BRECCIA CLASSIFICATION OF CM CHONDRITES

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Introduction: In general CM chondrites are complex impact (mostly regolith) breccias, in which lithic clasts and mineral fragments show various degrees of aqueous alteration. These components are mixed together and consolidated in a fine-grained clastic matrix; however, the conditions of aqueous alteration - in particular the chronological relationship to brecciation - are still controversial (e.g., [1-8]). Different classification schemes have been proposed to quantify the degree of alteration (e.g., [7-8]). Unfortunately, brecciated CM-chondrites are forced into an alteration sequence unjustifiably treating and discussing the breccias like being homogeneous rocks (e.g., by using one alteration index for a complex breccia obtained by the compositions of PCP-intergrowths [8]).

Results: We noticed that the CM-breccia of Nogoya (Fig. 1c; also see [3]) was classified by Rubin et al. [8] as a CM2.2. In our thin section (39.6 mm^2) most fragments of the rock are significantly less altered. Using the procedure suggested by [8] about 50% of the clasts have an aqueous alteration index of 2.5-2.6 (FeO/SiO_2. = 2.26; S/SiO_2 = 0.21). We also classified one fragment as type 2.2 (FeO/SiO_2 = 1.53; S/SiO_2 = 0.14; Fig. 1c). Thus, the value given by [8] can clearly lead to misinterpretations. Therefore, we are suggesting a new classification scheme for CM chondrites which is consistent with the classification procedure for ordinary chondrite breccias. In this context, the Meteoritical Bulletin states for a typical H-chondrite breccia (e.g., Zag): The recommended classification H3-6 means: "An ordinary chondrite from the H group that is a breccia of components ranging from petrologic type 3 to type 6" [9]. Applying this approach to Nogoya we suggest a classification of Nogoya as CM2.2-2.6. In the same way we studied different clasts in Cold Bokkeveld (classified as a CM2.2 [8]) and Jbilet Winselwan (classified as a CM2.3 (with clasts ranging from type 2.0-2.3) by [10]). Cold Bokkeveld has clasts ranging from CM2.6 (FeO/SiO_2 = 2.46; S/SiO_2 = 0.35) to CM2.1 (FeO/SiO_2 = 1.18; S/SiO_2 = 0.12; Fig. 1b,d). CM2.6-clasts were also encountered in Jbilet Winselwan (FeO/SiO_2 = 2.56; S/SiO_2 = 0.35; [11]). Haack et al. [12] estimated high values for FeO/SiO_2 =2.9-4.6 and S/SiO_2 = 0.19-0.69 in the CM chondrite Maribo, although the typical brecciated CM-texture [2] is not observed within the studied thin section. In this respect Maribo appears to contain the most primitive components within CM chondrites.

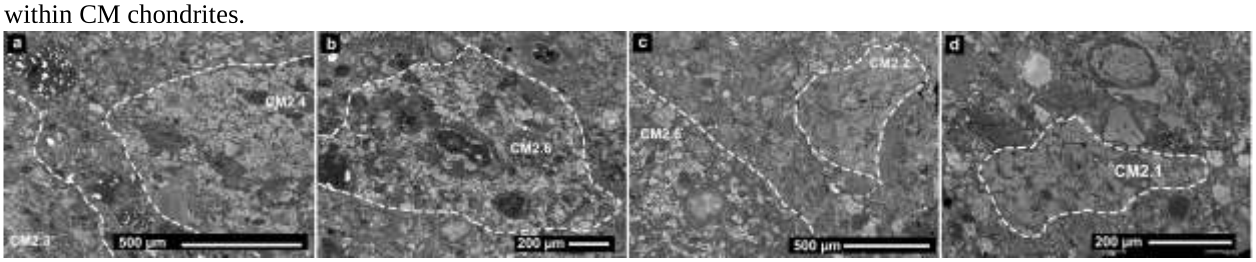

Fig. 1: Distinct clasts in Cold Bokkeveld and Nogoya. a) Two different altered clasts CM2.3 and CM2.4 from Cold Bokkeveld. b) CM2.6-clast from Cold Bokkeveld. c) Two clasts from Nogoya showing strong differences in alteration (CM2.2 and CM2.6). d) The strongest altered lithology from Cold Bokkeveld with an alteration index of 2.1. SEM-BSE images.

Discussion and Conclusions: Different classification schemes have been proposed and applied to CM chondrites to quantify the degree of alteration a rock has undergone and place the brecciated CM chondrites into an alteration sequence [7,8]. This inevitably leads only to an “average” degree of alteration for the respective meteorite and oversimplifies the context, as the rocks have experienced a much more complex history. Therefore, strict application of the proposed alteration indices to CM chondrites requires that different clasts with different degrees of aqueous alteration have to be treated separately. To force inhomogeneous breccias into such an alteration scheme makes no sense. We suggest to classify CM chondrites in the same way as ordinary chondrite breccias (e.g., as CM2.1-2.6 or CM2.3-2.8, etc.). As a result we are suggesting a CM2.2-2.6, CM2.1-2.6, and CM2.0-2.6 classification for Nogoya, Cold Bokkeveld, and Jbilet Winselwan, respectively.

References: [1] Fuchs L.H. et al. (1973) *Smiths. Contrib. Earth Sci*. 10:1-39. [2] Metzler K. et al. (1992) *Geochim. Cosmochim. Acta* 56:2873-2897. [3] Metzler K. (1995) *Lunar Planet Sci*. 26:961-962. [4] Bischoff A. (1998) *Meteoritics & Planet. Sci*. 33:1113-1122. [5] Bischoff A. and Schultz L. (2004) *Meteoritics & Planet. Sci*. 39:A15. [6] Metzler K. (2004) *Meteoritics & Planet. Sci*. 39:1307-1319. [7] Browning L. et al. (1996) *Geochim. Cosmochim. Acta* 60:2621-2633. [8] Rubin A.E. et al. (2007) *Geochim. Cosmochim. Acta* 71:2361-2382. [9] The Meteorite Bulletin; https://www.lpi.usra.edu/meteor/metbullclass.php?sea=H3-6. [10] Pernet-Fischer J.F. et al. (2014) *Lunar Planet Sci*. 45:#2386. [11] Friend P. et al. (2017) *Meteoritics & Planet. Sci*. (submitted). [12] Haack H. et al. (2012) *Meteoritics & Planet. Sci*. 47:30-50.

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