SITE SELECTION FOR THE INTERLUNE-1 MISSION; D.J. Wilcox[1] and C.J. Merry, Center for Mapping, Dept. of Civil Engineering, The Ohio State University, 1216 Kinnear Road, Columbus, Ohio 43212 [1]now at the Virginia Institute of Marine Science, Gloucester Pt., VA

ABSTRACT. We investigated how current remote sensing and geographic information system (GIS) methods can be applied to map a promising area of the moon for lunar volatiles. Data from multispectral telescopic CCD (charged coupled device) images, an early geology map, and an elevation contour map were combined and analyzed using a GIS to produce a set of multispectral and terrain-based signatures for ten geologic units in Mare Tranquillitatis. The accuracy of this new map was assessed by comparison with an older geologic map and also by overlaying it on Orbiter orthophotos for a manual interpretation. Through this approach, we found some inaccuracies in the data sets, however, most geology formations were correctly classified and delineated. The database will be augmented with Galileo and Clementine data to improve the definition of potential sites for future lunar exploration.

INTRODUCTION. In the next 50 to 100 years, terrestrial resources may become sufficiently depleted that we may look to lunar resources as a viable alternative. For example, recent work has shown that the moon is a source of Helium-3, an isotope of helium that shows promise as a source for fusion energy [1]. Multispectral studies of the moon's surface have shown that Helium-3 is strongly associated with the percentage of $TiO_2$ in the soil [2,3].

Despite the relative proximity of the moon, our knowledge of the precise composition and distribution of lunar resources remains incomplete. Since the collection of lunar samples essentially ended with the Apollo program and was restricted to only the few sites that were visited, the samples can provide detailed geologic information for only a small area.

For the remainder of the moon most of our geologic understanding is based on the analysis of multispectral data. The fact that telescopic observations were used to correctly predict many geologic characteristics of the moon prior to the Apollo landings demonstrates the power of this approach [4].

METHODOLOGY. An area of Mare Tranquillitatis was selected for the present study, as it was carefully mapped for the Apollo program and has been studied extensively by lunar geologists. The study area was also shown to possibly contain an above average amount of Helium-3 by Cameron (pers. comm., 1993) and is a 350 km by 210 km area centered at approximately 25° East, 8° North on the east side of the Julius Caesar quadrangle.

A set of four 16-bit telescopic CCD images at wavelengths of 0.40 μm, 0.56 μm, 0.75 μm and 0.95 μm were acquired from the Tumamoc Hill Observatory. The images are 490 by 299 pixels in size and have a resolution of approximately 0.7 km per pixel. The raw image data were read into the PC-based MIPS (Map and Image Processing System) image processing program, reformatted and written to ERDAS (Earth Resources Data Analysis System) format files that were read by the software packages used in this project.

Elevation contour lines were digitized into a GIS layer and then manipulated analytically to produce percent slope estimates for each pixel. The geologic map of the Julius Caesar quadrangle [5] was also acquired and digitized into a GIS polygon layer.

Before the data layers could be used together, all of the materials had to be registered to a common map projection. To minimize changing the radiometric information in the image data, all other data sources were projected to match the remote sensing images.

A supervised classification to produce a map of the geologic units for the image area was used. Training sets were selected by overlaying the geology map onto the images and slope map, and the mean relative spectral band ratio and slope values were calculated for ten classes. To permit the values to be directly comparable, all four data layers were normalized to their standard deviation before processing. The minimum distance classifier that was applied to the relative reflectance ratios using these ten signatures to create a classified image. The classifier was unable to separate features with similar spectral signatures. Many of the errors that occurred were between classes that were spectrally similar, but differed in average slope. Therefore, slope was added to the classification process and used to generate a second classification. A comparison of this classification and the classification using only the multispectral data clearly showed that the slope data contributes important information that was confirmed by a 13.2% increase in accuracy.

In addition to differentiating geologic units using a supervised classification, it is possible to use the multispectral band ratios to estimate the amount of $TiO_2$ in the image area. Since the relative reflectance ratio data were normalized to match the values in McCord *et al.* [6], it was possible to directly apply the Charette *et al.* [2] relation to predict the percentage of $TiO_2$. The 0.40/0.56 μm multispectral band ratio was used to map the distribution of $TiO_2$ over the image area. The resulting map shows that the image area contains approximately 5,500 $km^2$ with a $TiO_2$ concentration above 10% and, therefore, should be investigated as a source of Helium-3.

This area will be studied in more detail for final site selection for the Interlune-1 mission being planned as part of NASA's Discovery program. Data from the Galileo and Clementine missions will be incorporated into our database for additional analyses.

CONCLUSIONS. Standard GIS and image processing systems can be used effectively to study lunar data. The systems are capable of handling a change of coordinates and projections easily, making it possible to analyze several different map and image sources. In addition, many of the spatial analysis tools that are used for terrestrial terrain analysis can also be applied effectively to lunar data. These include surface visualization and draping tools, calculation of Triangulated Irregular Network (TIN) models and spatial analysis. When high resolution lunar DEMs become available, these will be invaluable tools for extending our knowledge of lunar geology.

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