Corals constrain $CaCO_3$ chemistry at the Triassic–Jurassic boundary, a potential ocean acidification event

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Ocean acidification associated with emplacement of the Central Atlantic Magmatic Province (CAMP) has been suggested as a kill mechanism for the Triassic–Jurassic (T–J) mass extinction (~200Ma), but few direct proxies for ocean acidity are available in the Mesozoic. In this work, we show that the presence of corals and reefs in the fossil record can provide a proxy for saturation state, and we use this proxy to determine the plausibility of an acidification event at the T-J.

The new proxy for surface aragonite saturation (Ω_{Arag}) proposed here uses the physiological constraints of modern corals to determine minimum Ω_{Arag} during the intervals when coral are preserved in the fossil record. Corals lose the ability to biomineralise below aragonite saturation (Ω_{Arag}) of 2 and coral reefs are restricted to $\Omega_{Arag} > 3$, so when scleractinians are preserved in the rock record, surface ocean Ω_{Arag} was > 2, and when coral reefs are preserved, $\Omega_{Arag} > 3$. Coral reefs are preserved throughout the latest Triassic but disappear from the fossil record at the T–J boundary, reappearing in the mid Hettangian (~370 kyr coral gap).

We use atmospheric pCO_2 reconstructions from the literature in conjunction with these Ω_{Arag} limitations to calculate the total dissolved inorganic carbon (TCO_2) in the T-J ocean. Our results suggest that the T-J pCO_2 increases recorded by stomatal and pedogenic carbonate proxies would depress saturation state to the point where it would be extremely difficult for corals to biomineralise ($\Omega_{Arag} < 2$), resulting in a coral and reef gap in the fossil record. However, the Jurassic elevation of pCO_2 observed in the proxies does not produce complete carbonate undersaturation in the surface ocean. Models suggest that higher pCO_2 values (between 3000 ppm and 7000 ppm) could be possible, and at these levels, the saturation state would have been low enough for aragonite undersaturation in the surface ocean. This short but extreme acidification in an ocean with low TCO_2 would explain the significant extinction of calcareous organisms and the Early Hettangian coral gap.

Surface $\delta^{11}B$-pH reconstructions and insights into the dynamics of the oceanic carbonate system during the last deglaciation

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There is a long-standing debate about the role of an isolated deep-ocean carbon-rich reservoir in the rise of atmospheric CO_2 during the last deglaciation. One of the most commonly invoked hypotheses implies that CO_2 is 'stored' in the deep ocean during glacial periods, and that re-communication of this reservoir with the surface ocean and atmosphere at deglaciations (mainly via upwelling in the Southern Ocean) increases atmospheric pCO_2. While several studies in the Southern Ocean, Eastern Equatorial Pacific and Indian Ocean have confirmed the validity of this hypothesis, others have cast doubt on the existence and even the feasibility of such ^{14}C-depleted reservoir [1-5].

Boron isotopes in planktic foraminifera are a proven proxy for surface oceanic pH [6, 7], which has been shown to provide valuable insights into past changes in the ocean carbonate system and ultimately into past atmospheric pCO_2. Here we will present novel results from sediment cores retrieved from the equatorial regions of several ocean basins that provide valuable insights into the causes and mechanisms of deglacial pCO_2 rise.

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