Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30773

Microstructure of Baltica conodonts: biomineralization insights from EBSD analysis

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Conodonts are an extinct group of probably early vertebrates known for their tooth-like elements composed of fluorapatite. These microfossils, preserved in sedimentary rocks, serve as valuable proxies for reconstructing paleoenvironmental conditions and provide key insights into early vertebrate evolution. The process of conodont biomineralization involved the uptake of various ions from seawater, resulting in the formation of complex mineralized tissues with distinct structural properties. In this study, we investigated the crystallographic properties of conodont elements from multiple taxa, including *Costiconus*, *Semiacontiodus*, *Pterospathodus*, *Panderodus*, and *Venoistodus,* extracted from Ordovician and Silurian strata in Estonia. We aimed to assess variations in their biomineralization processes, which is the first step in their detailed characterization and part of a larger initiative for paleoenvironmental reconstructions based on sedimentary archives from Baltica.

We used the Electron Backscatter Diffraction (EBSD) technique to analyze the crystallographic orientation and crystal size of albid and hyaline crown tissues distinguished using optical microscopy. The results show a single fluorapatite crystal orientation and large crystal size in the albid crown, whereas the hyaline crown displays a more complex and heterogeneous, fine-crystalline texture, often forming parallel lamellae or arcuate structures. The degree of crystallographic alignment in hyaline tissue varies among taxa, suggesting taxon-specific biomineralization mechanisms that likely evolved in response to differing ecological niches or functional demands. The observed differences in hyaline crystallographic orientation may be influenced by several key factors as functional adaptations related to feeding mechanics, evolutionary control over biomineralization, morphological and biomechanical differences, mechanical stress, and diagenetic processes [1].

EBSD analysis has been introduced relatively recently in conodont research [1,2]; therefore, our study provides valuable insights for EBSD data collection and the integration of crystallinity data with isotopic and geochemical results obtained by techniques that might be influenced by the crystallographic orientation. Our integrated approach enhances interpretive certainty using conodont elements as environmental archives in paleoceanographic reconstructions, particularly concerning Ordovician climate transitions.

This research was funded by the National Science Centre, Poland, project no. 2023/49/B/ST10/03922.

[1] Shirley *et al.* (2024), *Nat. Commun.* 15, 5273. [2] Atakul-Özdemir *et al.* (2021), *R. Soc. Open Sci.* 8, 202013.