SUB-PIXEL DETECTION AND MAPPING OF SPECTRALLY UNIQUE MATERIALS ON MARS USING ISM DATA. William H. Farrand, Space Science Institute, 1540 30th, #23, Boulder, CO 80303 (farrand@rmi.net)

Introduction: One of the primary goals in the exploration of Mars is the location of geologic deposits formed by, or associated with, liquid water. These types of deposits would include hot spring formed materials (silica and calcic sinters), cold spring formed materials (ferricretes, tufas, travertines), evaporites, carbonates, and mineral deposits formed by hydrothermal activity (containing sulfides, and sulfide alteration products). Many of these deposits, in particular spring-formed deposits, are spatially restricted in area. In fact, the ground instantaneous field of view (GIFOV) of current and planned Mars orbital multi- and hyperspectral sensors is greater than many of these types of deposits. Hence, in order to find these types of deposits using existing and planned sensors, sub-pixel detection techniques will be necessary. A number of techniques that can detect materials at spatial coverages of less than 10% of a pixel have been developed for terrestrial airborne multi- and hyperspectral sensors [1-3]. These techniques can be applied against Mars multi- or hyperspectral data sets to very good effect. Anomalous pixels mapped with sub-pixel detection methods can be located on higher resolution panchromatic (Viking Orbiter or MGC MOC) imagery. In this paper the applicability of one of these techniques, Foreground / Background Analysis (FBA) [4] will be tested against ISM data from the Phobos 2 mission [5].

Technique: FBA is very similar to Spectral Mixture Analysis [6], but differs in its implementation and also in its results. While SMA results in a fractional abundance image for each spectral endmember, FBA distinguishes the endmembers into one or more which constitute the "foreground" and the remainder which constitute the "background". A vector of weights is calculated which when applied against a pixel covered entirely with the foreground/target material will return a data number (DN) of 1.0 and when applied against a pixel devoid of the target material will return a DN of 0. The vector of weights, w, is determined by means of a singular value decomposition and solving for a weighted matrix of endmember spectra.

Example: ISM data were examined using SMA and FBA. An example is presented using ISM data over the Melas and Coprates Chasmata. The atmospherically corrected ISM data were provided to the author by Dr. Stephanne Erard. The data for the "aur" ISM "window" (whose location is shown in Figure 1) were analyzed by standard SMA in order to determine three primary endmembers: dust/bright area deposits, basalts, and an undetermined intermediate albedo material. A fourth less abundant, but spectrally unique material was also determined. FBA was applied to the data using this fourth material and the resulting abundance image is shown in Figure 2. The spatial pattern displayed by high abundances corresponds to the northern wall of Coprates and Melas Chasmata. Geometric registration of the highest value FBA pixels to a Viking base image is shown in Figure 1; the highest values correspond to areas of slumping in the canyon wall. The spectrum of the target material is shown in Figure 3a and a profile across the FBA abundance image in Figure 3b shows the accentuation of the target material and the successful suppression of the background.

References: [1] Farrand,W. and J. Harsanyi, *JGR*, **100**, 1565-1578 (1995); [2] Goetz, et al. *SPIE 2819*, 7-14 (1996); [3] Boardman, J. et al. *JPL Publication 95-1*, 23-26 (1995); [4] Smith, M. *IGARSS '94*, 2372 (1994); [5]; [6] Adams, J. et al. *Remote Geochemical Analysis*, C. Pieters and P. Englert (eds.) 145-166 (1993).

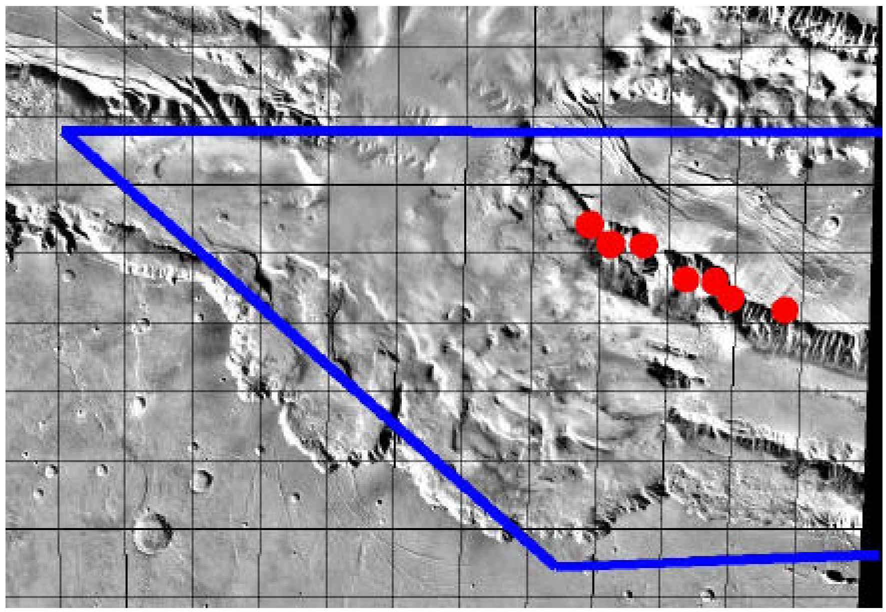

Figure 1: Viking orbiter base image over Melas Chasma and western Coprates Chasma. The box outlines the approximate borders of the “aur” ISM window. The circles indicate the approximate centers of the highest value pixels in the FBA “wall rock” abundance image.

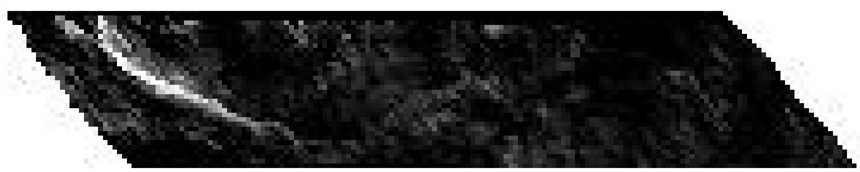

Figure 2: FBA abundance image of “wall rock” endmember. The highest value pixels in this figure correspond to the circles in Fig. 1.

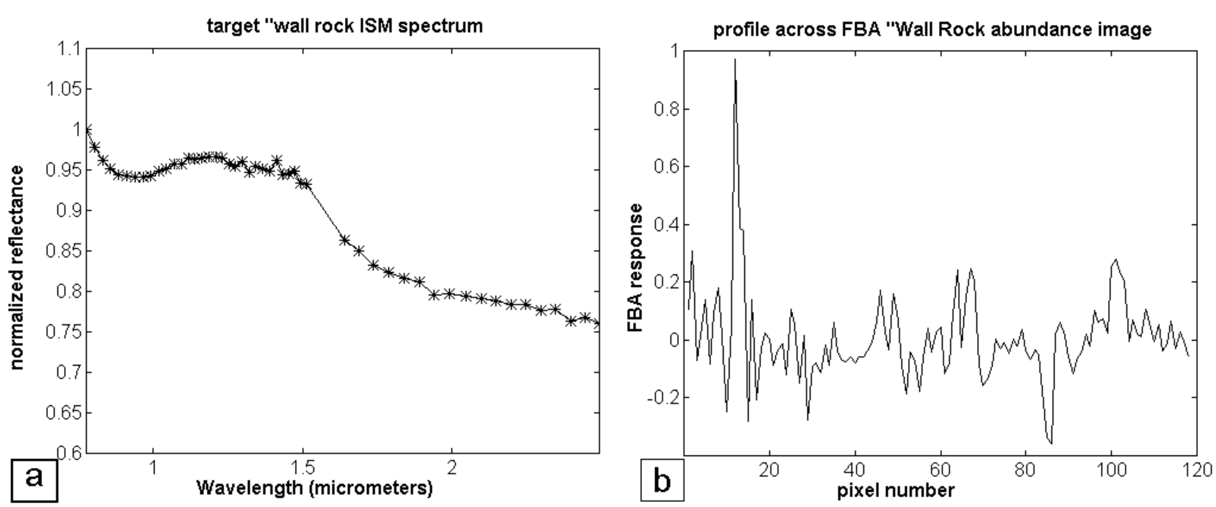

Figure 3: (a) 50 channel spectrum (from the ISM “even” channels) of the “wall rock” endmember. (b) Profile across FBA “wall rock” abundance image.