CRYSTALLOGRAPHY AND ORIGINS OF ETCH PITS IN NAKHLA OLIVINE

T.Tomkinson[1], M.R. Lee[2], D.F Mark[1], F.Stuart[1]. P.Lindgren[2] [1]SUERC, East Kilbride, Glasgow, U.K. [2]GES, Glasgow University, U.K. (tim.tomkinson@glasgow.ac.uk).

Introduction: Etch pitted olivine grains have been observed within the nakhlite meteorite MIL 03346 [1] but have rarely been described from Nakhla [2]. Velbel et al. in 2010 [1] concluded that the pits in MIL 03346 olivine were a result of terrestrial weathering in Antarctica as they occur only within the outermost few hundred microns of the meteorite. However, the pitted olivines that we have found in Nakhla are on freshly exposed pieces of the meteorite that were taken from the interior of this fall (~5 cm into the sample). As these etch pits occur only on some olivines and the majority are filled with alteration products of martian origin, they must have formed on Mars.

Results: The Nakhla etch pits range from diamond to wedge to circular in shape, reflecting the crystallographic orientation of the grain surface on which they have formed. The largest of the two pitted regions found has an array of 80 by 100 round pits with a preferred orientation. The smaller region is a mix of small arrays and single lines of diamond shaped pits. The largest pit observed is ~30 µm and the smallest is sub-micron in diameter. Some of the pits are empty or filled with a hydrous Fe-silicate that has been interpreted by [3] to be a gel, while others contain a Cr-rich material that was exposed during sample preparation. If this Cr enriched material occurs beneath the amorphous gel it is likely to predate the gel formation.

Implications: These etch pits can be used to obtain information on the duration of exposure to aqueous solutions. For these calculations pit volumes are required, and they will be obtained by imaging their profiles using SEM and making digital elevation models of the largest pits (~30 um diameter) using Alicona MEX software, and by excavating cross-sections through them using the focused ion beam (FIB) technique. These data will yield the minimum duration of exposure to the etching fluid [4]. As the pits are observed in only two of the 14 olivine grains so far examined, we will investigate the crystal orientation of the etched olivine grains in order to assess whether there is a preferred etching orientation. Alternatively the etching could predate the main phase of aqueous activity when the fluid was exposed to a limited surface area of the sample when it was less densely fractured.

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References: [1] Velbel M. A, et al. (2010) *LPSC*, Abs#2223. [2] Velbel, M. A. (2010) *AGU Fall meeting*. Abs #P52B-07. [3] Changela, H.G. and Bridges J.C. (2011) *MAPS*, 45, 1847-1867. [4] Olsen A.A., (2007) *American Mineralogist*, 92, 598-602.