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UNRAVELLING HISTORIES OF MINERALIZATION DURING PARENT BODY AQUEOUS ALTERATION USING BREUNNERITE-CALCITE-DOLOMITE GRAINS IN QUE 93005

M. R. Lee, M. R. Sofe[1], and P. Lindgren[1] [1]Department of Geographical and Earth Sciences, University of Glasgow, Glasgow G128QQ, UK. E-mail: Martin.Lee@ges.gla.ac.uk

Introduction: CM carbonaceous chondrites contain the carbonate minerals aragonite, calcite and dolomite, which together provide very important information on the chronology of aqueous alteration, evolution of fluid compositions and late-stage compaction [1-3]. We have sought to understand better the physical properties of mineralizing fluids (i.e. static fluid films *vs* fracture-mediated fluid flow) and the sequence of mineralization by characterizing QUE 93005 using SEM imaging, X-ray microanalysis and Raman spectroscopy. This highly aqueously altered Antarctic find was chosen because previous work has shown that it contains calcite-dolomite intergrowths [1,4].

Results: Most of the QUE 93005 carbonates form roughly equant grains upto 0.3 mm in diameter scattered through the meteorite matrix. Some are solely calcite, others dolomite with/without calcite, but there is an additional group that comprises fine-scale intergrowths of euhedral breunnerite (i.e. Fe-rich magnesite), zoned dolomite and calcite. Breunnerite occurs at the grain edges, is overgrown by dolomite with calcite in grain centres. The sequence of crystallization is difficult to determine, especially given the propensity of dolomite to replace earlier formed carbonates, but breunnerite may have formed first, followed by dolomite with calcite last. In addition to the isolated matrix grains, Ca-carbonate, dolomite and pentlandite also occur as networks of sub-μm wide by few tens of μm long veins within the fine-grained rims around chondrules (themselves replaced by phyllosilicates). These veins are oriented approximately normal to the chondrule-rim interface, and have tapered terminations.

Discussion: To the author's knowledge breunnerite has not been previously described from a CM meteorite, although is known from CIs. Its presence together with dolomite in QUE 93005 is consistent with the pattern of increasing carbonate Mg, Mn and Fe concentrations with greater degrees of aqueous alteration of their host meteorites [4]. The inferred crystallization sequence of the QUE 93005 polymineralic grains indicates decreasing fluid Mg/Ca and Fe/Ca over time, and so contradicts the sequence expected if compositional variations between meteorites are a proxy for the temporal evolution of carbonates in any one sample. The veins within the QUE 93005 fine-grained rims are inferred to be pre-terrestrial, although an origin by Antarctic weathering cannot be discounted. If pre-terrestrial, these veins show that carbonate crystallization postdated fracturing of the fine-grained rims. The lack of any preferred orientation to the veins may indicate that fracturing was due to chondrule hydration and expansion rather than lithostatic or impact-related compaction.

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