AN EXAMINATION OF THE NEW MILLER RANGE NAKHLITES (MIL 090030, 090032, AND 090136).
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Introduction: During the 2003-2004 field season to the Miller Range (MIL), the Antarctic Search for Meteorites (ANSMET) team recovered MIL 03346, deemed to be Martian in origin [1]. This stone, a member of the nakhlite group, is a cumulate clinopyroxenite with rare olivine set in a fine-grained, intercumulate mesostasis, and has experienced both terrestrial and pre-terrestrial alteration [1-13]. The 2009-2010 ANSMET team returned to the Miller Range and collected three additional meteorites; namely, MIL 090030, MIL 090032, and MIL 090136. These three specimens have been classified as nakhlites as they share petrographic features, they have been tentatively paired with MIL 03346 [9]. Our study explores the relationship between these four meteorites in order to solidify the pairing group by evaluating the mineral chemistry and quantitative microstructure of the cumulate phases, in addition to detailed chemical imaging of the mesostasis.

MIL 03346: A number of features make MIL 03346 unusual among the nakhlite group. While likely derived from the same magmatic complex as the earlier described nakhlites, this specimen appears to have experienced more rapid cooling [6], as evidenced by preserved olivine zonation. In MIL 03346, the mesostasis is made up of intergrown dendrites of Ti-magnetite, fayalitic olivine, ferro-hedenbergite, apatite, silica glass (cristobalite), feldspathic glass, and sulfide blebs (pyrrhotite) [6, 10].

New MIL '09 Martian Meteorites: Using an FEI NanoSEM600 and an FEI Quanta 200F at the Smithsonian Institution and NIST respectively, we have examined the Smithsonian library sections of the newest nakhlites (MIL 090030,4, 090032,4, and 090136,4) in detail. A first order description of the mineralogical characteristics of the new specimens include unequilibrated Ca-pyroxenes with normally zoned Fe-rich rims, and diffusively zoned olivines. The mesostasis in these meteorites appears to share the same phase assemblage that is found in MIL 03346, containing Ti-magnetite, fayalitic olivine, ferro-hedenbergite, apatite, silica glass , feldspathic glass, and sulfide blebs.

Quantifying Mineral Abundances: In order to rigorously evaluate the modes for accumulated phases for both the new meteorites and MIL 03346, we have developed a new quantitative method for rapidly analyzing thin sections using backscattered electron imagery (BSE). The first step in the process involves collecting high pixel density (2048 x 1768) BSE images that capture a large field of view (~2 mm HFW). BSE contrast resolution is optimized for silicate phases using an accelerating voltage of 30 kV and a beam current of ~10 nA (Figure 1 a, b). Histograms for the electron images are automatically fitted with a series of Gaussian peaks above a user selected threshold intensity. These Gaussians are then assigned a color and "traced-back" to the image where the corresponding pixels retain the false color of the peak (Figure 1 c, d). The integrated counts associated with each peak represent either a mineral phase, or a distinct chemistry within a compositionally zoned phase. This method accounts for pixels where peaks overlap one another owing to similar average atomic number (Z) by way of peak width scaling. Three sections of MIL 03346 (2, 119, and 121) and one section each of MIL 090030, 090032, and 090136 were mapped by collecting image tiles across the thin sections and merging these into one composite image using the Soft Imaging System's Scandium software.

MIL Nakhlite Pairing Group: While our complete methodology has not yet been utilized to rigorously compare the four meteorites, the area fractions (and therefore the volume fractions) of the phases on the liquidus prior to accumulation in the three MIL 03346 sections and the new MIL '09 meteorites are quite similar and suggest these meteorites are, indeed, paired.

References: [1] Satterwhite and Righter, 2004, *Antarctic Meteorite Newsletter* 27, 1-2. [2] Anand et al., 2005, *LPSC* 36, #1639. [3] Stopar et al,. 2005, *LPSC* 36, #1547. [4] Sautter et al. 2005, *MAPS* 40, A134. [5] Sautter et al., 2006, *EPSL* 252, 45. [6] Day et al., 2006, *MAPS* 40, 581. [7] Imae and Ikeda, 2007, *MAPS* 42, 171. [8] Velbel, 2008, *LPSC* 39, #1905. [9] McKay and Schwandt, 2005, *LPSC* 36, #2351. [10] Rutherford et al. 2005, *LPSC* 36, #2362. [11] Vicenzi et al. 2007, *LPSC* 38, #2335. [12] Hallis et al. 2010, *Trans. Am. Geophys. Union* #P53A-1488. [13] Velbel et al, 2010, LPSC 41, #2223. [14] Satterwhite and Righter, 2010, *Antarctic Meteorite Newsletter* 33, 2. [12].

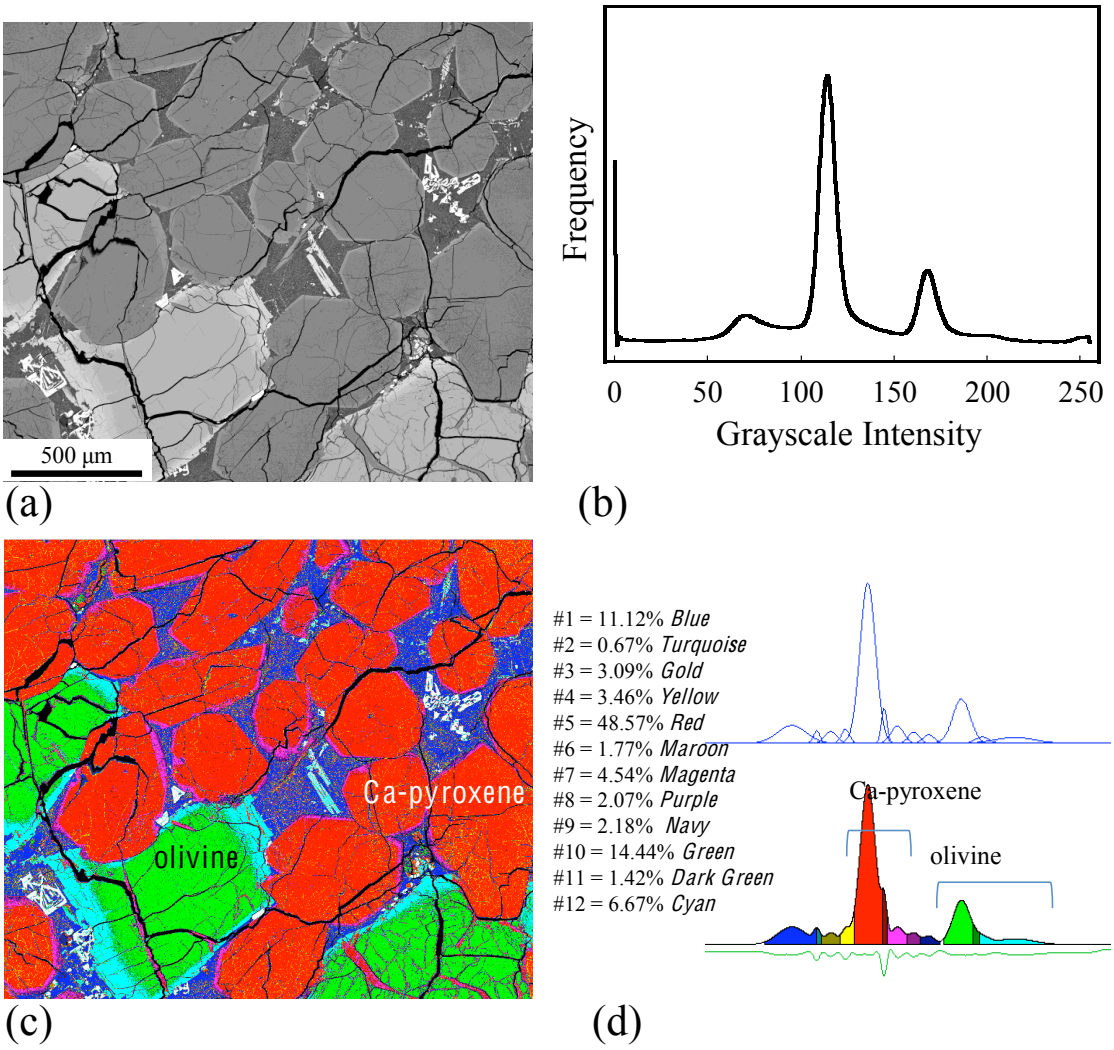

Figure 1 a) Backscattered electron image of MIL 09136. b) Greyscale intensity histogram of image. c) False-colored phase image based upon deconvolution of gaussians in the average atomic number histogram. d) upper: 12 fitted Gaussian peaks note: the uppermost and lowest intensity channels have not been fitted; d) lower: false colored Gaussian peaks of cumulate mineral zoning, green curve represents the fitting residual, and table indicates area percentages for all peaks.