NAKHLITE EMPLACEMENT MECHANISMS FROM ELECTON BACKSCATTER DIFFRACTION

S. Griffin[1], T. Keller[1], L. Daly[1,2,3,4], M. R. Lee[1], B. E. Cohen[5], L.V. Forman[2], S. Piazolo[6], P.W. Trimby[7], R. Baumgartner[8], and G. K. Benedix[2,9,10]. [1]School of Geographical and Earth Sciences, University of Glasgow, UK, (Sammy.Griffin@glasgow.ac.uk). [2]Space Science and Technology Centre, School of Earth and Planetary Sciences, Curtin University, Australia. [3]Australian Centre for Microscopy and Microanalysis, The University of Sydney, Australia. [4]Department of Materials, University of Oxford, UK. [5]School of Geoscicences, University of Edinburgh, UK. [6]School of Earth and Environment, University of Leeds, UK. [7]Oxford Instruments Nanoanalysis, High Wycombe, UK. [8]Australian Centre for Astrobiology, University of New South Wales, Australia. [9]Department of Earth and Planetary Sciences, Western Australia Museum, Australia. [10]Planetary Institute, USA.

Introduction: The nakhlites are currently the largest group of meteorites ejected from Mars in a single eventl [1]. Consisting of 23 individual stones that are geochemically evolved from the same parental melt source [2], the nakhlites represent several distinct magmatic events from a singular volcanic edifice spanning at least 1300 ± 7 Ma - 1400 ± 10 Ma [1-3]. Thus, the nakhlites can provide insight into the variability of a Martian volcanoe's magmatic activity through time. Here we use electron backscatter diffraction (EBSD) data to assess the presence of textures and inform emplacement model parameters (grainsize, crystal:melt ratios *etc.*). For our models we calculated rudimentary thicknesses for three different emplacement mechanisms in order to constrain and better define the samples source environment, and provide indicators for future modelling work.

Methods: We studied 21 sections, encompassing 16 of the 23 known nakhlite stones. These samples were mechanically and chemically polished using standard EBSD preparation methods then carbon coated for analysis [4]. EBSD and electron dispersive X-ray spectroscopy (EDS) data were collected using four different instruments at the ISAAC imaging centre, University of Glasgow, Geochemical Analysis Unit (GAU), Macquarie University, Oxford Instruments Nanoanalysis HQ, High Wycombe, and at the John de Laeter Centre, Curtin University. EBSD data were processed to assess augite crystal preferred oriention (CPO) and shape preferred orientation (SPO) using the Matlab toolbox MTEX. The same data was then used to inform grain parameters in our rudimentary emplacement models. Potential thicknesses for each section were calculated based on pure kinetic diffusion, crystal settling, and crystal convection emplacement and cooling.

Results: All 21 sections exhibited an augite <c> axis girdle CPO with similar J-index strengths as observed in terrestrial igneous rocks with moderate strength fabrics despite not all analysed sections exhibiting an identifiableSPO (Fig. 1). Modelling results for Kinetic diffusion produces unit thicknesses (flow/sill) on the order to 10's of metres, while crystal settling calculations yield a range of unit thickness spanning from ≤1 m (Yamato nakhlites) to several tens of meters (Miller Range nakhlites), while crystal convection produces unit thicknesses on the nanometre scale.

Implications and conclusions: Textural observations within samples can expand our knowledge about individual flows from a singular volcano. Modelling results based of nakhlite textural observations support conclusions age and chemical data for multiple flows. From our initial modelling results we can say that crystal convection is not a plausible mechanism, crystal settling is the mechanism that best agrees with our EBSD textural data, producing the most diverse range of unit thicknesses (≤1 m to 10's of m) however, a component of kinetic diffusion cannot be completely discounted within the nakhlites. Augite CPO results support a crystal settling driven emplacement environment, comparable to moderate strength textured igneous rocks of a similar mineralogical composition.

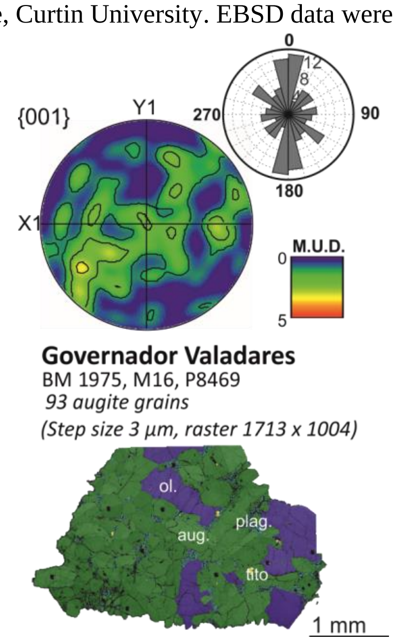

Figure 1: Lower hemisphere, equal area CPO, inferred SPO and phase map (augite = green, olivine = blue, plagioclase = aqua, Titanomaghemite = yellow) of one of the 21 sections analysed in this study.

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