MG-PHYLLOSILICATE PSEUDOMORPHS AFTER CALCITE IN THE POLLEN (CM2) CARBONACEOUS CHONDRITE: NEW INSIGHTS INTO AQUEOUS ALTERATION

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Introduction: CM2 carbonaceous chondrites contain carbonates as rare and small crystals. These are mainly calcite, but include aragonite and dolomite. Carbonate minerals were formed during low temperature (~20-70°C) aqueous alteration in the parent body or bodies of CM chondrites (e.g. [1-4]). Some aspects of carbonates such as their formational conditions, timing of precipitation relative to each other (were the carbonates precipitated all at once, or were there several generations?), and relative to alteration of the matrix remain poorly understood. This information can provide new insights into the mechanisms of carbonate growth and alteration process that took place within CM parent body(ies). Here we describe evidence for multiple generations of carbonate crystallization in Pollen (CM2 chondrite) and show that one generation has been pseudomorphed by phyllosilicates.

Methods: Carbonates within fine grained matrix were located in a polished thin section of Pollen (CM2) using calcium X-ray maps combined with backscattered electron (BSE) images. These grains were studied by SEM electron backscatter diffraction (EBSD), for accurate determination of crystallographic orientations, SEM cathodoluminescence (CL) imaging and spectroscopy to identify zoning, and laser Raman spectroscopy for mineral identification. Electron probe microanalysis (EPMA) was also used for quantitative chemical analysis of Ca-carbonates, Mg-phyllosilicate pseudomorphs and the matrix.

Results and discussion: Pollen contains 2.02 volume % aragonite and calcite, mainly as isolated single grains, but in rare cases also as aggregates. We can identify one generation of aragonite and three generations of calcite from their petrographic relationships with each other and with matrix phyllosilicates. The first calcite generation forms zoned crystals that are rimmed by serpentine-tochilinite and contain iron sulphide inclusions. This generation was then partially replaced by Mg-rich phyllosilicates to leave serpentine-tochilinite rimmed pseudomorphs, which comprise 3.15 vol% of the meteorite. A later generation of calcite then replaced chondrule and matrix olivines/pyroxenes and these grains are free of serpentine-tochilinite rims. Aragonite is inferred to mark the end of carbonate crystallization and possibly formed synchronously with the third calcite generation.

Ca-carbonates in Pollen record a complex history of crystallization. The formation of Mg-phyllosilicate pseudomorphs by replacement of rimmed calcite grains shows that carbonate crystallization was discontinuous, but synchronous or overlapping with matrix phyllosilicate formation. Our observations of other CM2 carbonaceous chondrites suggest that complex histories of carbonate and phyllosilicate crystallization, dissolution and replacement are the norm and require further detailed study.

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