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Investigating the effects of diagenesis on the environmental signals within species of *Gigantoproductus*

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The stable isotope composition (δ^{18}O and δ^{18}C) of biogenic (low-magnesium) calcite is commonly used as a palaeoenvironmental proxy. However, to validate the isotope data, there needs to be an assessment of preservation of the calcite to ensure that the data generated reflect the original environmental conditions. Most commonly, preservation analyses include: scanning electron and cathodoluminescence microscopy (SEM and CL), and measurement of trace element composition. The shells of species of *Gigantoproductus* (Brachiopoda) have thick valves, which allows sampling from the inner to the outer shell margin, perpendicular to the orientation of growth lines, on an internal surface exposed by longitudinal sectioning of the shell. This sampling can be conducted at high resolution, potentially revealing seasonal variability that may be preserved in the shell isotope geochemistry. We collected Mississippian species of *Gigantoproductus* from two locations on the Derbyshire carbonate platform and assessed preservation through SEM and CL; 11 specimens were selected for trace element abundances (primarily Mn, Fe, Mg, Sr, and Na), of these, 5 were chosen for stable isotope analysis. δ^{18}O and δ^{18}C values of the well-preserved material range between –2.6 to –6.4‰ and –1.7 and +2.7‰ respectively. Assuming normal marine salinity, the range in δ^{18}O suggests a seasonal range of about 16°C in shallow sea water temperature at this time. The different shell fabrics (i.e. the secondary laminar shell layer, the prismatic tertiary shell layer and growth lines) show trace element and stable isotope values that lie outside of the normal range whilst still appearing to be well-preserved from the SEM and CL data. Overall, this study illustrates the importance of conducting systematic preservation tests in order to select the best-preserved specimens for biogenic calcite isotope analysis, and sampling at very high resolution (hundreds of μm) reveals heterogeneity of preservation within several specimens.