THE C3-UNGROUPED CHONDRITE NWA 13053: FURTHER EVIDENCE FOR A HETEROGENEOUS AND THERMALLY ALTERED CARBONACEOUS ASTEROID?

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Introduction: From 2010 – present, a number of carbonaceous chondrite finds of classification C3-ungrouped or CM-anomalous have been acquired from dealers in Morocco and Algeria (e.g. Chwichiya 002, 003; NWA 5377, 12416, 13671, 13984, 14051, 14052, 14139, 14179, 14200, 11024, 11086 and Telakoast 001). These may sample a strewn field [2,3]. Here we present an oxygen isotope study of a newly classified Moroccan C3-ung meteorite, NWA 13053. Our aim is to compare the results to the comprehensive oxygen isotope data from [1,2,3] in order to investigate the possible linkages between these unusual meteorites to better understand the diversity of the C3-ung parent bodies.

Materials and Methods: One thin section and one polished block of NWA 13053 were investigated using an SEM. Different lithologies were sampled prior to sectioning by chipping / scraping with a steel spatula. Oxygen isotopes were obtained using laser assisted fluorination in 'single shot' mode to minimise complications that arise from running CC samples. X-ray diffraction (XRD) of selected powders were undertaken at the NHM, London.

Results and discussion: Cutting the specimen (single stone, 41.9 g) revealed a diamond shaped, reflective, metal rich clast in the center. The clast is distinct from the host as it contains notably more metal. In both lithologies, metal bearing, type I chondrules are abundant and contain intact mesostasis. Zoned, type II chondrule fragments are present, as are rare de-vitrified chondrules. The remaining phases are fine grained, predominantly anhydrous matrix, as revealed by - EDX analyses which yield high analytical totals (> 93 %). No hydrated minerals (serpentine, cronstedtite or tochilinite) were detected in either host or clast by XRD. Owing to its type 3 classification, this chondrite may be considered unaffected by alteration, however the oxygen isotopes define a large spread (Fig. 1) and suggest varying degrees of incipient alteration occurred. The metal rich clast is 7 ‰ lighter in $\delta^{18}O$ than its host, likely caused by different aqueo-thermal histories experienced by each, followed by regolith processing on the asteroid. Most interestingly, oxygen isotope analyses of the host and clast plot close to, but below (more -ve $\Delta^{17}O$) the CM mixing array and directly below several moderately – heavily altered CMs. Furthermore, when these results are plotted together with MetBul data, the C3-ung and CM-an chondrites define a new array of slope ~ 0.7 (Fig. 1) which originates from the CCAM and diverges from the CM mixing line to a shallower slope. This raises interesting questions as the CM array has long been attributed to the interaction of isotopically 'heavy' water and isotopically 'light' anhydrous precursors [10]. Applying this mixing hypothesis to the C3-ung necessitates an explanation for the lack of aqueous alteration products. A prominent characteristic of the fine grained matrix in both lithologies is dessication cracks, therefore a Stage III (500-750˚C), IV (>750˚C) [11] or equivalent level of heating post-aqueous alteration could be inferred to account for the prevalence of metal and the cause for type '3' classification. Moreover, these observations suggest the 'heavy' oxygen isotope signatures that were induced by aqueous alteration were retained and/or exaggerated by dehydration and perhaps even hot desert weathering. This is particularly true for the host lithology of NWA 13053, which bears the isotopically heaviest signature so far (Fig. 1).

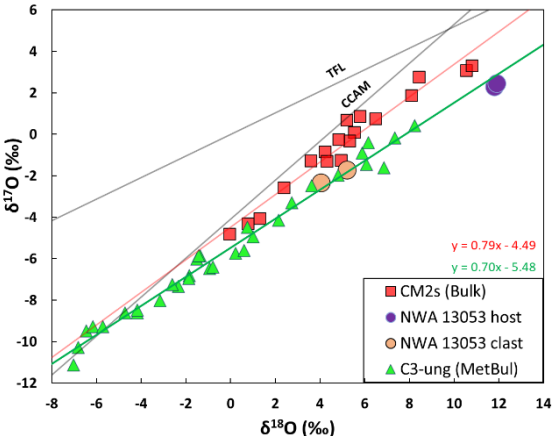

Fig 1: O-isotope plot of C3 ungrouped [1,2,3], NWA 13053, and CM data: [4,5,6,7,8,9]

Conclusions: These oxygen isotope data support the existence of genetically similar asteroids in the 'CM forming region' of the protoplanetary disk. However, in contrast to the CM chondrite source, the C3-ung chondrites sample a region which: hosted reservoirs of subtly different composition, and accreted an asteroid(s) that retained enough heat to promote dehydration, either deep in a common asteroid or on a separate asteroid which retained more ^{26}Al. Furthermore, distinct regions body will have experienced varying degrees of aqueo-thermal processing, as evident from the two distinct lithologies in NWA 13053. We support the proposition a of 'CT' (Telakoast-like) chondrite group by [2,3] and tentatively propose that NWA 13053 is a 'CT3'.

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