Facies analysis and stratigraphy of the Suances Upper Albian carbonate platform (Northern Spain)

Análisis de facies y estratigrafía de la plataforma carbonatada Albiense Superior de Suances (Norte de España)

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ABSTRACT

A detailed stratigraphic and sedimentological study has been carried out on three stratigraphic sections logged along a Suances to Punta del Dichoso headland transect. The analysed sedimentary units belong to the Upper Albian Barcenaciones Formation, which is represented by shallow-marine facies. The sedimentary record consists of carbonate platform calcarenites and micritic limestones, with interbedded mixed carbonate-siliciclastic deposits. Correlation of the three studied sections shows evidence of significant variations in facies and thickness across a N-S short distance. Such variations point to two tecto-sedimentary domains: a less subsident Punta del Dichoso block to the north, and a more subsident Suances block to the south. These domains were separated by the E-W oriented Marzán synsedimentary fault in a half-graben pattern.

Key-words: *Upper Albian, Cantabria, carbonate platform, stratigraphy, synsedimentary tectonics.*

RESUMEN

Se han analizado sedimentológica y estratigráficamente tres secciones ubicadas en Suances y en Punta del Dichoso, y se han correlacionado entre sí. Las unidades sedimentarias pertenecen a la Fm. Barcenaciones (Albiense Superior), representada por facies marino-someras. La sucesión consiste esencialmente en calizas micríticas y calcarenitas depositadas en una plataforma carbonatada, que puntualmente alternan con sedimentos mixtos carbonatados y terrígenos. La correlación N-S de las tres secciones estratigráficas revela importantes cambios laterales de facies y de espesor en distancias cortas. Estas variaciones han permitido establecer dos dominios tecto-sedimentarios: un bloque menos subsidente en el sector norte (Punta del Dichoso) y un bloque más subsidente en la parte sur (área de Suances). La actividad de la falla E-W de Marzán controló la sedimentación en ambos dominios, y dio lugar a una estructura de semigraben.

Palabras clave: *Albiense Superior, Cantabria, plataforma carbonatada, estratigrafía, tectónica sinsedimentaria..*

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Introduction

The Aptian-Albian deposits are widespread in the Basque-Cantabrian Basin (Fig. 1). They extend from the northern fringe of the Navarre-Cantabrian Trough into the Basque Arc. They consists mainly of carbonate platforms developed on palaeogeographical highs, with terrigenous sediments accumulated in troughs. This arrangement was due to strong differential subsidence created by block faulting, during the opening of the Bay of Biscay. Several authors reported lateral and vertical relations of the Urgonian Complex facies over wide areas (*e.g.*, Rat, 1959; García-Mondéjar, 1979; García-Mondéjar and Pujalte, 1982). Pascal (1985) analysed the Punta del Dichoso stratigraphic section in Suances. The complex internal organization and significant facies variability of the Urgonian carbonate platforms still require additional small-scale research. Thus, the aim of the present study is to find out facies, environments and depositional controls of the Urgonian carbonate platform in Suances (Cantabria), which will contribute to get a detailed Albian palaeogeographic reconstruction.

The study area lies at the Cantabrian coast, 20 km west of Santander (northern Spain). During the Albian, Suances was placed at the northwestern margin of the Ramales platform. This platform extended slightly northwards in respect of the scheme proposed by García-Mondéjar (1990), as evidenced by current data. Three stratigraphic sections are logged in detail across a NNW-SSE oriented, 1.5-km-long transect (Fig. 2A): Suances-A and Suances-B are located in the western side of the Ría de San Martín de la Arena, whereas the third section is in the northwestern margin of the Punta del Dichoso headland.

Facies analysis and correlation

The focus of this study is the Upper Albian Barcenaciones Fm., which is marked by the presence of the Vraconian *Caprina choffati* (DOUV.) rudists and *Neorbitolinopsis conulus* (DOUV.) orbitolinids (*e.g.*, Pascal, 1985). This Formation is underlain by the Upper Aptian – Lower Albian carbonate Reocín Fm. and overlain by the Upper Albian – Lower Cenomanian terrigenous Bielva Fm., both out of the scope of this work.

Suances-A (56 m thick) and Suances-B (84 m thick) sections are logged 300 m far away from each other within the locality of Suances

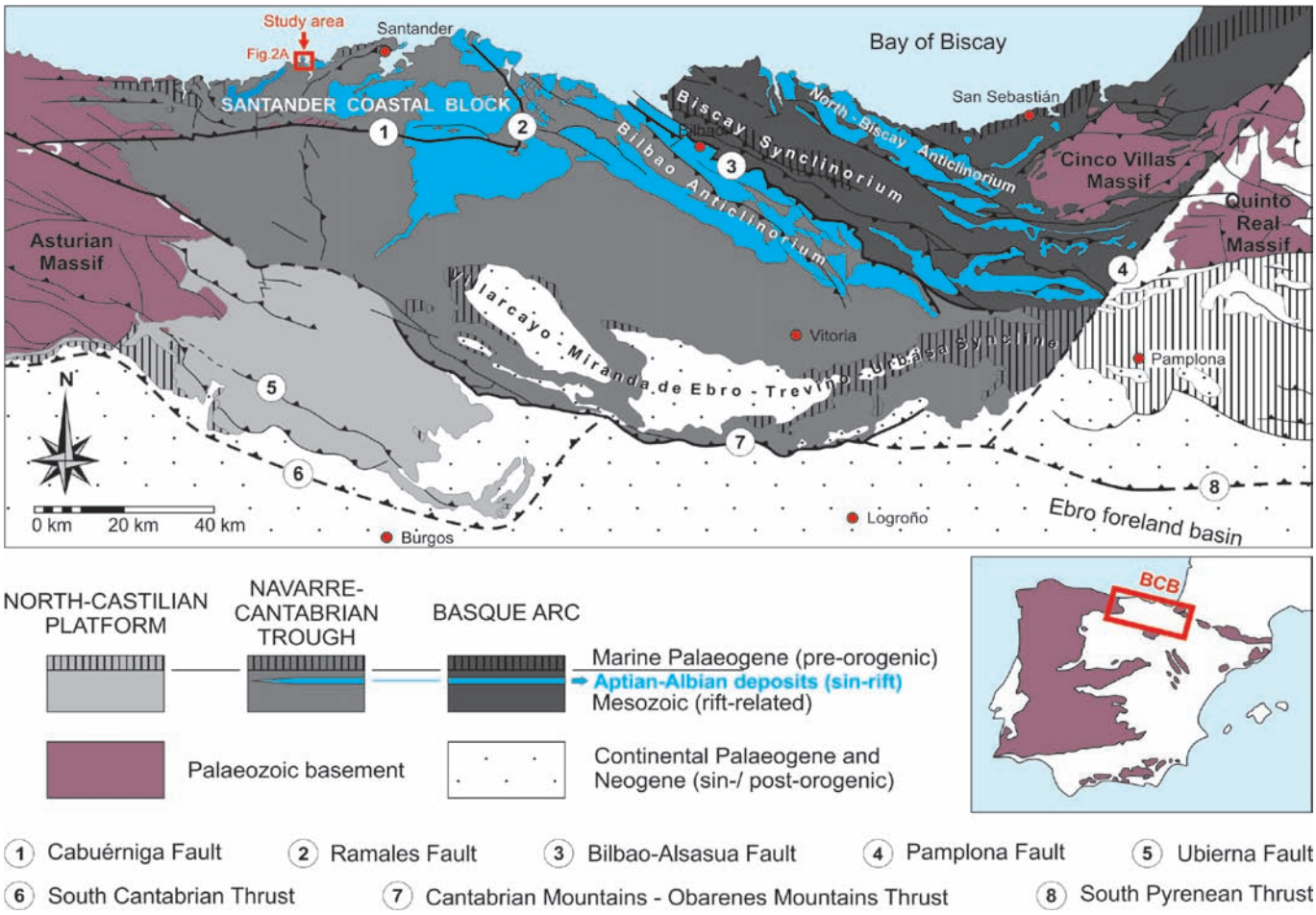

Fig. 1.- Simplified geological map of the Basque-Cantabrian Basin/ BCB (based mainly on EVE, 1992, Alonso *et al.*, 2007, and Ábalos *et al.*, 2008), including structural domains defined by Barnolas and Pujalte (2004) and the study area location. Aptian-Albian deposits are highlighted in blue, and correspond to the middle and late stages of the Bay of Biscay rifting described by Barnolas and Pujalte (2004).

Fig. 1.- Mapa geológico de la Cuenca Vasco-Cantábrica/ BCB (síntesis basada fundamentalmente en EVE, 1992, Alonso* et al., *2007, y Ábalos* et al., *2008), con los dominios estructurales propuestos por Barnolas y Pujalte (2004) y la localización de la zona de estudio. Las unidades del Aptiense-Albiense (destacadas en azul) se formaron durante la etapa media y tardía de un proceso de rifting ligado a la apertura del Atlántico Norte.

(Fig. 2). The Reocín Fm. and the base of the Barcenaciones Fm. do not outcrop. The sedimentary record of the Barcenaciones Fm. can be subdivided into three correlatable units. From the base to the top these are: units 1, 2 and 3.

Unit 1 is made up of coarse-grained echinoid-rich grainstones and intrabioclastic rudstones with cross-stratification (Fig. 2B), attributed to a high-energy environment. They alternate with wackestones and rudist biostromes related to a more restricted setting. Unit 1 has been physically correlated from Suances-A to Suances-B sections along the available outcrops. In Suances-B section, the micritic limestone interval is laterally interfingered with a coral boundstone, where massive, ramose and platy growth forms occur along with rudists and stromatoporoids. It represents an inner carbonate platform in lateral change to a margin setting. Multiple palaeokarst surfaces are recognized in Suances-A section, but they are absent in Suances-B section.

Unit 2 is characterized by mixed carbonate-terrigenous facies (Fig. 2B). In Suances-B section, sandy calcarenites evolve upwards to cross-bedded sandy rudstones and calcareous sandstones, which vertically grade into sandy calcarenites again. Clay chips, ostreid fragments and echinoderms are abundant. In Suances-A section, calcareous sandstones and ostreid-rich sandy rudstones are recognized in the available outcrops. Facies from Unit 2 are interpreted as deposited by high-energy ebb tidal currents. Palaeocurrent measurements in tidal bundle foresets of Unit 2 indicate a northwest-wards (N296E) sediment transport.

Unit 3 consists of fine-grained packstones and grainstones, micritic limestones and scarce rudist biostromes (Fig. 2B). Different types of rudists, corals, orbitolinids and large nerineids are common. Abundant micritic limestone intraclasts, incipient ooids, miliolids and other benthic foraminifera are also identified within the calcarenites. Unit 3 corresponds to a low-energy inner carbonate platform setting occasionally winnowed by marine currents. Subaerial exposure surfaces are frequent both in Suances-A and in Suances-B sections, and they are sometimes overlain by discrete terrigenous deposits. In Suances-B section, the base of Unit 3 comprises at least 5 m of strongly bioturbated muddy limestones with scarce macrofossils (monopleurids and thin-shelled bivalves) alternating with thin calcareous marl layers. These "mottled limestones" imply high turbidity in seawater, and suggest interruption of the former tidal current regime.

The three described units are also recognized in the 27-m-thick Punta del Dichoso section (Fig. 2B). The first 10 m of the represented succession correspond to Reocín Fm., which is composed of two distinctive units: the lower part consists of a thick rudist biostrome, whereas the upper part is made up by densely packed *Lithocodium-Bacinella* oncoids. Barcenaciones Fm. includes two very coarse-grained grainstone lithosomes laterally equivalent to units 1 and 2. The upper

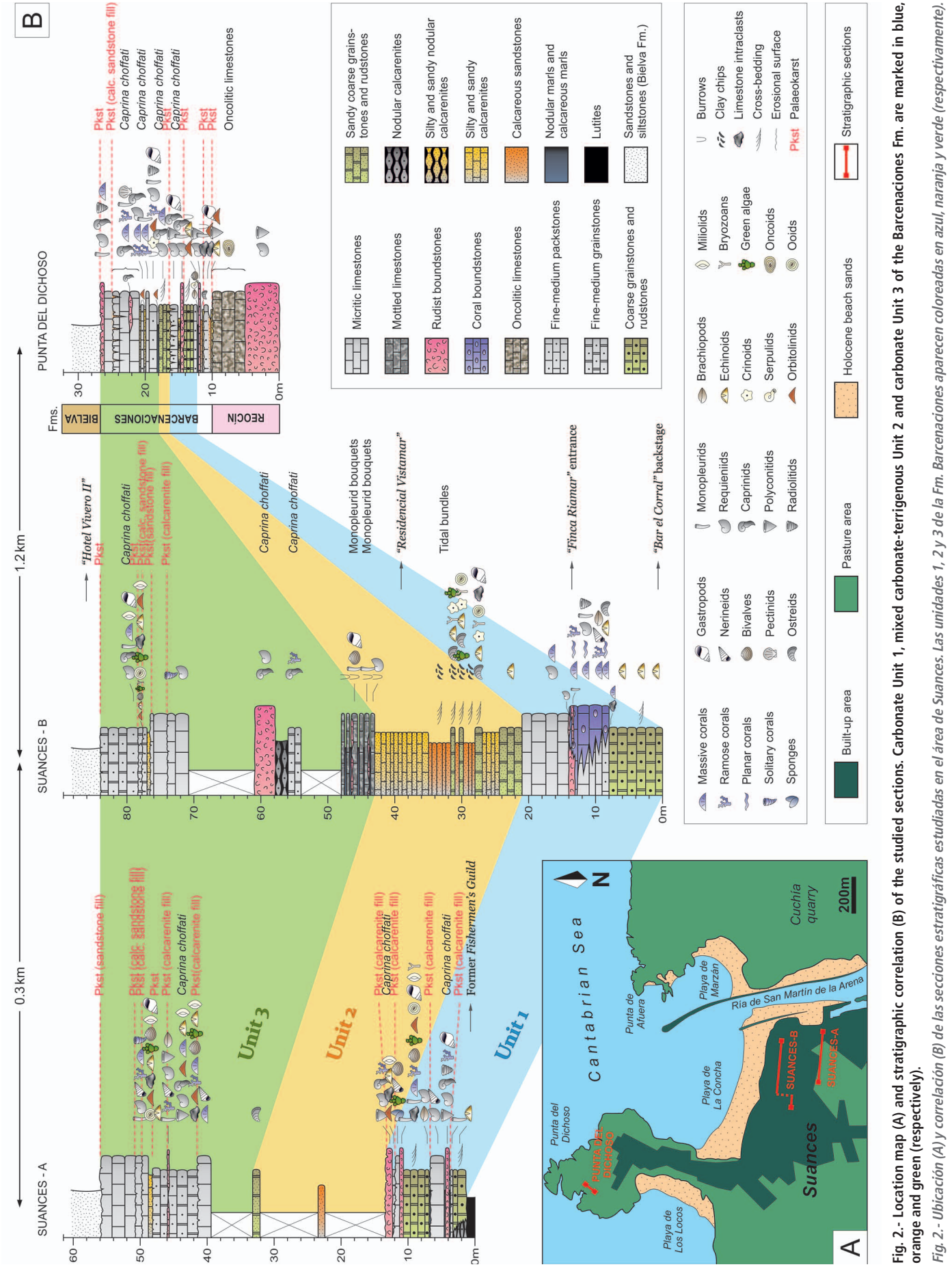

Fig. 2.- Location map (A) and stratigraphic correlation (B) of the studied sections. Carbonate Unit 1, mixed carbonate-terrigenous Unit 2 and carbonate Unit 3 of the Barcenaciones Fm. are marked in blue, orange and green (respectively).

Fig. 2.- Ubicación (A) y correlación (B) de las secciones estratigráficas estudiadas en el área de Suances. Las unidades 1, 2 y 3 de la Fm. Barcenaciones aparecen coloreadas en azul, naranja y verde (respectivamente).

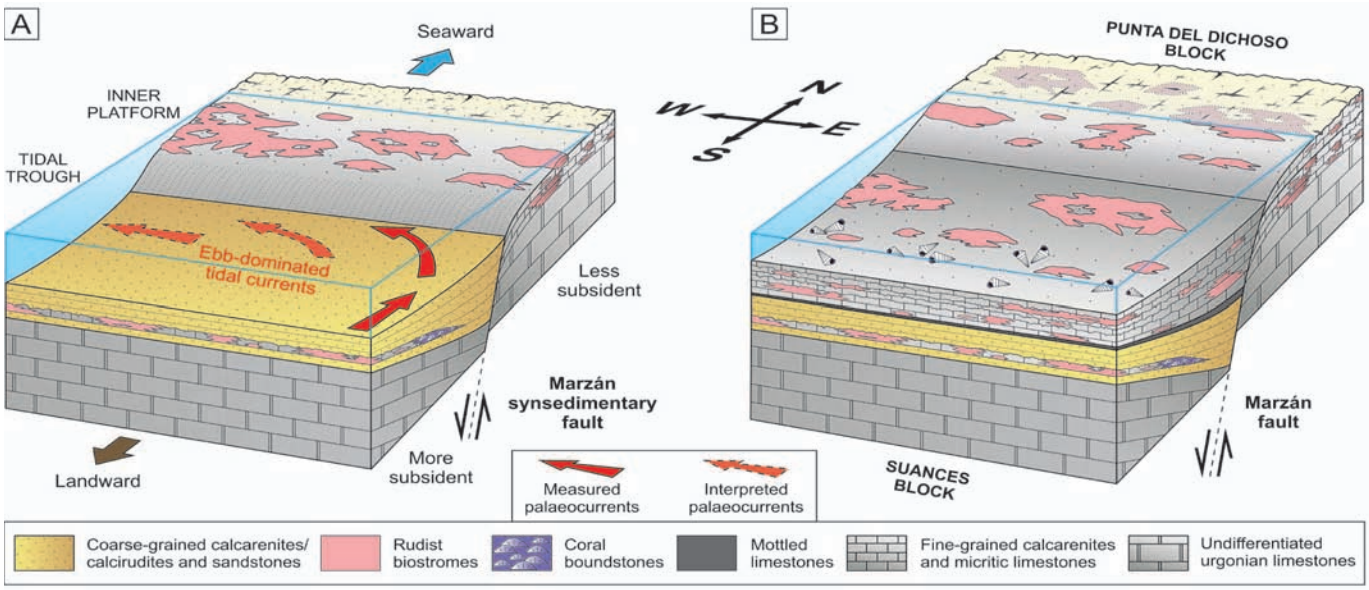

Fig. 3.- Block-diagrams showing the two tecto-sedimentary domains developed during deposition of Barcenaciones Fm. at: A) Stage 1 (units 1 and 2), and B) Stage 2 (Unit 3).

Fig. 3.- Bloques-diagrama que muestran los dos dominios tecto-sedimentarios establecidos durante la sedimentación de la Fm. Barcenaciones. La Fase 1 (A) corresponde a las unidades 1 y 2, mientras que la Fase 2 (B) representa la sedimentación de la Unidad 3.

limestone interval (Unit 3) contains abundant rudists and corals, and it is repeatedly capped by pervasive palaeokarst surfaces and interlayered terrigenous sandy deposits.

Considering the base of Bielva Fm. as a datum horizon, the stratigraphic correlation in figure 2B shows that Unit 1 reaches a total thickness of 12 m in Suances-A section, at least 21 m in Suances-B section, and only 4 m on Punta del Dichoso. Unit 2 ranges in thickness from about 20 m (Suances-A) to 22 m (Suances-B), and finally to less than 2 m (Punta del Dichoso). Similarly, the thickness of Unit 3 varies from 23 m (Suances-A), to 41 m (Suances-B) and to 9 m on Punta del Dichoso headland.

Discussion and conclusions

The stratigraphic correlation in figure 2 shows that boundaries between the three units are timelines. Based on gathered data, a two-stage model for the Barcenaciones Fm. is proposed (Fig. 3): Stage 1 encompasses units 1 and 2, whereas Stage 2 corresponds to Unit 3. The reduced thickness of the Punta del Dichoso sedimentary record, as well as prolonged subaerial exposure episodes revealed by pervasive multiple palaeokarst surfaces, indicate that this section formed on a structural palaeohigh (i.e., Punta del Dichoso block). The thicker Suances-A and Suances-B sections deposited in a more subsident sector (Suances block). During the Stage 1 tidal currents were funneled along an E-W elongated palaeotrough (Fig. 3A). Palaeocurrent data suggest that the northrunning ebb currents of the Ría de San Martín tidal palaeotrough (Fernández-Mendiola *et al.*, 2015) deflected to the west before facing the E-W Suances block. Wackestones and rudist-rich biostromes interbedded in high-energy tidal facies represent limestone tongues that ended with coralline margins similar to those described by Fernández-Mendiola *et al.* (2015). The Stage 2 of the Barcenaciones Fm. was characterized by the infilling of the former tidal trough, and subsequent shallowing and flattening trend of the seafloor topography (Fig. 3B). This is based on more homogeneous facies in the upper part of Unit 3 (Fig. 2B), although differential subsidence between Suances block and Punta del Dichoso block persisted.

All units of the Barcenaciones Fm. reach their maximum thickness in Suances-B section. In addition, this section does not preserve features of all emersion episodes of the platform, which suggests that it belongs to a slightly deeper setting than Suances-A section. All of this implies that the Suances block was gently tilted towards the north, limited by the E-W oriented Marzán fault in a half-graben configuration (Fig. 3). The Marzán fault influenced the sedimentary record of the Barcenaciones Fm. during the Upper Albian.

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