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Can coral skeletal B/Ca be used to reconstruct coral calcification media dissolved inorganic chemistry?

NICOLA ALLISON

Earth and Environmental sciences, University of St Andrews, Scottish Oceans Institute, University of St Andrews

Presenting Author: na9@st-andrews.ac.uk

Boron is incorporated into coral skeletons probably as borate, $B(OH)_4^-$, substituting for carbonate, CO_3^{2-}, in the aragonite lattice. Coral skeletal B/Ca (effectively B/CO_3^{2-}) in combination with $\delta^{11}B$ has been used to reconstruct the dissolved inorganic chemistry (DIC) of coral calcification media and to explore the biomineralisation process and its response to ocean acidification. However interpreting skeletal B/Ca requires accurate estimates of the $B(OH)_4^-/CO_3^{2-}$ partition coefficient under the conditions which occur at the coral calcification site.

Here we precipitated aragonite from seawater in vitro under tightly controlled conditions that simulate the compositions of the calcification fluids used to build coral skeletons. We estimate $B(OH)_4^-/CO_3^{2-}$ partition coefficients over variable pH, DIC and Ω and a broad range of aragonite precipitation rates. We also explore the impact of key skeletal biomolecules on partitioning in some experiments.

We observe significant positive relationships between the $B(OH)_4^-/CO_3^{2-}$ partition coefficients and both fluid $[CO_3^{2-}]$ and aragonite precipitation rate. Adding amino acids under one set of pH/DIC conditions decreased aragonite precipitation rate but did not affect the $B(OH)_4^-/CO_3^{2-}$ partition coefficient suggesting that the $B(OH)_4^-/CO_3^{2-}$ partition coefficient is not controlled by mineral precipitation rate.

The relationship between the $B(OH)_4^-/CO_3^{2-}$ partition coefficients and fluid $[CO_3^{2-}]$ is linear and doubling $[CO_3^{2-}]$ effectively doubles the $B(OH)_4^-/CO_3^{2-}$ partition coefficient so aragonite B/Ca is almost unaffected by changes in $[CO_3^{2-}]$. This indicates that coral skeletal B/Ca can not be used to reconstruct the DIC chemistry of coral calcification fluids.