PREFERRED MINERAL ORIENTATIONS IN MARTIAN SHERGOTTITES: MAGMATISM OR SHOCK?

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Introduction: The shergottites, nakhlites and chassignites (SNC-meteorites) are igneous rock believed to originate from Mars [e.g. 1]. Petrological characteristics of these meteorites allow to decipher magmatic processes that have occurred on Mars. Sub-groups such as lherzolitic shergottites are infered to represent olivine and pyroxene cumulates possibly formed at depth, while picritic and basaltic shergottites are interpreted as surface (or subsurface) magmatic products. Nakhla and Zagami are both clinopyroxene-rich basaltic shergottite, with some Fe-rich olivine. We have studied the micro-textures and the preferred orientation of pyroxene in subsamples of both Zagami and Nakhla using Electron Backscatter Diffraction (EBSD) method.

Results and discussion: Nakhla displays a granular texture, with grain size of 0.2-0.5 mm, essentially composed of augite, fayalite, plagioclase and magnetite. Clinopyroxenes (augite and pigeonite) exhibits twinning and thin exsolution lamellaes. Our Zagami sample is part of the "coarse grained" portion of Normal Zagami texture [2, 3]. The grain size is from 0.5 mm with long prism of clinopyroxene (up to 2.5 mm) underlying a weak preferrential orientation. Our results indicate that most grains are indexed as augite with some large grains rimed by pigeonite. Zagami also contains olivine, plagioclase, and whitlockite.

Clinopyroxene, in both samples, shows a weak crystal-preferred orientation (CPO) with a preferred orientation of (100) marked by a point concentration. Nakhla CPOs show two maximum of concentrations on (001) axes perpendicular to (100). High resolution maps (2-10µm steps) on single grains of clinopyroxenes were performed to characterise intra-crystalline deformation. The studied grains display several sets of weak subgrain boundaries. The maximum misorientation within the analysed grains is up to 27˚, and the misorientation axes in most of the grains lie parallel to the <010> direction.

The two point concentrations of (001) axes in Nakhla sample and the several orientations of subgrain boundaries suggests the possible activation of several glide systems. Data show that the classical slip system observed within the grains is (100)[001], with a possible activation of (010)[100] slip system in Zagami sample. From the augite cores to the pigeonite rims, there is no variation in the slip system, suggesting either no variation of deformation during the evolution of the geochemical system, or a late deformation event. Nakhla has been only middly shocked with an estimated peak pressure of about 20 GPa [4], suggesting that the deformation observed should pre-date shock event. Zagami exhibits more shock related microtextures (formation of melt pockets, plagioclase converted to maskelynite, [5, 6]). Consequently, the various systems observed could be related to both magmatic deformation and shock event.

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