The response of the Apenninic Carbonate Platform to the Toarcian OAE

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Introduction

The record of the carbon isotope ratio of the ocean, preserved in marine carbonates and organic matter, has revealed some extreme events of perturbation of the global carbon cycle. These isotopic events coincided with widespread environmental perturbations which involved rapid climatic changes, sudden shifts in the hydrological cycle, changes in the pattern of nutrient distribution in the oceans and episodes of mass extinction on land and in the oceans (Jenkyns, 2003). One of the best documented episodes of sudden perturbation of the global carbon cycle occurred in the early Toarcian (Early Jurassic, ca.183 Ma ago) which is regarded as one of the Oceanic Anoxic Events (OAEs) because it is characterized by exceptionally high burial rates of organic carbon with widespread deposition of black shales from shelf seas to the open ocean. The Toarcian OAE coincides with a pronounced negative carbon isotope excursion (CIE) recorded in marine organic matter, marine carbonate and terrestrial material. This CIE resulted from massive emission of isotopically light carbon, due to volcanic degassing, thermal alteration of organic rich rocks or the massive dissociation of methane clathrates (Hesselbo et al. 2000; Jahren et al., 2001; Beerling & Bretnall 2007; Gröcke et al., 2009). A dramatic decrease in nannoplankton production took place across the T-OAE negative carbon isotope shift (Mattioli et al., 2009).

Motivation

Most of what we know about the record of the early Toarcian OAE has been revealed by the study of relatively deep-water marine sediments, deposited in epicontinental basins and shelves. Comparatively much less is known on the response of shallow-water carbonate platforms. A recent paper demonstrated that the Toarcian CIE is preserved in two southern Tethyan carbonate platforms and that both are characterised by a change to more clay-rich facies more or less coinciding with the CIE (Woodfine et al., 2008). In order to further document the response of the carbonate platforms to the paleoenvironmental perturbations related to the T-OAE, in terms of facies and biotic changes, I have sampled a new succession (103 m thick) in the Apenninic Carbonate Platform. The purpose of this first part of my work has been to recognize the stratigraphic interval related to the early Toarcian carbon cycle perturbations, with the aid of chemostratigraphy.

Preliminary results

The carbon isotope ratios of 171 carefully microsampled limestones have been used to produce an accurate $\delta^{13}C$ curve. After a steady increasing of the values, the carbon-isotope curve shows a sharp negative excursion, followed by a more gradual return to higher values. This profile of the $\delta^{13}C$ curve seems to be a characteristic feature of the T-OAE excursion in all sequences formerly examined (Jenkyns et al., 2002; Jenkyns 2003, Kemp et al., 2005; Hesselbo et al., 2007; Woodfine et al., 2008). Particularly, the initial rise in $\delta^{13}Ccarb$ values, corresponds to a transition to more clay-rich carbonates. The onset of the negative carbon isotope excursion (CIE) seems to correspond to the disappearance of the Lithiotis facies (heavily calcified bivalves) and to the deposition of the first oolitic limestones. The positive trend after the CIE registers the continuous deposition of massive oolitic limestone.

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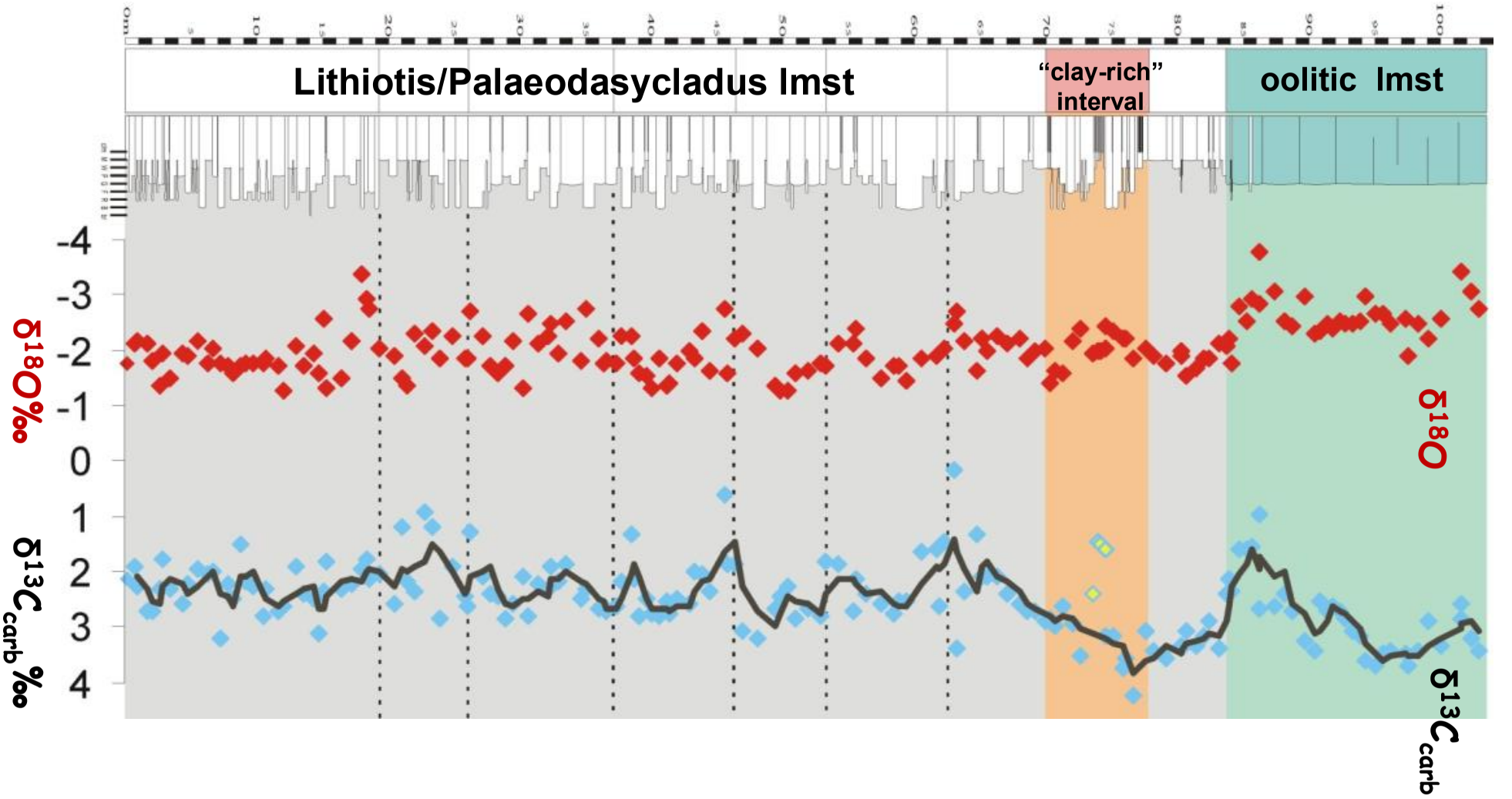
Lithiotis/Palaeodasycladus lmst
"clay-rich" interval
oolitic lmst
δ18O‰
δ13Ccarb‰
-4
-3
-2
-1
0
1
2
3
4
δ18O
δ13Ccarb