Cretaceous Research 30 (2009) 710–716

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Archaic-style shell concentrations in brackish-water settings: Lower Cretaceous (Wealden) examples from southern England

Jonathan D. Radley

School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

ARTICLE INFO

Article history:
Received 5 November 2008
Accepted in revised form 22 December 2008
Available online 31 December 2008

Keywords:
Shell concentrations
Brackish water
Lower Cretaceous
Southern England

ABSTRACT

Shell pavements, shelly gutter and scour fills, and coquinas are described from brackish-water mudrock facies of the southern English Lower Cretaceous (Wealden) successions. These shell concentrations are consistently thin, reflecting small shell sizes, conservative molluscan life-modes, high net deposition and low levels of bioturbation in lacustrine and lagoonal environments. In biostratinomic terms the shell concentrations are of archaic aspect and similar to other occurrences within Mesozoic mudrock formations ascribed to 'stressed', brackish-water settings. As such, Wealden mud-dominated brackish-water settings are identified as a biostratinomic 'window' for generation and preservation of archaic-style shell concentrations.

1. Introduction

Following their Cambrian inception, shell concentrations within shallow-marine successions have increased overall in thickness, internal complexity, taxonomic diversity, and probably, general abundance. These trends are thought to reflect essentially phylogenetic factors; notably increasing durability, complexity, size and abundance of skeletal hardparts, and radiation of benthic shell producers (especially molluscs) into high-energy nearshore habitats (Kidwell, 1990; Kidwell and Brenchley, 1994, 1996).

Archaic shell concentrations, characterizing the post-Cambrian Palaeozoic, were defined by Kidwell (1990) as a thin, essentially two-dimensional and typically brachiopod-dominated biostratinomic mode. This mode demonstrates simple biofabrics that reflect the semi-infaunal to epifaunal life modes of shell producers in predominantly low-energy, offshore habitats; their low reproductive rates, and low post-mortem durability of their high-organic shell microstructures. Within post-Triassic marine successions, archaic accumulations are augmented by thicker, mollusc-dominated 'modern' concentrations that demonstrate relatively complex internal stratigraphies and commonly, relatively durable low-organic shell microstructures (Kidwell, 1990). This biostratinomic mode reflects diverse processes including bed amalgamation, taphonomic feedback, input from ecologically and morphologically diverse shell producers, bioerosion and bioencrustation (Kidwell, 1990), and increased bioturbation depth (Sepkoski et al., 1991). A transitional mode has been identified from the Permian-Lower Triassic, comprising thin mollusc-dominated concentrations that are essentially archaic in style (Simões et al., 2000; Boyer et al., 2004).

Preliminary research on the Phanerozoic evolution of shell concentrations has focused on examples from level-bottom siliciclastic marine settings. Less well-documented are those concentrations generated by benthic molluscs in environmentally-stressed, marginal-marine settings influenced by salinities that deviate from that of normal seawater. Characterizing the post-Triassic, shells attributed to salinity-controlled bivalves and gastropods frequently attain abundance in brackish-water lagoonal, bay and estuarine facies. Such shells are morphologically conservative, represented by a limited number of morphotypes. These reflect unspecialized life modes and adoption of *r*-selected reproductive strategies for high fecundity (Fürsich, 1994; Kondo et al., 2006). This paper characterizes shell concentrations within brackish-water mudrock facies of the Lower Cretaceous (Berriasian-Aptian) Wealden strata of southern England (Fig. 1; Allen, 1975, 1981, 1989; Allen and Wimbledon, 1991), and assesses their biostratinomic mode.

2. Palaeoenvironmental framework

Wealden strata are developed within the Weald-Wessex Basin complex (Figs. 1,2) as two formation-scale facies associations. These are (a) predominantly oxidized mudrocks and sandstones of alluvial origin (arenaceous formations; Allen, 1981), and (b) relatively fossiliferous, mudrock-dominated formations of coastal lacustrine,

E-mail address: j.d.radley@bham.ac.uk

0195-6671/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cretres.2008.12.011

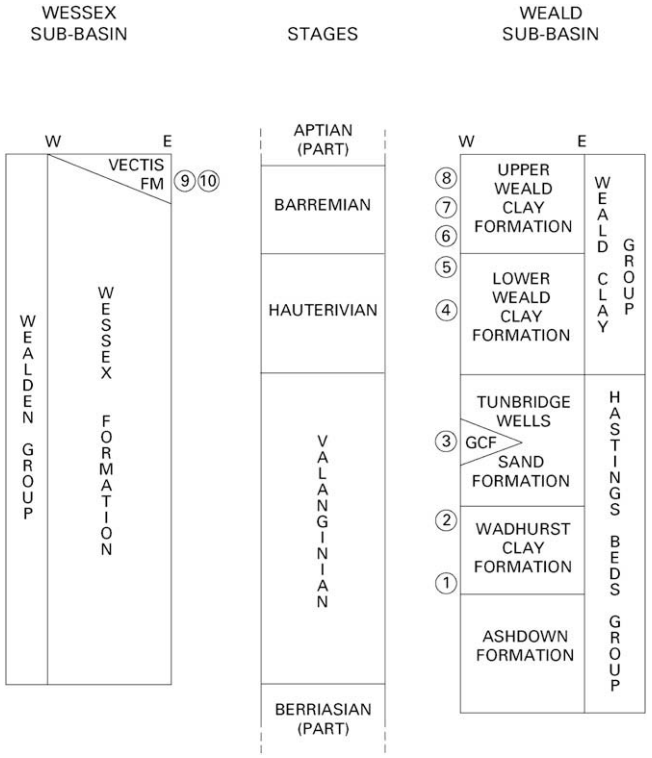

Fig. 1. Summary correlation of Lower Cretaceous marine stages with Wealden strata in the Wessex and Weald Sub-basins, southern England (based on Allen and Wimbledon, 1991). GCF = Grinstead Clay Formation. Numbered points indicate approximate stratigraphic levels of sampled sites (see Table 1). (1) Sharpthorne Brickworks pit. (2) Freshfield Lane Brickworks pit. (3) Philpots Quarry. (4) Warnham Brickworks pit. (5) Clockhouse Brickworks pit. (6) Smokejacks Brickworks pit. (7) Coneyhurst Common road cutting. (8) Bookhurst Tileworks pit. (9) Brightstone Bay and Compton Bay. (10) Sandown Bay.

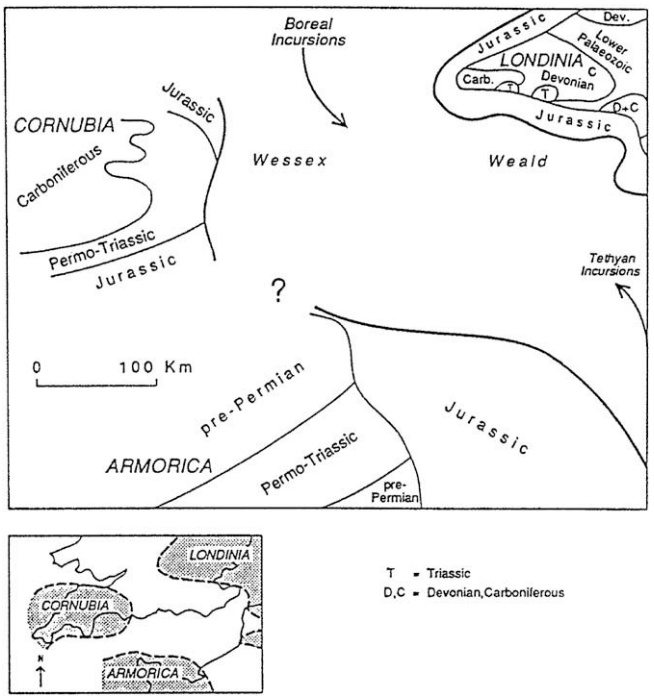

Fig. 2. Generalized Wealden (late Berriasian – early Aptian) palaeogeography, Wessex and Weald Sub-basins, southern England. Reproduced from Batten (1991) by permission of the Geological Society Publishing House.

lagoonal, mudflat and mudswamp origin (argillaceous formations; Allen, 1981). The latter include minor arenaceous (alluvial and lacustrine-deltaic) facies developments (Fig. 3). The mudrock-dominated formations record marine influence via Tethyan and/or boreal coastlines (Fig. 2), causing salinity fluctuations in the oligohaline-brachyhaline range (Allen, 1975, 1989; Radley et al., 2006). Lunar tidal effects were probably weak, and storms were a major influence on deposition (Allen, 1998; Radley and Barker, 2000). Eustatic influence on water depth, though likely, is hard to detect amongst the background 'noise' of regional tectonism and alluvial progradation (Allen, 1975, 1989). Sedimentological, geochemical and palaeontological data confirm warm to hot, seasonally wet 'Mediterranean'-type Wealden climates at a palaeolatitude of approximately 35°N (Allen, 1989, 1998).

3. Shell concentrations

Concentrations of small, morphologically conservative bivalve and/or gastropod shells are locally abundant within argillaceous formations (Allen, 1975, 1989; Stewart et al., 1991; Radley and Barker, 1998a; Figs 3,4), typically within laminated mudrock developments amongst metre-scale fining or coarsening-upward cycles (Allen, 1959, 1975; Stewart et al., 1991). Bioturbation within mudrock facies is typified by a suite of surficial and shallow-tier traces, associated with lenticular siltstones and fine sandstones (lacustrine/lagoonal association of Goldring et al., 2005). Concentrations are summarized below. Occurrences within arenaceous alluvial and lacustrine-deltaic developments (Allen, 1975, 1981 and above) are not considered in this account. Ten quarry sites and coastal exposures were studied in the Weald and Wessex Sub-basins, exposing fossiliferous mudrocks (Figs. 1,3; Table 1). Shell concentrations were described at outcrop using terminology adapted from that of Kidwell (1991). Hand specimens of thicker, calcite or siderite-cemented coquinas were collected and slabbed to reveal skeletal content and biofabric. Details for several sites are given by Radley (1999) and Radley and Barker (1998a,b, 2000), and are outlined in Table 1. The three principle concentration styles are summarized and interpreted below.

3.1. Shell pavements

Predominantly densely packed, two-dimensional, monospecific to paucispecific pavements of complete, disarticulated, predominantly convex-up bivalve shells, or variably oriented gastropods (Fig. 4A). Pavements are commonly laterally persistent at outcrop scale (Allen, 1959, 1975; Radley and Barker, 1998a) and frequently associated with coquinas (see below). Laterally restricted pavements, grading into linear 'stringers' (Kidwell, 1991) locally cap sandstone scour or gutter fills (see below), or occupy troughs within rippled sandstone lenses intercalated amongst the mudstones (Allen, 1959).

Principle constituents are shells of small neomiodontid bivalves (*Neomiodon* spp.) in the Valanginian Wadhurst Clay and Grinstead Clay formations; corbiculid bivalves (*Filosina* spp.) in the Barremian-Aptian Weald Clay Group and Vectis Formation, and/or gastropods (dominantly *Viviparus* spp.) throughout the Wealden successions (Table 1). Shells are sometimes preserved in skeletal aragonite and partly compacted (Allen and Keith, 1965; Allen et al., 1973; Radley and Barker, 1998a), but often replaced by calcite and relatively uncrushed in association with coquinas (see below and Fig. 4A). The typically unfragmented and unabraded shell preservation, coupled with occurrences of dispersed shells in mudstones between the pavements, indicates that these concentrations were generated largely or wholly through removal of fines. Weak storm