COMPARISON OF 1969 IRS AND 1971 IRIS SPECTRA TO TES. L. E. Kirkland[1], K.. C. Herr[2], and P. B. Forney[3], [1]Lunar and Planetary Institute, Houston, TX <kirkland@lpi.jsc.nasa.gov>; [2]The Aerospace Corporation, El Segundo, CA; [3]Lockheed Martin Missiles and Space, Palo Alto, CA <paul.forney@lmco.com>.

Introduction. Three spacecraft have carried spectrometers that returned thermal infrared spectra of Mars: the 1969 Mariner Mars 7 Infrared Spectrometer (IRS; 1.8 - 14.2 µm), 1971 Mariner Mars Infrared Interferometer Spectrometer (IRIS; 5 - 50 µm); and 1997 TES (6 - 50 µm). Each instrument measured spectra with different characteristics, so each data set provides complementary information that can be used to examine the composition of surface materials (Figure 1). Any spectral interpretation should be consistent with data from all three of these data sets.

We recently recovered the IRS data set from the original data tapes, calibrated, and released spectra that measured from 3.7 - 14.2 µm. IRS provides high quality coverage of the informative overtone spectral region, which runs from approximately 3 - 7 µm. IRIS measured with the highest spectral resolution, which allows the best separation of surface and atmospheric features, and the best definition of band shape. TES measures with the highest spatial resolution and coverage, which permits the most detailed mapping of spectral types.

IRS returned high quality spectra of Mars covering the wavelength region from 1.8 to 14 µm. IRS measured with the highest signal-to-noise ratio (SNR) of the three spectrometers (Figures 1 and 2). We recently recovered the full data set, calibrated and released spectra that measured from 3.7 - 14.2 µm [1]. Calibration of the shorter wavelength spectra is currently in progress.

Now for the first time since the 1970s we have IRS spectra calibrated in wavelength and intensity using the original data set and calibration information and expertise from the IRS team. Incorporating the expertise of original members of the IRS team proved crucial to the success of the calibration.

IRS spectra (1.8 - 14.4 µm) provide unique information of the 3 to 7 µm region. This region contains overtone features, which is important because finely-particulate minerals commonly have strong, diagnostic overtone features, but very weak fundamental features (which occur at longer wavelengths) [2]. TES measures from 6 - 50 µm, and the 1971 IRIS from 5 - 50 µm, so those instruments cover only part of this overtone region. Since both measure these wavelengths with poor SNR, only IRS provides high quality coverage of these wavelengths.

IRS used two circular variable interference filters with ~1% resolution to scan continuously two channels, from 1.8 to 6.0 µm and 3.7 to 14.2 µm [3]. Each spectrum contains approximately 1340 discrete measurements which were scanned every ten seconds. The IRS spectra have proven to be of very high quality, are available through the Lunar and Planetary Institute, Houston, or by emailing the authors.

IRIS is an interferometer spectrometer that returned spectra of Mars with the highest spectral resolution of the three spectrometers (Figure 1) [4]. High spectral resolution allows the best separation of atmospheric and surface absorptions, and the most accurate definition of band shape, center, and width (Figure 3). Thus IRIS spectra provide an alternate method to investigate the shape and width of surface features, and they also allow a more definite separation of surface and atmospheric features. An investigation of surface features in IRIS can complement surface studies utilizing TES spectra.

Each IRIS interferogram contained 4096 measurements, acquired in 21 seconds [4]. However, the heart of the IRIS data set, the interferograms, has been lost to the planetary community. During the original investigation, the interferograms were converted to spectra, calibrated in wavelength and intensity, reduced to 1500 points, and this is what remains of the data set. Access to the interferograms would allow an improved calibration, better processing to increase the SNR, and possible recovery of spectra that have been lost completely. We are currently attempting to locate the IRIS tapes at JPL, and we desire to recover the data set in a manner similar to IRS.

TES is an interferometer spectrometer, and it measures spectra with the highest spatial resolution. Each spectrum contains 143 or 256 measurements, with sample intervals of 10 or 5 cm^{-1}, respectively [5]. TES measures with poorer SNR than IRS, but better than IRIS.

The higher spatial resolution of TES allows the best definition of the extent of a spectral region, such as the one interpreted to contain coarsely crystalline hematite [6]. However, TES has the lowest spectral resolution of the three spectrometers, which causes the most mixing of atmospheric and surface features (Figure 1). A correction can be applied to reduce the distortion, but such corrections are never perfect. Thus IRIS spectra furnish an alternate means to examine spectral features of large spectral type regions (Figure 3).

References: [1] Forney, P. and L. Kirkland, *LPSC XXVIII*, 373-374, 1997. Kirkland, L. E. et al., *LPSC XXIX*, abstract 1516, 1998. Kirkland, L. E. et al.,

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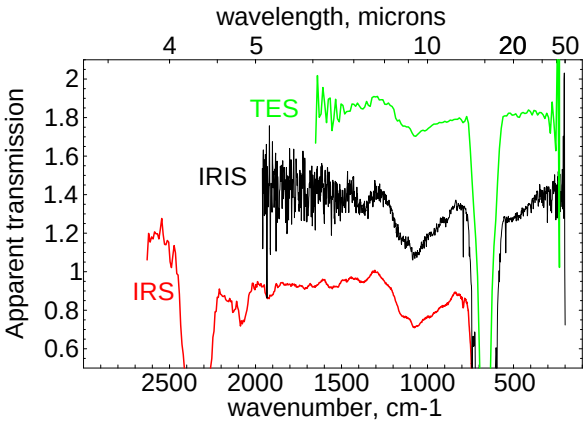

Figure 1: Comparison of typical IRS, IRIS, and TES spectra. IRS has the highest signal-to-noise ratio, especially at the shorter wavelengths. IRIS has the highest spectral resolution, which can be seen here by the sharp atmospheric lines present in IRIS spectra. For example, note the difference in appearance of the CO_2 gas feature at 12.6 µm (790 cm^{-1}) between the different data sets. IRS also measures to 1.8 µm (5500 cm^{-1}), but the spectra are not yet calibrated. TES measures with the highest spatial resolution.

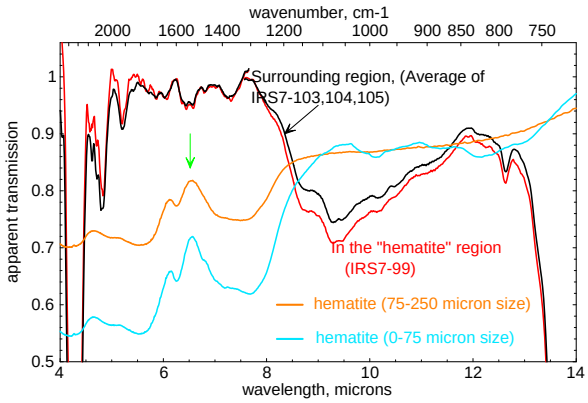

Figure 2: IRS Spectra of the "hematite region." IRS provides the highest signal-to-noise ratio coverage of the overtone region (~3 - 7 µm). The red IRS trace shows a spectrum that measured the region interpreted by the TES team as containing hematite [6]. The black IRS trace shows an IRS spectrum that measured a nearby region. Shown for reference are spectra measured of two different particle size distributions of hematite, from *Salisbury et al.* [1991].

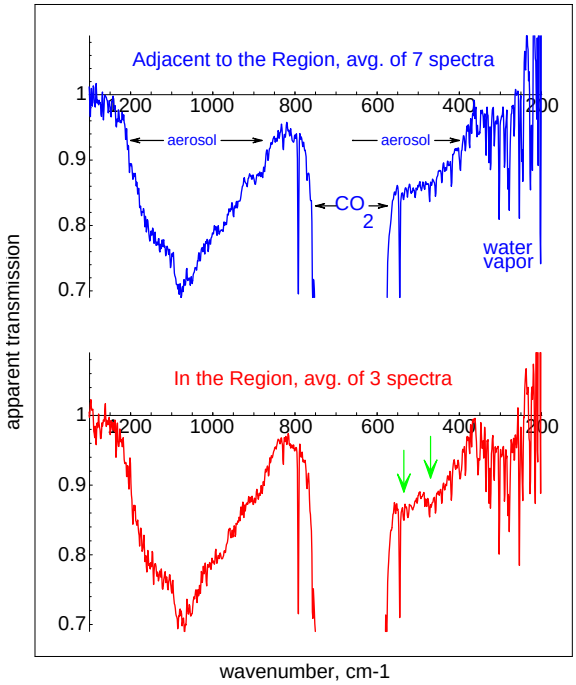

Figure 3: IRIS Spectra of the "hematite region." The upper (blue) plot shows an average IRIS spectrum that measured a region near the region interpreted as containing hematite, and the lower (red) plot shows a spectrum that measured the region. The lower plot shows similar bands as those measured of this region by TES. This provides independent confirmation that the bands exist, and that they show some stability with time. IRIS measures with higher spectral resolution, which will allows a more detailed examination of the band near the atmospheric CO_2 gas 15 µm band shoulder. The lower spectral resolution of TES causes much broader interference in TES spectra from the strong 15 µm CO_2 band, the narrow 18.2 µm (550 cm^{-1})CO_2 band, and the water vapor rotational lines.