SPECTRAL AND WATER ANALYSIS OF EXPERIMENTALLY HEATED TAGISH LAKE AND CR CARBONACEOUS CHONDRITES WITH NO EFFECTS OF ADSORBED AND REHYDRATED WATER.

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Reflectance spectra of hydrated C-complex asteroids and mineralogical study of carbonaceous chondrites indicate that heating and dehydration is common in the hydrous asteroids [e.g., 1-2]. Water contents of heated carbonaceous chondrites are lower than those of unheated meteorites because of dehydration of phyllosilicates [3] and experimental heating of hydrous carbonaceous chondrite Murchison weakened the strength of 3-μm band [e.g. 1-2], which indicate that heating and dehydration of the asteroids results in spectral changes and water depletion. However, recent experimental heating of Murchison [4] revealed that adsorption and rehydration of atmospheric water on the heated Murchison samples severely affect the strength of the 3-μm band and the water contents. This indicates that the same water contamination occurs on the Earth to CMs heated in asteroids. Therefore, spectral measurement and water analysis of heated hydrous carbonaceous chondrites without any effects of adsorbed and rehydrated water are obviously very important to compare reflectance spectra between asteroids and meteorites. In this study, we performed heating experiments of Tagish Lake and LAP 04721 CR2.4 carbonaceous chondrites and subsequently measured reflectance spectra and water contents of the heated samples without being exposed to atmosphere after heating.

Tagish Lake powders were heated for 50 hours at IW oxygen buffer at 400, 600, 700, and 900℃. Synchrotron-radiation X-ray diffraction analysis of matrix particles indicate that major-water bearing material in this meteorite is saponite and it loses interlayer water at 400℃ and structural water mostly at 700℃ and crystallization of secondary silicates and Fe metal proceeds to 900℃. Water contents, determined by Karl Fischer titration method, decrease from 4.4 wt% (unheated sample) to 2.5, 1.2, 1.1, 0.0 wt % for 400, 600, 700, and 900℃-heated sample, respectively. Reflectance spectra show that the 3-μm absorption band of the heated samples are sharp, which indicates that the 3-μm band is mainly ascribed to structural water in phyllosilicates and contribution from adsorbed and rehydrated atmospheric water is negligible. The 3-μm absorption band becomes smaller with increasing heating temperature and almost disappears at 700℃, which indicates that saponite decomposition and dehydration is almost complete at this temperature. The temperature is consistent with that of saponite break down estimated based on the results of mineralogical and water analysis.

LAP 04721 powders were heated for 50 hours at IW oxygen buffer at 400, 600 and 900°C. Based on the X-ray diffraction analysis, it is known that unheated matrix consists mainly of serpentine, while heating to 600°C almost decomposes the serpentine and at 900°C recrystallization of secondary olivine and Fe-metal are facilitated. Water contents of unheated, 400, 600 and 900°C samples are 2.8, 1.0, 0.2, 0.0, respectively. Spectral measurements indicate that the 3-μm absorption band becomes smaller at 400°C and almost disappears at 600°C. All these mineralogical, spectral, and water analysis indicates that serpentine in this CR chondrite starts to decompose at 400°C and dehydrates almost completely at 600°C. The decomposition temperature is lower than that of saponite in Tagish Lake meteorite.

Our results trace the precise changes of spectra and water contents by eliminating the effects of adsorbed and rehydrated atmospheric water on the experimentally heated Tagish Lake and LAP 04721 chondrite samples. All results taken together, including those from heating experiments of Murchison [4], we now understand how heating and dehydration proceed for CM, CR, and Tagish Lake carbonaceous chondrites. We found that, with increasing temperature of heating, the water content and the 3-μm band depth decrease in a similar way for the three different carbonaceous chondrites: They form a single trend of correlation between the water content and the 3-μm band depth. This correlation is valid for many C-complex asteroids, because it covers a variety of hydrated carbonaceous chondrites, CM, CR, and Tagish Lake. Recent spectroscopic observation of a largest C-complex asteroid Ceres from Dawn space craft shows a distinct, sharp 3-μm absorption band indicative of phyllosilicates as a major phase. We apply our correlation line to the 3-μm band depth of average Ceres spectra [5] and found that 3~4 wt% water content in the phyllosilicates at the surface of Ceres. The estimated water content of the surface is much lower than the average water content in a layer from surface to several-meter depth obtained from neutron-spectrometer measurement (~20 wt% [6]), which indicates that most of water seems to be present beneath the surface and only structural water in phyllosilicates remains on the surface of Ceres.

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