A geological cross- section along the Basque Pyrenees and the Parentis Basin (Western Pyrenees)

Corte geológico a través de los Pirineos Vascos y la cuenca de Parentis (Pirineos occidentales)

Y. Almar, O. Ferrer, E. Roca, M. Puigvert, A. Amilibia y J.A. Muñoz

Dept. Geodinàmica i Geofísica. Facultat de Geologia, Universitat de Barcelona 08028 Barcelona.yleniaalmar@ub.edu

Abstract: A new geological cross- section along the North Iberian Margin shows a complete image of the Western Pyrenees and the Parentis Basin as well as the geometric differences and age constraints between both Pyrenean fronts. The South Pyrenean front, developed during Uppermost Cretaceous- Middle Miocene, is represented by a major thrust which accumulates around 20 km of southward displacement. The Basque- Cantabrian basin is a mesozoic extensional basin which was inverted during Paleogene times as a consequence of the Pyrenean orogeny. A basement- involved thrust wedge with an upper south- directed back- thrust characterizes the North Pyrenean Frontal Thrust. The main thrust, emplaced during Late Eocene- Miocene times, shows a displacement around 2 km whereas the back- thrust detached in Paleocene materials shows a displacement about 1.5 km. Northwards, the Landes High, is interpreted as an uplifted plateau where a thick wedge of Upper Cretaceous- Cenozoic synorogenic deposits overlay unconformably the Hercinian basement. This package corresponds with the North Pyrenean foreland basin. More to the north, the Landes fault is the southern margin of the Mesozoic Parentis Basin, a semigraben infilled with a thick package of Triassic to Albian synrift sequence overlied by Cretaceous and Cenozoic deposits. There, inversion structures were poorly developed.

Key words: Western Pyrenees, frontal thrust, seismic, geological cross- section**.**

Resumen: *Un nuevo corte geológico realizado en el Margen Norte de Iberia muestra una imagen completa de la estructura de los Pirineos Vascos y la Cuenca de Parentis y permite deducir algunas diferencias geométricas y temporales entre ambos frentes Pirenaicos. El frente sur pirenaico, que se desarrolló durante el Cretácico superior- Mioceno medio, está representado por un cabalgamiento con un desplazamiento hacia el sur mínimo de unos 20 km. La Cuenca Vasco- Cantábrica es una cuenca extensional mesozoica que fue invertida durante el Paleógeno como consecuencia de la orogenia Alpina. El frente nor- Pirenaico está caracterizado por un cabalgamiento que involucra basamento con un retrocabalgamiento de dirección sur. El cabalgamiento principal fue activo durante el Eoceno superior- Mioceno y muestra un desplazamiento de 2 km mientras que el retrocabalgamiento, despegado en materiales del Paleoceno muestra un desplazamiento de 1,5 km. Hacia el norte, el Alto de las Landas, se interpreta como una plataforma levantada, dónde una potente cuña sinorogénica de materiales Cretácico superior- Cenozoico suprayace discordantemente al basamento Hercínico. Este paquete sedimentario se corresponde con el margen sur de la cuenca mesozoica de Parentis, un semigraben relleno por una potente secuencia sin- rift Triássica- Albiense fosilizada por materiales Cretácicos y Cenozoicos. La cuenca de Parentis se encuentra afectada levemente por estructuras de inversión tectónica.*

Palabras clave: *Pirineos Occidentales, cabalgamiento frontal, sísmica, corte geológico.*

INTRODUCTION

The Pyrenees are a collisional double vergent orogen which extends along the north Iberian margin. It was generated during the collision of the Afro-Iberian and Euroasian plates and it is bounded to the north and to the south by two foreland basins (Aquitanian basin and Ebro Basin), (see Fig 1). The Western Pyrenees are delimited to the east by a diapiric alignement associated to the Pamplona Fault and to the west by the Asturian Paleozoic Massif. The structure of the North Western Pyrenean front and the Parentis Basin was depicted from the newly obtained MARCONI- 3 seismic reflection profile. This profile was adquired with a seismic network survey projected at the offshore of the Bay of Biscay within the Marconi project. Information from well data and previous existing seismic surveys in the Parentis Basin were useful to constrain reflector ages.

Depth conversion of the seismic profile has been realized with velocity values obtained from wells located at the eastern sector of Parentis basin.

Data collected from several field surveys has been used to construct a geological cross- section along the Basque Pyrenees from Cabo Matxixaco to the Ebro Foreland Basin. Due to the scarcity of onshore seismic data, wide angle seismic refraction data from Pedreira, (2005) and Pedreira *et al*. (2007) have been used to constrain the crustal structure.

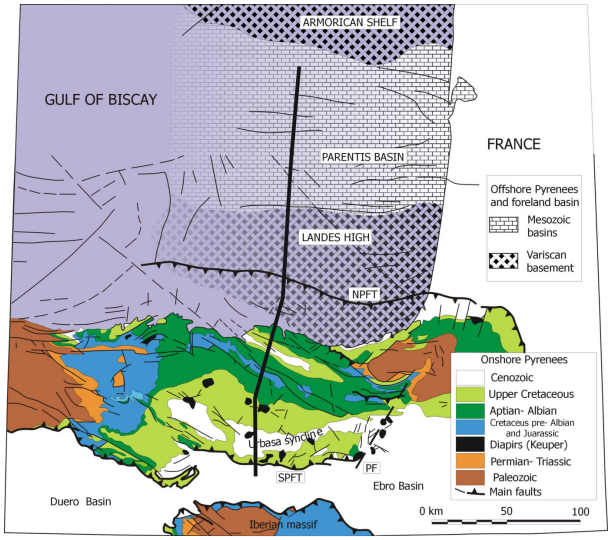

FIGURE 1. *Simplified geological map of the Western Pyrenees. Three main structural domains are represented offshore: Landes High, Parentis Basin and Armorican Shelf. Note cross section location in black including seismic profile MARCONI-3 (offshore). NPFT: North Pyrenean Frontal Thrust; SPFT: South Pyrenean Frontal Thrust; PF: Pamplona Fault.*

PROFILE DESCRIPTION AND DISCUSSION

From south to north there are several structural domains that can be recognized (Fig. 3):

The Sierra de Cantabria frontal thrust sheet represents the southern front of the Western Pyrenees. It is a very tectonized area basically composed by an inverted extensional fault transported above a detachment level located within Triassic evaporites (Keuper). The hangingwall is composed by mesozoic material with steep and narrow anticlyne structures verging to the south, some of them are faulted cored anticlines with intrusive Triassic (Keuper). Those Triassic intrusions produce diapiric structures linked to the main reverse faults. This frontal thrust sheet is highly partitioned as a result from the Alpine compression. The geometry of the frontal thrust is gently dipping to the north and becomes suddenly steep at the proximity of the Ebro foreland Basin. The footwall belongs to a tiangle zone bounded southwards by a passive- roof backthrust and overlaid by Cenozoic sediments of the Ebro basin. Midle to Upper Miocene sediments are clearly post-orogenic.

The Miranda- Treviño- Urbasa syncline is an asymetrical gentle dipping limb syncline located northward of the Sierra de Cantabria thrust where Cenozoic syntectonic sediments (Eocene to Miocene) were accumulated during Alpine deformation. The origin of the structure can be attributed to the compression activity during the Eocene- Early Miocene uplift of the Sierra de Cantabria and to the associated diapiric activity. This generated a syn-sedimentary northern migration of the basin depocenter which resulted in a thicker sediment accumulation in the southern flank of the syncline.

Further north there are several structures dominated by north verging imbricate thrusts: The Bilbao Anticline, involving basement rocks and with strong axial plane cleavage development, the Biscay syncline and the north Biscay anticlyne (see Fig.2). Thickness of Mesozoic successions decreases to the north. The minimung shortening calculated in this area is 25 km produced by overthrusting of basement units (Gómez *et al*., 2002).

The North Pyenean Front is made up by basement involved north- directed thrusts developed from the inversion of the lower Cretaceous intracontinental basins formed during the opening of the Bay of Biscay (Fig. 4). The frontal thrust is a wedge basement-involved thrust with a displacement of 5 km and with an upper south- directed back- thrust detached in Paleocene rocks.

The Landes High is located between the Parentis and the onshore Basque- Cantabrian basin and was inverted and incorporated into the Pyreneean orogen (Sanchez, 1991). It belongs to an uplifted plateau eroded with an uppermost Cretaceous- Cenozoic thick sedimentary succession that unconformably overlies the Hercinian basement or a thin and partially eroded Triassic-Jurassic cover.

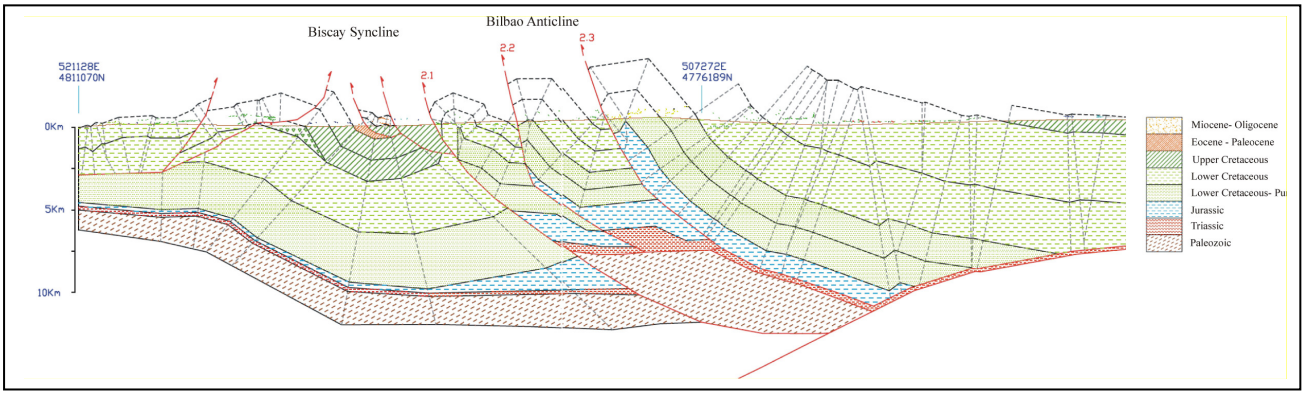

FIGURE 2. *Enlarged section of the north Basque- Cantabrian Basin with north directing thrusts of the Bilbao anticlyne and Biscay syncline.*

The Parentis Basin is filled by a 10 km sequence of syn-rift Jurassic to lower Cretaceous rocks overlying a lowermost Jurassic, Triassic and Permian successions. The Mesozoic sediments are affected by normal faults which compartmentalise the basin and bounded it both to the north and south. Diapirs deformed the overlying Upper Cretaceous and the Cenozoic synorogenic deposits.

Both Parentis Basin and Landes High are overlaid by a northwards- thinning wedge of Upper Cretaceous to Cenozoic syntectonic deposits affected by the north Pyrenean frontal structures along the Basque shelf. These structures consist of north- directed basement involved thrusts and recumbent folds whose geometry is controlled by the inversion of extensional faults.

CONCLUSIONS:

From the geometries observed in the geological cross- section we conclude that the deformation style in the Western Pyrenees is mainly influenced by the halokinetic movements and diapiric structures, the extensional fault configuration during opening of Bay of Biscay and the thickness of Mesozoic successions.

Northern and southern Pyrenean frontal thrusts present different geometries. In the South Pyrenean frontal thrust, deformation and displacement ist mostly acumulated in a single thrust sheet (Sierra de Cantabria) whereas the northern Pyrenean frontal thrust consists of several north directed thrust imbricates with basement involved.

Inversion structures are poorly developed in the Mesozoic sediments of the Parentis Basin, probably due to the existence of the Landas High which prevented or mitigated the propagation of the contractional deformation further north. The Basque– Cantabrian Basin instead, developed significant inversion structures onto the onshore Mesozoic sediments.

AKNOWLEDGEMENTS

This work was carried out under the financial support of the MARCONI (REN2001-1734-C03-02/MAR) and MODES-4D (CGL2007-66431-C02-02/BTE) projects as well as the "Grup de Recerca de Geodinàmica i Anàlisi de Conques" (2001SRG-000074). We would like to thank to Hidrocarburos de Euskadi the transfer of seismic and well data from Parentis Basin and 2D-Move for software support.

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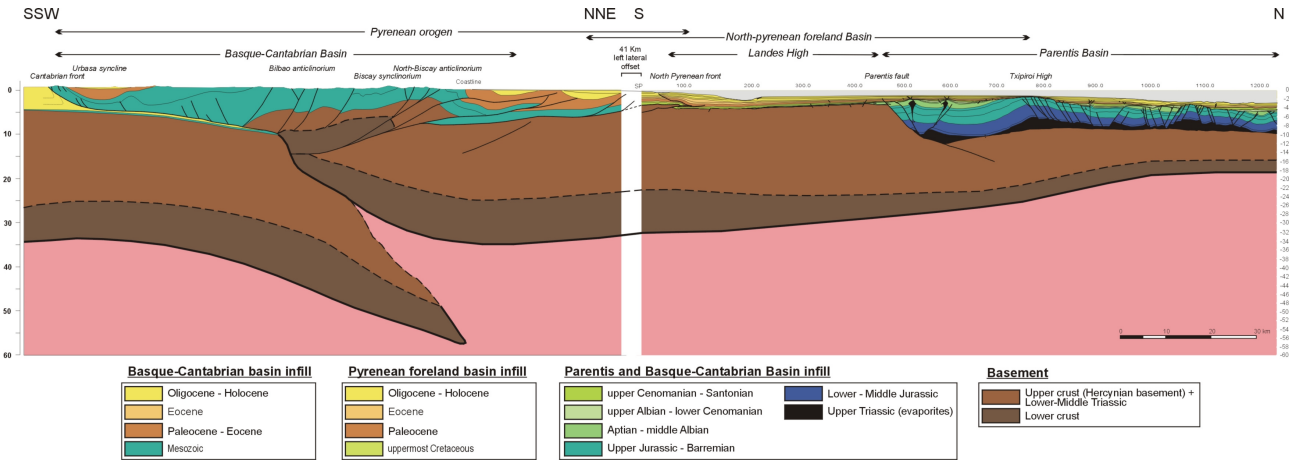

FIGURE 3. *Simplified cross- section of the northern margin of Iberia across the Basquen Pyrenees and the Parentis Basin (Western Pyrenees) based on MARCONI-3 profile interpretation and the cross- section made by Pedreira 2005 inmediatly southwards. See location in Fig 1.*

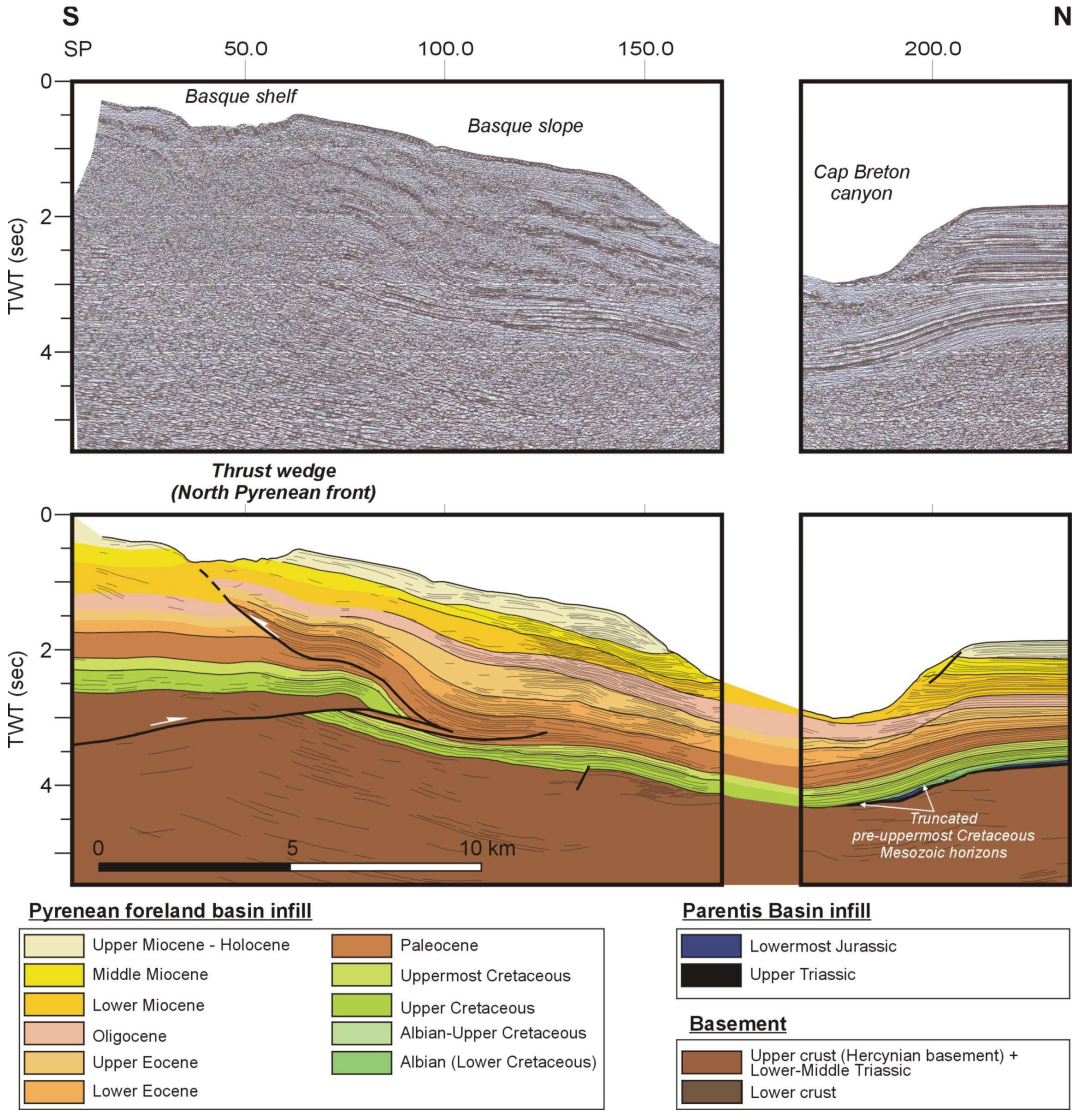

FIGURE 4. *Southermost part of the unmigrated MARCONI-3 seismic profile with line- drawing interpretation illustrating the structure of the uppermost Cretaceous- Cenozoic sediments in the Basque shelf and Cap Breton Canyon. See location in Fig3.*