EVOLUTION OF CARBONATE MINERALOGY THROUGH THE CM2-CM1 SERIES

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Introduction: Carbonates are a volumetrically minor constituent of the CM carbonaceous chondrites, but their chemical and isotopic compositions and microstructures can provide crucial information about the environment of parent body aqueous alteration. Most CM2s contain only Ca-carbonates (calcite±aragonite) [1] but some of the more highly altered CM2s and the CM1s additionally have Mg- and Fe-rich carbonates (i.e. dolomite±breunnerite) [2]. This correspondence between the mineralogy of carbonates and the extent of aqueous alteration of their parent rock has been investigated here in order to ascertain what it may reveal about alteration conditions through the CM series.

Methods: Carbonates in thin sections of twelve CMs were located and characterised using a Zeiss Sigma SEM, then quantitatively chemically analysed with a Cameca SX100 electron probe. The following meteorites were studied (in order of increasing degree of alteration): Murchison, Murray, Pollen, Mighei, EET 96029, LON 94101, Nogoya, Cold Bokkeveld, QUE 93005, LAP 031166, SCO 06043 and ALH 84045.

Results: Those CM2s that have been less altered overall contain aragonite and one or two generations of calcite. In Murchison the aragonite crystallized first and was overgrown by calcite. Different generations of calcite can be distinguished petrographically, and the later generation may fill fractures [3] or replace olivine or pyroxene. Calcite in many of the CM2s has itself been replaced by Mg-serpentine [4], and this reaction has almost gone to completion in LAP 031166 (CM2-1). In Pollen the replacement took place between crystallization of the two calcite generations. QUE 93005 is a highly altered CM2 and contains the widest range of carbonate minerals yet recorded, namely breunnerite, Ca-poor and Ca-rich dolomite, and calcite, and both the dolomite and calcite can form veins. Carbonate mineralogy and abundance differ within the CM1s [2], but several of them contain veins of dolomite, which in SCO 06043 cross-cut the compacted meteorite matrix [5]. Dolomite in both QUE 93005 and SCO 06043 has been partially replaced by calcite [5].

Discussion: Almost all of the CM2s contain multiple generations of carbonates, and recent work has shown that successive phases of calcite in the CM2s also have distinct O isotope compositions [6]. The earlier carbonates have formed by cementation of primary pore spaces whereas later generations typically fill fractures or have replaced earlier carbonates or olivine/pyroxene. Taken together, this evidence indicates that most of the sampled parent body regions experienced multiple phases of carbonate mineralization, with intervening compaction and/or phyllosilicate crystallization. The challenge is to reconcile this evidence for a dynamic aqueous system with models for static solutions.

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