Ocean acidification during the Toarcian Oceanic Anoxic Event (Early Jurassic) – a kill mechanism?

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The current anthropogenic progressive climate warming will have an effect on the marine system with ocean acidification and deoxygenation being two of the main stressors. To evaluate causes and effects of ocean acidification as a future-relevant stressor, past mass extinction events can be interrogated to provide important insight.

Significant and rapid releases of CO_2 can lead to ocean acidification, which in turn can cause a decline in calcification of marine organisms and/or their subsequent extinction. The Toarcian Oceanic Anoxic Event (T-OAE, ~183 Mya) was a second order mass extinction characterised by a series of short-term massive injections of CO_2 into the atmosphere-ocean system, probably linked to the intense volcanic activity of the Karoo-Ferrar Large Igneous Province. For the T-OAE, ocean acidification is suggested by the selective decline and extinction of heavily calcifying organisms such as corals and brachiopods [1,2], but direct evidence is to date lacking.

The boron isotopic ($\delta^{11}B$) composition of marine carbonates has been successfully used to track changes in the oceans' pH. To test for the potential occurrence and global scope of acidification during the T-OAE, we present high resolution bulk micrite $\delta^{11}B$ profiles for two carbonate sections at Rabaçal in Portugal (Lusitanian Basin) and Barranco de la Cañada in Spain (Iberian Basin). Both sections record a simultaneous drop of 3-4 ‰ in $\delta^{11}B$ across the T-OAE crisis interval, implying a transient decline in seawater pH. To assess the response of marine calcifying organisms to an acidification we also analysed well preserved brachiopod and bivalve shell materials for their $\delta^{11}B$ composition. The data implies that both organisms were able to endure lower pH seawater conditions probably through internal pH-regulations.

[1] Kiessling et al., 2011. Glob. Change Bio. 17, 56-57
[2] Trecalli et al., 2012. Earth and Pl. Sci. Let. 357, 214-225