COMPOSITION OF SYRTIS MAJOR VOLCANIC PLATEAU John F. Mustard[1], S. Erard[2], J-P. Bibring[2], Y. Langevin[2], J. W. Head[1],, C. M. Pieters[1] (1) Dept. Geol. Sci., Box 1846, Brown University, Providence RI, 02912, (2) Institut d'Astrophysique Spatial, University of Paris Orsay, 91405 Orsay France

Introduction: Syrtis Major, a low relief volcanic shield centered near 295° 10°N, is an old, well preserved and exposed volcanic region on Mars (1) which formed at the end of the heavy bombardment period (2). The composition of these volcanic materials has importance for understanding the thermal and chemical history of Mars. Imaging spectrometer data of the Syrtis Major volcanic plateau are used in this analysis to identify major compositional components. These data were acquired in March 1989 by the ISM instrument onboard the Phobos-II spacecraft. Previous analyses of these data have determined that the surface is spectrally heterogeneous down to the observing limit of the instrument (3) and there exists significant compositional variation in this region (4). Band ratios sensitive to mafic mineral absorptions have been used to identify spatial associations of surface materials containing mafic minerals (4). However identification of specific mineral species, and therefore surface compositions, from the ISM data have been hindered by residual calibration difficulties. New constraints on the calibrations have significantly improved the estimates of radiometric intensities such that mineralogic and lithologic interpretations can now be made.

Data Reduction: Detailed discussions of general data reduction are presented in (4). Briefly, all well characterized instrumental, solar, and atmospheric effects are removed in a series of additive and multiplicative steps, including new corrections for the third order overlap. As part of this process an improved spectral model for Phobos, based on laboratory meteorite spectra with an additive thermal component, is used. Absolute radiometric accuracy is estimated to be 10% with the greatest uncertainty at wavelengths < 0.9 μm (3). Detailed examination of calibrated ISM data from the Isidis-Syrtis Major region indicates that there are small (1-3 %) systematic offset errors in addition to radiometric inaccuracies related to the Phobos spectral model. The offset errors are remarkably uniform and are only visible because of the extraordinary signal to noise performance (≈500:1) of the instrument (4).

To correct for these remaining calibration concerns, we use a spectral model for bright and dark regions of Mars based on the telescopic observations of (5). The ISM data for the Syrtis-Isidis window were searched to find the closest match to the spectral model in both albedo and general slope. In this calibration, the second order even channels between 0.77 and 1.51 μm are considered but we will apply this aproach to the 1st order even channels between 1.6 and 3.15 μm in the future. Spectra from the matched regions are averaged and then regressed against the model spectra to determine a set of gain and offset corrections which are then applied to the entire image. Inspection of the corrected data indicates that systematic and persistent offset errors have been removed and the shape of the spectra are more consistent with the large body of telescopic data.

Results: First and second order even channel reflectance spectra between 0.77 and 2.55 μm from four broad classes of materials on Syrtis Major are shown in Figure 1. For the volcanic materials, there are three primary classes characterized by albedo, slope, and shape of the 1.0 μm band. To emphasize the latter, straight line continua have been removed from each spectral segment and replotted in Figure 2. Each spectrum shows a band minima near 0.96 μm and 2.15 μm indicative of pyroxene mineral absorptions. Comparison of these band minima with studies of pyroxene reflectance spectra suggest that the pyroxenes in the volcanics of Syrtis Major are high calcium pyroxene with at Ca/(Mg+Fe+Ca) ratio of 0.2-0.3 (6,7) and the most likely pyroxene is an augite.

Although the ISM spectra from Syrtis Major show relatively constant band minima, there are clear differences in the shape of the 1.0 μm band. Spectra for the eastern part of Syrtis Major exhibit a broadening towards shorter wavelengths probably from a ferric surface component . This area also exhibits the strongest negative spectral slopes which (8) demonstrated can be caused by thin coatings of dust or oxidized rinds on basaltic substrates. We interpret this broadening combined with large negative slopes as due to a coating of ferric bearing dust or an oxidized rind on a volcanic surface. Spatial distributions of surface materials with these spectral properties correlate with regions of Syrtis Major with observed color on Viking orbiter color photomosaics (9) suggestive of dust or oxidized coatings. A similar distribution in spectral slope from ISM and color from Viking observed in data acquired 10 years apart tends to support that the coatings are stable, oxidized rinds rather that transient dust deposits. Spectra of Nili Patera and along the topographic axis of Syrtis Major display a broadening of the 1.0 µm band towards longer wavelengths with an inflexion near 1.15 µm. Materials common in volcanic materials with absorptions longwards of 1.0 µm include olivine, anorthite, and glass and we are currently evaluating these possibilities. The broadening towards longer wavelengths is closely related to the area of the 1.0 µm band. To illustrate spatial variations in this compositional parameter, band area calculated from the ISM data is presented in Figure 3 overlain on digital Viking Orbiter photomosaics.

The major components of the surface of Syrtis Major, which includes direct evidence for augitic pyroxene, are identified in this analysis. We are continuing the analysis to characterize additional mineral components and relationships of compositional variations to surface features.

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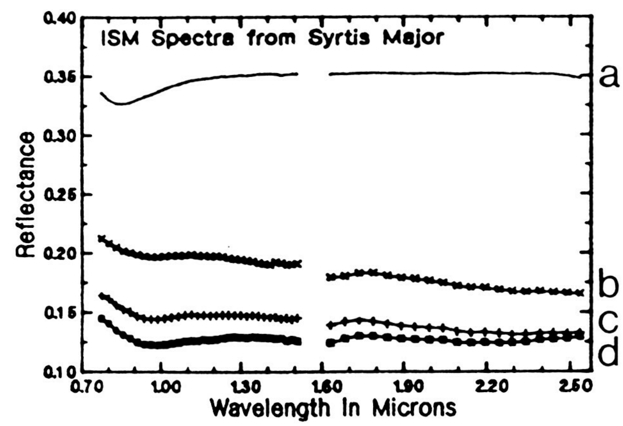

Figure 1. Spectra of major surface units in Syrtis Major. Spectra locations are shown in Figure 3. (a) Isidis (b) Syrtis East (c) Syrtis West (d) Nili Patera

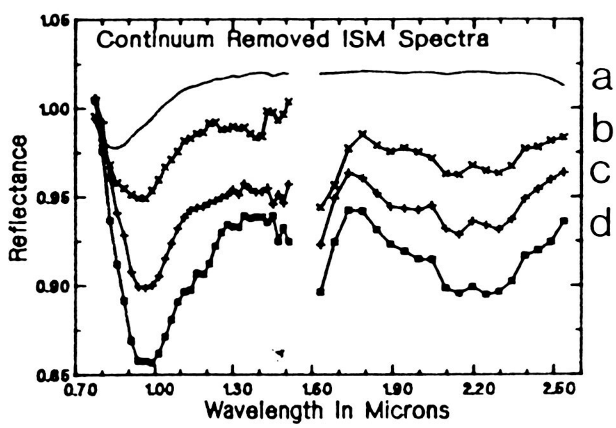

Figure 2. Same spectra as in Fig. 1 with straight line continuum removed. 0.96 and 2.15 µm band minima indicate augitic pyroxene. Broadening of 1.0 µm band in (d) suggests the presence of olivine, glass, or anorthite.

Figure 3. Area of the 1.0 µm ferrous absorption bands of Syrtis Major calculated from ISM data. A simple straight line continuum was fit to the reflectance data and the area is the sum of the difference between the continuum and the spectra. Note that the materials along the topographic axis of Syrtis Major contain the strongest absorptions and the eastern part of Syrtis Major has weaker absorptions that the western part. Data dropouts are indicated as the bright rectilinear areas.