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Taphonomy and sequence stratigraphic significance of oyster-dominated concentrations from the San Julián formation, Oligocene of Patagonia, Argentina

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Abstract

Oligocene siliciclastic shallow marine sediments of the San Julián Formation in southeastern Patagonia (Argentina) are interpreted as a deepening–shallowing cycle that represents a depositional sequence in which lowstand system tract deposits are not present. There are no significant compositional differences in the assemblages, all are dominated by the large oyster *Crassostrea*? *hatcheri*. However, four types of shell concentrations can be distinguished by differences in stratigraphic, sedimentologic, palaeoecological, and taphonomic features. These four types of shell concentrations are found in distinct positions within the depositional sequence: as a transgressive lag at the early phase of the transgressive system tract (TST), at the top of the TST, at the early phase of the high stand system tract (HST), and at the top of the HST. Oyster-dominated concentration in the early TST has a distinct basal erosional surface (ravinement surface), and the shells are completely disarticulated, fragmented and abraded with a chaotic orientation, suggesting reworking of previous deposited sediments, and deposition in a shoreface environment. Concentration at the end of the TST is a hiatal concentration formed from continued sea-level rise in the context of backlap deposition. It is characterized by high percentages of articulated oysters in life position, with high grades of bioerosion and encrustation. This concentration was accumulated during times of high rates of production of biogenic hard parts and low sedimentation rates, below fair weather wave base in an offshore environment. Concentrations over the maximum flooding surface in the early HST are in situ event concentrations (Census assemblages), characterized by high percentages of individual articulated adult specimens and clusters of juvenile oysters with well-developed endolithic bioerosion and encrustation, formed by rapid sedimentation in an offshore to lower shoreface environment. Concentrations at the top of the HST are multiple-event concentrations formed by densely fossiliferous deposits with completely disarticulated, convex-up oysters with low grades of abrasion and high grades of bioerosion and encrustation, intercalated with repeating beds with benthic colonizers. They were originated below fair weather wave base, in an offshore to lower shoreface environment, by sporadic high-energy events. The basic pattern of condensed deposits formed in the context of onlap, backlap, downlap, and toplap can be applied to the studied deposits. However, some differences are recorded, and these are attributed mostly to

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differences in the basin characteristics and to the high productivity and high preservation potential of large, thick-shelled oysters.

Keywords: Shell concentrations; Taphonomy; Sequence stratigraphy; Oligocene; Patagonia; Argentina

1. Introduction

The usefulness of shell concentrations as indicators of relative sea-level changes, system tracts, and depositional sequences and their boundary surfaces has been recognized for more than a decade (Abbott, 1997; Kondo et al., 1998; Fürsich and Pandey, 2003; for reviews, see Kidwell, 1991a,b; Brett, 1995, 1998; Holland, 2000, 2001). The formation of depositional sequences implies drastic changes in the physical component of the shallow marine ecosystem. These changes can be recorded in the composition of faunistic assemblages and their taphonomic attributes (Kondo et al., 1998). In addition, distinctive types of shell beds occur at different positions within sedimentary cycles and provide evidence for the sequence stratigraphic interpretation of sedimentary successions. One particular case is the Oligocene siliciclastic shallow marine sediments of the San Julián Formation exposed in southeastern Patagonia. This unit is characterized by the presence of numerous stratigraphic horizons with valves of the large oyster *Crassostrea*? *hatcheri* (Ortmann, 1897) and offers an excellent opportunity for taphonomic studies. These, together with conventional analyses of sedimentary facies, are an important element for identifying key sequence stratigraphic surfaces and systems tracts.

The San Julián Formation has been studied mainly on a regional scale or from petrographic or palaeontological points of view, and few attempts have been made to interpret the taphonomic aspects of the shell concentrations and their relationship with relative sea level changes (e.g., see Manassero et al., 1997; Parras and Casadío, 2002). This unit comprises Palaeogene shallow marine siliciclastic and calcareous sediments and shows upward-shoaling cycles developed in a sand-dominated shelf sequence (Manassero et al., 1997).

The purpose of this paper is to describe sedimentologic, stratigraphic, palaeoecological, and taphonomic features of the exceptionally well-preserved oyster-dominated concentrations of the San Julián Formation. This allows inference of depositional processes and identification of the distinctive types of oyster concentrations occurring at different positions within the depositional sequence. The recognition of bounding surfaces is used in order to assess the geological history from a sequence stratigraphic point of view. As a consequence, it is possible to reconstruct the relative sea-level changes and palaeoenvironmental conditions during the Oligocene in southern Patagonia.

2. Geological and stratigraphic framework

The Oligocene through Miocene marine sedimentary rocks in Patagonia, southern Argentina, were deposited during Atlantic transgressions. They have been described from the coast to the foothills of the Andes and grouped into the informal name of "Patagoniano" or "Patagoniense."

The lower part of the "Patagoniense" is represented by the shallow marine sedimentary rocks of the San Julián Formation. The formal name and age of this unit have been controversial since first visited by d'Orbigny and by Darwin during the first half of the 19th century (d'Orbigny, 1842; Darwin, 1846; Ameghino, 1896, 1898).

Discussions on the stratigraphy and age of the "Patagoniense" were framed by two main contrasting ideas. Ameghino (1898) and Feruglio (1949) considered that the "Patagoniense" comprised two units (Juliense and Leonense). On the other hand, Hatcher (1900) and Ortmann (1902) did not recognize this division and believed the "Patagoniense" strata to be one continuous stratigraphic succession. The main reason for the disagreement on the stratigraphy of Tertiary rocks of Patagonia was the cloudy and inconsistent distinction between lithostratigraphic and chronostratigraphic units (Legarreta and Uliana, 1994); the two concepts were used indistinctly in stratigraphic subdivisions.