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反射スペクトルから推定されるC型小惑星の多様性
Material diversity of C-type asteroids with reference to their reflectance spectra

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The target asteroid of Hayabusa 2 mission is Near-Earth asteroid 162173 (1999JU3) with a size of 0.87 ± 0.03 km and a low albedo 0.070 ± 0.006 (Muller et al. 2011). It is a C-type asteroid whose reflectance spectrum shows a 0.7 micron absorptipon band (Vilas, 2008), similar to CM-type carbonaceous chondrite meteorites. However, recent telescopic observations of JU3 failed to detect the 0.7 micron band, which probably indicates material diversity of the JU3 surface.

In the early solar system, rocky particles were accreted with icy particles to form C-type asteroids. Internal heating due to the decay of short-lived radionuclide 26Al has taken place within 5 million years after the birth of CAIs and molten ice to facilitate water-rock reactions. The deeper portions of the asteroids suffered high temperature heating and thus heavy aqueous alteration, while shallow layers experienced low-degree of alteration at low temperatures. This leads to the formation of zoned sturature from heavy altered interior to weakly altered surface. The aqueous alteration reactions ceased sometime between 10 to 100 million years after CAI farmation.

However, if we assume that JU3 formed with a size of 1km, which is comparable to current size, at 2 Myr after CAI formation, the internal temperature cannot reach melting temperature of ice by the decay heat of 26Al.In this case, aqueous alteration has never taken place in JU3, which contradicts the detection of hydrous minerals from JU3. Thereofere, JU3 might have been much larger than current size when it formed and later disaggregated. This suggests that JU3 is a rubble pile asteroid and the zoning structure of alteration is expevted to observe.

During 4.6 billion years after formation, surfaces of JU3 have been subject to impacts. Dust particles, the largest population is 200 microns, and solar winds continuously hit the surface of the asteroids, which results in changes of materials, callled ”Space weathering”. We have simulated dust-particle impacts on C-type asteroids experimentally. Pulse laser heating on the CM chondrite surfaces succeeds to reproduce ”bluing” of the reflectance spectra (Matsuoka et al. 2013), which is observed from space-weathered C-type asteroids. The blueing agents are probably nano-particles of iron sulfides and amorphization of Fe-rich serpentine.

Along with micrometeorite bombardments, large scale impacts occur occasionally on the asteroids which leads devolatilization of hydrous material. In fact, many C-type asteroids show reflectance spectra similar to dehydrated carboncaeous chondrites. Recent mineralogical investigation of such dehydrated CM chondrites revealed a wide variation of mineralogy in terms of dehydration (Nakato et al. 2013).

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