FLUID INCLUSIONS IN LAFAYETTE: A RECORD OF ANCIENT MARTIAN HYDROLOGY.

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Introduction: The nakhlites exhibit the best record of martian aqueous alteration present in any of the martian meteorite groups[1-4]. Lafayette contains the widest and most numerous olivine-bound alteration veins of all the known nakhlites. Vein filling minerals include phyllosilicates, Fe-oxides and hydroxides and carbonates[2,5]. There are also areas of non-olivine-bound alteration in Lafayette, mostly within the mesostasis. Okazaki et al. (2003)[6], among others, reported the crystallization ages of the nakhlites as 1.3 Ga. Therefore, the nakhlite alteration minerals must have formed after this time, during the latest and driest period in Mars' history (the Amazonian). Establishing the mechanism of fluid production is key to understanding the localized environment at the nakhlite site during this time.

Results: Optical microscope observations of Lafayette thin-section T505-5 revealed the presence of numerous fluid inclusions in both olivine and augite crystals. These inclusions appear to belong to two separate populations. The first population occurs solely in large (< 1mm) augite crystals. These inclusions are associated with chromite grains and are irregularly shaped, the largest being 15 µm across. The second population of fluid inclusions in Lafayette occur in tracks and planes up to 50 µm long within both augite and olivine grains. The tracks consist of typically tens of inclusions, which are smaller (<8µm diameter) and more rounded than the first population of inclusions, and are not associated with chromite. The tracks project in all directions throughout the augite and olivine grains. One plane within augite consists of < 50 inclusions, with the largest inclusions towards one side of the plane. Gas bubbles were not observed in any of the inclusions, despite the fact that Confocal Raman microscope analyses revealed the presence of water in both populations (indicating the inclusions have not been ruptured). No carbon signature was found in either population.

Discussion: The association of the first population of fluid inclusions with chromite mineral inclusions in augite could suggest primary emplacement during augite formation. However, the absence of gas bubbles in both fluid inclusion populations suggests low temperature emplacement (<<100 °C), indicative of secondary aqueous alteration. In addition, the absence of carbon peaks in the Raman spectra suggest these inclusions are of a different type to the primary carbon-rich globules reported in numerous martian meteorites[7]. The second fluid inclusion population lay along tracks and planes, which appear to be healed fractures. These fractures may have been produced by a shock event.

References: [**1**] Gooding et al., 1991. *Meteoritics* 26:135-143. [**2**] Treiman et al., 1993. *Meteoritics* 28:86-97. [**3**] Bridges and Grady, 2000. Earth and Planetary Science Letters 176:267-279. [**4**] Treiman, 2005. *Chemie der Erde* 65: 203–270. [**5**] Changela and Bridges, 2011. *Meteoritics and Planetary Science* 45:1847–1867. [**6**] Okazaki et al. 2003. *Antarctic Meteorite Research* 16:58-79. [**7**] Steele et al., 2012. *Science* 337:212.