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Deciphering processes controlling mid-Jurassic coccolith turnover

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ABSTRACT

The Middle Jurassic is characterized by major changes within the fossil coccolithophorid community, with a transition from *Lotharingius*-dominated to *Watznaueria*-dominated assemblages, concomitant with a significant increase in the pelagic carbonate production. The mechanisms that triggered this overturn remain poorly understood. Here, we present a compilation (new and previously published data) of *Lotharingius* and *Watznaueria* abundances through the Early–Middle Jurassic transition. Alongside this, trends in newly-acquired and literature-derived carbon and oxygen isotope data were used to represent paleoceanographic indicators, such as nutrient and temperature changes. The nannofossil data show a rapid (around 1.5 Myr) turnover around the Aalenian–Bajocian transition. Across the Aalenian/Bajocian boundary, assemblages dominated by *Lotharingius* spp. give way to assemblages dominated by *Watznaueria* spp., coinciding with a peak in a particular morphological group of *Watznaueria* (species with a cross in the central area). The proliferation of this morphogroup occurred during a time of oceanic opening and rearrangement of ocean circulation. This led on to the evolution of pioneering coccolithophorid taxa, but also to extinctions in several marine groups. In the Early Bajocian, the proliferation of two other morphogroups (*Watznaueria* without a central-area structure and *Watznaueria* with a bar) corresponds to the major diversification of *Watznaueria*, and the beginning of its Mesozoic dominance. The *Watznaueria* diversification and dominance are associated with radiation in other marine groups, and these biotic changes occurred during a time of putative enhanced oceanic fertility and relatively low temperatures. This study suggests that restructuring of fossil coccolithophorid communities may be favored during short turnover intervals related to major paleoceanographic change.

1. Introduction

During the Mesozoic Era, the Middle Jurassic was a key period for plankton evolution in marine environments, probably related to the opening of large oceanic domains, such as the Alpine Tethys and the central Atlantic Ocean. Nannofossil plankton carbonate production increased at that time and contributed significantly to the pelagic carbonate sedimentation in open oceans (Suchéras-Marx et al., 2012, 2014). The most remarkable pattern in nannofossil assemblages identified during this time is the transition between the coccolith genera *Lotharingius*, dominant in the Toarcian (Cobianchi, 1992; Cobianchi et al., 1992; Mattioli and Erba, 1999) and *Watznaueria*, which was dominant from the Middle Jurassic to the end of the Early Cretaceous, and ubiquitous in Upper Cretaceous assemblages (Erba, 1990; Lees et al., 2005; Linnert and Mutterlose, 2009; Tiraboschi and Erba, 2010). The transition between these two genera is well known and well defined in terms of phyletic relationships (Bown, 1987; Cobianchi et al., 1992; Mattioli, 1996). However, abundance changes precisely documenting this transition across the Early–Middle Jurassic transition are generally limited to semi-quantitative data, published as distribution charts for the western Tethys (Erba, 1990; Cobianchi et al., 1992; Reale et al., 1992; Stoico and Baldanza, 1995; Fauconnier et al., 1996; Chiari et al., 2007; Sandoval et al., 2008; Tiraboschi and Erba, 2010), and there is no up-to-date assessment of these data, nor any report on the quantitative abundance changes through time. We present in this study the abundance data for *Lotharingius* and *Watznaueria* through the Early–Middle Jurassic transition using new and published data. Correlation of these data

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with external proxies for paleoenvironmental change has allowed us to conjecture on which processes, biotic or abiotic, triggered this significant shift.

Sea-surface temperatures and surface-water nutrient levels are the two major parameters controlling nannoplankton distribution and proliferation (McIntyre et al., 1970; Okada and Honjo, 1973; Balch, 2004). In the geological record, these two parameters can be reconstructed, to some extent, using stable oxygen and carbon isotope data. For the Jurassic, several data, coming from both Tethyan and boreal regions, are available. These carbon and oxygen isotope data were measured on different fossil remains, such as bivalve shells (Paris Basin: France, Brigaud et al., 2009); and belemnite rostra (Lusitanian Basin: Portugal, Jenkyns et al., 2002; Basque–Cantabrian Basin: northeastern Spain, Gomez et al., 2009). Carbon and oxygen isotope ratios have also been

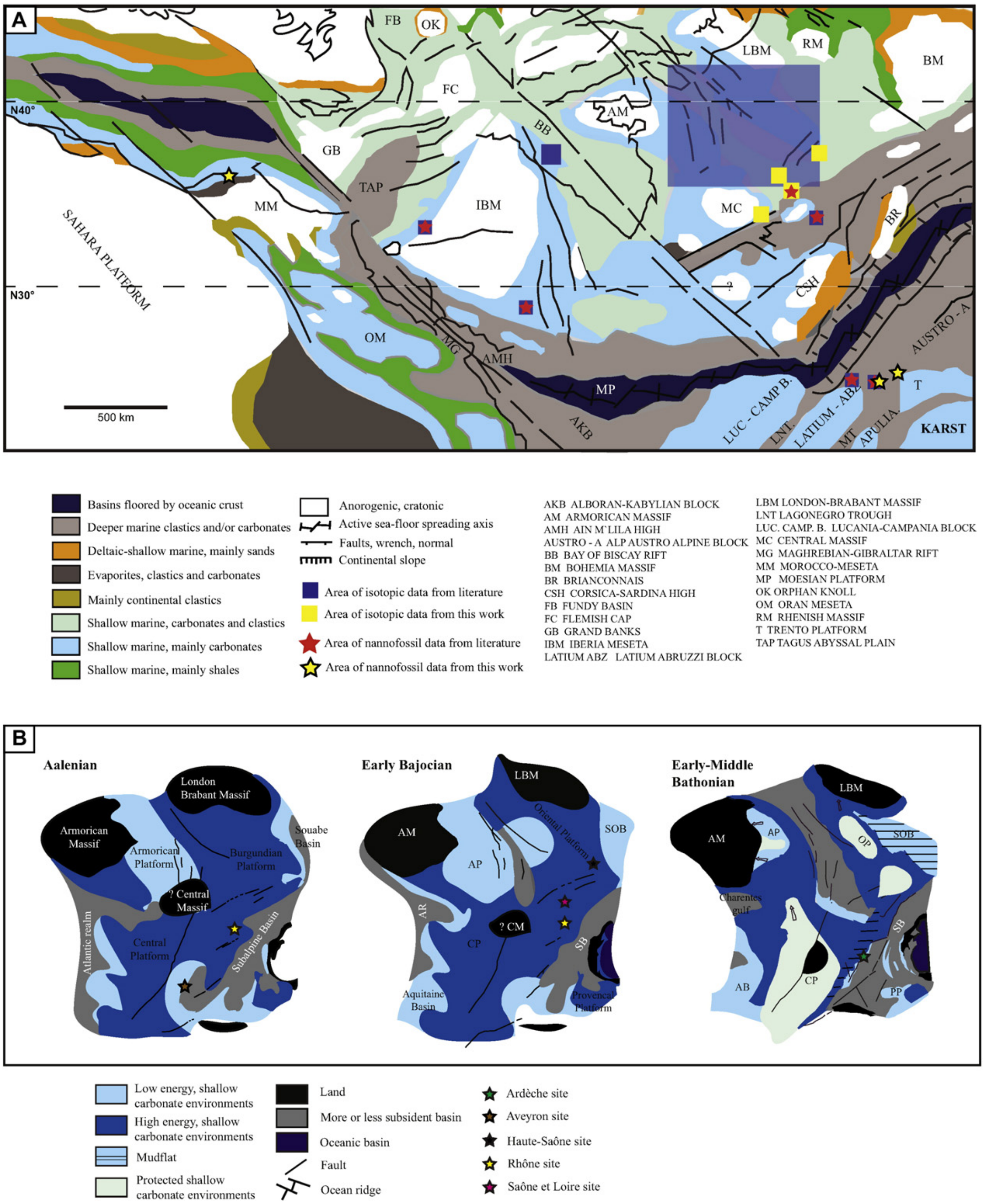

Fig. 1. A. Paleogeography of the western Tethys during the Bajocian–Bathonian interval, re-drawn after Ziegler (1988), showing sample locations. B. Three detailed paleogeographic maps from the Aalenian to the Middle Bathonian, redrawn after Enay and Mangold (1980), showing both the location and the paleoenvironments of selected brachiopod samples for carbon and oxygen isotope analyses. Abbreviations: AB: Aquitaine Basin; AM: Armorican Massif; AP: Armorican Platform; AR: Atlantic realm; CM: Central Massif; CP: Central Platform; LBM: London Brabant Massif; OP: Oriental Platform; PP: Provencal Platform; SB: Subalpine Basin; SOB: Souabe Basin.