ELECTRON BACKSCATTER DIFFRACTION AND FORESCATTER ELECTRON IMAGE ANALYSES OF THE GOVERNADOR VALADARES NAKHLITE.

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Introduction: Recent advancement of scanning electron microscopy (SEM) has enabled us micro-area crystallographic analysis on thin sections. These newly emerged techniques include electron backscatter diffraction (EBSD) [e.g., 1] and forescatter electron (FSE) image [e.g., 2] analyses equipped with SEM. These techniques are much less burdensome compared to the conventional crystallographic analytical techniques such as single crystal X-ray diffraction or transmission electron microscopy (TEM) and have a great potential to be applied for meteorite study. Here we report crystallographic analyses of symplectites in olivine and pyroxene twinning from the Governador Valadares (GV) Brazilian nakhlite by EBSD and FSE image analyses combined with field emission gun SEM (FEG-SEM).

Result and Discussion: Olivine grains in GV often contain symplectites composed of augite and magnetite. Such symplectites are common in all nakhlites except for Lafayette and interpreted as exsolution products at high oxygen fugacity [3]. Symplectites in GV olivine are present as either lamellar (several tens of μm long and a few μm wide) or patches (a few tens of μm). We previously determined orientational relationships of the host olivine and exsolved symplectites in Nakhla olivine by TEM [3] and found that they are identical to the symplectites in terrestrial olivines [4]. In this study we obtained EBSD patterns of the host olivine and exsolved magnetite and augite in GV olivine. The obtained magnetite EBSD patterns from several different patches are identical in a single olivine grain, and [001] and [010] of olivine are parallel to <110> and <112> of magnetite, respectively. These relationships are identical to [3, 4]. However, the EBSD patterns of exsolved augite show a few different patterns and we could not find any clear orientational relationship between augite and olivine/magnetite, but one of them shows that $[100]_{augite}$ is parallel to $[001]_{olivine}$ and $<110>_{magnetite}$. We also studied cumulus augite in GV by the FSE imaging system. Optical microscopy of the GV augite shows broad twin bands on (100) and some twin bands are then polysynthetically twinned on (001) with spacing of a few to tens of μm possibly caused by moderate shock. Because FSE images provide contrast for different orientations in a homogeneous phase [2], we could observe clear contrast in the FSE images of augite twins due to different orientations. We then analyzed these different orientational areas by EBSD and confirmed that the broad (100) twin and polysynthetic (001) twin share *b* and *c* axes and *a* and *b* axes in common, respectively.

Conclusion: EBSD and FSE detectors equipped with FEG-SEM enable us micro-area (~0.5 μm) crystallography of thin sections without difficulty in sample preparation. We believe that these techniques are useful for meteorite studies such as identification of micron-size minerals and characterization of microstructure as also noted by [5].

References: [1] Kogure T. 2002. *American Mineralogist* 87:1678-1685. [2] Prior D. J. et al. 1996. *Mineralogical Magazine* 60:859-869. [3] Mikouchi T. et al. 2000. *Meteoritcs & Planetary Science* 35:937-942. [4] Moseley D. 1984. *American Mineralogist* 69:139-153. [5] Bland P. A. et al. 2003. *Meteoritcs & Planetary Science* 38:A100.