% TiO_2) laths enclosed in gehlenitic mel. Ti-rich fass also occurs in some mel-rich, hib-free inclusions, both between mel grains and poikilitically enclosing mel ($\text{\AA}k_{5-10}$). The other fass occurrence is a $100 \times 200 \mu\text{m}$ sp-poor clast in an otherwise sp-, hib-, mel-rich inclusion fragment. In a unique inclusion, melt (now glass) with 80-85 wt% SiO_2 invaded a sp-mel ($\text{\AA}k_{70-75}$)-diopside assemblage. Twelve mel-rich fragments contain interstitial anorthite that appears to be primary.

Discussion. A few of the inclusion fragments may have been derived from Type Bs but most are consistent with derivation from compact Type As (CTAs), albeit atypical ones. Some unusual or unique assemblages found: (1) fassaite in contact with hibonite and perovskite. In such occurrences, fassaite probably exhibits the maximum extent of Ti substitution that can occur in meteoritic pyroxene. Some of the fass compositions found in the present study are unlike those seen in either typical Types A or B inclusions. The closest compositions to these were found in one grain in a rare, hib-bearing CTA from Allende [3], but even these are poorer in total Ti oxides by ≥ 3 wt% than the most Ti-rich composition in NWA 1465. The present fass represents the most extreme degree of crystal-liquid fractionation so far seen in a CTA; (2) primary anorthite with mel + sp but no fass; and (3) SiO_2 -rich glass in contact with mel. This object is puzzling, as the SiO_2 -rich liquid should have either evaporated away or reacted with mel to form diopside, which is not present at the contact.

References: [1] Russell S. et al. 2004. *Meteoritics & Planetary Science* 39:A215. [2] Greshake A. et al. 2003. Abstract #1560. 34th Lunar & Planetary Sci. Conf. [3] Simon S. B. et al. 2001. *Meteoritics & Planetary Science* 36:331.