SOLAR-RADIATION HEATING AS A POSSIBLE HEAT SOURCE FOR DEHYDRATION OF HYDROUS CARBONACEOUS CHONDRITES.

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Introduction: The visible–IR (VIR) spectra of several C-complex (C/G/B/F-types) main-belt asteroids are consistent with those of dehydrated carbonaceous chondrites (CCs) [e.g. 1]. This suggests that surfaces of these asteroids could be source regions of dehydrated CCs [e.g., 2]. On the other hand, some C-complex near-sun asteroids (NSAs) with a small perihelion distance, such as (3200) Phaethon, (155140) 2005 UD, and (225416) 1999 YC, undergo high temperature episodes due to solar radiation heating during perihelion passages. Phaethon would be the main mass of their complex stream, having characteristic orbital and physical parameters of orbital period P = 1.43 yr, perihelion q/aphelion Q at 0.14/2.40 AU, inclination i = 22º.2, a diameter of 5.1 km, thermal inertia $\Gamma = 600$ J $m^{-2}s^{-1/2}K^{-1}$, and geometric visible albedo $p_v = 0.122$ [3]. The sub-solar surface temperature of Phaethon at perihelion is estimated to be higher than the serpentine decomposition temperature, suggesting that Phaethon's surface material would be similar to dehydrated CCs [4]. It remains to be clarified whether mineralogical and compositional properties of dehydrated CCs are really produced by solar radiation heating. In the present study, we have calculated time-dependent temperature profiles of near surface layers of these three NSAs for a timescale of 1000 yr, estimated the degrees of dehydration and volatile loss, and compared the expected characteristics with naturally and experimentally heated hydrous CCs.

Calculation procedure for time-dependent temperature-depth profiles: The profiles are calculated using an implicit 1D finite-difference code assuming a spherically symmetric geometry. The calculation of the thermal evolution is based on the two simple models: (a) the sub-solar model and (b) the black-body model. The sub-solar model for maximum heating is valid for the point where the sun is in zenith. Calculations based on this model show that the dehydration can operate in certain surface regions of asteroids, but not everywhere on its surface. On the other hand, the fast rotation black-body model for minimum heating assumes the same temperature everywhere, since all three considered asteroids rotate very fast and therefore the emitted radiation comes from the total surface area. We simulate the uppermost 150 m of the asteroids of interest. The spatial resolution is 1 cm and the time resolution is 12 hours. Simulations cover more than 1000 years of thermal evolution to remove potential effects related to the initial temperature profile. For the temperature propagation in asteroids, we assume a thermal diffusivity as low as $\sim 10^{-7}$ m^2/s [5].

Results and discussion: The results assuming the subsolar model predict for Phaethon a peak temperature exceeding 1000 K at the surface and the uppermost 28 cm are heated to 673 ºC and more for more than 50 hours during each perihelion passage. On the other hand, assuming the fast rotation black body model, only the uppermost top 4 cm are heated to 673 K or more for only 24 hours during the perihelion passage. For the two other NSAs of interest, 2005UD and 1999YC, the peak temperatures reach 949 K and 784 K, respectively. Based on the sub-solar model for those two asteroids the top 25 cm and 14 cm are heated to 673 K or more for more than 50 hours during each perihelion passage, respectively. The time-dependent temperature profile depends on the position on the asteroids and on the polar axis of the asteroids (sub-solar latitudes on Phaethon at perihelion would be located at 8º.7 N based on [3] and 41º.4 N based on [7]) and thus the real heating degree is expected to be somewhere between the two model calculations. Experimental heating of Murchison (CM2) [6] indicates that heating at 673 K for 50 hours decomposes Fe- serpentine and tochilinite, evaporates 2/3 of water, and weakens 3-μm absorption band in the VIR reflectance spectra. The 50 hr heating at 873 K changes all hydrous phases to anhydrous, removes almost all water, and causes disappearance of 3-μm absorption band. These mineralogical and compositional changes are expected to occur at all three NSAs regolith during a single perihelion passage. Phaethon's perihelion has dynamically been staying at < 0.14 AU for ~3,800 yr (1738 BC to AD 2024), so that the heating effects cumulate over time. The present results indicate that 10- to 20 cm-sized dehydrated meteoroids can come from objects like Phaethon. Such dehydrated CCs would show depletion of radiogenic noble gases such as ^{40}Ar and ^{129}Xe due to recent heating and depletion of light cosmogenic noble gases because of diffusive loss of light cosmogenic gas from regolith surface during solar radiation heating. All these signatures are observed in some dehydrated CCs, such as B-7904 and PCA-02012 [8]. **Acknowledgement:** This work was supported by the JSPS Japanese-German Graduate Externship.

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