Mafic Materials in Scott Crater? A Test for Lunar Reconnaisance Orbiter. Bonnie L. Cooper[1], [1]Oceaneering Space Systems, 16665 Space Center Blvd., Houston TX 77058 bcooper@oceaneering.com.

Introduction: Clementine 750 nm and multispectral ratio data, along with Lunar Orbiter and radar data, were used to study the crater Scott in the lunar south polar region. The multispectral data provide evidence for mafic materials, impact melts, anorthositic materials, and a small pyroclastic deposit. High-resolution radar data and Lunar Orbiter photography for this area show differences in color and surface texture that correspond with the locations of the hypothesized mafic and anorthositic areas on the crater floor. This region provides a test case for the upcoming Lunar Reconnaissance Orbiter. Verification of the existence of a mafic deposit at this location is relevant to future lunar resource utilization planning.

Figure 1. 750 nm basemap for Scott crater, as downloaded from the U.S.G.S. Planetary Data System website.

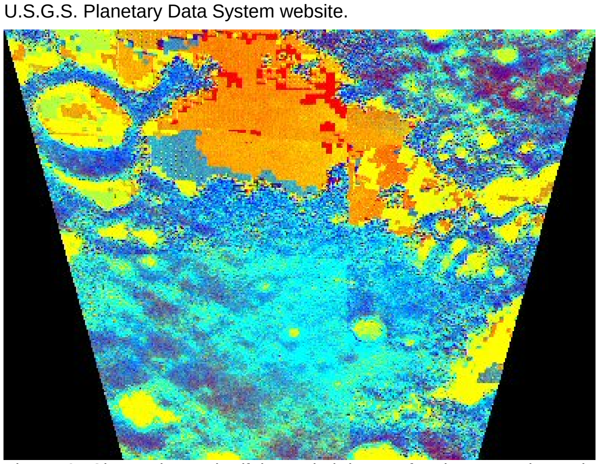

Figure 2. Clementine ratio (false color) image for the area shown in Figure 1, as downloaded. Note that yellow, orange and red colors correspond to shadowed areas.

Data Processing Method: Clementine 750 nm and multispectral ratio data were obtained from the United States Geological Survey (USGS) Planetary Data System (PDS) website for the area of the crater Scott (82.1ºS,48.5ºE). The as-downloaded images are shown in Figures 1 and 2. Information provided on the PDS website cites [2] as the method by which the false-color ratios may be interpreted.

Figure 2 illustrates the phenomenon described by [1], that shading due to topography can severely limit the usefulness of Clementine multispectral data. Shadowed areas show up as bright red, orange and yellow, and it becomes difficult to determine whether any of these are due to chemical differences. To address this issue, information from the 750 nm image was used to create a mask (Figure 3). The 750 nm (grayscale) image was used so that there would be no tendency to pre-judge whether a colored area was spurious or not. Only shadows or lack of shadows can be judged from the 750 nm image, making it a more objective method to eliminate the spurious signals.

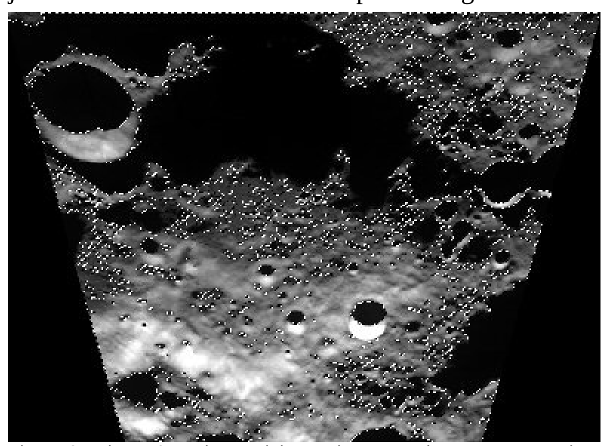

Figure 3. The 750 nm image (Figure 1) was used to create a mask to block out areas of the image that are in shadow.

The mask created from the 750 nm image was then applied to the false-color multispectral ratio image. The result is shown in Figure 4.

Several small areas of yellow/orange remain, which are not caused by shadowing. The six largest areas that show the yellow to orange coloring range in size from 23 pixels to 100 pixels, thus they satisfy the 8x8 averaging criterion of [2] to establish color data (although no attempt is made here to quantify the color data). Yellow, red and orange may be associated with high-titanium mafic materials [2] or pyroclastic materials [4].

Light blue and green colors also represent mafic materials in the Clementine multispectral data [2], and they may be interpreted as mafic signatures in Scott as well. Darker areas of the crater floor in Scott correspond to cyan and green colors in the ratio image, whereas higher-albedo materials correspond to dark blue or purple. Cyan is representative of mafic material when it is coupled with low albedo, whereas darker blue and higher albedo suggest more aluminous rocks.

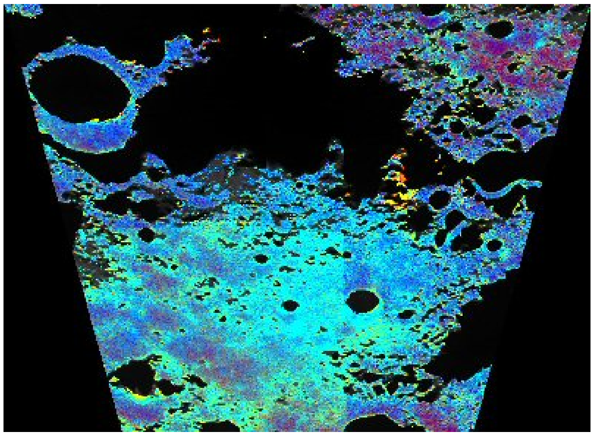

Figure 4. Result of masking process, which removes the spurious yellow, orange and red colors from the ratio image (compare to Figure 2).

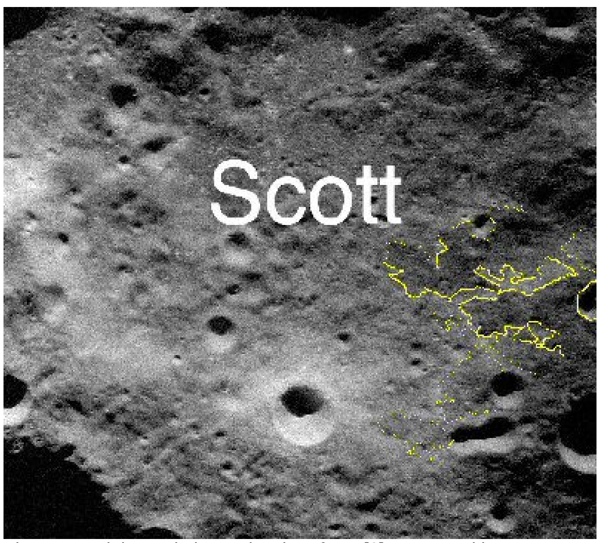

Figure 5. High-resolution radar data from [3]. Areas with greater surface roughness appear darker in the radar image. Yellow outline shows the area of darker material that corresponds with the yellow and organge colors in the multispectral false color ratio image of Figure 4.

Impact melt is shown as an intense red in the data described by [2], and this deep red color is also seen in the masked ratio image, as an arcuate shape at the top of the image. This corresponds to the wall of the crater Demonax, which is relatively younger than Scott, as shown by its sharper features and by the fact that its rim overlies and deforms the rim of Scott. Similar to Copernicus, this deep red color is concentrated in small areas along ledges of the crater walls, corresponding to locations where impact melt might be expected.

Materials rich in plagioclase feldspar and low in mafic minerals are relatively bright in the 750 nm images [2] and in standard grayscale photography. In the Lunar Orbiter imagery (Figure 6) the area that corresponds to the yellow and orange color is seen to be darker (lower albedo) than the surrounding area, which corresponds to the situation in Copernicus. This suggests the possibility of a higher iron content in this area, further supporting the hypothesis that mafic materials are present at this location.

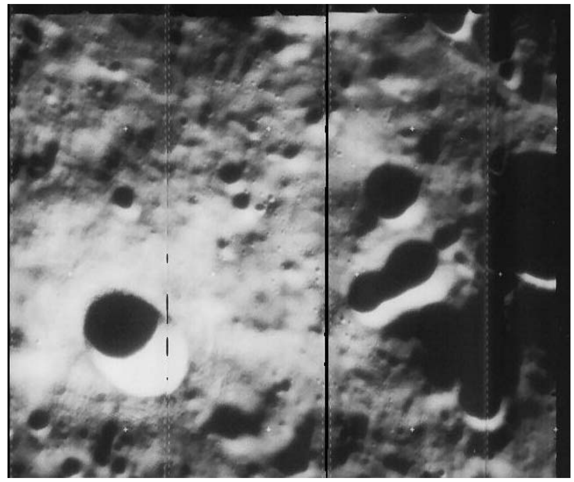

Figure 6. Lunar Orbiter IV image of the area of interest. Note the optically dark material at the top and top-right areas. This corresponds to the area where the yellow/orange colors appear in the masked Clementine ratio image.

Conclusions: Spurious color information from shadowed areas in the Clementine multispectral imagery can be removed by manual selection and masking of shadowed areas in the 750 nm image, then transferring the mask to an identically-sized and located multispectral image. This procedure allows useful spectral data to be obtained from images that are otherwise swamped by spurious bright reds and yellows. Using this procedure, areas of mafic material have been identified on the wall and floor of Scott crater. Evidence for albedo and surface roughness variations for this same area were obtained from Lunar Orbiter and high-resolution radar data, respectively, sproviding additional evidence of compositional variation.

This area presents a test-case opportunity for the upcoming Lunar Reconnaissance Orbiter in its search for lunar resources in the polar regions. The LAMP instrument will image the shadowed areas and give improved information on the overall morphology of the region, which will improve our understanding of the topographic relationships of the hypothesized pyroclastic materials. The Lunar Reconnaissance Orbiter Camera will provide meter-scale mapping over a two year period, providing information on the parts of Scott crater that are shadowed in the Clementine data.

References: [1] Lucey *et al.* (1998) *JGR*, 103, 3679. [2] Pieters et al. (1994) *Science*, 266, 1844. [3] Campbell and Campbell (2006) *Nature*, Oct. 19. [4] Farrand *et al.* (1999), *New Views of the Moon II.*