SPECTRAL IDENTIFICATION OF MAJOR AND MINOR CONSTITUENTS OF MARTIAN METEORITE ALH 84001 AND THE IMPORTANCE FOR REMOTE SENSING ON MARS. J. L. Bishop[1], C. M. Pieters[2], J. F. Mustard[2] and T. Hiroi[2], [1]NRC/NASA-ARC, MS-239-4, Moffett Field, CA 94035 (jbishop@mail.arc.nasa.gov), [2]Brown University, Dept. of Geological Sciences, Providence, RI 02912.

Spectroscopic measurement and analysis of Martian meteorites provide important information about the mineralogy of Mars, as well as necessary ground-truths for deconvolving remote sensing spectra of the Martian surface rocks. The spectroscopic properties of Martian meteorite ALH 84001 have been reported recently from 0.3 to 25 µm for the surfaces of chips from splits 92 and 271 [1] and a particulate sample of split 92 [2]. These analyses correctly identify low-Ca-pyroxene as the dominant mineralogy. Infrared spectra measured at multiple spots along the surface of chips 92 and 271 show subtle spectroscopic variations due to changes in the low-Ca pyroxene texture and composition and to the presence of secondary minerals. Selected spots on the chip surfaces exhibited spectral features due to carbonates, magnetite and organic material. Spectroscopic identification of the minor carbonate and magnetite minerals in this probable piece of Mars indicates that detection of small amounts of these minerals of possible biological significance will be possible using infrared hyperspectral analyses of the Martian surface.

Methods. Reflectance spectra were measured of small chips from meteorite ALH 84001, split 92 (~ 3 X 5 X 10 mm) and split 271 (~3 X 4 X 7 mm). Multiple 1 mm-sized spots were measured across the surface of these chips using an FTIR spectrometer and at two locations on chip 271 and one location on chip 92 from 0.3-2.5 µm using the bi-directional RELAB spectrometer. Following measurement of the surface of split 92, it was ground to <125 µm particle size for the particulate measurements. The ALH 84001 chips were obtained from the Meteorite Working Group. Additional mineral samples analyzed for comparison include minerals from the RELAB database at Brown University and literature sources as cited.

Pyroxene soils. Synthetic low- and high-Ca-pyroxene soils were prepared in the laboratory from fine-grained size separates for previous studies (Mustard *et al.*, 1993; Pieters *et al.*, 1993). These separates were combined to form particle size (p.s.) distributions with different mean and modal characteristics: the “small” soil consists of 65 wt.% <25 µm p.s., 25 wt.% 25-75 µm p.s., 10 wt.% 75-250 µm p.s.; the “medium” soil consists of 25 wt.% <25 µm p.s., 50 wt.% 25-75 µm p.s., 25 wt.% 75-250 µm p.s.; and the “large” soil consists of 10 wt.% <25 µm p.s., 25 wt.% 25-75 µm p.s., 65 wt.% 75-250 µm p.s.

Figure 1 Bidirectional reflectance spectra of martian meteorite ALH 84001. The visible to near-infrared spectra of chips from splits 92 and 271 are shown here and are characteristic of low-Ca pyroxene. Spot 2 on chip 271 was taken of a region containing a brown area on the gray chip surface. Spectral differences observed near 0.5, 1.4 and 2.5 µm between spots 1 and 2 for chip 271 may be due to pyroxene texture and particle size variations, as well as to the presence of secondary minerals such as Fe-bearing carbonate.

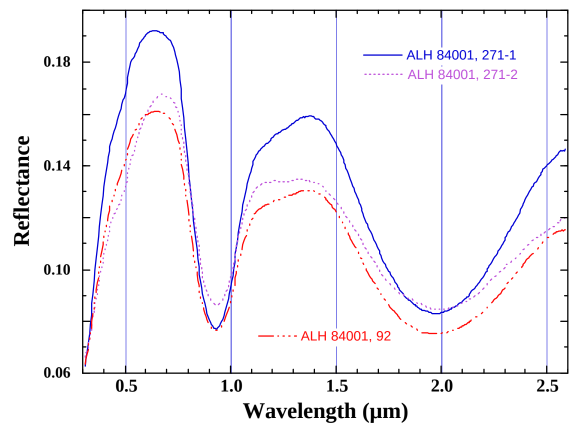


Figure 2 Bi-directional visible to near-infrared reflectance spectra of a powder (<125 µm particle size) of ALH 84001, split 92. Spectra of particulate low-Ca-pyroxene and high-Ca-pyroxene soils are shown for comparison.

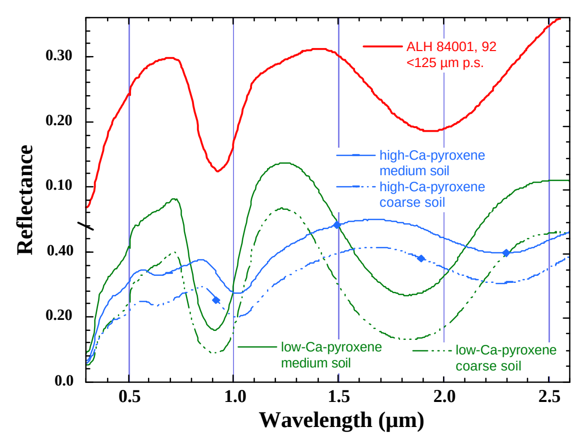


Figure 3 Reflectance spectra from 2.5 to 8 µm of the particulate (<125 µm particle size) sample of ALH 84001, split 92. This spectrum is an average of 9 FTIR measurements and is scaled to the bi-directional reflectance at 2.5 µm. Spectra of particulate low-Ca-pyroxene and high-Ca-pyroxene soils [3,4] are shown for comparison.

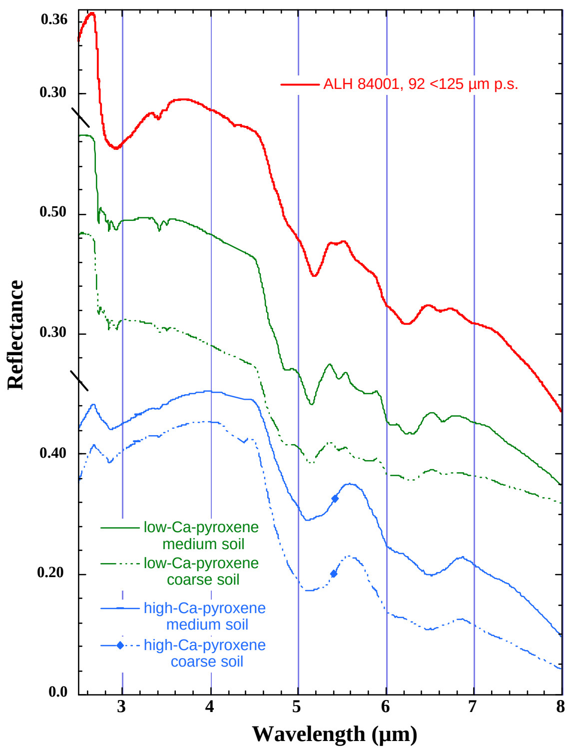
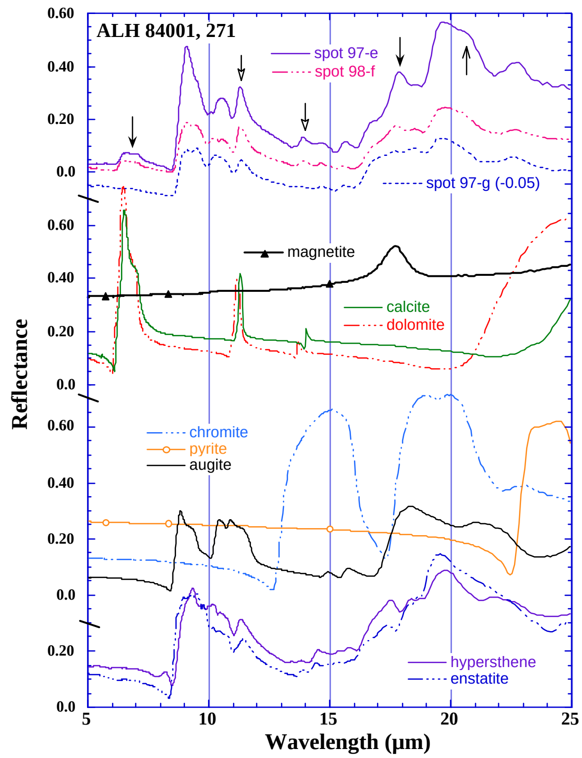


Figure 4 Reflectance spectra of selected ALH 84001 spots and mineral slabs. Spectra are shown of three spots on ALH 84001, split 271 that are representative of the spectral variations observed. Spectra of smooth surfaces of two low-Ca-pyroxenes are shown for comparison along with several secondary minerals. The carbonate and magnetite spectra exhibit distinctive narrow features, which enables identification of these minerals in spectra of spots 97-e and 98-f of meteorite ALH 84001, split 271. The hypersthene, enstatite, magnetite, calcite, dolomite, chromite, pyrite and augite spectra are from Salisbury *et al.* [5].



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References: [1] Bishop J. et al. (1998) *Meteorit. Planet. Sci.*, 33, 693-698. [2] Bishop J. et al. (1998) *Meteorit. Planet. Sci.*, 33, 699-708. [3] Mustard J. F. et al. (1993) *LPS XXIV*, 1041-1042. [4] Pieters C. M. et al. (1993) *LPS XXIV*, 1147-1148. [5] Salisbury J. W. et al. (1991b) *Infrared (2.1-25 µm) Spectra of Minerals*, Johns Hopkins Press.