THE METAL-RICH LITHOLOGY WITHIN THE AGUAS ZARCAS BRECCIA:CHARACTERIZATION, ORIGIN, AND EVOLUTION.

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Introduction: Carbonaceous chondrites are important samples for studying early solar system bodies of relatively high volatile content. They have experienced a wide range of processes, including aqueous alteration and thermal metamorphism or a combination of both that provide important information about the environment of their evolution. We investigated the petrography, mineralogy, chemistry, and isotopic composition of an unusual 'metal-rich lithology' (termed Met-1) from the CM chondrite Aguas Zarcas in order to better understand its characteristics, affinities, origin, and formation history.

Samples and analytical methods: The study was based on homogenized powders and three thin sections prepared from a pre-rain fragment. Back-scattered electron imaging, electron microprobe analysis, and Ti, Cr and Te isotope analyses were conducted at the Institute für Planetologie (Münster). Bulk O isotope data were obtained using the IR-laser fluorination at the Universität Göttingen and XRD data at the Natural History Museum (NHM), London. *In-situ* O isotope analyses of carbonates and silicates were carried out using a Cameca IMS1280-HR at the Institute of Earth Sciences, Heidelberg University.

Results and discussion: Fe-Ni metal beads, sulfides, olivine and pyroxene grains, as well as carbonates are major phases in Met-1. Several chondrule types (PO, BO, POP, RP), with fine-grained, Phyllosilicate-rich rims of typical thickness have been identified. Most chondrules contain high abundances of metal and sulfide grains, either inside and/or at their edges, and are texturally similar to typical 'armoured' chondrules in CR2 chondrites [1-3]. Some CAIs have remarkably high abundances of calcite (~53 vol%). They are typically composed of calcite and primary spinel and the O isotopic compositions of these carbonates are consistent with those of T1 calcites in other CM chondrites (precipitation temperature of 0-50°C, [4]). Calcite grains in the matrix of Met-1 show O isotope values consistent with T2 calcites, thus suggesting formation at higher temperatures (100-150°C), and indicating two-phase aqueous alteration.

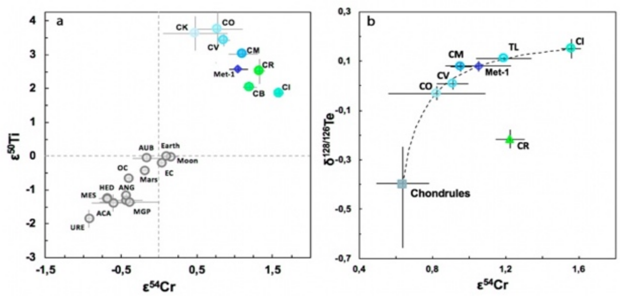

Fig. 1: (a) ε^{50}Ti vs. ε^{54}Cr, and (b) $\delta^{128/126}$Te vs. ε^{54}Cr space. Literature data from [6,8].

The bulk O isotope composition differs from that of CM chondrites [5]. Chromium and Te isotope compositions are indistinguishable from CM chondrites, whereas the Ti isotope composition agrees within error with literature data for CR chondrites [6,7] (Fig. 1). The mean diameter (~190 µm) and abundance of chondrules (~30 vol%) differs from typical CM and CR chondrites, and the presence of highly-altered material (e.g., TCIs and T2 calcites) associated with unaltered minerals (e.g., metals) makes its formation scenario more complicated. These mineral assemblages are out of equilibrium, indicating formation in two different reservoirs, separated by distance and/or time. The brecciated texture in Met-1 supports a brecciation and re-accretion model proposed by [6,7]. The 'matrix' component and the chondrules had already formed in the precursor CM-like parent body as indicated by Cr and Te isotope compositions, before being impacted by a metal-rich object that was characterized by lower abundances of CAIs (i.e., lower ^{50}Ti).

Conclusion: The Met-1 lithology is distinct from all other known individual carbonaceous chondrites providing previously-unknown material. The fresh fall of the Aguas Zarcas meteorite represents an exceptional opportunity to study valuable extraterrestrial materials uncontaminated by terrestrial processes.

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