COMPARISON OF SYNTHETIC AND NATURAL NAKHLITE PYROXENES: COMPLEXITY OF MINOR ELEMENTS.

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Introduction: Zoning in pyroxenes in martian meteorites contains a rich record of the petrogenesis of these samples. In the clinopyroxene cumulate nakhlite group, major element zoning is generally limited to the outer rims of the pyroxenes. However, minor element zoning, especially of Al, Ti, and Cr, is extensive, complex, and difficult to interpret [e.g., 1-3]. To help mine the rich information about petrogenetic processes from these samples, we have been comparing minor element zoning in synthetic pyroxenes grown under known conditions with zoning observed in natural nakhlite pyroxenes. We have focused on two nakhlites, MIL03346 (MIL), which is one of the most rapidly cooled nakhlites, and Y000593 (Y593), which cooled at a more moderate rate [e.g., 4].

Experiments and Analyses: The synthetic samples were partially crystallized at oxygen fugacities of IW, IW+1.5, and IW+3.5 (QFM). EPMA analyses were performed on MIL, Y593 and the three synthetic samples using a single standardization. Standards were repeatedly analyzed during the analytical run. Individual elements were counted for sufficient time to yield 1-sigma counting statistics of better than ±0.16 wt% for Si and Ca, 0.10% for Fe, .06 for Mg, and .02 for all other elements. All samples were carbon-coated at the same time. These procedures result in minimum bias between samples so that all can be directly compared.

Results: MIL and Y593 have very different zoning patterns. MIL has limited Al zoning, but Cr varies by ~2x. Y593 has limited Cr zoning, but Al varies by ~2x. MIL pyroxenes consist of a Cr-depleted central region surrounded by an outer region with Cr content similar to the bulk of Y593 crystals. Al-rich zones in Y593 pyroxenes have slightly less Al than bulk MIL pyroxenes. Pyroxenes from both samples have significant and similar octahedrally coordinated Al, as calculated from stoichiometry [5].

Synthetic pyroxenes all have significant sector zoning in Al, Ti, and Cr. Al-rich and Al-poor sectors of the QFM sample have Al contents similar to the Al-rich and Al-poor portions of Y593. The Al-poor sectors of the IW sample have slightly more Al than the Al-poor portions of Y593. The IW sample has virtually no octahedrally coordinated Al. The QFM sample has some, but much less than the natural pyroxenes. QFM shows a much smaller range in Ti than both IW and natural pyroxenes, but a larger range in Cr.

Conclusions: The crystallization conditions and/or melt compositions used in our crystallization experiments do not accurately reflect the crystallization of Nakhlite pyroxenes, especially in terms of minor element zoning patterns. The much higher octahedrally coordinated Al in the natural pyroxenes suggests crystallization from a more Al-rich, Si-poor melt and/or crystallization at higher pressure.

[1] McKay & Mikouchi (2005) MAPS 40, A5335. [2] McKay *et al.* (2006) Antarctic Meteorites 30, 61. [3] McKay *et al.* (2007) LPSC 38, 1721. [4] Mikouchi *et al.* (2006) LPSC 37, #1865. [5] Cameron & Papike (1981) Am. Min 66, 1.