Stratigraphy and facies of the Early Aptian Robayera section (Cantabria, Northern Spain)

Estratigrafía y facies de la sección aptiense inferior de Robayera (Cantabria, Norte de España)

Pedro Ángel Fernández-Mendiola, Joanaitz Pérez-Malo and Joaquín García-Mondéjar

Universidad del País Vasco (UPV/EHU), Facultad de Ciencia y Tecnología, Departamento de Estratigrafía y Paleontología, Apdo 644, 48080, Bilbao, Spain.
kepa.fernandezmendiola@ehu.es, jperez070@ikasle.ehu.es, joaquin.garciamondejar@ehu.es

ABSTRACT

A new stratigraphic section of 235 metres is logged in the Robayera peninsula, where Early Aptian units are represented by shallow-marine facies. The sedimentary record was controlled by early tectonic activity. Four transgressive-regressive cycles have been recognized. The Late Bedoulian San Esteban carbonate platform was karstified, tilted and drowned at the top of the first cycle, and was subsequently overlain by three transgressive-regressive cycles of the Rodezas Formation. The Rodezas Fm stratigraphic type-section is described in Robayera including five units. The first three units wedge updip towards the synsedimentary Usgo N-S fault. The activity of this fault influenced the facies and sedimentary record of both Early Aptian Formations.

Key-words: *Early Aptian, Cantabria, stratigraphy, facies, synsedimentary tectonics.*

RESUMEN

Se ha realizado una sección estratigráfica detallada de 235 metros en la península de Robayera, que integra unidades estratigráficas marino-someras del Aptiense Inferior. Se identifican la Formación San Esteban y la Formación Rodezas, las cuales presentan cuatro ciclos transgresivo-regresivos. El registro sedimentario estuvo controlado por tectónica sinsedimentaria: la plataforma carbonatada de San Esteban (Bedouliense tardío) experimentó karstificación, basculamiento y hundimiento subsiguiente a techo del primer ciclo. El registro subsiguiente de la Fm Rodezas contiene tres ciclos transgresivo-regresivos. La Fm Rodezas se describe en su sección tipo incluyendo cinco subunidades. Las tres primeras se acuñan hacia el oeste en dirección a la falla sinsedimentaria de Usgo. La actividad de esta falla influenció el depósito de facies y el registro sedimentario de ambas Formaciones del Aptiense Inferior.

Palabras clave: *Aptiense Inferior, Cantabria, estratigrafía, facies, tectónica sinsedimentaria.*

Geogaceta, 58 (2015), 3-6
ISSN (versión impresa): 0213-683X
ISSN (Internet): 2173-6545

Fecha de recepción: 2 de febrero de 2015
Fecha de revisión: 29 de abril de 2015
Fecha de aceptación: 15 de mayo de 2015

Introduction

Former studies describe the Robayera vertical succession in different manners. Some descriptions of the lithofacies by previous authors are confusing or partial. Portero-García *et al*. (1976) differentiate C^1_{152} Middle Bedoulian rudist limestones and C^1_{153} Late Bedoulian ostreid limestones, whereas Robador *et al*. (1991) refers to sandy limestones and sandstones with ostreids and orbitolinids, and rudist limestones of Bedoulian age. However, the distribution of the rocks in this area requires greater detail. Gobierno de Cantabria (2013) describes Late Bedoulian sandstones, shales, marls and argillaceous limestones (Cuchía Fm). In contrast, Mediato *et al.* (2009) enumerate for the same area (Punta del Águila section) the following units: Reocín Unit (Late Aptian), Las Peñosas Unit (Albian), Barcenaciones Unit (Albian) and Bielva Unit (Cenomanian).

Our research of the Robayera section is a part of a wider study of the North Cantabrian Basin, and we investigate the Robayera peninsula stratigraphy and facies clarifying some of the former interpretations.

The Robayera peninsula is located in north Cantabria (north of Spain), between the Usgo beach to the west and the Mogro estuary to the east (Fig. 1). It is a SW-NE oriented small peninsula reaching 1.2 km long and 0.7 km wide. We document a sequence spanning the Early Aptian from the Usgo beach to the Robayera beach end.

The Robayera section can be correlated with earlier described sections such as Cuchía (García-Mondéjar *et al.*, 2015), and with sections presently in study such as Punta del Dichoso (Suances lighthouse) and Punta de Afuera (Cuchía).

Geological setting

The study area lies in the northwestern end of the Navarre-Cantabrian Trough, in the Peri-Asturian domain (Feuillée and Rat, 1971) or Santander Coastal Block (Barnolas and Pujalte, 2004). This block is located north of the Cabuérniga Ridge being a less subsident sector in the Cretaceous as compared to the areas south of the Ridge.

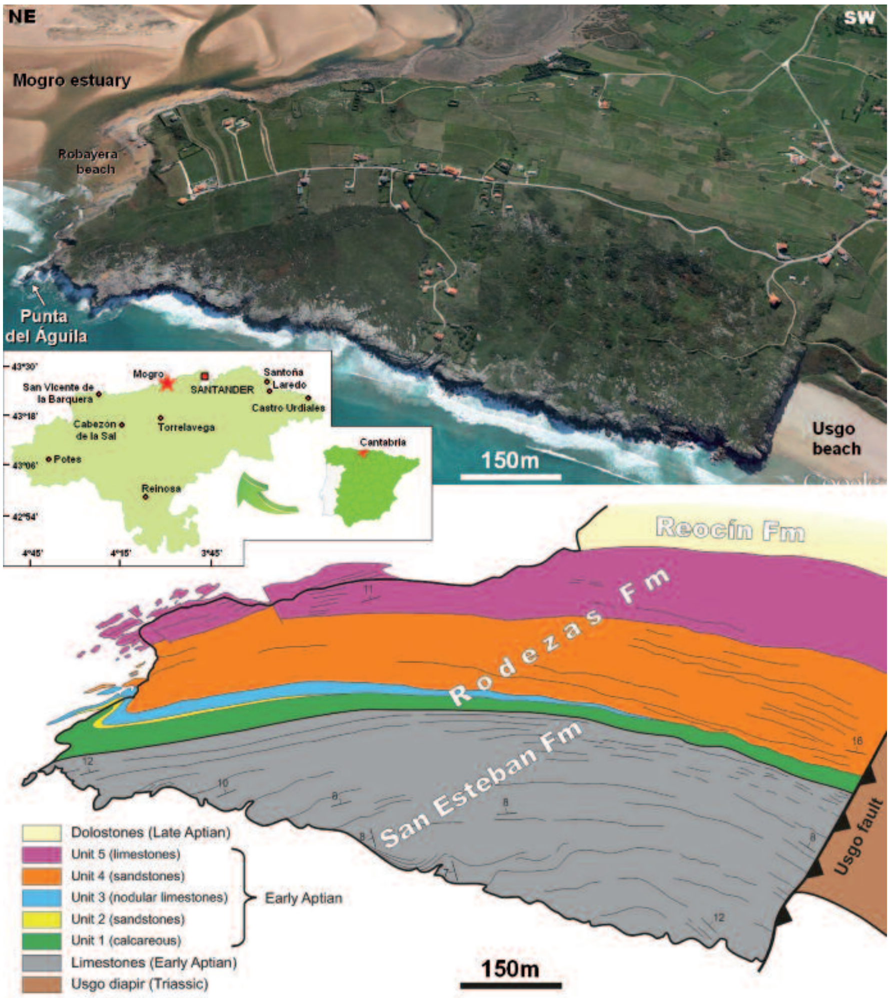


Fig. 1.- Aerial view of the Robayera peninsula (above), along with a detailed schematic diagram including the outcropping lithoestratigraphic units (below).

Fig. 1.- Vista general de la península de Robayera (arriba), junto con el esquema de las unidades litoestratigráficas aflorantes en la zona (abajo).

Stratigraphic succession and facies

Figure 2 illustrates the vertical section logged in the Robayera peninsula. It reaches a total thickness of 235 metres. The section was built along the coast starting at Usgo beach, following the northern side of the Robayera peninsula from west to east towards Punta del Águila, and finally completing the section along the cliffs oriented N-S from Punta del Águila to the Mogro estuary mouth (Fig. 1). The overall succession dips gently (10° average) towards the southeast following a homoclinal pattern.

The stratigraphic succession is divided in two main formations: San Esteban Fm (limestones) and Rodezas Fm (mixed carbonate and siliciclastic).

San Esteban Formation

The first 116 metres of the succession correspond to limestones with rudists outcropping at the northern side of the Robayera peninsula (Figs. 1 and 2). This formation could be still thicker as its base lies under the present coastline and is not outcropping. Several facies are identified, including: a) requieniid rudists (*Toucasia* sp.) in living position and embedded in a micrite matrix forming up to 2 m thick biostromes, b) miliolid and echinoid packstones, c) coral/caprinid (*Pachytraga paradoxa*, J. P. Masse pers. com.) wackestones, d) miliolid-orbitolinid grainstones. These facies are arranged in shallowing up cycles ending with exposure surfaces. The first 78 metres of the succession are very rich in requieniids, whereas from that point onwards caprinids and corals join in the environment.

An interval of orbitolinid grainstones at metre 93 (Fig. 2) reveals the presence of *Iraqia simplex*, *Orbitolina (Mesorbitolina) parva* and *Palorbitolina lenticularis*. This suggests an Early Aptian (Late Bedoulian) age.

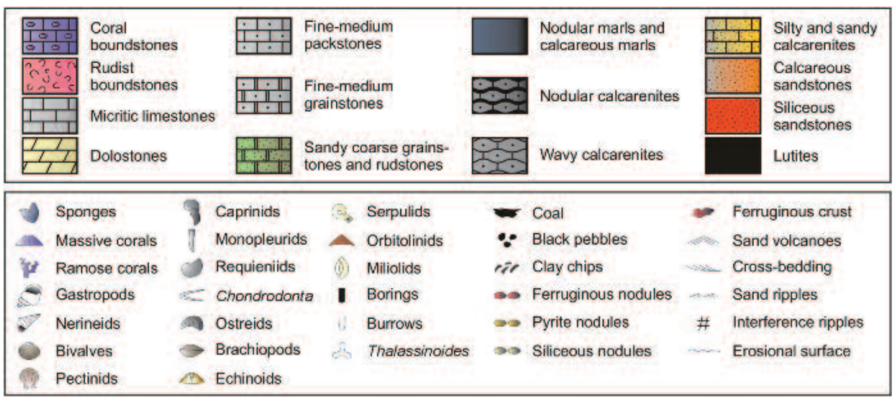
The top of the San Esteban Fm displays an irregular erosional surface with up to 1.5 m local paleorelief, and a nest of tubular and irregular dolomitic patches penetrating the last 50 cm of the underlying limestones. The top of the unit is further eroded towards the west, showing slight truncation of strata (Fig. 1).

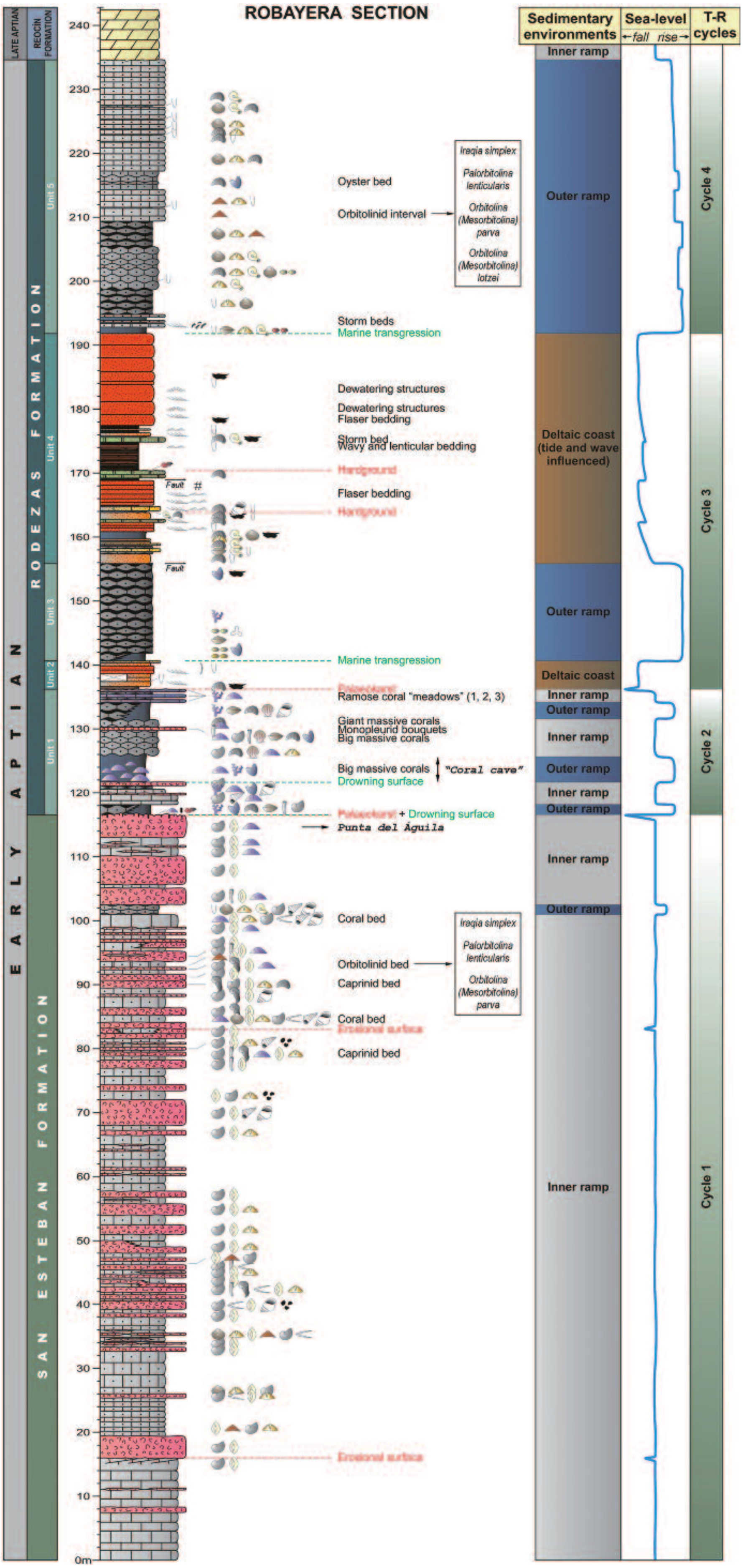
The San Esteban Fm represents a shallow-water subtropical carbonate platform environment (Pascal, 1985). The palaeokarst surface at its top reflects the top of the first transgressive-regressive cycle (T-R cycle) of figure 2.

Rodezas Formation

The Rodezas Fm was originally mentioned in García-Mondéjar *et al.* (1985), and is equivalent to the Cuchía Fm (García-Mondéjar, 1982). The total thickness of the Rodezas Fm is 119 m and is divided into five units: Units 1 to 5.

Unit 1 (20 m thick) is made up of: 1)





lower nodular limestones, marls and limestones (6 m, from metre 116 to 122), middle marls and limestones (12 m, from metre 122 to 134) and upper limestones (2 m), from metre 134 to 136. The nodular limestone deposits fill up the irregular erosional surface on top of the San Esteban carbonate platform. These nodular limestones contain sponges, small corals (*Cryptocoenia*, *Astreofungia* and *Placocolumastrea*, H. Löser pers. com.), brachiopods, pelecypods and scarce rudists. They are overlain by a 4 m thick limestone interval: coral-gastropod wackestones, requieniid rudist wackestones, ramose coral packstones, nodular limestone with corals, sponges and gastropods and finally biostromal requieniid rudist wackestones. At metre 122, nodular marls and calcareous marls with corals and sponges form the "coral cave" appears. The corals range from planar colonies to big domes up to a metre wide and form biohermal structures. The identified colonies include phaceloid corals, and the giant corals correspond to *Thalamocaeniopsis* sp. (H. Löser pers. com.). Above this cave, coral dominated wavy limestones with ramose corals, pectinids and high dome corals (*Thalamocaeniopsis* sp.) are overlain by a monopleurid biostrome. This is followed by ostreid, coral and terebratulid nodular limestones and marls, and finally by biostromal reefal limestones with tightly packed communities of spectacular ramose coral (*Actinastreopsis*) colonies up to 40 cm high. Unit 1 dominated by coral communities represents a transgressive phase relative to the underlying San Esteban platform, and is topped by a palaeokarst surface. Unit 1 forms the second T-R cycle of figure 2.

Unit 2 is 4 m thick. The first 30 cm of siltstones and fine sandstones fill up the rugged irregular palaeokarstic surface of Unit 1. Above them stand burrowed calcareous sandstones, siltstones, cross-bedded siliceous sandstones, and sandy calcarenites. These facies represent coastal siliciclastic deposits formed during the early transgression of the third T-R cycle (Fig. 2).

Fig. 2.- Stratigraphic section, facies, sedimentary environments, relative sea-level changes and transgressive-regressive cycles of the Early Aptian in the Robayera peninsula (Cantabria).

Fig. 2.- Sección estratigráfica, facies, ambientes sedimentarios, curva del nivel relativo del mar y ciclos transgresivo-regresivos del Aptiense Inferior de la península de Robayera (Cantabria).

Unit 3 is 16 m thick, and is composed of an alternation of nodular limestone and marl beds containing abundant *Thalassinoides* burrows, terebratulid brachiopods and sponges with siliceous nodules. Its top is affected by minor faulting so that the transition to the overlying Unit 4 is missing. Unit 3 indicates an open marine outer ramp setting, and reflects a sharp pulse within the ongoing transgressive trend of the third T-R cycle (Fig. 2).

Unit 4 is 36 m thick, and is divided into a lower interval of mixed siliciclastic-carbonate facies (20 m) and an upper subunit of siliceous sandstones (16 m). The lower part displays rippled and cross-bedded sandstones and siltstones, calcareous sandstones with carbonaceous fragments, ostreids, brachiopods, echinoderms and serpulids, and cross-bedded calcarenites. The upper interval sandstones display flaser and lenticular bedding. The sandstones are unfossiliferous and non-calcareous and towards the top show occasional sand volcanoes, burrow structures and thin coal patches. Unit 4 represents deltaic sediments with distributary channels, levees and interdistributary bays, and reflects the regressive phase of the third T-R cycle (Fig. 2).

Unit 5 (43 m thick) is made up of marly wavy limestones and fine-grained calcarenites with ostreids and other bivalves (*Pinna* sp.), serpulids, orbitolinids and siliceous nodules. They include *Palorbitolina lenticularis*, *Choffatella decipiens*, *Orbitolina (Mesorbitolina) lotzei*, *Orbitolina (Mesorbitolina) parva* and *Iraqia simplex*, which indicate a late Early Aptian age. Unit 5 is interpreted as the transgressive pulse with open marine facies of the fourth T-R cycle (Fig. 2). The top of Unit 5 and the transition to Reocín Fm reflects a regressive pulse from outer ramp facies to inner ramp limestones.

Geologic implications

The facies mapping of the Robayera peninsula reveals the presence of a sequence boundary between the San Esteban and Rodezas Fms (Fig. 2). The sedimentary wedge of Units 1 to 3 that thin towards the west indicates a less subsident area in that direction. This could be a reflection of a tilting pulse of the underlying San Esteban Fm associated with early activity of the Usgo fault. The geometry of Unit 4 is more tabular, so these sandstones and calcarenites are thought to postdate the tectonic pulse.

San Esteban Fm is at least 116 m thick at Robayera and is much thicker compared to the same Unit at Cuchía (14 m). This suggests differential subsidence across the Usgo N-S fault. West of this fault the San Esteban Fm is relatively condensed, but suddenly shows a thickness increment up to a factor of x6.5 in the Robayera block. In both structural blocks the San Esteban Fm ends with a palaeokarst surface (Figs. 1, 2 and García-Mondéjar *et al.*, 2015). Additionally, the Rodezas Fm with 119 m of thickness is represented by a hiatus in Cuchía (García-Mondéjar *et al.*, 2015). This suggests a strong influence of synsedimentary tectonics in this area.

Conclusions

The new discovery of a very thick and continuous stratigraphic section in Robayera peninsula enables the recognition of the Early Aptian San Esteban and Rodezas Formations. The study area could be considered one of the Early Aptian type-sections of northern Spain, especially in the case of the Rodezas Fm, which had been poorly described because of the lack of good quality outcrops.

Facies analyses reveal a lower San Esteban carbonate ramp evolving upwards to the Rodezas Fm outer ramp, which is punctuated by two distinct terrigenous units. Four main transgressive-regressive cycles have been recognized throughout the Robayera section. The San Esteban platform underwent tilting and karstification at the Early Aptian, and was later onlapped by the first three Rodezas Fm units, whereas Units 4 and 5 deposited in a non-wedge style. The Early Aptian sediments formed onto differentially subsiding active tilted blocks that influenced the sedimentary record.

Acknowledgements

This work is financed by research projects EHU12/11 and PPM 12/11 of the Basque Country University. We thank A. Pérez-López and an anonymous reviewer for their helpful comments and suggestions that contributed to improve the original draft.

References

Barnolas, A. and Pujalte, V. (2004). In: *Geología de España* (J.A. Vera, Ed.). SGE-IGME, Madrid, 233-241.

Feuillée, P. and Rat, P. (1971). In: *Histoire Structurale du Golfe de Gascogne: Tome 2* (J. Debyser, X. Le Pichon and L. Montadert, Eds.). Publications de L'Institut Francais du Petrole, Technip, 1-48.

García-Mondéjar, J. (1982). In: *El Cretácico de España*. Universidad Complutense, Madrid, 63-76.

García-Mondéjar, J., Hines, F.M., Pujalte, V. and Reading, H.G. (1985). In: *Excursion Guidebook: IAS 6th European Regional Meeting* (M.D. Milá and J. Rosell, Eds.). Institut d'Estudis Ilerdencs, Lleida, 308-392.

García-Mondéjar, J., Owen, H.G. and Fernández-Mendiola, P.A. (2015). *Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen* 276, 1-26.

Gobierno de Cantabria (2013). *Plan de Ordenación de recursos naturales de las dunas de Liencres, Estuario del Pas y Costa Quebrada*. Consejería de Ganadería, Pesca y desarrollo rural. Dirección General de Montes y conservación de la naturaleza, 345 p.

Mediato, J.F., Solé, X., Larrondo, E. and Hernaiz, P. (2009). In: *6º Simposio sobre el Margen Ibérico Atlántico MIA09*, Oviedo, 121-124.

Pascal, A. (1985). *Les systemes biosedimentaires urgoniens (Aptien-Albien) sur la marge Nord-Iberique*. Mémoires Géologiques de l'Université de Dijon 10, 569 p.

Portero-García, J.M., Olivé-Davó, A., Martín-Alafont, J.M. and Ramírez del Pozo, J. (1976). *Mapa Geológico de España 1:50.000, hoja nº 34 (Torrelavega) y memoria*. IGME, Madrid, 40 p.

Robador, A., Heredia, N., Rodríguez-Fernández, L.R. and Marquínez-García, J. (1991). *Mapa Geológico de Cantabria 1:100.000*, IGME, Madrid.