Tectonophysics 637 (2014) 30–44

Contents lists available at ScienceDirect

Tectonophysics

journal homepage: www.elsevier.com/locate/tecto

The Naval diapir (southern Pyrenees): Geometry of a salt wall associated with thrusting at an oblique ramp

Pablo Santolaria [a,*], Antonio M. Casas-Sainz [a], Ruth Soto [b], Victor Pinto [c], Albert Casas [c]

[a] Departamento de Ciencias de la Tierra, Universidad de Zaragoza, C/Pedro Cerbuna, 12, 50009 Zaragoza Spain
[b] Instituto Geológico y Minero de España, Unidad de Zaragoza, C/Manuel Lasala 44, 9B, 50006 Zaragoza Spain
[c] Departament de Geoquímica, Petrología i Prospecció Geològica, Universitat de Barcelona, C/Martí i Franquès s/n, 08028 Barcelona, Spain

ARTICLE INFO

Article history:
Received 14 April 2014
Received in revised form 11 September 2014
Accepted 20 September 2014
Available online 2 October 2014

Keywords:
Salt tectonics
Salt wall
Gravity modelling
Sierras Marginales
Pyrenees
Oblique thrusting

ABSTRACT

The southern Pyrenees provide several examples of diapiric structures linked to migration of Triassic evaporites associated with the movement of thrust sheets. Among them, the Naval diapir, the westernmost diapiric body in the Sierras Marginales unit, is key to understanding the mechanisms controlling salt tectonics in this sector of the Pyrenees. In this paper, we use geological mapping, field data, cross-sections, seismic reflection profiles and detailed gravity data to characterize the geometry of the Naval diapir, a body of Middle and Upper Triassic evaporites and shales, and its relationship with the sedimentary cover and compressional structures. The information obtained from these methods was used to construct 2.5D and 3D models. These models indicate the significant role of compressional oblique structures and crestal weakening in the origin of the N-S salt-wall geometry, during the translation–rotation of the western end of the Sierras Marginales thrust sheet in the Late Eocene–Oligocene times. The uplift of low-density materials outlived compressional activity in the area and continued during the Oligocene–Early Miocene.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

Historically, interest in salt tectonics is linked to hydrocarbon exploration. In addition, in recent decades, new potential uses and economic activities (waste repositories, CO_2 and hydrocarbon reservoirs) of evaporite-related structures have increased the number of studies of diapirs. In fold-and-thrust belts, the presence of ductile detachment levels consisting of evaporites has been seen to play an essential role in controlling their deformation processes (e.g. Davis and Engelder, 1987; Hudec and Jackson, 2007). A reliable characterization of the geometry and kinematics of evaporite-related structures is crucial to unravelling salt migration patterns and their relationships with the emplacement of thrust-sheet systems during the evolution of mountain belts. Geometric and kinematic analyses of evaporite-related structures have traditionally been derived from surface and subsurface data (i.e. boreholes and seismic sections). However, in areas with scarce subsurface data and/or where the direct observation of this kind of structure is not possible, powerful field geophysical methods (gravity, magnetics) have been widely documented as good tools for determining the structures' geometry at depth (e.g. Jacques et al., 2003; Key et al., 2006; Nagihara and Hall, 2001).

The southern Pyrenees shows an interesting diapiric province characterized by the existence of several diapiric bodies of Triassic evaporites and claystones, related to a thrust-and-fold system. The direct observation from surface data of the regional structure of this area is precluded by the existence of unconformable widespread Oligocene–Miocene continental sediments and, the only outcrops of pre-Oligocene rocks are linked to these diapirs. Several studies, specially focused on thrust geometry, have addressed the geometry of this thrust system and speculated about the origin of the diapiric bodies assuming a common cause. According to previous works, the mechanism of diapir formation there has been linked, in a general way, to (1) lateral thrust ramps (e.g. Martínez Peña, 1991), (2) the lateral migration of Triassic viscous rocks towards the west as a result of the differential overburden of Mesozoic deposits and thrust stacking (Holl and Anastasio, 1993; Soto et al., 2003; Storti et al., 2007; Teixell and Barnolas, 1995), (3) anticline crest erosion (Poblet et al., 1998) and (4) along-strike extension to solve space problems linked to the clockwise rotation of structures of the Sobrarbe fold system to the North (Muñoz et al., 2013). However, the different shapes of each diapir and their different locations in relation to thrust sheets, point to a different origin for the different bodies. Up-to-date, no detailed study including fieldwork, potential-field geophysics and/or analysis of seismic sections has been presented to definitely explain the origin and mechanism of formation of these bodies.

The aim of the present study is to determine the geometry at depth and the volumetric distribution of the Naval diapir using new field and available subsurface data together with 2.5 and 3D gravity modelling coming from a new gravity set and to locate this diapiric body into its

* Corresponding author.
E-mail addresses: psotin@unizar.es (P. Santolaria), acasas@unizar.es (A.M. Casas-Sainz), r.soto@igme.es (R. Soto), albert.casas@ub.edu (V. Pinto), victorpinto@ub.edu (A. Casas).

http://dx.doi.org/10.1016/j.tecto.2014.09.008
0040-1951/© 2014 Elsevier B.V. All rights reserved.

regional context to constrain its origin. We select the Naval diapir, a particularly interesting evaporite-related structure located in this diapiric province at the Southern Pyrenees, because of its singular shape in map view and its relationships with surrounding thrusts. The strong density contrast between the Middle–Upper Triassic evaporites and shales and the host carbonate and detrital rocks, and the possibility of accurate terrain correction, provide good conditions for determining its 3D geometry from gravity surveys. The main differences of this approach with respect to the above-cited previous works is that our goal is the determination of the precise relationship between diapirs and thrust sheets, depth to the décollement level, and the characterization of the structure of syn-emplacement deposits, that allow to constrain a feasible emplacement model. Relationships derived from this study will undoubtedly be useful for deciphering the particular evolution of the Southern Pyrenean belt and the kinematics of diapirs in fold-and-thrust belts underlain by low-strength evaporitic layers.

2. Geological setting

The Pyrenees are a double-verging asymmetric fold-and-thrust belt resulting from the collision between the Iberian and the Eurasian plates during Late Cretaceous to Miocene times (e.g. Muñoz, 1992). South of the Axial Zone, the Variscan-derived backbone of the range, the South Pyrenean flexural foreland basin developed, mainly filled by marine and continental syn-tectonic deposits. The central sector of the Southern Pyrenees is occupied by Mesozoic pre-tectonic and Cenozoic syn-tectonic units that form the South Pyrenean Central Unit (SPCU, Séguret, 1972, Fig. 1). It comprises several thrust sheets detached on the Middle–Upper Triassic evaporites and shales and emplaced in piggyback sequence from Late Santonian to Early Miocene times (e.g. Muñoz, 1992; Séguret, 1972; Teixell and Muñoz, 2000; Vergés and Muñoz, 1990). The Middle–Upper Triassic evaporites and shales are also the main detachment level for the rest of the southern Pyrenean cover (e.g. Séguret, 1972), except in some areas close to the Axial Zone (Teixell, 1998).

The sedimentary cover sequence in the southern sector of the SPCU begins with Middle–Upper Triassic shales and evaporites. In addition, the Upper Triassic unit contains interbedded limestones and dolostones (e.g. Salvany and Bastida, 2004) and sills and dikes of Triassic dolerites (e.g. Lago et al., 1987, 2000). Overlying this regional *décollement*, the sedimentary cover consists of Jurassic to Cenozoic deposits. The Lower Jurassic is composed of partially brechified limestones, dolostones and

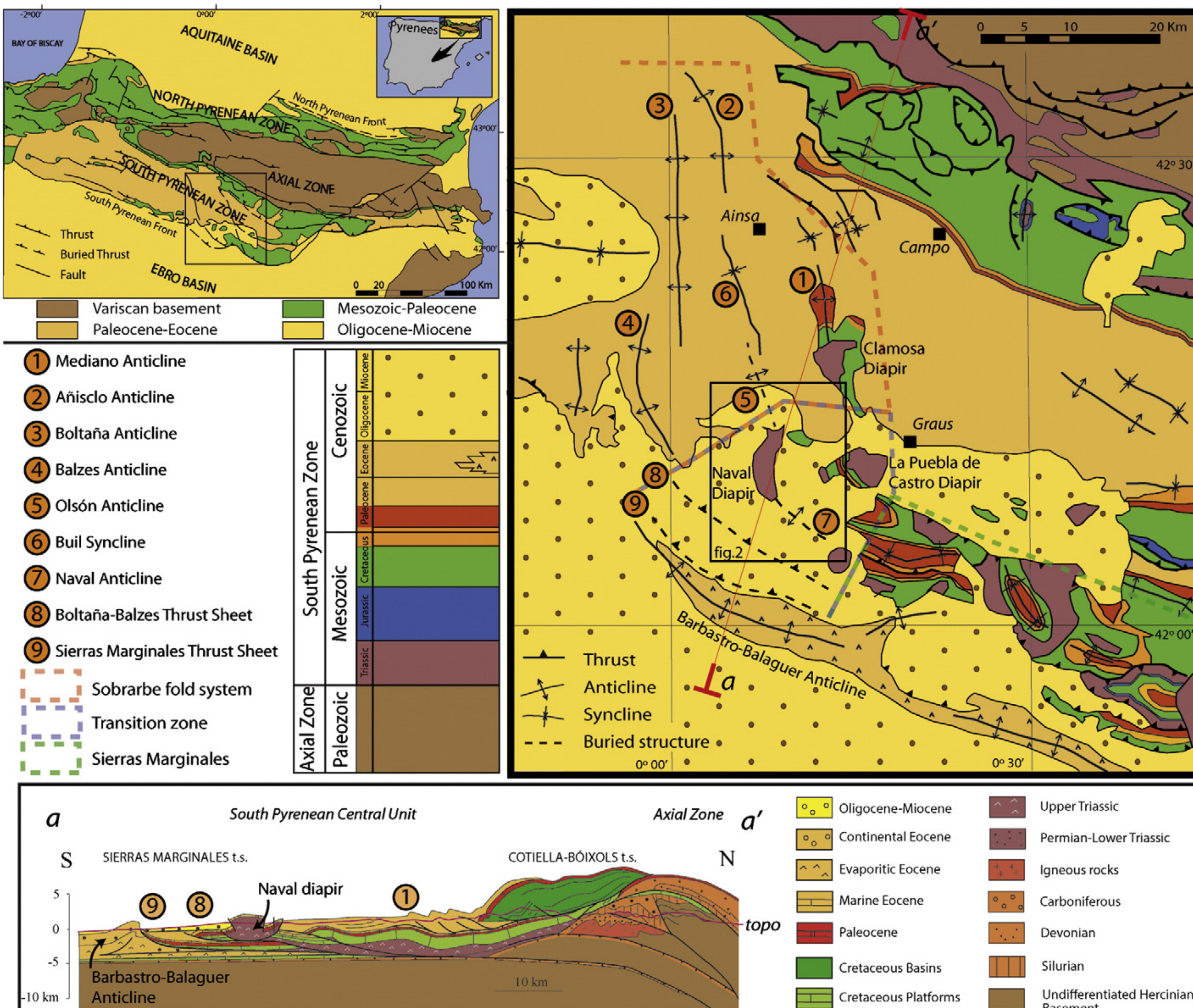

Fig. 1. Left: Location of the studied area within the Pyrenees and legend. Right: Close-up view of the western end of the South Pyrenean Central Unit (SPCU), showing several Middle–Upper Triassic rocks outcrops. Numbers refer to the legend. Bottom: Characteristic cross-section of the studied area (modified after Martínez-Peña and Casas-Sainz, 2003).

Download English Version:

https://daneshyari.com/en/article/6433749

Download Persian Version:

https://daneshyari.com/article/6433749

Daneshyari.com