

Carbon isotopes in brachiopod calcite: a case of equilibrium!

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Since Lowenstam (1961)³ paper, it has been generally inferred that brachiopods incorporate $\delta^{13}\text{C}$ into shell calcite in equilibrium with ambient seawater $\delta^{13}\text{C}_{\text{DIC}}$. But this hypothesis - speculation has remained largely untested. A few recent studies provide results with different outcomes, but generally, they are in favour of equilibrium incorporation of $\delta^{13}\text{C}$ into secondary and tertiary layer shell calcite.

We are presenting carbon isotope results of a systematic study of modern shallow-water brachiopods from the poles to the equator ranging from the intertidal zone down to a depth of ~ 200 m. 417 brachiopod specimens from 16 localities, supplemented by material from other authors, form the database for our evaluation. Our database represents 30 species from 24 sublocalities and of several age groups (group 1 – collected in the past 20 years, and group 2 – collected 40 years or more ago). Seawater was collected at these localities and tested for temperature, salinity, trace chemistry, and for $\delta^{18}\text{O}$ and $\delta^{13}\text{C}_{\text{DIC}}$. The study by Brand *et al*¹ demonstrated that brachiopods incorporate $\delta^{18}\text{O}$ in equilibrium, and this one represents the second installment of our investigation into the incorporation of elements and isotopes into brachiopod shell calcite.

Using well established calcite-bicarbonate enrichment factors for ^{13}C ($\epsilon_{\text{calcite-HCO}_3^-} = 0.1$ to 2.6 ‰), their ambient seawater $\delta^{13}\text{C}_{\text{DIC}}$ and shell $\delta^{13}\text{C}$ compositions, we can conclude that brachiopods, as a group, incorporate carbon isotopes in equilibrium into secondary and tertiary layer shell calcite. This confirmation applies only to their secondary and tertiary layer calcite, but not to their primary layer calcite nor to other shell parts². Also, group 2 brachiopods support the ^{13}C -Suess effect on brachiopod-shell $\delta^{13}\text{C}$ compositions. Our results confirm the importance of brachiopods as archives and proxies for paleoceanography and paleoclimatology.

[1] Brand, U. et al 2013. Oxygen isotopes and MgCO_3 in brachiopod calcite and a new paleotemperature equation. *Chem. Geol.* 359, 23-31 [2] Carpenter, S.J. & Lohmann, K.C. 1995. $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values of modern brachiopod shells. *G.C.A.* 59, 3749-3764 [3] Lowenstam, H. 1961. $\text{O}^{18}/\text{O}^{16}$ ratios, and strontium and magnesium contents of recent and fossil brachiopods and their bearing on the history of the oceans. *J. Geol.* 69, 241-260