MINERALOGICAL STUDY OF A WHITE CLAST FROM MURCHISON (CM2): COMPARISON WITH R-CHONDRITES

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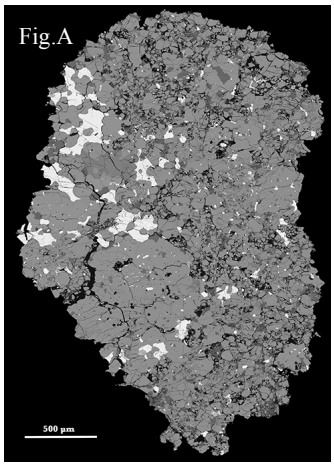
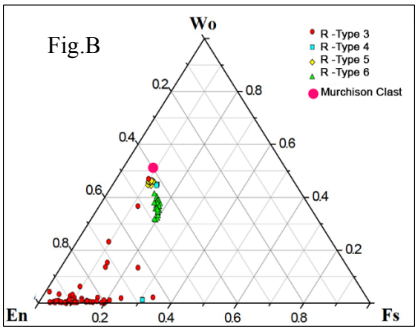
Introduction: R-chondrites share some properties with ordinary chondrites (OC) and carbonaceous chondrites (CC). The proportions of the textural types of chondrule from R chondrites and their FeO/(FeO+MgO) ratios are similar to those of OC, but the high matrix abundance in R chondrites more closely resembles that of CC (matrix abundances: OC ~12 vol% vs. CC 34–>60 vol%; [1-5]). In this study, we characteristize the mineralogy of a white clast from Murchison (CM2), which was earlier considered to be a R-chondrite [6]. First, all the petrographic and mineralogical characteristics will be described and compared with those of R-chondrites [7,8]. Finally, all data will be considered in order to test, whether this clast is a real R-chondrite or a unique recrystallized chondrite?

Analytical methods: A polished thick section of Murchison was used for this study. Backscattered electron (BSE) imaging was performed with scanning electron microscope. Mineral compositions were measured using a electron microprobe. The modal abundances of the clast, were determined on the thick section using the open source image processing program "ImageJ" [9]. Each component was precisely thresholded based on its grey value on BSE images and the corresponding area% measured. Bulk compositions were determined using modal recombination following the protocol of [10,11].



Petrography and mineralogy: The studied section with the white clast comprised two areas with a granular texture: (a) a coarse-grained (grain size: ~200 µm) and (b) a fine-grained area (grain-size: ~20 µm). Both areas show a well-recrystallized chondritic texture. The olivine and Ca-pyroxene grains are equilibrated in the whole clast, while the plagioclase and sulfides do show some variations within the two domains (Fig. A).

The dominant phase is olivine (~Fa_{38}; ~54 vol%). Ca-rich pyroxene (diopside, ~$Fs_{10}Wo_{50}$; 16 vol%), plagioclases (14 vol%), and sulfides (~13 vol%) are also abundant. The plagioclases are somewhat unequilibrated ~An_{32-45}. Some nepheline has been analyzed. As sulfides pyrrhotite (or troilite), monsulfide solid solution and pentlandite were found. In the coarse-grained areas mainly Fe-rich sulfides occur, while the dominant sulfides within the fine-grained areas are rich in Fe, Ni, and S. Cr-spinel (2 vol.%) are the only oxides and one grain of amphibole (Fe#=0.57) was detected. No metals are found.



Discussion and conclusions: Based on the mineralogy it is unlikely that the white clast is a R-chondritic fragment as suggested by [6], because:

(1) The clast contains olivine with low NiO (~0.1 wt%); this clearly is below the normal value for equilibrated R-chondrites (>0.3 wt%). (2) The fragment contains abundant diopside, unlike normal R chondrites (Fig. B). (3) Plagioclases are unequilibrated and often An>30, which is not consistent with typical plagioclase from R-chondrites [7]. (4) Oxygen isotope analyses clearly show that the clast is not related to R chondrites [12]. Additionally, the clast is of high petrologic type and appears relatively unshocked. Probably, it was thermally metamorphosed in a different environment prior to incorporation into the Murchison parent body. According to [6] it was – if at all – only slightly affected by alteration on the Murchison parent body.

References: [1] McSween H. Y. (1977a,b) *Geochim. Cosmochim. Acta* 41: 1777–1790 and 41:447–491. [2] Huss G. R. et al. (1981) *Geochim. Cosmochim. Acta* 45:33–51. [3] Rubin A. E. and Kallemeyn G. W. (1989) *Geochim. Cosmochim. Acta* 53:3035–3044. [4] Weisberg M. K. et al. (1993) *Geochim. Cosmochim. Acta* 57:1567–1586. [5] Wasson J. T. (2008) *Icarus* 195:895–907. [6] Isa J. et al. (2014) *Geochim. Cosmochim. Acta* 124:131-151. [7] Bischoff A. et al. (2011) *Chemie der Erde-Geochemistry* 71:101-133 [8] Schulze H. et al. (1994) *Meteoritics* 29:275-286. [9] Schneider C.A. et al. (2012) *Nat. Methods* 9:671–675. [10] Hezel, D.C. et al. (2010) *Comput. Geosci.* 36:1097–1099. [11] Berlin, J.,et al. (2008) 37th *Lunar Planet. Sci.* # 2370.. [12] Bischoff et al. (2018) *Meteoritics & Planet. Sci.* (this issue).