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Changing physiography of rift basins as a control on the evolution of mixed siliciclastic–carbonate back-barrier systems (Barremian Iberian Basin, Spain)

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ABSTRACT

A detailed analysis of both sedimentary facies and stratigraphic architecture of a mixed-siliciclastic carbonate depositional system in the synrift Cretaceous Galve sub-basin (eastern Spain), is carried out. Two different stages in the sedimentary evolution are recognised from the stratigraphic architecture of the back-barrier system: (1) extensive back-barrier mud flats with tidal creeks, and minor washover fans interbedded with the lagoonal carbonates and influenced by local synsedimentary tectonics (thickness variations, rotated blocks and angular unconformities), and (2) a back-barrier with flat-lying architecture and characterised by washover fan deposits interbedded with lagoonal carbonates, well-developed ebb- and flood-tidal delta deposits and a complete absent of back-barrier tidal mud flats and associated creeks. Evidence suggests that synsedimentary extensional tectonics modified the basin configuration, and tectonically-induced physiographic changes controlled the distribution and areal extension of barrier-island sub-environments (open marine, barrier, and lagoon) and their resultant stratigraphic architecture. Physiographic changes in basin configuration ultimately modulated the effect of tides, which produced changes in depositional sub-environments determining the stacking pattern of depositional systems.

1. Introduction

Sedimentation in rift basins is mainly controlled by synsedimentary tectonics. Accommodation changes in marine rift basins are controlled mainly by local basin-floor rotation, basinwide subsidence and, to a lesser degree, by eustatic changes (Ravnas and Steel, 1998). Synsedimentary tectonics controls thickness variations of depositional systems and distribution of sub-environments. The shape, depth and orientation of a basin also determine the potential controls on the dynamics of the system such as amplification of tidal motions and formation of tide-influenced deposits (Sztanó and de Boer, 1995). In particular, in rift basins, both blind and surface faults determine the location and amalgamation of high-energy siliciclastic sequences in the footwall of the syn-sedimentary fault (e.g., Leeder and Gawthorpe, 1987; Noe-Nygaard and Surlyk, 1998; Gupta et al., 1999; Jackson et al., 2005; Peropadre et al., 2007). In past examples, the physiography of a basin can be deduced from indirect evidence provided by tidal deposits (Sztanó and de Boer, 1995) and the detailed study of the sedimentary record allows differentiation of the relative role of allocyclic process on stacking patterns and cyclicity (e.g., Soria et al., 2012). A detailed analysis of both sedimentary facies and stratigraphic architecture is crucial in order to basin controlling parameters.

This paper presents a detailed analysis of a mixed-siliciclastic carbonate depositional system in the Cretaceous Galve sub-basin in eastern Spain, its stratigraphic architecture and the relationship between sedimentation and active faulting. This study suggests that synsedimentary tectonics modified basin configuration which controlled the distribution of depositional sub-environments, their areal extent (open marine, lagoon, and barrier location) and the tidal regimes under which sedimentation took place.

2. Geological setting and stratigraphic context

The study area is located in the northeastern sector of the Galve sub-basin (Fig. 1A). The Galve sub-basin is located in central-eastern Iberia, within the Iberian Chain, and represented a marginal sedimentation area at the western part of the Cretaceous Maestrazgo Basin (Salas and Guimerà, 1996; Soria, 1997). Synrift sedimentation in the Galve sub-basin spans from the late Hauterivian to the early Albian (e.g., Soria, 1997; Soria et al., 2000; Salas et al., 2001; Liesa et al., 2004, 2006; Peropadre, 2012), and it mainly comprises (Fig. 1B): (1) an alluvial and lacustrine series (El Castellar Formation; Soria, 1997) that recorded the transition from the initial rifting to the rift climax stages (Liesa et al., 2006; Meléndez

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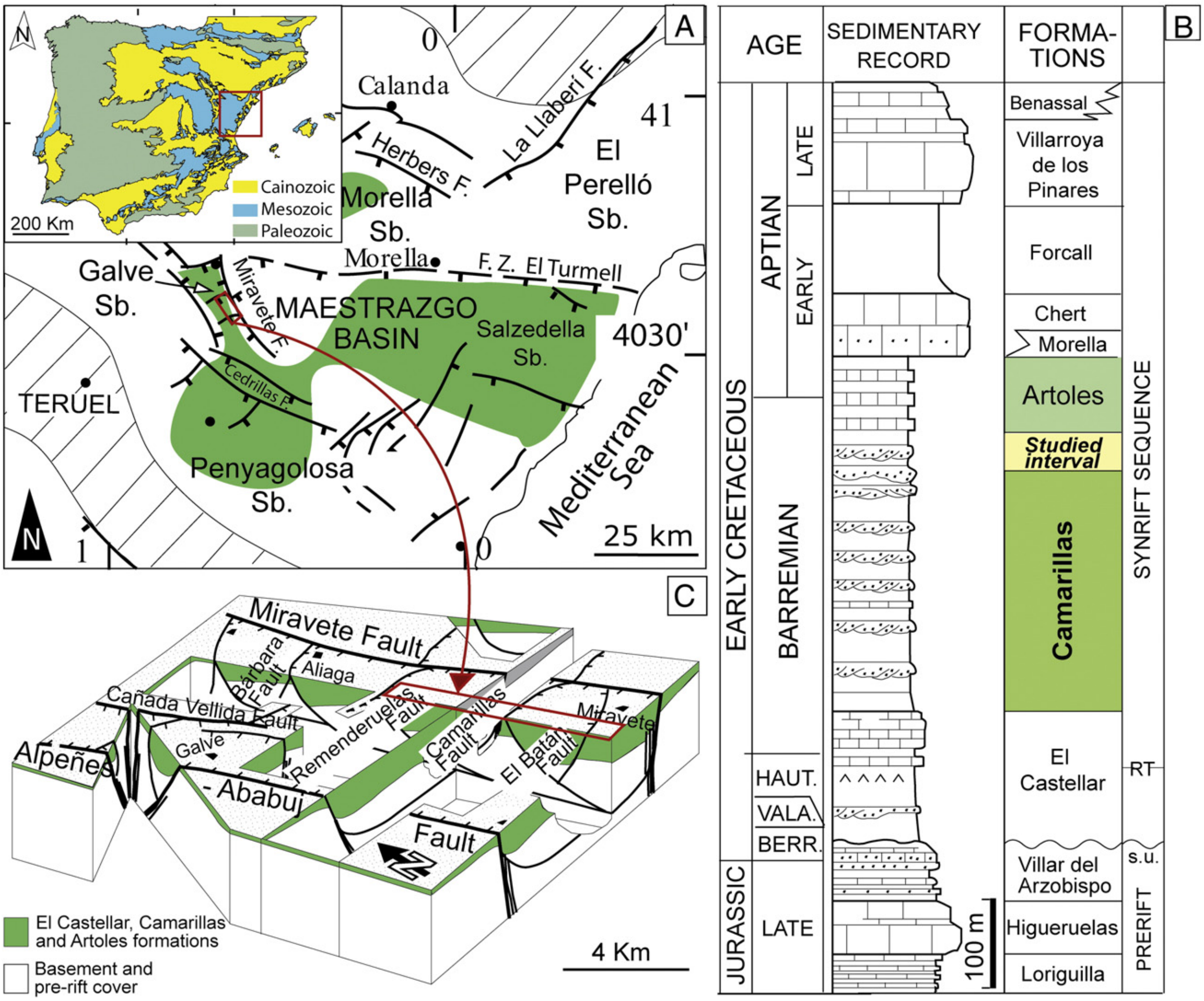

Fig. 1. Geological setting of the study area in Galve sub-basin. (A) Maestrazgo Basin where the Galve sub-basin and the study area are marked (modified from Capote et al., 2002). (B) Chronostratigraphic diagram and sedimentary record of the Galve sub-basin and the studied interval (s.u. synrift unconformity, RT. Rift transition). (C) Block diagram showing the tectonic setting of the Galve sub-basin during the sedimentation of El Castellar, Camarillas and Artoles formations.
(B) and (C) modified from Liesa et al. (2006).

et al., 2009); (2) red clays and sandstones (Camarillas Formation) previously interpreted as a low sinuosity fluvial system with broad flood plains (Salas, 1987; Soria, 1997); (3) marls and limestones (Artoles Formation), rich in calcareous algae, planktic foraminifera, and molluscs, interpreted as deposited in a shallow marine to transitional carbonate system (Salas, 1987; Soria, 1997) that evolved northwards (towards the Las Parras sub-basin) to a coastal lacustrine systems (Soria, 1997); (4) a series of siliciclastic and/or carbonate marine platforms (the Morella, Chert, Forcall, Villarroya de los Pinares, and Benasal formations) that characterise the Aptian sedimentation (Vennin and Aurell, 2001; Peropadre et al., 2008; Peropadre, 2012), and (5) a Late Aptian–Early Albian transitional siliciclastic series with coal beds (Escucha Formation).

The extensional structure of the Cretaceous Galve sub-basin was characterised (Fig. 1C) by a NNW–SSE trending graben defined by large NNW–SSE trending and steep normal faults, such as the Miravete and Alpeñés–Ababuj faults (Soria, 1997; Liesa et al., 2000, 2004, 2006; Soria et al., 2001; Meléndez et al., 2009). This main graben was compartmentalised by a set of ENE–WSW listric normal faults (e.g., the Campos, Santa Bárbara, Aliaga, Remenderuelas, Camarillas and Jorcas faults) resulting in a system of minor traverse grabens and half-grabens (Liesa et al., 2006). This fault system determined a basin configuration with an elongated N–S trending geometry (Liesa et al., 2004, 2006). After restoring Tertiary shortening (based on Simón Gómez et al., 1998 and Simón and Liesa, 2011), the basin was 24 km long, 11 km wide at the northern area, 6–8 km wide at the studied area (middle sector of the basin) and 9 km wide at the southern part.

The studied stratigraphic interval comprises the transition series between the Barremian Camarillas (siliciclastic-dominated) and the Barremian Early-Aptian Artoles (carbonate-dominated) formations (Fig. 1B). This transition is characterised in many sites through the Galve sub-basin by a sedimentary break with a lithological change that separates two depositional sequences. These sequences broadly coincide with both lithostratigraphic units (Soria, 1997). In the study area, however, this boundary is much more complex and a 45 m-thick interval of mixed siliciclastic–carbonate deposits appear. In this area, the Camarillas and Artoles formations display great thickness variations related to basinal and intrabasinal faults (Soria, 1997; Liesa et al., 2006).

The Palaeogene–Neogene folding structure of the study area facilitates the observation of these variations and of their main geometries. In this way, geological mapping of the highly dipping (>75°), western limb of the NNW–SSE Aliaga–Miravete anticline provides a cross-section view of the Cretaceous Galve sub-basin infill across the WSW–ENE listric normal faults (Fig. 2). In this view, the Camarillas and Artoles formations have a wedge-like geometry, i.e. towards the south dipping, ENE–WSW Camarillas listric normal fault. The study area includes the half-graben located between the ENE–WSW Remenderuelas and Camarillas listric