An integrated Eocene chronostratigraphy for the central sector of the SE margin of the Ebro Basin

Cronoestratigrafía integrada del Eoceno del sector central del margen SE de la Cuenca del Ebro

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Abstract: The Paleogene sedimentary record in the Pontils area (SE sector of the Ebro Basin) consists of a ~ 2000-m-thick sequence formed by the Mediona Fm, the Orpí Fm, the Pontils Gp, the Santa Maria Gp and the Sant Miquel de Montclar Conglomerates. The age of these materials is loosely constrained based on stratigraphic relationships with marine sediments and punctual mammal fossils and charophyte assemblages within the continental materials. In order to precise their chronology, a magnetostratigraphic section up to 1500-m-thick in the Pontils-Sant Miquel de Montclar area has been studied and correlated to the Global Polarity Time Scale. From this correlation the age of the Pontils Gp is established in Lutetian to middle Bartonian, the Collbàs Fm would be middle Bartonian and the overlying Sant Miquel Conglomerates would range from Bartonian to Priabonian. This new chronology has been integrated with recent magneto- and biostratigraphic studies in more northeasterly sectors of the SE margin of the Ebro Basin (Igualada and Montserrat areas). This new and continuous chronological framework is essential to unravel and quantify the rates of change in the Ebro Basin-Catalan Coastal Ranges system.

Key words: Magnetostratigraphy, Eocene, Ebro Basin.

Resumen: *El registro sedimentario paleógeno de la zona de Pontils (sector SE de la Cuenca del Ebro) consiste en una secuencia de unos 2000 m de potencia formada por la Fm. Mediona, la Fm. Orpí, el Gp. Pontils, el Gp. Santa Maria y los Conglomerados de Sant Miquel de Montclar. La edad de estos materiales es poco precisa en base a relaciones estratigráficas con materiales marinos y datos puntuales de asociaciones de carófitas y mamíferos fósiles en los materiales continentales. Con el objetivo de precisar esta cronología, se ha estudiado una sección magnetoestratigráfica de unos 1500 m de potencia que se ha correlacionado con la Escala de Tiempo de Polaridad Geomagnética. A partir de esta correlación, la edad del Gp. Pontils se establece en Luteciense-Bartoniense medio, la Fm. Collbàs tendría una edad Bartoniense y los conglomerados de Sant Miquel de Montclar abarcarían el Bartoniense-Priaboniense. Esta nueva cronología se ha integrado con estudios magneto- y bioestratigráficos recientes en sectores situados más al NE en el mismo margen de la cuenca (áreas de Igualada y Montserrat). Este nuevo marco cronológico continuo es esencial para descifrar y cuantificar las tasas de evolución del sistema formado por la Cuenca del Ebro y las Cadenas Costeras Catalanas.*

Palabras clave: *Magnetoestratigrafía, Eoceno, Cuenca del Ebro.*

INTRODUCTION

The South Pyrenean Foreland Basin (NE Spain, Figure 1) has an exceptional sedimentary record with up to 5000 meters of marine and continental sediments ranging in age from Upper Cretaceous to Middle Miocene. Moreover, the present level of erosion of the basin infill and its surrounding mountain ranges is at an optimal stage for studying tectonostratigraphic relationships on surface, making this region a natural laboratory for the study of collision belts and their adjacent foreland systems.

Recent bio- and magnetostratigraphic studies within the central sector of the SE margin of the Ebro Basin (Igualada and Montserrat areas; Costa et al., in press; Gómez-Paccard et al., in press) have provided a precise chronology of the Eocene-Oligocene infilling of this basin margin. Nevertheless, time constraints still lack in more southwesterly positions (Pontils/Sant Miquel de Montclar area).

In this contribution we present the integration of a new magnetostratigraphy based chronology in the Pontils area with the established Igualada-Montserrat

chronostratigraphy. This will provide a continuous chronological framework for the central part of the SE margin of the Ebro Basin which will allow constraining the margin evolution and calculating rates of change of this geodynamic system.

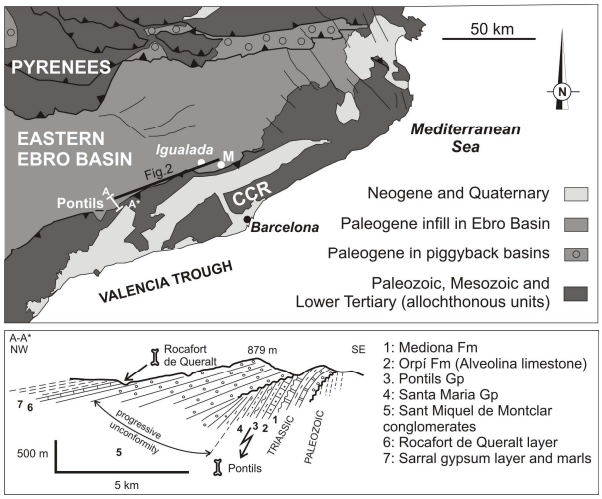

FIGURE 1. *Geological map of the eastern Ebro Basin. The position of the cross section A-A* and the lithostratigraphic sketch (Figure 2) are shown. M indicates the Montserrat area, CCR: Catalan Coastal Ranges. Cross section A-A* redrawn from Anadón et al (1987)*

GEOLOGICAL SETTING AND STRATIGRAPHY

The Ebro Basin is a triangular shaped foreland basin bounded by three Alpine thrust-and-fold belts, the Pyrenees to the N and the Catalan Coastal Ranges and the Iberian Chain to the SE and SW respectively. These margins were tectonically active during most of the sedimentary basin infilling (latest Cretaceous to Middle Miocene in age). The Ebro Basin was filled by marine and continental sediments until the Priabonian (Costa et al., 2010), when it was disconnected from the Atlantic Ocean. Following the basin closure, steady and continuous continental sedimentation took place from Late Eocene to the late Middle Miocene (Barberà et al., 2001). During this endorheic stage, alluvial and fluvial sedimentation predominated in the basin margins, whereas in the inner parts fluvial and lacustrine systems were set up.

Our study area is located in the SE margin of the Ebro Basin where the Paleocene to Eocene basin infill records the coeval development of the adjoining Catalan Coastal Ranges contractional structures. Specifically, it is located in the NW limb of a frontal anticline that formed at the tip of a major basement thrust. Growth strata geometries and angular unconformities preserved in the Ebro Basin sedimentary record denote that this fold and its related thrust were formed during the sedimentation of the Sant Miquel de Montclar Conglomerates and after the sedimentation of the underlying continental to shallow marine deposits.

The Paleogene sedimentary record in the Pontils area consists of a ~ 2000-m-thick sequence divided into five lithostratigraphic units (Figure 2). From base to top these units are the Mediona Fm, the Orpí Fm, the Pontils Gp, the Santa Maria Gp and the Sant Miquel de Montclar Conglomerates.

The Mediona Fm (Anadón, 1978) directly overlies the thin Mesozoic cover and consists of an up to 50-m-thick unit of red mudstones with interbedded sandstones and calcareous paleosoils. It was deposited before the Ilerdian marine transgression recorded by the up to 100-m-thick limestones of the Orpí Fm (Ferrer, 1971), informally known as Alveolina limestone.

The Pontils Gp (Ferrer, 1971; Anadón 1978) directly overlies the Orpí Fm and mainly consists of fine-grained terrigenous rocks with minor carbonates and evaporites deposited in continental and transitional environments with a variable thickness from 100 to 800 meters. The Pontils Gp can be subdivided into 7 formations, represented in Figure 2. The uppermost levels of the Pontils Gp contain the classical mammal fossil site of Pontils, attributed to the MP15 mammal Paleogene reference level (Anadón et al., 1983).

Overlying the continental Pontils Gp it crops out the marine Santa Maria Gp (Ferrer, 1971). This unit, 400 to 1000 meters thick, was deposited during the Bartonian transgression and can be divided into three main formations; the Collbàs Fm (limestones and marls with subordinated sandstones and fine conglomerates), the marls of the Igualada Fm, and the coralline limestone unit of the Tossa Fm. Recent bio-magnetostratigraphic studies in the Igualada area have attributed a Bartonian age to the Collbàs Fm and a Priabonian age to the Igualada and Tossa formations (Costa et al., in press).

Finally, the alluvial Sant Miquel de Montclar Conglomerates consist of more than 500 meters of massive conglomerates with interbedded red sandstones and mudstone lenses. Basinwards, the Sant Miquel de Montclar Conglomerates grade to the distal alluvial and fluvial facies of the Artés Fm (Ferrer, 1971). The mammal site of Rocafort de Queralt, assigned to the MP19-20 reference level, has been reported within the lowermost levels of the Artés Fm in the study area (Barberà et al., 2001).In the northeasterly position of Montserrat only four Paleogene lithostratigraphic units crop out. The lowermost unit, the Mediona Fm, is overlain by the El Cairat Fm (Triassic-derived breccias with an Ypressian estimated age; Anadón 1978). Both on top and interfingering the uppermost levels of the El Cairat Fm, the red sandstones, mudstones and conglomerates of the La Salut Fm crop out (Anadón, 1978). The topmost unit in the Montserrat area is the informal Montserrat conglomerates, which grade basinwards into distal

alluvial sandstones and mudstones and finally into the marine Santa Maria Gp. Recent magnetostratigraphic studies have attributed a Lutetian age to the La Salut Fm and an upper Lutetian to lower Priabonian ages to the Montserrat Conglomerates (Gómez-Paccard et al., in press).

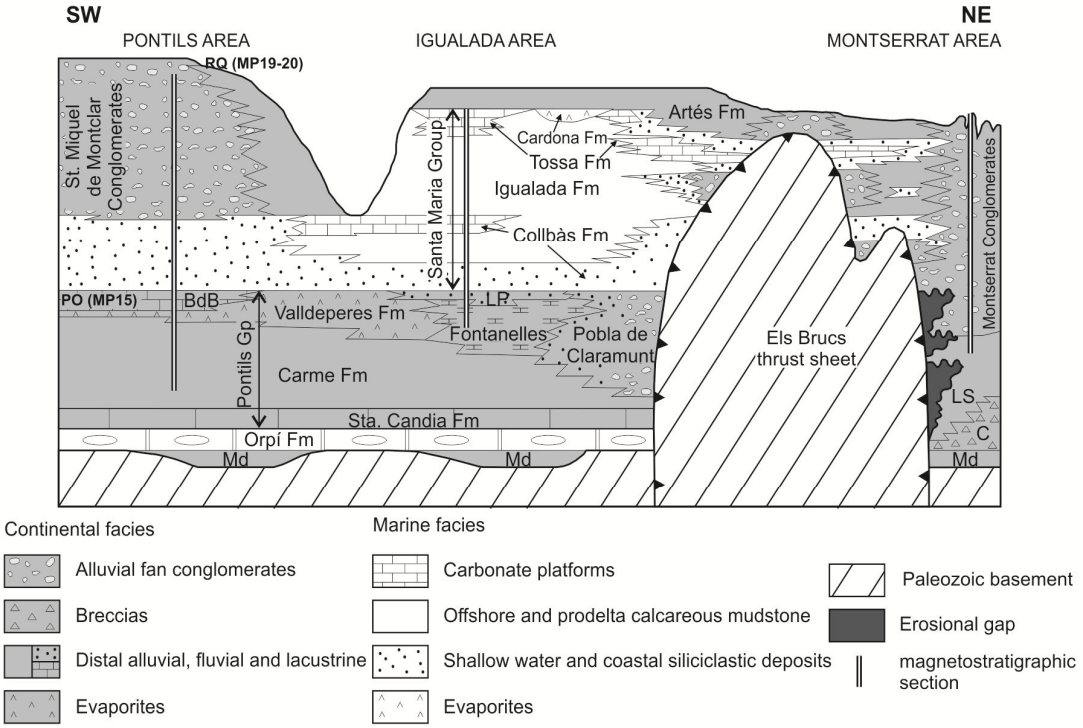

FIGURE 2. *Lithostratigraphic sketch of the Central Sector of the SE margin of the Ebro Basin. The position of the magnetostratigraphic sections is shown. PO indicates the Pontils fossil locality in the Bosc d'en Borràs Fm, (BdB in this figure), RQ indicates the Rocafort de Queralt fossil locality, LP indicates La Portella Fm, Md indicates the Mediona Fm, C indicates the Cairat Fm and LS indicates the La Salut Fm. Redrawn from Anadón et al. (1979) and Costa et al. (in press).*

METHODOLOGY AND RESULTS

238 sites were drilled along ~ 1450 m of sedimentary succession in the Pontils section, comprising the Carme, Valldeperes and Bosc de'n Borras formations (Pontils Gp), the Collbàs Fm (Santa Maria Gp), and the Sant Miquel de Montclar Conglomerates (Figures 2 and 3). At least 2 samples per site were obtained with both an electrical and a gasoline power drills with diamond core bits cooled with water. Samples were oriented *in situ* with a magnetic compass coupled to an orienting device. Laboratory treatment consisted in stepwise thermal demagnetization of, at least, 1 sample per site and subsequent measurement of the Natural Remanent Magnetization (NRM). Samples were heated in a MMTD-80 thermal demagnetizer up to 680 ºC and the NRM was measured in a superconducting rock magnetometer 2G Enterprises in the Paleomagnetic Laboratory of Barcelona (CCiT UB and CSIC).

Characteristic components of the NRM were obtained after visual inspection of the Zijderveld diagrams (Figure 3). The local magnetostratigraphy was determined by calculating the virtual geomagnetic pole paleolatitude per site; positive and negative paleolatitudes were interpreted as normal and reversed polarities respectively.

The obtained local magnetostratigraphy has later been correlated to the Global Polarity Time Scale (GPTS) (Gradstein et al., 2004). From this correlation it can be stated that in this area the sedimentation of the Pontils Gp would extend from Lutetian to middle Bartonian, the Collbas Fm would be middle Bartonian in age and the overlying Sant Miquel Conglomerates would range from Bartonian to Priabonian. Sedimentary trends have been calculated from this new chronology, ranging from 8 to 24 cm/kyr in the studied section.

CONCLUSIONS

Within the study area new time constraints have been assigned to the Eocene materials of the Pontils Gp, Collbàs Fm and Sant Miquel de Montclar Conglomerates. This allows dating as Bartonian to Priabonian the growth of the NE-trending flexure (Carme-Cabra Anticline) that constitutes the contractional front of the adjoining parts of the Catalan Costal Ranges thrust-and-fold belt. Moreover, the age of the Pontils fossil site (attributed to MP15) has been constrained to the upper part of C19 (late Lutetian). The obtained chronology allows a precise correlation with time-equivalent materials in more northeasterly positions within the Ebro Basin (Igualada and Montserrat areas) yielding an integrated

chronostratigraphic framework for the Eocene record of the SE margin of the Ebro Basin.

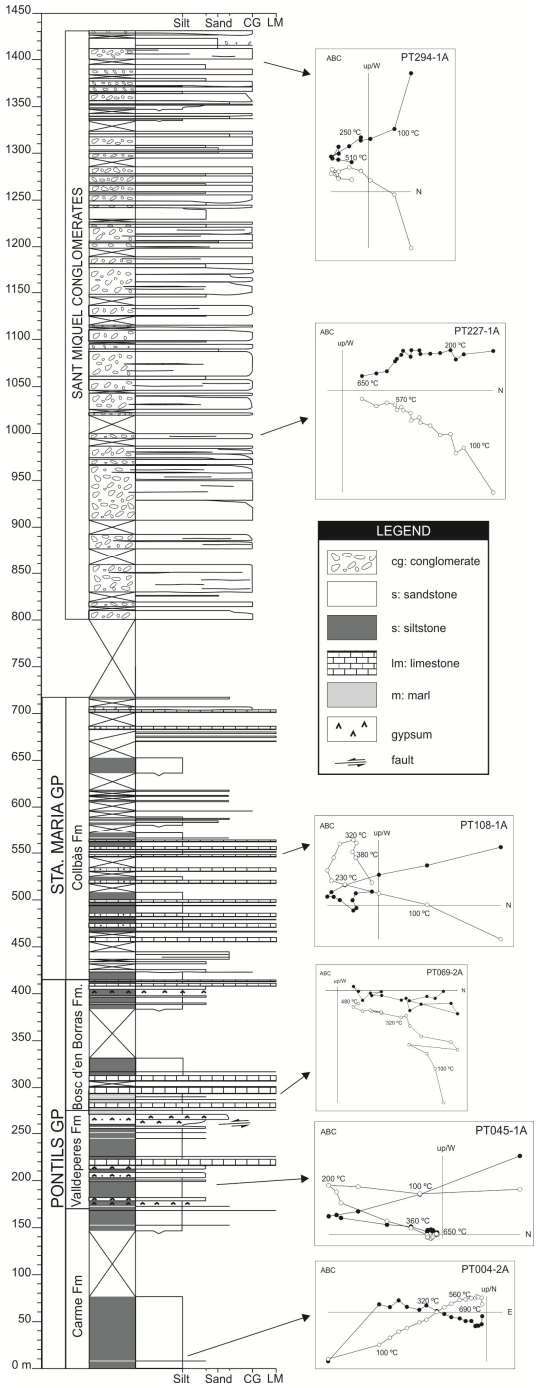

FIGURE 3. *Stratigraphic section and demagnetization diagrams of selected samples for the different formations.*

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