LITHOLGICAL MAPPING OF LUNAR TERRANES USING HYBRID CLASSIFICATION APPROACH.

Deepak Dhingra, Planetary Sciences & Exploration Programme (PLANEX), Physical Research Laboratory, Navrangpura, Ahmedabad-380009 (India). Email: deepakd@prl.res.in.

Introduction: The type of rocks, their geographic distribution and stratigraphic relations form the fundamental dataset in interpreting geological history of any region of a planetary body. In the case of the lunar crust, eleven rock types have been identified based on their spectral character [1]. A new classification approach that integrates diverse parameters like mineralogy, elemental composition and maturity for identification and mapping lithological classes of [1] on the lunar surface is proposed. Such an integrated approach is desirable as the different methodologies adopted for deciphering lithological composition have their own limitations. This is especially true in case of multispectral data like UVVIS Clementine datasets.

Datasets: UVVIS multispectral datasets (415 nm - 1000 nm) at spatial resolution of 100 m from Clementine mission [2] have been used in this study. Various parameters like mineralogy, elemental composition and maturity have been derived from this original dataset using standard algorithms [1, 3, 4, 5, 6]. Further, the eleven spectral classes observed by [1] have been used to derive criteria for discriminating among these different classes.

Methodology: This hybrid classification or code comprises of mathematical formulations which have been implemented using image processing software ENVI. It involves devising a set of criteria or conditions where the output is based on a binary decision. After applying the criteria, the target dataset gets divided into two classes: one for which applied criterion/condition holds true and the other, for which it is false. One can further analyze each of the generated classes by applying additional conditions and hence obtain subclasses.

In the present work, the approach starts by deriving major classes which are subsequently subdivided based on the differences that exist within each major class. These differences are broadly based on the 11 spectral classes defined previously [1] but not limited by them. Further, the mathematical implementation is not limited to the spectral shape alone. In the beginning of the classification, regions least affected by processes of optical maturity are identified [7]. The present classification is applied at present only to these regions with immature materials as they would provide the most reliable information pertaining to composition. The OMAT parameter [6] has been used in identifying immature material.

Results and Discussions: The code has been tested on specific lunar sites for which compositional information is already available. Results obtained for central peaks of craters Bullialdus and Tsiolkovsky match with the interpretations of earlier workers [1, 8, 9, 10] to the first order. Some new features, such as, exposures of probably gabbroic affiliation, in the case of Tsiolkovsky central peak, have been identified that were not reported earlier. This observation is im portant in view of the recent detection of pyroxene at some other locations on Tsiolkovsky peak [11]. In addition, lithological diversity map, generated on the basis of 11 rock type classes also provide the geological context in terms of rock type associations.

High spatial and spectral resolution data is being collected by SELENE and Chandrayaan-1 missions. These dataset would improve identification of known lithologies through remote sensing. One may also expect many new rock types and subclasses of existing rocks to be discovered. The new classification scheme can be suitably modified to incorporate additional criteria for analysis of data from the new generation missions to infer geological history of various lunar terrains. The proposed classification scheme will be tested on other well characterized targets to make it more robust for application in the lunar context.

References:

[1] Tompkins S. & Pieters C.M. (1999) *MAPS, 34*, 25-41. [2] Nozette S. et al. (1994) *Science, 266 (5192)*, 1835-1839. [3] Pieters C.M., Head J.W., Gaddis L., Jolliff B. and Duke M. (2001) *JGR, 104(E11)*, 28001-28022. [4] Dhingra D. (2008), *Adv. Space Res., 42 (2)*, 275-280. [5] Lucey P.G., Blewett D.T., and Jolliff B. (2000) *JGR, 105(E8)*, 20297-20305 [6] Lucey P.G., Blewett D.T., Taylor G.J. and Hawke B.R. (2000), *JGR, 105 (E8)*, 20377-20386 [7] Fischer E.M. & Pieters C.M. (1994) *Icarus, 111 (2)*, 475-488 [8] Pieters C.M. (1991) *GRL, 18*, 2129-2132 [9] Cahill J.T. and Lucey P.G. (2007) *JGR, 112, E10007*, doi 10.1029/2006JE002868 [10] Pieters and Tompkins (1999) *JGR, 104 (E9)*, 21935-21949 [11] Matsunaga et al, (2008) *GRL, 35*, L23201, doi:10.1029/2008