

Crystallographic properties of Cretaceous fossil coccoliths

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Coccoliths are calcified scales formed around unicellular algae, coccolithophorid, and divided into three types, heterococcolith, holococcolith, and nannolith due to their ultrastructures. Heterococcoliths, which are the most common type of coccoliths, consist of radial arrays of complex crystal units and they have appeared as nanofossils from the Late Triassic (230 Ma). In crystallographic viewpoint, most living and fossil heterococcoliths were investigated using light microscopy, indicating that they are generally interlocked with V- and R-units which represent the calcite crystals with sub-vertical and sub-radial orientations of the c-axis respectively (e.g. Young et al. 2004). More accurate crystallographic properties are investigated for two living coccoliths, *Emiliana huxleyi* and *Pleurocysis carterae*, using transmission electron microscope (TEM) and electron back scattered diffraction (EBSD) in scanning electron microscopy (SEM), but not for fossil coccoliths. Thus, detailed crystallographic orientations of Cretaceous fossil coccoliths from Dover, England, were investigated using EBSD combining with SEM stereo-photogrammetry, which is a method to reconstruct three-dimensional surface based on a pair of SEM images with different tilt angles (e.g. Lockwood and Reynolds 1999). Combining these methods, it is possible to determine the indices of crystallographic plane and edge directions that constitute distal and proximal shield elements. As the results, V- and R-units show the crystallographic properties similar to the present coccolith units as well as those different from the present ones. This indicates that crystallographic properties of V- and R-units were modified for the past 230 million years. Based on the above results, the calcite nucleation mechanism for all the coccoliths with different crystallographic properties is discussed with the atomic arrangements along the edge of the organic baseplate.