

Deciphering fossil bio-archives: how Raman microscopy contributes to palaeo-environmental studies

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Throughout the last decades the anatomical and/or geochemical properties of marine biogenic hard-parts (e.g., mollusc shells, fish otoliths or coralline algae) have become a valuable source for palaeo-environmental information. Regular growth patterns are an important characteristic of these bio-archives, which allow proxy information to be generated with distinct and high temporal resolution. However, standard methods of growth pattern visualization may fail in fossil bio-archives owing to alterations of the organic compounds within the biogenic materials over time.

We demonstrate that confocal Raman microscopy (CRM) can identify and visualize growth patterns of mollusc shells from different geological ages with high spatial resolution (300 nm). In contrast to standard staining techniques (e.g., Mutvei's solution), CRM has been applied successfully to samples in which the organic components are altered. Furthermore, CRM is ideal for identifying mineral (and organic) phases and potential taphonomic alterations (e.g., recrystallization from aragonite to calcite) in marine biogenic carbonates. Checking for such alterations should be a mandatory step prior to any kind of biogeochemical analysis (e.g., stable isotopes or trace elemental ratios) of fossil samples. Therefore, CRM can play an important role in the quality control of biogenic carbonate studies.

Here we use CRM to visualize growth structures in the umbonal and the ventral shell portion of the marine bivalve *Arctica islandica* at different spatial resolutions (μm to mm). The reliability of the method has been tested and proven by comparing the growth structures in Mutvei and CRM derived images of the same modern *A. islandica* specimen. In addition, CRM has been applied to fossil samples in which staining techniques failed. Derived growth trends are shown and all CRM results are compared to reflected light microscopy and staining methods in the same specimens.