Measurement and analysis of pyroxene by VIS-NIR reflectance spectra for chemical composition on the lunar surface

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[Introduction]

Many researchers made measurements of visible and near-infrared reflectance spectra of natural pyroxenes since the Apollo project (Adams, 1974 et al.). However, they used natural samples containing several transition elements, and the spectra shows complex spectra from the absorption from several transition elements. Therefore, it is difficult to quantify the effect of a single transition element on the absorption spectra of pyroxene. In order to argue the effect of a single transition element on the absorption spectra more systematically, we need to use synthesized pyroxenes of which compositions are controlled systematically.

Moreover, the main factor of the absorption bands of a reflectance spectrum is the electronic transitions of transition metals (especially pyroxene Fe) (Burns, 1970 et al.). Since two or more electronic transitions occur simultaneously, some absorption bands overlap with each other. Therefore, it is important to carry out peak separation of the overlapped absorption bands for investigating the bands more precisely and systematically.

In this work, we measured the visible and near-visible spectra of synthetic pyroxenes in the MgO-FeO-CaO-SiO2 system, and analyzed the spectra by deconvolution applying the modified Gaussian model (MGM) (Sunshine et al., 1990).

[Experimental procedure]

Pyroxene samples were synthesized at high pressure with the multi-anvil apparatus in the 1,000ton uniaxial press. Compositions of the samples were 1.En30Fs20Wo50, 2.En40Fs20Wo40, and 3.En80Fs20. The synthesis of the pyroxene samples was performed at 3GPa, and the temperature range from 1000 to 1200 degrees centigrade. Micro-Raman spectroscopy and Micro-Area X-ray Diffractometer were used for identification of the phases. The analysis of the composition was made by EDS. Grain size of all samples ranges from 75 to 105um. We measured the visible and near-infrared reflectance spectrum using a JASCO UV-VIS-NIR reflectance spectrometer at Japan Aerospace Exploration Agency (0.4-2.6um in wavelength). Incidence and emission angles were 30 degrees and 0 degrees, respectively.

[Results]

In three synthesized samples, sample 1. and sample 2. were clinopyroxene and sample 3.were orthopyroxene.

Absorption wavelengths before analysis were 1.07um(1.Cpx), 1.05 and 2.34um(2.Cpx), and 0.91 and 1.87um(3.Opx). After decomvolution, their wavelengths were 1.07um(1.Cpx), 0.83, 1.02, 1.25, and 2.32um(2.Cpx), and 0.91, 1.14, and 1.87um(3.Opx). The relations between the absorption wave length and Fe#(=FeO/(MgO+FeO+CaO)) or Ca#(=CaO/(MgO+FeO+CaO)) for our data before the MGM deconvolution are consistent with those for natural pyroxenes (Adams, 1974; Cloutis, 1991). The data of wavelength after the deconvolution does not fit the above relations. However, we can expect a new correlation between the composition and the absorption wavelength by accumulation of the new data separated by the MGM deconvolution.