Geophysical Research Abstracts, Vol. 7, 09355, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09355

Oxygen isotope, Mg/Ca and Sr/Ca records of Lower Jurassic belemnite shells: implications for the interpretation of the isotopic record of old fossils and changes of ancient seawater paleotemperature

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Because belemnite calcite constitutes the best proxy for the geochemistry of Jurassic seawater, secular variations in the δ^{18}O composition of belemnites have been used as paleo-archives for changes in the Jurassic seawater temperature. However, these fossil mollusks preferably inhabited shelf areas that are more prone to be affected by freshwater inputs (enriched in the ^{16}O isotope) than the pelagic environment. One of the best-documented example of rapid climate change of the Jurassic took place during the late Pliensbachian–early Toarcian ($\sim$181–185 Ma), a period punctuated also by times of global oceanic anoxia and elevated rates of benthic extinctions. For this time span, the correlation of δ^{18}O, Mg/Ca and Sr/Ca records of belemnite calcites from northern Spain have demonstrated that the Mg/Ca and Sr/Ca ratios are useful tools to discriminate between temperature and salinity effects on the δ^{18}O composition of belemnites. Although this Mg/Ca and Sr/Ca temperature dependence has been widely established in modern biogenic carbonates, very few studies have tested this approach in old fossil molluks.

Despite the uncertainties in the interpretation of δ^{18}O ratios using an extinct fossil group (diagenesis and unknown vital and specie effects, regional variability or seasonality), comparison of the Lower Jurassic geochemical archives from northern Spain with those from northern and southern Europe suggests that some geochemical trends are inter-regionally reproducible. Some of the most noticeable features brought out by comparison of these records are a synchronous increase in δ^{18}O and a decrease in Mg/Ca and Sr/Ca ratios of the belemnite calcite during the *P. spinatum* Zone of the end Pliensbachian, followed by a rapid shift to more negative values of δ^{18}O and more positive values of Mg/Ca and Sr/Ca for the *H. serpentinus* Zone of the early Toarcian. These excursions can be interpreted as indicators of global changes in paleoclimatic and environmental conditions prior and during the Early Toarcian Anoxic Event (OAE), which was reflected largely in the geochemical composition of seawater.