Improved method of the TiO2 abundance estimation of the lunar surface regarding ilmenite UVVIS reflectance spectra

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Ilmenite (Chemical formulae: $FeTiO_3$) is a kind of mineral mainly made by igneous and metamorphic processes. The color of ilmenite is dark and it contents Ti^{4+} in the crystal structure. In the solidification process of the magma, ilmenite tends to go in the liquid phase mostly because of the charge repulsion of Ti^{4+} with other elements, such as Fe^{2+} and Mg^{2+}. On the Moon, ilmenite is especially concentrated in the basalt soil and rocks (Mare region), which is formed by eruption of a magma from the lunar interior. Ilmenite is the dominant carrier of titanium (Baldridge et al., 1979; Beaty and Albee, 1978; Dymek et al., 1975) and Mare soil and rocks contain ilmenite as much as 15-20% by volume, according to the measurements of Apollo and Luna mission return samples. We can understand the lunar surface TiO_2 distribution by knowing the lunar surface ilmenite distribution.

To understand the lunar surface TiO_2 distribution, visible-near infrared reflectance spectra help us to understand the stratigraphic relationship in mare region. Also, the lunar surface TiO_2 distribution is used to understand the time-variable information of chemical compositions of each stratigraphical unit.

Lucey et al, (1998) is one of the commonly used Lucey diagram to make the lunar TiO_2 distribution map. It uses the 415nm and 750nm reflectance spectra from lunar surface.However, neither the presence of absorption band around 500 nm nor the grain size dependency of the ilmenite spectrum are clearly understood in Lucey et al, (1998, 2000). Therefore, reflectance at 415nm and 750nm used by Lucey et al, (1998, 2000) might not make the best use of the characteristics of the ilmenite spectrum, and there is a possibility to need consider the grain size dependency of the ilmenite spectrum for TiO_2 abundance estimation.

In this study, we first clarify the grain size dependency of the ilmenite spectrum and presences of the absorption band in the UVVIS wavelength region. Then, we determine the most appropriate wavelengths to estimate the lunar surface TiO_2 abundance. Finally we check the improvement of the estimation accuracy of the lunar surface TiO_2 abundance by the reflectance at the most appropriate wavelength except area of moon, where the volcanic glass with ilmenite exists, needs to be removed because of arising error by spectrum of volcanic glass.

The result by estimating the TiO_2 abundance of the return sample, we clarify the characteristics of the ilmenite spectrum, the presences of absorption band around 500 nm and the grain size dependency of the ilmenite spectrum in the UVVIS wavelength region. To estimate lunar surface TiO_2 abundance more precise than Lucey et al, (1998, 2000), the reflectance at 415nm and 1500nm wavelength is the most appropriate combination in case of removing volcanic glass-rich area of moon.