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Palaeogeography and relative sea-level history forcing eco-sedimentary contexts in Late Jurassic epicontinental shelves (Prebetic Zone, Betic Cordillera): An ecostratigraphic approach

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ABSTRACT

The analysis of macroinvertebrate and foraminiferal assemblages from Upper Jurassic (Middle Oxfordian to Lower Kimmeridgian) epicontinental shelf deposits in the Prebetic (Betic Cordillera, southern Spain) reveals the influence of environmental changes. They are expressed as selected parameters in palaeogeographic and stratigraphic trends (litho- and microfacies, faunal composition, taphonomy), which are interpreted in the context of relative sea-level histories.

Middle Oxfordian to early Kimmeridgian (Transversarium to Planula Chrones) rocks and faunal assemblages in comparatively distal sectors (distal shelf) show lower sedimentation rates (lumpy lithofacies), and higher proportions of ammonoids, planktic foraminifera, corrasion degree, microboring and encrustation. Landwards, towards the mid-shelf, eco-sedimentary conditions resulted in spongiolithic limestones and marl-limestone rhythmites with local development of microbial-sponge buildups.

Greater distance from shore during relative sea-level highs accords with greater: (1) stratigraphic condensation; (2) abundance in ammonoids, planktic foraminifera and nubeculariids; and (3) degrees of corrasion, microboring and encrustation. These trends in faunal composition and taphonomy agree with backstepping phases, increasing ecospace and a longer exposition of shelly remains on the sea bottom.

Decreasing distance from shore during relative sea-level lows relates to opposite trends, as evidenced by: (4) increasing terrigenous input and decreasing stratigraphic condensation; (5) impoverishment in ammonoids and planktic foraminifera; and (6) diminution of corrasion, microboring and encrustation. Phases of forestepping/progradation and aggradation, a reduction of ecospace for nekto-planktic organisms, and comparatively rapid burial of shell remains are interpreted to force the recorded trends.

An ecostratigraphic approach is used here to correlate and characterise sea-level changes, applying high resolution stratigraphy to sections where the identification of relevant surfaces is more difficult. The changes in distance from shore and ecospace, triggered by relative sea-level fluctuations, are considered prime factors forcing trade-offs in faunal communities of the studied fossil assemblages. Ecostratigraphy was used as a template for the characterization, correlation and interpretation of relative sea-levels and associated sedimentary packages in a time span from just above the Milankovitch band to the million-year scale.

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1. Introduction

The southeastern palaeomargin of the Iberian subplate became differentiated in epicontinental and epioceanic environments (the Prebetic Zone and the Subbetic Zone and lateral equivalents, respectively) early in the Jurassic, and drowning of the epicontinental shelf took place in the Late Jurassic (Olóriz et al., 2002a; García-Hernández and López-Garrido, 2004). Studies of regional geology in the Prebetic Zone during the seventies (Behmel, 1970; Foucault, 1971; Jerez-Mir, 1973; Azéma, 1977; García-Hernández, 1978) provide data on Upper Jurassic deposits. Recent approaches to interpret Late Jurassic deposits in the Prebetic Zone entail precise biostratigraphy, taphonomy and paleoenvironmetal reconstruction, with preliminary ecostratigraphic interpretations (Rodríguez-Tovar, 1993; Olóriz et al., 1999, 2002b, 2003b; Reolid, 2003; Olóriz et al., 2004a,b, 2006; Reolid, 2007; Olóriz et al., 2008; Reolid et al., 2008a,c). Here we propose ecostratigraphic analyses to interpret Late Jurassic deposits from the Prebetic Zone in terms of sequence stratigraphy.

1.1. Remarks on sequence stratigraphy

An integrative approach to sedimentary packages can be conducted through sequence stratigraphy analysis. However, even after thirty years of development, such an approach can give rise to debate regarding differences between subsurface and outcrop level observations. There are disparate models of sequence and surface definition, interpretation and correlation, as well as conceptual revisions for the evaluation of surface dyachroneity (for a recent, general picture see Miall and Miall, 2001; Miall, 2004; Schlager, 2005; Christie-Blick et al., 2007; Embry et al., 2007; Catuneanu et al., 2009, 2010; Bhattacharya, 2011; and references therein). At present, sequence stratigraphic interpretations cover a wide array of unconformity-bounded and unconformity-plus-relative-conformity-bounded sedimentary packages. Moreover, assumptions about the chronostratigraphic potential of reference surfaces and subsequence units can vary (i.e., sequence boundaries and other intra-sequence surfaces of reference, systems tracts and parasequences). Early on, the so-called "procedure inverse" was supported in sequence stratigraphic interpretation, with correlation on the basis of assumed surface isochroneity regardless of the depositional environment – e.g., Mitchum and Vail (1977), Vail et al. (1987, 1991), Haq et al. (1988), Van Wagoner et al. (1987, 1988), Galloway (1989), Hunt and Tucker (1992 *pro parte*), Plint and Nummedal (2000), Posamentier and Morris (2000) – and identification of surface dyachroneity and use of physical surfaces minimising diachrony (e.g., Nummedal and Swift, 1987; Hunt and Tucker, 1992 *pro parte*; Helland-Hansen and Gjelberg, 1994; Catuneanu et al., 1998; Posamentier and Allen, 1999; Anderson, 2005; Catuneanu, 2006; Embry et al., 2007; Catuneanu et al., 2010; Bhattacharya, 2011; but see Christie-Blick et al., 2007). Siliciclastic and carbonate systems, as well as mixed carbonate–siliciclastic systems, are known to represent scenarios forcing different, autocyclic sedimentary trends for a given allocyclic process of variable magnitude — indeed, Davaud and Lombard (1973), Hallam (1986), Sarg (1988), Dromart (1989), Galloway (1989, 1998, 2002), Einsele and Ricken (1991), Schlager (1991, 1992, 2005), Hunt and Tucker (1993), Leinfelder et al. (1993), Pomar (1993, 2001a,b), Pomar and Ward (1995), Pittet and Strasser (1998a,b), Brandano and Corda (2002), Catuneanu (2002), Kerans and Loucks (2002), Anderson (2005), and Pomar and Kendall (2008) all describe records of sedimentary packages as disparate responses to factors controlling local siliciclastic vs. carbonate and mixed carbonate–siliciclastic systems.

We agree that sequence stratigraphy analysis is a valuable template for interpreting stratigraphic architectures, and coincide with Embry (2002), amongst others, on focusing sequence stratigraphy interpretation on changes in sedimentary trends and their identifiable bounding surfaces, while recognising limitations for surface identification in distal and/or basinal settings (Embry, 1995; Posamentier and Allen, 1999; Plint and Nummedal, 2000; Embry, 2002; Posamentier and Kolla, 2003; Posamentier and Walker, 2006; Christie-Blick et al., 2007; Catuneanu et al., 2009, 2010), especially when monotonous low-energy conditions persist. In such a context, we conducted ecostratigraphic analysis based on the selected fossil assemblages described below.

1.2. Ecostratigraphy — from HIRES to the record of ecological dynamics

Ecostratigraphy assumes that sedimentary successions record information about environmental dynamics affecting the ecological conditions for diverse organisms and/or species assemblies, with fluctuations of key environmental factors forcing ecological tradeoffs' readjustment in the local community. From the understanding of ecostratigraphy as the stratigraphy of ecosystems (Martinsson, 1973) to the relevance of the ecostratigraphic analysis to identify bioevents within the framework of "High Resolution Event Stratigraphy" (HIRES in Kauffman, 1986, 1988) as promoted by Boucot (1986), ecostratigraphy appears as a tool of great potential in basin analysis that is environmentally oriented (ecology included; e.g., Brett and Baird, 1997; Brett, 1998; Brett et al., 2007a,b). One major avenue for ecostratigraphy is to improve stratigraphic subdivisions by providing more detailed stratigraphic intervals than those obtained from classic biostratigraphy (Waterhouse, 1976; Sokolov, 1988). Thus,