MELT INCLUSIONS IN AUGITE FROM NAKHLITES: A KEY FOR THE COMPREHENSION OF MARTIAN MAGMATISM

M. Macrì[1,2], V. Sautter[1], N. Guilhaumou[1], A. Maras[2], J.P. Lorand[1]. [1]Minéralogie MNHN CNRS FRE 2456, 61 rue Buffon 75005 Paris, France, [2]DST-Università di Roma "La Sapienza", P. Aldo Moro, 5 -00185 Rome, Italy

The SNC groups of meteorites are believed to have originated from Mars 1 , but only the nakhlites are supposed to come from the same cooling magmatic pile. They are clinopyroxenites consisting of augite and olivine grains set in a feldspar-rich mesostasis; chemical and petrological differences among them evidence different positions in a cooling sequence 2 . To understand the thermodynamic and chemical evolution of this Martian magma, we studied melt inclusions in NWA817 and NWA998 (respectively the top and the bottom of the pile); Nakhla and Governador Valadares (in intermediate position). As the origin of olivine in nakhlites is still a matter of debate (phenocrysts vs. xenocrysts), we focused our studies on melt inclusions in augite.

Melt inclusions have been selected by optical microscopy, SEM and FIB, and analysed by EMP and TEM techniques. Heating experiments and laser ablation ICP-MS analyses are in progress. For the first time, we characterize three different generations of melt inclusions in augite of Nakhla and Governador Valadares: *Type I* (10-70 m diameter), are isolated. These are multiphase inclusions composed of silica-rich glass, Ti-magnetite, low Ca-pyroxene and a single gas-bubble 3 . Silica-rich glass is partially devitrified. Type I melt inclusions are not surrounded by fractures that are indicative of partial lost of fluids. *Type II* inclusions (10-50 m diameter), look like type I but form clusters and are surrounded by inclusions of smaller size (type III). Tiny fractures are observed around the inclusions. *Type III* (less than 10 m diameter), are the last generation of inclusions; they are widespread and form trails. These inclusions are probably related to late liquids percolating near the Martian surface and responsible for hydrous alteration phases present in nakhlites.

Melt inclusions in NWA817 are type I multiphase inclusions. They are composed by a recrystallized silica-rich phase together with sub-Ca augite, ferrosilite and chlorapatite. Most of them are surrounded by tiny fractures. Trails and flags of type III melt inclusions are also present. Type I melt inclusions in NWA998 are constituted by a silica-rich phase partially re-crystallized, low Ca-pyroxene, Ti-magnetite and dark globular inclusions, and are surrounded by tiny fractures. Trails and "hieroglyphic" group of type III inclusions are also observed.

Conclusions: melt inclusions provide a unique method to understand magmatic processes in Martian cumulate rocks. A detailed description and chemical analyses on generations of melt inclusions trapped in augite allow to formulate hypothesis about the composition of the nakhlites parent magma and its late evolution in the cooling sequence. Differences between melt inclusions in olivine and augite crystals favoured a xenocrystic origin for olivine.

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