CARBONATES REPLACING PLAGIOCLASE GLASS IN THE MARTIAN METEORITE ALH84001

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Introduction: The pyroxene dominated matrix of the ALH84001 meteorite contains both plagioclase glass and various carbonates [1]. The carbonates can be divided into three types: Mg-Fe-Ca zoned discs, carbonate globules within plagioclase glass and irregular carbonates in crush zones [2]. Here we have sought to understand better the mode of carbonate formation, specifically: (i) whether some or all of the carbonates could have formed by replacement of feldspathic glass and orthopyroxene [3, 4]; such an origin would be consistent with advances in understanding the formation of porous alteration products [5], (ii) the carbonates are cements that have occluded in fracture or dissolution pores [6] or (iii) the carbonates have solidified from a shock melt [2]. These distinctions are important because they determine whether such carbonates are compatible with forming at low temperatures in the martian crust [6], therefore potentially containing biosignatures within the carbonate globules [7]; or if the glass and carbonate formation is more indicative of high temperature and pressure impact shock melting ~4Ga ago [2], which would preclude a biosignature. In addition, our study will help to answer long-standing questions over the origin of the magnetite in the carbonate [8].

Methods and results: Our work has used thin section ALH84001, 173. SEM X-ray element maps of the sample were used to locate areas of carbonates that were spatially associated with plagioclase glass. With a FEI DuoMill focused ion beam (FIB) instrument, electron-transparent foils were cut across the plagioclase glass-carbonate interface for imaging and electron diffraction work using a FEI T20 TEM. SEM imaging and elemental mapping has revealed carbonates in a variety of contexts from fractures to distinct clusters of carbonate-glass patches. These carbonate-glass patches, which are 0.1-0.2mm across, have carbonates inter-grown with plagioclase on a very fine scale. Each patch is composed of interconnected groups of zoned carbonate grains. These carbonates are intimately intergrown with the plagioclase in a manner that would be consistent with the carbonates replacing the glass, but other possibilities, such as shock melting, cannot be ruled out at this stage. Examination of the FIB-produced foils will focus on nanoscale petrographic relationships at the carbonate-glass and carbonate-pyroxene contacts.

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