The modified gaussian model that incorporate a characteristic of the absorption band in spectrum of olivine

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In the surface reflectance spectra of planets, we often find a composite absorption band around 1 micron in wavelength due to the component silicates. As a method of deconvolving this complex absorption band into those of its component minerals, MGM (modified Gaussian model) is used as a standard method (Sunshine et al., 1990). However, each mineral species usually has multiple bands around 1 micron which overlap with one another and those of other minerals, making it difficult to assign the deconvolved bands into individual mineral components. Because the relationship between the chemical composition and absorption band characteristics of some minerals is known to some extent, it is expected that the above problem can be solved by such knowledge. In this study, we used this relation. Especially, three absorption bands of olivine are studied relatively well (Sunshine and Pieters 1998).

In the case of olivine, there are three bands (band 1, band 2, and band 3 from short wavelength side), making the number of parameters 9 (3  3). In this study, we investigate relationships between the Fa value (Fe content in olivine) and band center, band width and relative strength of olivine based on data (Sunshine and Pieters 1998), and utilizes them in our MGM calculations.

Reflectance spectra of olivine samples (0-45 micron and 0-60 micron) were taken from the RELAB database (http://lf314-rlds.geo.brown.edu/) and the USGS database (http://speclab.cr.usgs.gov/).

We assume each relationship is a linear function. MGM enables us to obtain three band center values from just one Fa value. We find little correlation between the Fa values and band width values for each band. All the band width values for each band are averaged to be used in our model calculations. We study the relative strengths of the three absorption bands. As previous investigation (Sunshine and Pieters, 1998), the band 1 strength relative to the band 3 strength seems to be modeled well as a constant, while the band 2 strength relative to the band 3 strength seems to change linearly along with the Fa value. Based on revelations between them, we can model each olivine spectrum using, instead of 9 variables, only 2 variables (Fa values and band 3 strength), and 12 constants.

We applied these new constraints to the MGM calculations of the same olivine spectra used above again. In MGM with these constraints, there is Fa value as a parameter. We give the relationship between the actual Fa values and those derived by MGM fits with these constraints. In the middle Fa value range MGM fits with these constraints have smaller errors. Even thought the low and high Fa value ranges have relatively large errors. This scheme was also applied to the spectrum of the Altaameem sample. A sample of Altaameem LL5 chondrite was ground into powder of 0-45 micron in size, and its reflectance spectrum was measured at 0 degree incidence and 30 degree emergence angles, using a spectrometer (MIRAI: mineral reflectance analysis instrument) of JAXA Institute of Space and Astronautical Science. While the normal MGM cannot give the correct features of olivine absorption within the Altaameem sample, this scheme of MGM can produce the correct features. We can also accurately give the absorption of pyroxene by removing. olivine absorption.

This preliminary study of putting constraints on olivine bands in the MGM calculations has shown a potential usefulness, although there still remain issues to address, such as accuracy.