MAPPING ROCK AND SOIL UNITS IN THE MPF IMP SUPERPAN USING A KOHONEN SELF ORGANIZING MAP.

W. Farrand[1], E. Merenyi[2], S. Murchie.[3], O. Barnouin-Jha[3], J. Johnson[4], [1]Space Science Institute, 4750 Walnut St., #205, Boulder, CO 80301, farrand@spacescience.org, [2]Department of Electrical and Computer Engineering, Rice University, Houston, TX, [3]Applied Physics Lab, [4]USGS Astrogeology Team, Flagstaff, AZ.

Introduction: The 1997 Mars Pathfinder mission provided information on a site in the Ares Vallis floodplain. Initial analysis of multispectral data from the Imager for Mars Pathfinder (IMP) [1] indicated the presence of only a single rock type, the "gray rock" spectral class and various coated variants thereof (e.g., "maroon rock") [2]. Continued analysis of the IMP "SuperPan" mosaic has confirmed multiple examples of a second "black rock" spectral class existing as small cobbles in the near field [3,4,5] and as boulders in the far field [6]. These results are consistent with recent analysis of MGS Thermal Emission Spectrometer (TES) data which indicates that there is likely a mix of both "Surface Type 1" (ST1) and "Surface Type 2" (ST2) spectral classes at the MPF landing site [7]. Nominally, the black rock spectral class would correspond to ST1 (basalts) and "gray rock" would correspond to ST2 (andesites).

Orbital remote sensing has also revealed the pervasive presence of layering on Mars [8]. Recently it was suggested that there are extensive outcrops of the black rock spectral class in the SuperPan far field on the flanks of the Twin Peaks and on the rim of Big Crater [6]. These authors suggested that these exposures represented outcrops of black rock from beneath a surficial, flood deposited layer. In this work, we have reexamined the MPF IMP SuperPan mosaic using an artificial neural network self organizing map (SOM) processing architecture in order to classify the distribution of spectral classes within the SuperPan. In this paper, we present initial results from that work and draw specific attention to a subset of the identified spectral classes in order to address questions relating to whether there are extensive exposures of black rock in the IMP far field, what other materials might be exposed in the far field, and what evidence there is for subsurface layering at the MPF landing site.

Application of SOM to IMP data: We analyzed a recalibrated and geometrically registered version of the "Super Pan" data set, acquired in all 12 IMP bands (440-1000 nm) and covering most of the MPF landing site. The Super Pan was acquired in eight separate image mosaics or octants, with each mosaic consisting of many separate but contiguous camera azimuth and elevation pointing positions. The data analyzed were released by the USGS and corrected to relative reflectance by Version 3 of the IMP calibration algorithm [9]. Further empirical corrections were applied to the data in order to mitigate differences between component segments [6].

Class maps were produced using a Kohonen SOM neural network architecture [10]. A 40 x 40 SOM was used for each of the left and right eye clustering. Approximately 7 million learning steps were performed for each image.

Results and Discussion: Fig. 1 shows a composite of the first three left eye bands for octant S0184 of the SuperPan, and Fig. 2 is a right eye class map of that octant. Discussion of all the spectral classes identified is beyond the scope of this abstract; however, in Fig. 3 we draw attention to the slopes of South Twin Peak and the exposures of (top to bottom) classes M, Y and b (purple, maroon, and cyan colors). This indication of layering is not expressed as strongly in the corresponding left eye class map. At the time of writing, the SOM was not applied to octant S0183 which contains North Twin Peak and was noted by [6] as having the best putative black rock exposures. However, a constrained energy minimization detection algorithm [11] was applied to the data with results shown in Fig. 4b. While a number of far field black rock boulders were identified, the flanks of North Twin Peak had only a weak black rock response and only on the lower southern flank. This corresponds to the location identified in [6] as having a strong 900 nm band depth, the lowest far field 670/440 nm ratio and the weakest 530 nm band; the latter two parameters indicating low dust cover. In Fig. 5, the spectrum of the patch on N. Twin Peak with the moderate response in the CEM black rock fraction image is compared with representative black rock spectra. The characteristic reflectance maximum at 671 nm in the near field black rock spectrum is approximately co-equal with the 752 nm band in the far field black rock boulder and the peak is at 752 nm in the N. Twin Peak patch. The long wavelength band minimum of the N. Twin Peak patch also occurs at a shorter wavelength than the near and far field black rock examples. The exposure on N. Twin Peak could be the result of exposures of black rock mixed with material that has a shorter wavelength absorption (e.g., hematite-rich material). However, the fact that this patch occurs low on the flanks of N. Twin Peak and the lack of response of black rock elsewhere on N. Twin Peak in the CEM fraction image of Fig. 4b indicates that it is very possibly a layer within N. Twin Peak overlain by a material without a strongly defined long wavelength absorption (N. Twin Peak top spectrum in Fig. 5). The concept of the Twin Peaks being layered deposits is consistent with the ubiquitous presence of layering observed in MOC images [8]. The possibility of the Twin Peaks being layered deposits with a lower layer of black rock is consistent with the paradigm of ubiquitous layering on Mars and also with the suggestion of limited exposures of ST1 in ST2 terrains suggested by analysis of TES data [12].

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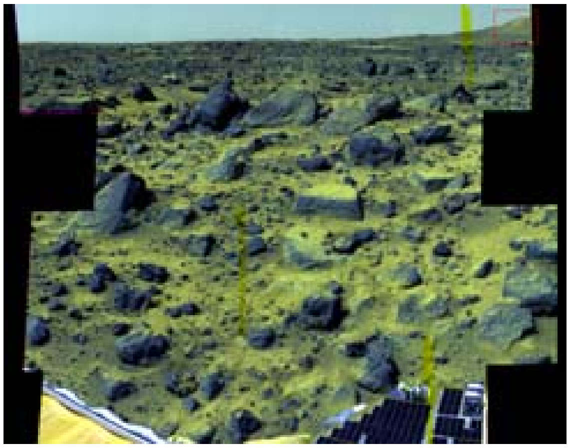

Figure 1. Composite of left eye bands 802, 671, and 443 nm for octant S0184.

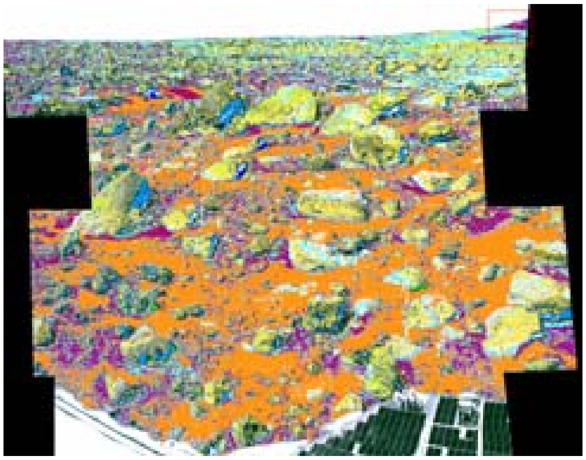

Figure 2. Class map generated using SOM on octant S0184 right eye bands. Red box in upper right indicates South Twin Peak.

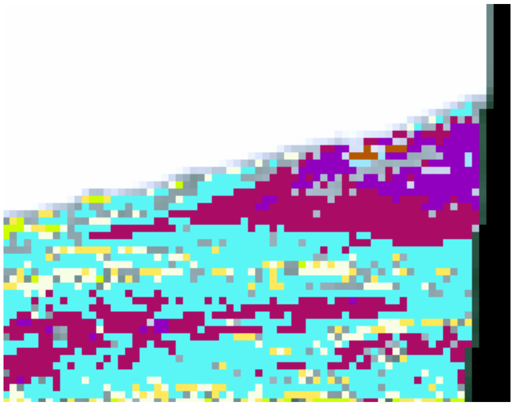

Figure 3. Close-up of flank of S. Twin Peak in right eye SOM class map of octant S0184. Purple corresponds to spectrum shown in Fig. 5.

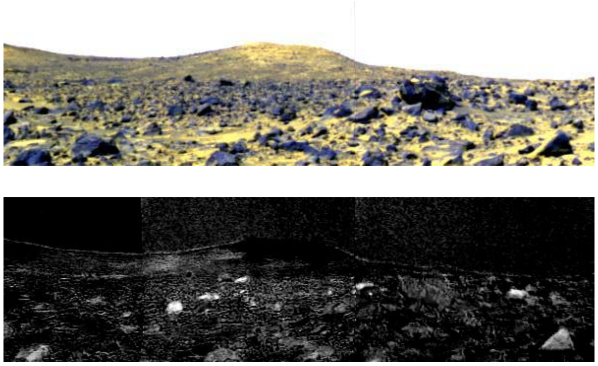

Figure 4. **A**. (top). 802, 671, and 443 nm composite of subset of octant S0183 centered on N. Twin Peak. **B**. (bottom) CEM fraction images highlighting occurrences of black rock in far field of S0183.

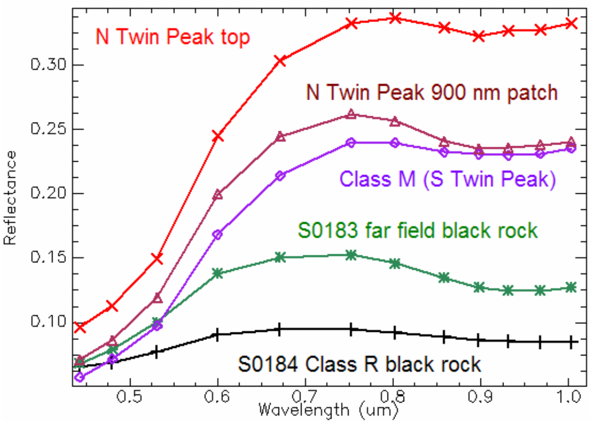

Figure 5. Combined eye spectra from of Twin Peak layers and black rock examples.