

CARBONATES REPLACING PLAGIOCLASE GLASS IN THE MARTIAN METEORITE ALH84001

A. Macartney¹, T. Tomkinson¹, E. R. D. Scott², M. R. Lee¹,
¹School of Geographical and Earth Sciences, University of Glasgow, UK. E-mail: a.macartney.1@research.gla.ac.uk ²Hawai'i Institute of Geophysics and Planetology, USA.

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.

References: [1] Score R. and Mittlefehldt D.W. 1993. Antarctic Meteorite Newsletter 16 (3). [2] Scott, E. R. D. *et al.* 1997. *Nature*, 387: 377–379 [3] Treiman, A. 1995. *Meteoritics*, 30:294–302. [4] Gleason, J. *et al.* 1997. *Geochimica et Cosmochimica Acta* 61:3503–3512. [5] Putnis, A. 2002. *Mineralogical Magazine*, 66:689–708. [6] Halevy, I. *et al.* 2011. *PNAS*, 108: 16895–16899 [7] McKay, D. and Gibson Jr. E. 1996. *Science* 273:924. [8] Treiman, A. and Essene, E. 2011. *Geochimica et Cosmochimica Acta* 75: 5324–5335.

Acknowledgements: We thank Dr Kevin Righter and NASA-JSC for loan of ALH84001, 173.