Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PPS22-P07 Room:Convention Hall Time:May 27 18:15-19:30

Characterization of aqueous alteration of the C-complex asteroids by reflectance spectra of carbonaceous chondrites

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C-complex asteroids are a key object to elucidate the evolution of volatile materials in the solar system, because they are enriched in volatiles and most abundant asteroids. Therefore, we need to investigate the mineralogy and the degree of aqueous alteration of the C-complex asteroids using reflectance spectroscopy. Each absorption band observed in reflectance spectra of C-complex asteroids should be characterized and assigned based on reflectance spectra of carbonaceous chondrites which are thought to derive from the C-complex asteroids (e.g. Beck et al. 2010, Takir et al. 2013). Therefore, we need to measure reflectance spectra of hydrated carbonaceous chondrites whose mineralogy and petrology are well characterized. In this study, we measured reflectance spectra of 16 CM carbonaceous chondrites under vacuum (2hPa) using a FT-IR (Fourier Transform Infrared) spectrometer and investigated relationships between features of reflectance spectra and mineralogical properties, especially between the degree of aqueous alteration and properties of 3μm and 0.7μm absorption bands that are related to hydrous minerals. All CM chondrite samples were characterized in detail by synchrotron X-ray diffraction and electron microscopy (Nakata et al. 2014).

There is a weak correlation between the 3μm-band absorption position and subtype of the meteorites that expresses the alteration degrees (Rubin et al. 2007). Samples with the absorption position at shorter wavelengths are more altered, while those with the absorption position at longer wavelengths are less altered. This trend is consistent with previous studies (Beck et al. 2010, Takir et al. 2013). However, samples with the absorption position at middle wavelengths show a wide range of alteration degrees. Therefore, it is the case that the absorption position at shortest or longest wavelengths corresponds to greatest or least alteration, respectively. In addition, Fe/Mg ratios of matrix phyllosilicates and the 3μm-band absorption position show a weak correlation. The absorption position shifts from long to short wavelengths with decreasing Fe contents.

On the other hand, 0.7μm-band depth shows no correlation to subtype and thus the 0.7μm-band properties seem to have no relation to the degrees of aqueous alteration. The 0.7μm-band depth also shows no correlation to Fe/Mg ratio of matrix phyllosilicates. Since the 0.7μm band is attributed to Fe^{3+} and Fe^{2+} charge transfer in phyllosilicates, the lack of the correlation suggests no clear relation between the alteration degrees and Fe^{3+}/Fe^{2+} ratios of matrix phyllosilicates

In this study, we investigated relationships between 3μm and 0.7μm band properties and the mineralogy of CM carbonaceous chondrites, and we show that it is possible to characterize to some extent the degrees of aqueous alteration of C-complex asteroids using reflectance spectroscopy.

Keywords: aqueous alteration, C-complex asteroids, reflectance spectra