Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

BPT011-04 Room: 301B Time: May 24 16:15-16:30

Crystallographic variation and uniformity in Cretaceous fossil heterococcoliths

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Coccoliths are calcified scales formed around unicellular algae, coccolithophores, and they consist of radial arrays of calcite crystal units with complex morphologies. Since their first appearance at the Late Triassic (230 Ma), it is considered for the phyletic evolution that the morphological properties have variously changed but the crystallographic property has been conserved by the V/R model in which coccoliths are generally consist of two calcite units with sub-vertical (V-units) and sub-radial (R-units) c-axis (Young et al., 1992). However, the recent SEM-EBSD analyses revealed that a Cretaceous fossil coccolith, Watznaueria barnesae, has a different type of R-units compared with the living coccoliths, Emiliania huxleyi and Gephyrocapsa oceanica, suggesting the crystallographic variations of fossil coccoliths (Saruwtari et al., 2008). In order to elucidate the crystallographic variation of fossil coccoliths, we determined detailed crystallographic properties of several major genera of coccoliths in Cretaceous chalk from Dover, England, using electron backscattered diffraction (EBSD) analyses and SEM stereo-photogrammetry.
The results showed that both V- and R-units are divided into the several types with respect to the inclination and orientations of c- and a-axes, indicating the crystallographic variations of Cretaceous fossil coccoliths. As a general property, all units are likely aligned with the calcite <4 8 -1> direction parallel to coccolith rings. Concerning the morphology, most of the heterococcoliths developed calcite rhombohedral {10-14} surfaces but the imbricating murolith V-units did the {2-1 -10} planes. These results indicate that crystallographic properties of both V- and R-units varied with their morphologies for the past 230 million years, but are regulated by the alignments of calcite <4 8-1> directions along the coccolith ring.

Keywords: heterococcolith, crystallographic orientaion, calcite, EBSD, Cretaceous