

# Carbonaceous chondrite clasts in H chondrite regolith breccias: their features and implications

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**Introduction:** Ordinary chondrite regolith breccias are thought to have been formed near the surface of ordinary chondrite parent bodies. We have been studying mineralogy, noble gas signatures and oxygen isotopic compositions of ordinary chondrite regolith breccias to investigate evolution of surface materials of their parent asteroids. In this study, we will show the mineralogy of carbonaceous chondrite clasts in three H chondrite regolith breccias: Tsukuba, Willard (b) and Zag. We will discuss the lithification processes in the regolith of their parent body and origin of the clasts.

**Results:** We have already reported briefly mineralogy of carbonaceous chondrite clasts in Tsukuba and Willard (b) [1,2]. In the clasts in Tsukuba, their major minerals are saponite, serpentine, magnetite, pyrrhotite, pentlandite, olivine, and low-Ca pyroxene. TEM observation and analysis show that the clasts have mineralogical features similar to those of CI chondrites although the clasts do not contain ferrihydrite that is a typical mineral in Orgueil CI chondrite and that the clasts contain Fe-bearing olivine and low-Ca pyroxene that were derived from host H chondrite. In the case of Willard (b), major minerals are saponite, serpentine, magnetite, pyrrhotite, pentlandite, ferrihydrite, and magnesite-siderite. TEM observation and analysis show that the clasts have mineralogy intermediate to that of CIs and Tagish Lake carbonaceous chondrite that was derived from a D-type asteroid. A carbonaceous chondrite clast contains major minerals such as saponite, magnetite, pyrrhotite, and pentlandite. Their mineralogy is similar to that of Tagish Lake. Existence of magnesite-siderite in the clast also suggests their similarity to Tagish Lake.

**Discussion:** Phyllosilicates in these clasts do not show the decrease of basal layer spacing and the degree of crystallinity of them. Moreover, clasts in Willard (b) and Zag, siderite-rich carbonate exists. These facts mean that these clasts did not experience high temperature (more than 500 oC) during collision, disruption, capture, and lithification processes. These facts also suggest that velocities of meteorites and cosmic dust that collided onto the H chondrite parent body were lower than the cases of the Moon and HED parent body.

This study also suggests that materials derived from C-type asteroids (CI-like material), P-type asteroids (intermediate between CIs and Tagish Lake), and D-type asteroids (Tagish Lake-like material) collided onto the H chondrite parent body (probably near-earth asteroid(s)). Our previous study shows that fine-grained materials derived from C- and D-type asteroids occupy the majority of cosmic dust that falls onto the Earth [3]. This coincidence may indicate that these carbonaceous chondrite clasts are relict cosmic dust that survived in the regolith of H chondrite parent body.

**References:** [1] Nakashima et al. (2003) EPSL, [2] Noguchi et al. (2003) GCA (Goldschmidt 2003 abstract), [3] Noguchi et al. (2002) MAPS (Meteoritical Society Annual Meeting abstract).