THE UNIQUE CARBONACEOUS CHONDRITE ACFER 094: THE FIRST CM3 CHONDRITE (?) A. Bischoff and T. Geiger, Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany.

Acfer 094 is a small sample (82 grams) recovered from the Sahara and has recently been classified as a CO(CM)-chondrite [1,2]. Based on chemical and mineralogical investigations and isotope studies Acfer 094 can be characterized as follows: The sample has trace element characteristics of a CM2-meteorite [1,3], but the oxygen isotopes are very different to that of CM2-chondrites and are more closely related to the CO-samples [1]. Initial stable isotope studies indicate that Acfer 094 contains isotopically anomalous carbon and nitrogen [4]. Mineralogically, Acfer 094 is a breccia consisting of abundant chondrules (mean chondrule diameter: 165 µm), olivine aggregates, Ca,Al-rich inclusions, and fragments embedded in an extremely fine-grained, sulfide-rich groundmass [5,6]. Most chondrules contain Fa-poor olivine ($Fa_{<2}$), but olivines in the matrix exist having a broad peak at Fa_{37-50} (Fig. 1). These latter grains (usually <5 µm in size) appear somewhat clastic and are different in appearance to matrix olivines known for example from Allende. A significant abundance of phyllosilicates like in CM2 chondrites can be ruled out [5,6]. It is suggested that Acfer 094 is a CM3 chondrite.

Discussion

About 63 vol.% of Acfer 094 are fine-grained materials (<50 µm in size [6]). From CO3 chondrites it is known that the average matrix abundance is 33.7 vol.% [7]. The abundances of fine-grained components in CM2 chondrites is about 70 vol% [8,9]. Comparing the data of Acfer 094 with those of CO and CM chondrites it is obvious that Acfer 094 is more closely related to CM chondrites.

This is also the case by comparing the abundances of various chondrule types. Porphyritic chondrules (POP, PO, PP) together contribute about 90% of the chondrules; 2% of barred-olivine chondrules occur. The percentage of the nonporphyritic radial-pyroxene/cryptocrystalline (RP/C) chondrules (about 8%) is certainly higher in Acfer 094 than reported for CO-chondrites (2-3% [10,11]). The abundance of non-porphyritic chondrules is similar to that of CM-chondrites (3-8% [10]).

Based on defocussed-beam microprobe analyses of the bulk matrix of Acfer 094 we rule out the occurrence of significant portions of phyllosilicates, since high totals were obtained (typically 90 wt%), although the matrix shows some porosity. This clearly does not speak for a type 2 chondrite. Although the matrix is extremely fine-grained it is suggested that olivine and pyroxene (and not phyllosilicates) are the most abundant phases. Based on the fact that a broad peak between 37 and about 50 mol% Fa in the olivine distribution exists (please note that there is only one peak (at Fo-rich olivines) in the distribution of olivines from chondrules; Fig. 1) it is suggested that the matrix olivines belong to an own primitive matrix component, similarly to matrix olivines in CV and CO chondrites [5,12]. These results are clearly consistent with type 3 chondrites.

<u>Formation and evolution of the Acfer 094 parent body</u>

The Acfer 094 precursor material was formed in a reservoir of the solar nebula that was chemically similar to that, where the components of the CM2 chondrites derived from; however, the formation and evolution process of the parent body was different from that of the CM2 chondrites. Based on observations of Metzler et al. [9] major precursor materials of the CM2 chondrites were affected by aqueous alteration processes in the nebula or on relatively small and uncompacted pre-existing precursor planetesimals, that were destroyed and dispersed, prior to the accretion of dust mantles and CM2 parent body formation. In the case of the precursor components of the Acfer 094 parent body this aqueous alteration process did not take place to such an extent (if at all) as found in the CM2 chondrites. Based on the existence of probably anhydrous accretionary dust mantles around chondrules it is clear that no major aqueous processing occurred prior to accretion. Also, significant aqueous activity on a meteorite parent

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body can be ruled out. However, the parent body of Acfer 094 was affected by heavy impact activities. This is indicated by the brecciated nature of the chondrite, the abundant clastic matrix, the lack of fragments of primary accretionary rock [9], and the loss of accretionary dust mantles arround many coarse-grained components.

Acfer 094 has an oxygen isotope composition, which is similar to that of type 3 carbonaceous chondrites basically consisting of anhydrous minerals. The bulk rock lies somewhat below (probably due to some terrestrial weathering processes) the mixing line AM of Clayton and Mayeda [13] connecting a weighted mean of the oxygen isotopic composition of anhydrous silicates (A) and the matrix composition of Murchison (M). Clayton and Mayeda [13] assumed that the isotopic composition of CM2 chondrites could be established by reactions of anhydrous silicates with a liquid rich in ^{18}O and ^{17}O. In the case of Acfer 094 reactions of this kind (or with a gas) were not as significant as it was the case for the CM2 chondrites. Therefore, Acfer 094 might be a primitive CM chondrite, whose components escaped major hydrous processes in the solar nebula or on small preexisting parent planetesimals. Acfer 094 may be the first CM3 chondrite.

References:

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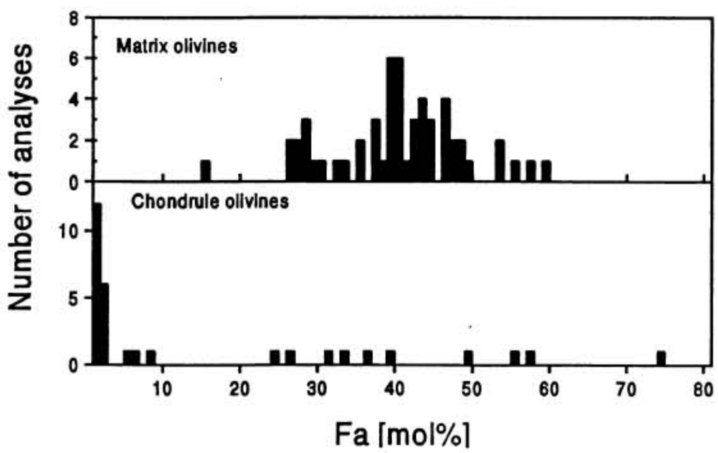

Fig. 1: The composition of olivines within chondrules and matrix of Acfer 094.