

Mapping of pyroxenes on the lunar nearside using Terra/ASTER data

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Advanced Spaceborne Thermal Emission and Reflection radiometer (ASTER), a multiband high resolution sensor onboard the Earth observation satellite Terra, has six spectral bands in the range of 1650nm to 2395nm in the SWIR region. ASTER obtained image data of the near side of the moon for the purpose of lunar calibration.

One of major minerals in the lunar mare basalt is pyroxene, whose chemical composition widely varies. The absorption peak by Fe²⁺ crystal field transitions in the SWIR reflectance spectra of pyroxene shifts to longer wavelength when Ca or Fe increases.

The purpose of this study is to develop a method to estimate abundance and composition of pyroxene in the lunar mare basalt by using the ASTER/SWIR bands.

A continuum slope is known as a method to reduce the space weathering effect, and is employed to detect the spectral feature in ASTER/SWIR data. Continuum Depth (CD) is defined as a ratio between output of each band and the value on the continuum slope. We draw 2 straight lines as the continuum slope, one line between bands 4 to 9 to detect the pyroxene absorption depth and another between bands 5 to 9 to detect the shift of the pyroxene absorption due to their chemical composition change. As shown below, inside of () was the function of above straight line.

$$CD = 1 - \text{band } i / (a * Wav_i + b)$$

(a: gradient, b: intercept, Wav_i:wavelength of band i, band i:reflectance of band i)

We applied this method to the Apollo samples. Reflectance spectra, modal abundance of minerals, and chemical composition of pyroxene for different grain size (0-10, 10-20, 20-45 micro meter) were measured for 9 mare samples. The correlation coefficient between pyroxene abundance and the CD of band 5 to the bands 4 to 9 continuum (CDB 5) was 0.92.

And we applied this method to the reflectance spectra of orthopyroxene and clinopyroxene mixture measured by Sunshine et al. (1990). The correlation coefficient between clinopyroxene abundance and the CD of band 6 to the bands 5 to 9 continuum (CDB 6) was 0.93.

We can conclude that the CD is a useful method for pyroxene mapping, so that we applied it to ASTER data. According to the results of CDB 5 mapping (pyroxene abundance mapping) and CDB 6 mapping (clinopyroxene abundance mapping), the mare basalt could be separated to a larger number of different units in mare Tranquillitatis and Humorum compared with the lithologic mapping by previous studies.