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Unsupervised Classification of the Moon's Surface Reflectance Spectra and Geological Significance (2)

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Clarifying of lunar geological map is essential in understanding the initial formation of lunar crust and the mixing process of lunar surface rocks due to igneous activities and meteorite impacts. However, the global geological map shown today has been published in the 1980s after the Apollo era, which does not include various new knowledge found in recent exploration. Therefore, we started a project to make a new global geological map of the Moon based on new data as topography, mineral and elemental composition acquired by Japanese lunar explorer "Kaguya".

A basic item for the project is a classification map of reflectance spectra obtained by Maltiband Imager (MI) and Spectral Profiler (SP) aboard Kaguya, which include information of rock and mineral kinds. However, since the data collected by MI and SP is very huge, data processing for whole moon is impossible to complete by working of only human's eyes and hands. And, the classification should be exclude researcher's subjective or philosophy as possible, especially in the first phase of analysis. Standing this point of view, we adopt ISODATA (Iterative Self-Organizing Data Analysis Technique) method as Unsupervised Classification (UC) with Independent Component Analysis (ICA) for classification of the reflectance spectra.

ICA is a powerful tool for analysis of multispectral or hyperspectral datasets to extract mutually independent components (ICs) from a set of mixed-random signals. This work is the first examination to apply ICA to the reflectance spectra from lunar surface, though ICA has been adopted to lunar gamma-ray spectra obtained gamma-ray spectrometer onboard Kaguya [10]. It was found that the global maps of extracted ICs clearly showed some mineral and/or rocks distributions as true signals, some characteristic patterns as noises due to mechanical and observational conditions and many random noises.

After ICA, the signal ICs are put in UC. This work employed ISODATA method as UC. ISODATA calculates class means evenly distributed in the data space then iteratively clusters the remaining pixels using minimum distance techniques. Users do not need to know the number of clusters and can define threshold values for parameters as minimum distance or minimum number of pixels for a class and so on. As a result, whole moon were divided into 50 -100 classes, though it was depended on the threshold values.

This report will shows the detail procedure for classification of lunar reflectance spectra and discusses validity and applicability of this procedure based on the results.

Keywords: Moon, Geological Classification, Reflectance, Independent Component Analysis, Unsupervised Classification, Kaguya