Lunar geologic map based on auto classification of Kaguya spectral data

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Geologic mapping is essential to understand the history of the crust formation and the volcanic activity of its plant or satellite. For the Moon, many researchers have made the lunar geological map. Those work were mainly based on albedo, texture and topography of the lunar terrain, and relative age from crater counting, which were obtained in the Apollo era. There is no mineral and chemical composition-oriented geologic map of the entire Moon up to today, while those have been reported about many local area.
By using reflectance spectrum data set obtained by the Spectral Profiler (SP) and Multiband Imager (MI) aboard Kaguya, we have started a project to make a new geological map that is mineral and chemical composition-oriented. The SP observed lunar reflectance with 296 bands in the wavelength range of 510 to 2600 nm with footprint of 500 m×500 m. The SP data of 160 bands between 510 and 1600 nm was averaged pixel by pixel of 0.5 degree interval in longitude and latitude and was removed a continuous part from each reflectance spectrum, called as SP-Cube Depth. And, the abundance map of titanium oxide calculated from MI data was also used for this work.
To construct the geologic map, the unsupervised clustering methods as K-means and ISODATA were adopted to classify the SP-Cube Depth. These are similar algorithm, but the input parameters for the classification are different. One of them is the final number of class. While the K-means needs it, the ISODATA do not need it. Since nobody knows the true number of class as the lunar spectral surface unit, the ISODATA is more suitable for this work than the K-means. However, comparing with the K-means, the ISODATA requires more calculation time, as the data increase. Therefore, at first, we divided the entire Moon into 7 classes by K-means, which correspond approximately to two mare regions, South Pole–Aitken (SPA), two highland regions, boundary regions between mare/SPA and highland, and relatively fresh crater ejecta. Then, the 3 classes corresponding to the mare regions and the boundary region between mare and highland were divided into 5 classes in each by the titanium content, because the sensitivity for that is small in the SP-Cube depth. Finally, all classes were applied to the ISODATA to classify the SP-Cube Depth. As a result, the SP-Cube Depth was divided into 66 classes in total.
Focusing on the Aristarchus and Marius regions, Aristarchus crater, the Aristarchus plateau and the Marius hills can be classified as other classes. At Aristarchus crater, inside and outside of the crater was divided into other classes. The crater ejecta in the outside were recognized as some classes near the crater and one of their classes has SPA-like spectrum as low calcium pyroxene type.
This report presents the analytical procedure and the result of automatic classification of lunar reflectance spectra.

Keywords: Moon, geologic map, spectroscopy, unsupervised clustering, SELENE/Kaguya

