**Regional Dark Mantle Deposits on the Moon: Rima Bode and Sinus Aestuum Analysis.** S. Pinori and G. Bellucci, CNR - IFSI (CNR - IFSI, Area di Ricerca di Tor Vergata, Via del Fosso del Cavaliere 100, 00133 Roma - Italy, Sabrina.Pinori@ifsi.rm.cnr.it).

### Introduction

Regional pyroclastic deposits on the Moon usually are located on mare basins borders, blanketing adjacent highlands [1], [2].

We present the study of two Dark Mantle Deposits (DMD): Rima Bode and Sinus Aestuum. The statistical approach allows us to identify not only the dark mantle terrain, but also some areas spectrally different from the DMD that we have interpreted as a mixing of DMD and the neighboring soils.

### Instrument and Data Analysis

The data (Table 1) have been obtained at the 1.5 m telescope of Sierra Nevada Observatory (Granada, Spain) using an imaging spectrometer working in the 0.4 - 1.0 micron spectral range, corresponding to 96 spectral bands.

<table>
<thead>
<tr>
<th>Lunar region</th>
<th>Date</th>
<th>Time (U.T.)</th>
<th>Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rima Bode</td>
<td>March 19, 1997</td>
<td>20:58</td>
<td>3 W 13 N</td>
</tr>
<tr>
<td>Sinus Aestuum</td>
<td>December 7, 1998</td>
<td>01:26</td>
<td>7 W 5 N</td>
</tr>
</tbody>
</table>

Table 1. Characteristics of the data sets.

The spectra have been normalized to Mare Serenitatis (MS2) average spectrum, a standard area centered at 21° 25' E, 18° 40' N [3].

Two different statistical procedures have been employed to analyze the two regions and to discriminate between the different geologic units: the Pixel Purity Index (PPI) and the Spectral Angle Mapper (SAM).

The PPI is a method of finding the most "spectrally pure", or extreme, spectra in multispectral images [4]. The PPI is computed by repeatedly projecting n-dimensional scatter plot onto a random unit vector. The extreme pixels in each projection are recorded and the total number of times each pixel is marked as extreme is noted. In this way it is possible to create a PPI image in which the DN of each pixel corresponds to the number of times that pixel has been recorded as extreme (see Fig. 1a and 1b).

The SAM is a method for comparing the image spectra to a set of spectra chosen as a priori endmembers [5], [6]. The algorithm determines the similarity between two spectra by calculating the "spectral angle" between them, treating them as vectors in a space with dimensionality equal to the number of band. For each reference spectrum chosen, the spectral angle is determined for each pixel and the final classification image shows a map where pixels of the same color represent regions of similar composition (see Fig. 2a and 2b). The DMD borders, obtained from the 0.7 micron albedo image, are overlapped on the maps.

### Identification of Mixing Areas

Our analysis is devoted to the study of the relationship between the DMD and the adjacent terrain and to better understand the spectral properties of the different terrain present in the area. The PPI procedures point up the spectral variability of the region and the DMD are clearly identified as "pure" or more extreme spectra. Both the DMDs present the highest values of the images (white and violet areas ranging from 200 to 400 DN) while the adjacent zones present intermediate values (red areas ranging from 100 to 200 DN). The maria and highlands present in the images have been classified as green areas (ranging from 0 to 100 DN). Rima Bode deposit presents a narrow and long shape and an extensive red area, while Sinus Aestuum dark mantle deposit is heart-like shaped and shows a not vast red area. Rima Bode deposit (Fig. 1a) is more homogeneous than Sinus Aestuum, where are present some patches (white areas) corresponding to the more extreme spectra.

Using the analysis the PPI image, we have chosen five different endmembers for each region to apply the SAM procedure. The results are shown in Fig. 2, and in Fig. 3 are presented the mean spectra of the DMD and the mixing areas classes.

On the basis of the spectra and of the position we identify the red class as highland, the blue class as mare, the yellow class as pure DMD and the cyan class as crater ejecta. The last two classes, the green and the sea green, have been interpreted as mixing soils of pyroclastic products and highland, the green one, and DMD and mare the sea green.

Sinus Aestuum mean DMD spectrum shows a deep absorption band with the minimum at 0.7 micron in the visible range and symmetrical wings at the extremes. Rima Bode DMD spectrum presents a less absorption in the visible and a lower NIR/VIS value. The difference suggests an effective distinct mineralogical composition: the Sinus Aestuum deposit could be dominated by crystallized beads, while Rima Bode could be a mixing of volcanic glasses and black beads.

We expect that DMDs mixed with the highland soils show a decrease in the UV/VIS slope [2]. This effect is visible in both the spectra corresponding to the green areas.

The analysis points up the presence of another mixing area (the sea green color in Fig. 2a) in Rima Bode region between DMD and the mare. The mean spectrum of this class shows a negative slope.
Conclusions: The new statistical techniques allow us to identify some mixing areas with mare or highland soils. These regions are spectrally distinct from the DMDs and can help us to better understand the possible evolution of the eruptions that led to the deposits emplacement.