The ALCUDIA Seismic Profile: an image of the Central Iberian Zone (Southern Iberian Variscides, Spain)

El Perfil sísmico ALCUDIA: una imagen de la Zona Centroibérica (Varisco Ibérico meridional, España)

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Dedicamos este trabajo a nuestro compañero Ángel Pelayo, del equipo de adquisición de ALCUDIA, recientemente fallecido.

Abstract : The 250 km long, vertical incidence seismic reflection profile ALCUDIA was acquired in spring 2007. It samples the Variscan Central Iberian Zone from Toledo to Fuenteovejuna. Its main goal was to continue the structure obtained for the crust and mantle from the IBERSEIS transect towards the N and NE. The acquisition parameters, similar to those used in the IBERSEIS profile have proven to be adequate to show a detailed image of the whole crust and upper mantle. After preliminary processing, the upper crust shows a moderate reflectivity that can be easily correlated with identifiable surface geologic features. The middle and lower part of the crust seems to be very reflective, laminated and afected by deformation, although to a different extent. The Moho is placed at approximately 10 s TWT and appears to be flat in the time section. The section can be divided into four domains of reflectivity that can be key to stablish different domains of crustal evolution. This new transect, together with the previous IBERSEIS profile, complete an almost 600 km long lithospheric section that crosses the southern half of the Iberian Variscides.

Key words: Deep seismic reflection profile, Southern Iberia, Variscan orogen

Resumen : *El perfil sísmico de reflexión ALCUDIA , de 250 km de longitud, fue adquirido en la primavera del año 2007. Este perfil ha muestreado la Zona Centroibérica entre Toledo y Fuenteovejuna, y su objetivo principal ha sido continuar hacia el NE la estructura de corteza y manto ya obtenida mediante el perfil IBERSEIS. Los parámetros de adquisición, similares a los de IBERSEIS, han sido adecuados para mostrar una imagen detallada de toda la corteza y el manto superior. Una vez efectuado el procesado preliminar, la corteza superior presenta una reflectividad moderada que puede correlacionarse fácilmente con rasgos geológicos de superficie. Las partes media e inferior de la corteza son muy reflectivas, laminadas y afectadas por una deformación que varía a lo largo del perfil. La Moho se localiza a unos 10 s TWT y tiene geometría plana en la sección de tiempo. La variación en los patrones generales de reflectividad permite dividir el pefil sísmico en cuatro dominios, que corresponden a diferentes evoluciones corticales. Este nuevo perfil sísmico, unido al anterior perfil IBERSEIS, constituye una sección litosférica de casi 600 km de longitud, que atraviesa la parte meridional del Varisco Ibérico.*

Palabras clave: *Perfil sísmico profundo de reflexión, Iberia meridional, Orógeno Varisco*

INTRODUCTION

The IBERSEIS seismic profile provided an image of the S Iberian Variscan orogen from the South Portuguese Zone (SPZ) to the Central Iberian Zone (CIZ) (Simancas *et al*., 2003; Carbonell *et al*., 2004). The identification of the Iberseis Reflective Body (IRB), the constant thickness of the crust, and the good correlation between reflectors and surface tectonic features where the basis to complete the knowledge of the tectonic evolution of the SPZ and the OMZ. However, the fact that the profile only entered the CIZ a few km hampered the continuation of the tectonic models to the N.

The ALCUDIA deep seismic profile has been shot to the N of the IBERSEIS profile in spring 2007, extending along 235 km and cutting across the main

trend of the tectonic structures in the CIZ. Its goal was to obtain a high resolution image of the CIZ crust and upper mantle, from Toledo to Fuenteovejuna (Figure 1). This image should provide enough information to complete the tectonic evolution of the southern half of the Iberian Variscan Orogen. Other goals were to better image in a 3D context the suture between the CIZ and the OMZ and to study the Almaden syncline, home of the most important mercury mine in the world.

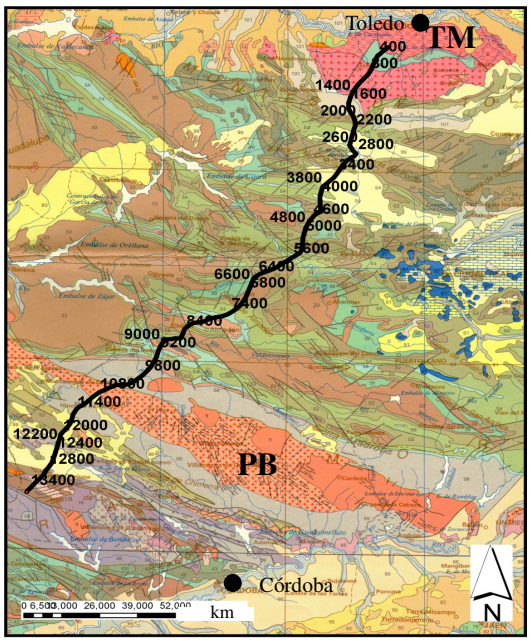

FIGURE 1. *Geological map of the CIZ in the area sampled by the ALCUDIA seismic profile. Numbers along the profile correspond to CDP locations. The main localities near the extremes are Fuenteovejuna, to the SW, and Toledo, to the NE. Key geological references are the Pedroches batolith (PB) and the Toledo migmatites (TM).*

GEOLOGICAL BACKGROUND

The Central Iberian Zone is supposed to represent the northern margin of Gondwana all along the Paleozoic. The surface geology is characterized by kilometric scale upright folds with synclines cored by Ordovician to Devonian rocks and anticlines cored by Late Neo-Proterozoic rocks (Schist-Graywacke Complex). The metamorphic grade is very low all along the seismic profile, except to the northern and southern edges. To the north, migmatites crop out bounded by the Toledo fault. The southern part of the profile corresponds to a crustal domain which records a Variscan tectonometamorphic evolution related to the suture with the Ossa Morena Zone (OMZ). In this southern domain, the following units crop out (Figure 1): a) The OMZ/CIZ suture unit (Central Unit) containing gneises, amphibolites and medium to high grade metasediments; b) the so called 'allochtonous unit' charaterized by NE vergent recumbent folds affecting the pre-Carboniferous Paleozoic series; c) a thick Lower Carboniferous flysch affected by upright folds and intruded by the Pedroches batholit at around 300 Ma. See Martínez Catalán *et al.*, (2004) and references therein.

ACQUISITION AND PROCESSING PARAMENTERS

The acquisition of the ALCUDIA profile was designed to obtain the highest possible resolution for a crustal scale image. With this goal, shot spacing was only 70 m and station spacing was 35 m. The number of active channels was variable, but always above 240. The nominal fold therefore varies from 60 to 90. Other acquisition parameters are found in Table I.

Preliminary processing has been applied to the data. This includes, trace editing, frequency analysis, geometry (crooked line processing), CMP sorting, frequency filtering, spherical divergence correction, refraction statics, NMO, velocity analysis, stack, migration.

The high signal-to-noise ratio and the high fold of the data provide us a very detailed image of the crust and mantle down to 20 s TWT.

Station spacing	35 m
Shot spacing	70 m
CDP spacing	17.5 m
Source	4, 22tn Vibroseis
Sweeps lenght	20 s
Sweeps frequency	8-80 Hz
Number of channels	240-400

TABLE I. *Acquisition parameters*

PRELIMINARY IMAGE, INTERPRETATION AND CONCLUSIONS

The upper crust shows moderate reflectivity which can be correlated with the upright folds characteristic of most of this area and with some important faults.

The middle and lower crust are very reflective, and are separated from the less reflective upper crust by a detachment located from 2.5 s TWT in the north to 4.5 s TWT to the south. The crustal detachment can be followed along the whole profile with different reflectivity implying a varying character. The variable level of this detachment seems to be in connection with the flat-and-ramp geometry of a distinctive reflectivity in the underlying crust.

The reflective part of the crust, thickens to both edges of the profile due to deformation. Accordingly, it frequently appears in the range from 5 to 10 s TWT, which would correspond to around 15 km of very reflective crust.

To the south, there are noticeable differences both in the laminated crust and in the upper crust. The laminated crust appear with a dome-like form and the reflectivity of the upper crust has a different character

from that of the rest of the profile, showing a planar fabric with no folds. The boundary between those two contrasting upper crusts appears to be located around the Pedroches batholit. These differences in the seismic signature inside the profile are supported by contrasting geological features, such as the geochemical signature of igneous rocks, the development of a Lower Carboniferous basin, and contrasting Neo-Proterozoic sequences. It all suggests a complex continental accretionary evolution in this area.

The Moho appears at 10 s TWT, the same time at which it was observed in the IBERSEIS section. It appears to be flat in the time section although depth migration would be necessary to adreess its real shape.

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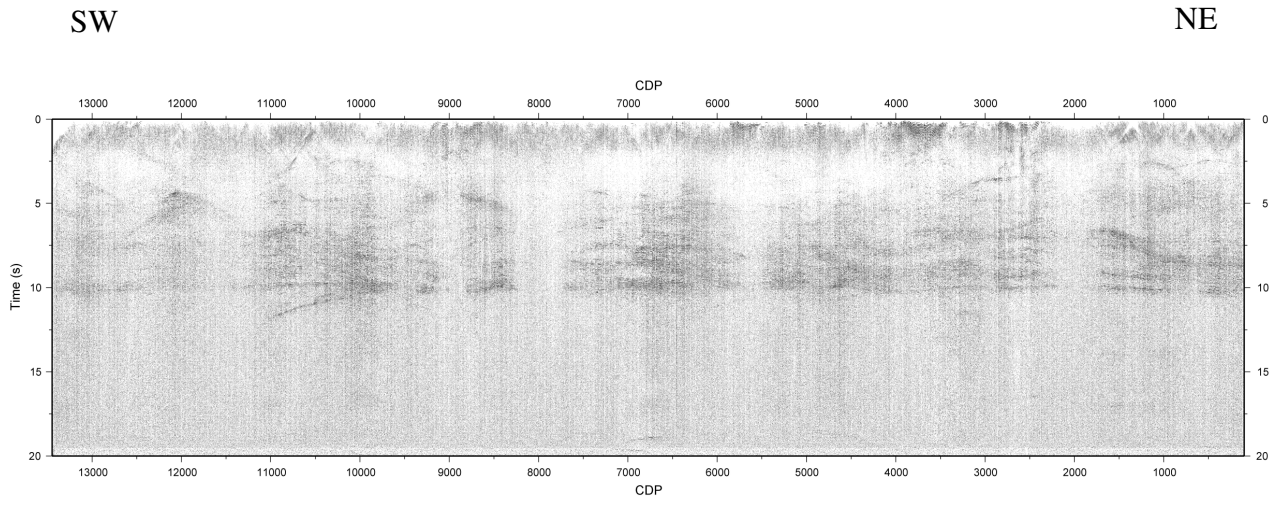

FIGURE 2. *Processed (stacked) image of the seismic profile ALCUDIA*