INTEGRATED SPECTROSCOPIC STUDIES OF MIL03346. M.D. Dyar[1], C.M. Pieters[2], T. Hiroi[2], M.D. Lane[3], G.J. Marchand[1]. [1]Dept. of Astronomy, Mount Holyoke College, South Hadley, MA 01075; mdyar@mtholyoke.edu. [2]Dept. of Geological Sci., Brown University, Providence, RI 02912; [3]Planetary Science Institute, 1700 E. Fort Lowell Rd., Suite 106, Tucson, AZ 85719.

Introduction: Spectroscopic studies of the SNC meteorites continue to be of great interest because they provide the only "ground truth" available for ongoing Mössbauer, thermal emittance, MidIR, nearIR, and visible spectral analysis of the martian surface. We present here results of an integrated series of measurements made on the same split of MIL03346, in order to expand our understanding of the properties of these materials and to relate them to other SNCs.

Approach: A 528 mg whole rock sample of MIL03346 was obtained and a 100 mg chip was set aside for whole rock analyses. The remaining mass was gently crushed by hand at Mount Holyoke under acetone to prevent oxidation during grinding. Clinopyroxene grains were handpicked from the sample; special care was taken to *avoid* incorporation of grains with reddish rinds that suggest alteration. All separates were first sent to the RELAB at Brown University for bidirectional and FTIR spectroscopic measurements. Mössbauer spectra were then acquired at the Mineral Spectroscopy Laboratory at Mount Holyoke College. Masses of the mineral separates ranged from 5-34 mg. Samples are in particulate form (est. <45 µm), but inadequate mass is available for further size separates. Additionals splits of the most coarsely-crushed whole rock and the cpx separate were reserved for thermal emittance measurements.

Visible to near-infrared bidirectional reflectance spectra (0.3 to 2.6 µm; 5 nm sampling resolution) were acquired relative to halon at 30° incident, 0° emergent angles. The same samples (in the same dish) were measured using a Pike diffuse reflectance attachment (off-axis, biconical) with the Nicolet 870 Nexus FTIR spectrometer (2 to 50 µm) using a diffuse gold standard. The data were typically spliced at 2.6 µm, to use the absolute reflectance of the bidirectional system.

Room temperature Mössbauer spectra were acquired to determine Fe^{2+} and Fe^{3+} mineral species. A source of 45 mCi ^{57}Co in Rh was used on a WEB Research Co. model W100 spectrometer. Run times ranged from 1-2 days. Results were calibrated against α-Fe foil of 6 µm thickness and 99% purity.

Results: Mössbauer spectra are shown in Figure 1, where they are compared with the whole rock spectrum of Nakhla. The whole rock and clinopyroxene spectra are very similar. The MIL03346 spectra both lack any signs of olivine, which would have an Fe^{2+} doublet with broad quadrupole splitting of ~3.10 mm/s. Instead, the MIL03346 spectra both show typical features for clinopyroxene (Table 1), consistent with parameters observed in the other SNCs previously studied [1].

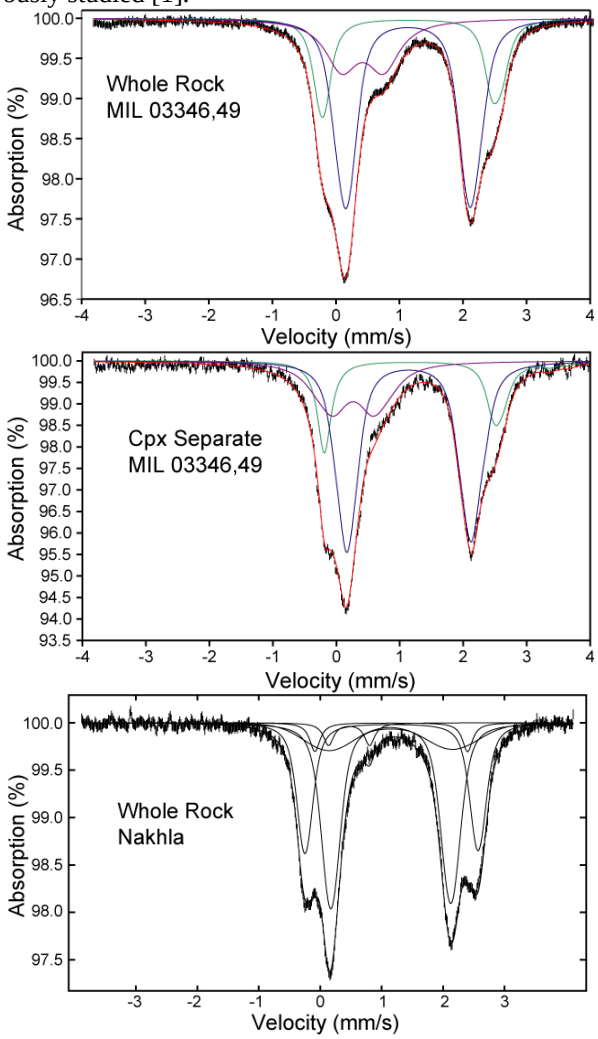

Figure 1. Mossbauer spectra of whole rock (top) and clinopyroxene separates from MIL03346,49 (middle), contrasted with the whole rock spectrum of Nakhla from [1](bottom).

These MIL03346 spectra are unique among the SNC's in that they both show a significant proportion of the total iron as Fe^{3+} (23% and 24% for whole rock and cpx separate, respectively). Previously, the most oxidized SNC was ALHA 84001 at 4.5% Fe^{3+} [1]. This result suggests that either the martian source region of this meteorite was more oxidizing than those

for the other SNC's, or the sample was more extensively altered in Antarctica. We expect that geochemical (isotopic) data and petrographic observations will help resolve this issue.

Table 1. Mössbauer parameters for MIL03346,49

		Whole Rock	CPX
Fe^{2+}	QS	2.60	2.68
	IS	1.29	1.77
	Correlation	-0.118	-0.462
	CS	1.14	1.15
	Width	0.26	0.26
	Area	23.1	19.8
Fe^{2+}	QS	1.95	1.97
	IS	1.14	1.16
	Correlation	-0.00362	-0.0362
	CS	1.13	1.15
	Width	0.26	0.26
	Area	54.2	56.1
Fe^{3+}	QS	0.66	0.61
	IS	0.42	0.27
	Width	0.62	0.55
	Area	22.8	24.2
	χ^2	1.33	5.67

QS=quadrupole splitting, IS=isomer shift, and CS=center shift. All parameters given in mm/s.

Thermal emission spectra: The emissivity spectra have not been obtained yet due to the remodeling of the spectrometer laboratory at ASU. Measurements and analysis will be forthcoming.

Visible-nearIR and midIR spectra of the same MIL03346 samples are shown in Figure 2. Spectra of Nakhla separates prepared in a similar manner by our spectroscopy consortium [2, 3] are shown for comparison along with a different whole rock spectrum available in the literature [4]. The spectrum of MIL03346 clinopyroxene separate is almost identical to the parent whole rock spectrum. All MIL03346 features observed are due to high-Ca pyroxene (with the exception of the transparency feature TF near 800 cm^{-1}). In addition to the Fe^{2+} M2 bands at 1 and 2.3 µm and a M1 band at 1.2 µm [e.g., 3], MIL03346 contains a prominent feature in the visible region near 0.7 µm that is commonly attributed to Cr. The minor variations observed in band strength between MIL03346 whole rock and pyroxene separate are likely due to small variations in the distribution of particle sizes in the two samples.

Although the pyroxene of MIL03346 is very similar to that of Nakhla, there are some important differences between the two meteorites. To a first order, the Fe^{2+} bands of MIL03346 are comparable to those of Nakhla, but the MIL03346 spectra are darker. This albedo difference could be due to particle size differences between the two, but it could also be due to an inherent property of the MIL03346 samples, such as their relatively oxidized composition.

The most prominent differences between the spectral features of MIL03346 and Nakhla are linked to their bulk mineralogy, namely MIL03346 is monomineralic (clinopyroxene) and Nakhla contains small amounts of Fe-rich olivine. The presence of olivine in Nakhla reduces the strength of the 2.3 µm band and substantially reduces any 0.7 µm feature in the whole rock spectra. Differences are more subtle in the midIR, although a weakening of the feature near 550 cm^{-1} can be detected.

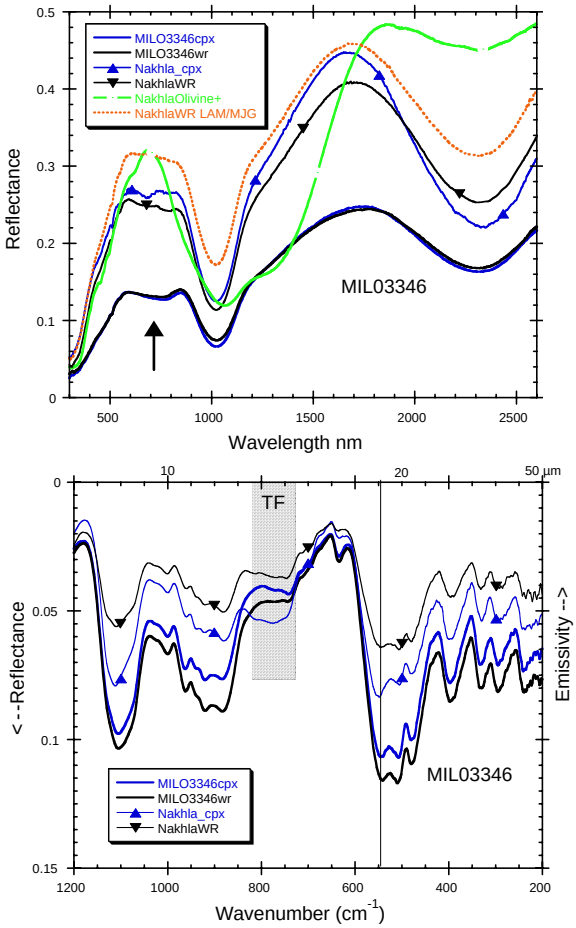

Figure 2. Reflectance spectra of MIL03346 whole rock and pyroxene separates and similar Nakhla samples. Bidirectional vis-nearIR reflectance (top). MidIR (bottom).

Further work planned by our spectroscopy consortium includes midIR emission spectra and MGM analysis of nearIR features in this meteorite.

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References: [1] Dyar M.D. 2003, *MaPS*, 38, 1733-1752. [2] Pieters et al. 2004, *LPSC*, 35, 1171. [3] Sunshine et al. 2004, *LPSC*, 35, 1636. [4] McFadden et al., 2004, *MaPS*, in press.