SELF-ORGANIZING MAP CLASSIFICATION OF THE BERLIN EMISSIVITY DATA BASE. T.L. Roush[1], J. Helbert[2], R.C. Hogan[3] and A. Maturilli[2], [1]NASA Ames Research Center (MS 245-3, Moffett Field, CA 94035-1000, troush@mail.arc.nasa.gov), [2]Institute for Planetary Research, DLR, Berlin, Germany, [3]Bay Area Environmental Research Institute.

Introduction: Existing and planned space missions to planets and their satellites produce increasing volumes of spectral data. Understanding the scientific content in this large data volume is a daunting task. Various statistical approaches are available to assess such data sets. We apply an automated classification scheme based on Kohonen Self-Organizing maps (SOM) to thermal emission spectra of individual minerals from the Berlin Emissivity Data (BED) base [1-3]. Currently the BED incorporates many minerals and materials that have been suggested as being present on Mercury and Mars based upon previous measurements [2]. Testing the ability of the SOM on carefully controlled laboratory samples represents one of several steps towards its application for automatic data processing on future missions with a higher degree of autonomy.

Samples Studied: The samples studied here are listed in Table 1 along with a hierarchal labeling scheme previously used for SOM clustering of other mineral data [4-5]. Four grain sizes separates are available for each sample (0-25, 25-63, 63-90, and 90-125 μm).

Spectral Measurements: The spectral measurements were performed with a Fourier transform infrared spectrometer (Bruker VERTEX 80v), purged with dry air and equipped with a liquid-nitrogen-cooled HgCdTe (MCT) detector. A "warm" (60°C) and "hot" (90°C) blackbody, together with a gold plated standard sandpaper at room temperature were measured for calibration. The sample was placed in a 3 cm diameter aluminum cup and heated to 90°C in an oven for 24 hours to reduce adsorbed water, then was placed on a heating plate and heated from below to a constant temperature of 90°C. Further details on apparatus, data preparation, standard measurement procedures and emissivity calculation can be found in [1,2]. Thus, the new spectral data expand the wavelength domain of the previous measurements of the BED [3].

Clustering with the SOM: Previous work developed an automated unsupervised classification scheme based on SOMs that does not suffer from the limitations of the K-means and Isodata algorithms; requirement for predefining the number of clusters [4-5]. The SOM maps the clustering inherent within the input data to an output layer. Commonly there are two steps with application of the SOMs; training and testing. During training the cells of the SOM are randomly populated-with data having known labels and as similar data are grouped together disjoint regions in the output layer are formed and are associated with the data labels. Here we apply the SOM only using the training phase to investigate how the emissivity spectra cluster. In this case we ask if similar data are associated with each other. Before the SOM analyses, we eliminate data from the spectra in regions where telluric CO_2 can introduce artifacts and a few other regions where signal precision is relatively low.

Table 1. Hierarchal labels of minerals in BED

Class	#	Subclass	#	Group	#
soils	1	C-U	1	C-U	1
oxide-hydroxide	1	hydroxide	0	Fe	0
		oxide	1	hematite	1
				spinel	1
silicate	15	inosilicate	7	cpx	4
				opx	3
		nesosilicate	5	garnet	2
				olivine	3
		sorosilicate	1	melilite	1
		tectosilicate	2	K-spar	1
				feldspathoid	1

C-U=category unspecified, cpx= clinopyroxene, opx = orthopyroxene, K-spar= alkali feldspar

Results: The specific location of a sample in an output layer "cell" (boxes created by the grid in the figures) is due to two factors; initial random placement of spectra at the beginning of the SOM training and similarity with near-by spectra during training. So, in addition to location it is important to consider the strength of the boundaries between individual "cells". The thickness of the grid lines indicates the absolute difference between spectra in adjacent cells. Thin and thick lines indicate a relatively small and large difference, respectively.

Figures 1 and 2 show the results of applying the SOM to the a subset of the BED spectra two different times and indicates:

1) Oxide (hematite) spectra form a distinct region with strong boundaries from the silicates (pyrope and enstatite) suggesting this material is readily recognized as being different from the silicates. A strong boundary separates the finest grain size sample from all others.

2) Silicates (pyrope and enstatite) form at least two distinct regions with intermediate strength boundaries that separate the coarser and finer grain sizes of these two materials.

3) The finest grain size pyrope spectrum is segregrated from the other fine-grained silicates by strong boundaries.

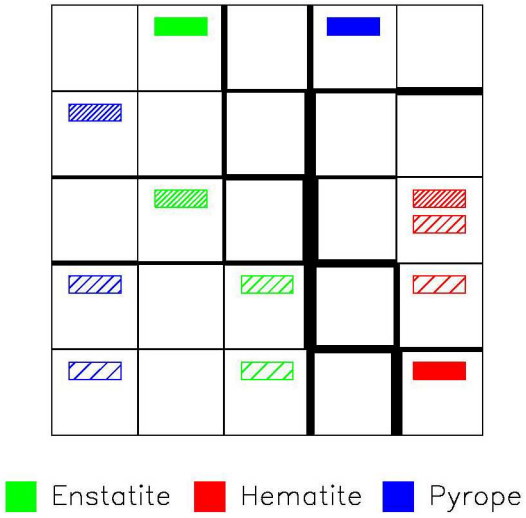

Figure 1. SOM output layer. The colored symbol codes the grain size as follows: solid= 0-25 μm; smallest spacing= 25-63 μm; medium spacing= 63-125 μm ; and largest spacing= 125-250 μm.

The conclusions presented in this initial effort will benefit from additional analyses of other materials in the BED data set. One natural extension of this effort is analyses of the informational content contained within differing spectral regions that would provide the potential to increase the accuracy of any classification scheme (e.g. 4)

References: [1] Maturilli, A., Helbert, J., Witzke, A., Moroz, L. (2006) *PSS 54, 11, p. 1057-1064* [2] Maturilli, A., Helbert, J., Witzke, A., Moroz, L. (2007) LPSC 38, abstract 1281. [3] Maturilli, A., Helbert, J. (2007) European Planetary Science Congress, abstract EPSC2007-A-00281 [4] Roush T.L. & R.C. Hogan (2007) *Proc. IEEE 2007 Aerospace Conf., paper #1456.* [5] Hogan, R.C. and T.L. Roush (2002) SOM classification of TES data, LPSC 33, abstract 1693

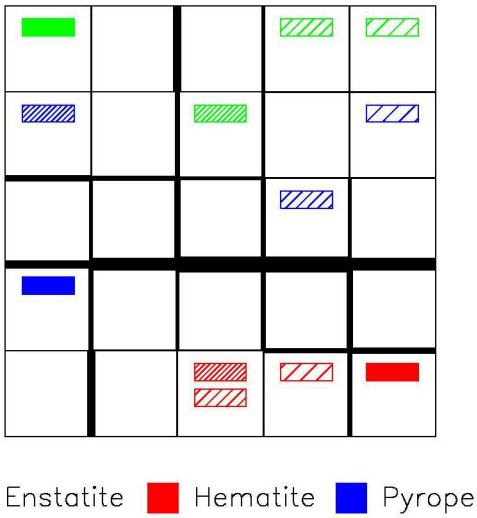

Figure 2. SOM output layer for a second independent evaluation of the data. The colored symbol codes are the same as in Figure 1.

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