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# The use of electron backscatter diffraction analysis (EBSD) for understanding the microstructure and preservation state of planktonic foraminifera: implications for geochemical interpretations

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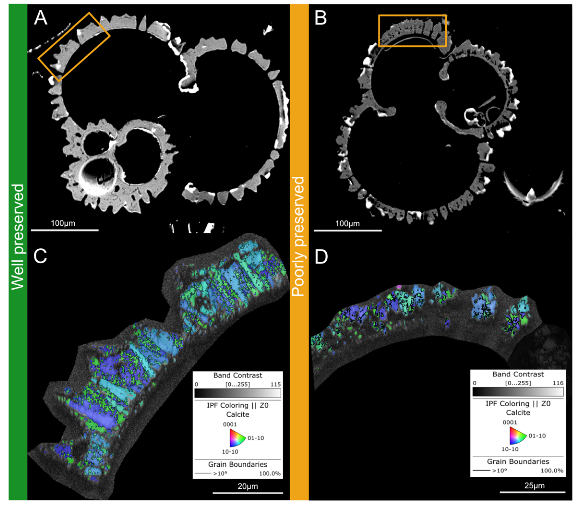
Geochemical proxies from marine microfossils are frequently used in palaeoclimate and palaeoenvironmental reconstructions due to the way in which microfossil shell chemistry is influenced by ambient seawater conditions. One group of such marine microfossils are planktonic foraminifera, which secrete calcite shells. In certain conditions these calcite shells can be susceptible to post-mortem modifications through dissolution, reprecipitation and/or recrystallization. Consequently, these processes must be considered when using these fossils for past climate reconstructions. Currently, screening methods applied to assess such post-mortem modification of specimens are typically subjective, in the form of visual inspection by light microscopy. In contrast, in this study we demonstrate the utility of electron backscatter diffraction analysis (EBSD) combined with chemical analysis for the recognition of the modification of the calcite shells of planktonic foraminifera.

EBSD is an SEM-based microscopy technique that enables quantitative crystallographic characterization at high spatial resolution. Here we present EBSD data for two species of planktic foraminifera commonly utilized for palaeo-proxies, to characterize their microstructure and preservation state. Our EBSD maps highlight the extent of microstructural alteration of foraminiferal calcite by post-mortem modification, enabling visualization of intra-test recrystallisation principally by dissolution-precipitation events. In poorly preserved specimens, while the general crystallographic orientation of calcite in the test is preserved, where the c-axis is aligned perpendicular to the growth surface, the original biogenic calcite structure is lost. Crystal orientation, particularly of a and b axes is much more chaotic in samples of poorer preservation. We compare EBSD data alongside chemical electron microprobe analysis (EMPA) image maps of Mg/Ca as the Mg/Ca palaeothermometer represents a commonly applied palaeo-proxy. This comparative analysis provides a quantitative means to indicate whether or not primary geochemical signals can still be preserved despite structural alteration to test microstructure.




SEM images and respective EBSD maps of *Globigerinoides ruber* specimens of different preservation state. Orange boxes highlight the localities of the EBSD maps on each specimen. A) SEM image of well-preserved specimen of *G. ruber*, sample GLOW 22 Box top; B) SEM image of poorly preserved specimen of *G. ruber*, sample U1335A 13H 2 0/5; C) EBSD map with band contrast, inverse pole figure colouring and grain boundaries for the well preserved *G. ruber* specimen; D) EBSD map with band contrast, inverse pole figure colouring and grain boundaries for the poorly preserved *G. ruber* specimen.