A refraction/wide-angle reflection seismic profile through the Iberian Chain: preliminary report

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ABSTRACT

As a result of the Eurasian and African plates convergence, Tertiary intraplate deformation of the Iberian plate gave rise to the basement-involved thrust-system of the Iberian Chain. Subsequently, a crustal thickening beneath the Iberian Chain was produced, as deduced from Bouguer anomaly maps. A very preliminary interpretation of a new seismic profile through the Iberian Chain is presented, which leads us to infer a crustal thickening beneath the central part of the profile, where Moho depths of at least 40 km should be reached.

Key words: *seismic profile, crustal thickness, intraplate deformation, Iberian Chain*

INTRODUCTION AND GEOLOGICAL SETTING

The Iberian Chain developed by contraction within the Iberian plate during the Palaeogene, coeval with the Pyrenean deformation and the early phases of the Betic orogeny. Thrust-systems involving the Hercynian basement developed (Fig. 1), producing crustal thickening and a moderate relief of about 2000 m of maximum height (Salas *et al.*, 2001; Guimerà *et al.*, 2004). Up to know, the only available data documenting the crustal thickening beneath the Iberian Chain were the Bouguer anomaly maps, compiled by Salas and Casas (1993) and Mezcua *et al.* (1996). The map of Mezcua *et al.* (1996, figure 1) shows that the Iberian Chain is associated with a regional gravity low (a minimum of less than -110 mGal) that contrasts with the relative gravity high of the Ebro, Duero and Tajo basins (-30 to -40 mGal) and the pronounced high of the Valencia Trough (with positive values), in the western Mediterranean. The large and negative anomalies of the Iberian Chain are consistent with a thickened crust. Salas and Casas (1993) using direct modelling of gravity data, obtained two gravity profiles (see figure 2 for the reproduction of one of them) in which the crust reaches a maximum thickness of 43 km in the Sierra de Albarracín area. This crustal thickness has been interpreted as the result of the crustal thickening during Tertiary contraction (Salas and Casas, 1993; Guimerà *et al.*, 1996), and to explain this thickening a thrust system involving only the upper crust (Guimerà and Álvaro; 1990 and Salas *et al.*, 2001) or the hole crust (Salas and Casas, 1993; Casas Saínz *et al.*, 2000) has been proposed. The total Palaeogene crustal shortening in the Iberian Chain estimated from a surface balance of the profile of figure 2 is about 75 km (~20%) (Guimerà *et al.*, 1996; Salas *et al.*, 2001), resulting in the formation of a 43 km deep crustal root.

CRUSTAL STRUCTURE: NEW SEISMIC CONSTRAINTS

In order to improve our knowledge of the Iberian Chain crustal thickness, a 300 km-long refraction/wide-angle reflection seismic profile has been performed through the chain in early December 2003. The profile samples the area that shows the minimum of the Bouguer anomalies (Fig. 1). A reversed profile is obtained by using three shots implemented at the edges and middle part of the line (Fig. 1, B-B'). Up to 1500 kg of dynamite were loaded in a single hole and detonated from each shotpoint at the edges of the profile and 1000 kg from the one at the mid part of the line. The shots were recorded by 76 portable seismic stations deployed along the line at a nominal spacing of 4 km. The instruments, 3-component sensors and digital recorders, were basically of two types, RefTek and Leas-Hator, plus a few Mars88, and come from the Inst. J. Almera and the American (Iris-Passcal) and French (Lithoscope) pools. The data processing sequence has just been completed, including downloading, individual checking, transformation and storage in Seg-Y formats. Finally, for each shot the data are gathered and displayed as record-sections with a reduction velocity of 6 km/s and a band-pass filtering between 3-20 Hz.

PRELIMINARY RESULTS

Figures 3 and 4 show the record-sections from the shots 1 and 3, at the NE and SW ends of the profile, respectively. Both sections display a similar pattern, in which different seismic phases could be clearly identified, coming respectively from the upper crust, from the deep part of the crust

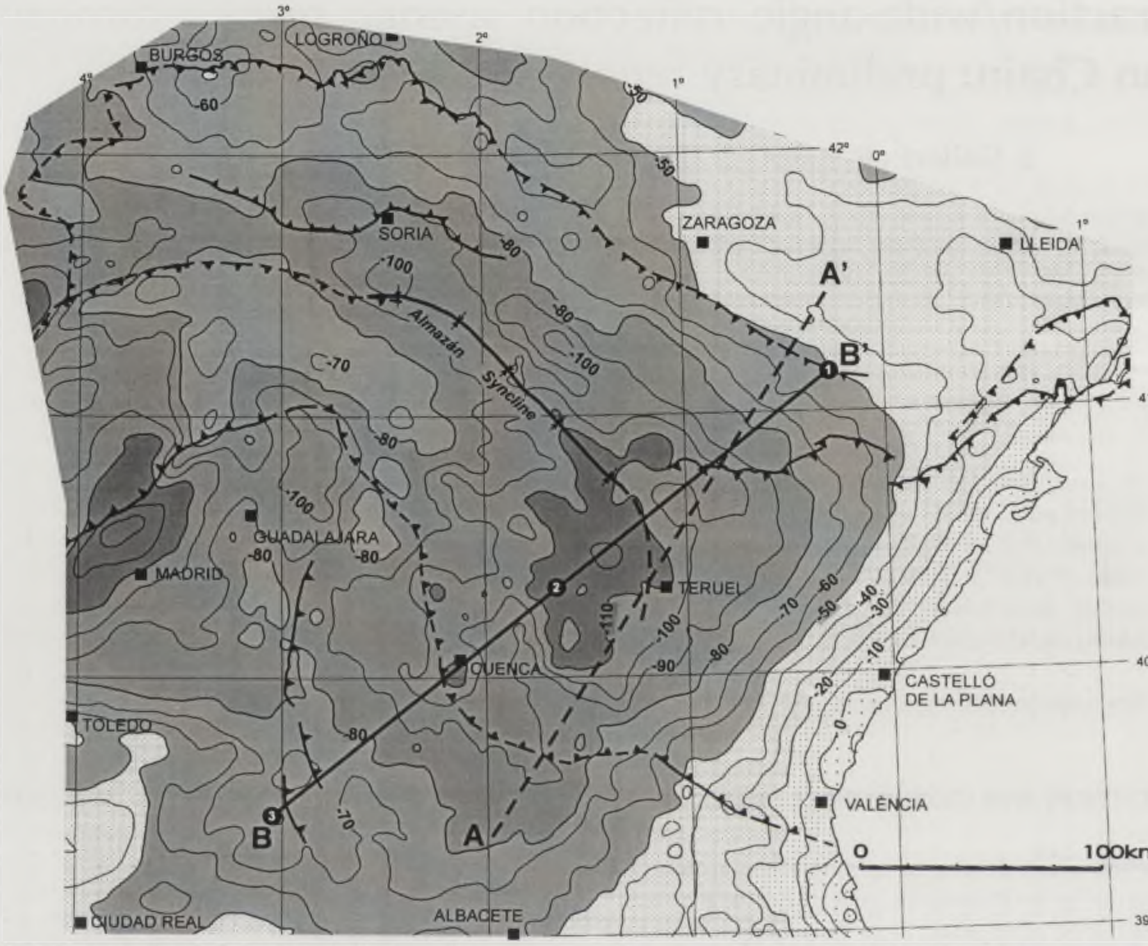

FIGURE 1. *Bouguer anomaly map (mGal) of the Iberian Chain and surrounding areas (after Mezcua et al., 1996). The main thrusts of the Iberian Chain, the location of the gravimetric profile (A-A') of figure 2 and the seismic profile presented (B-B', figures indicate shotpoints) are also shown.*

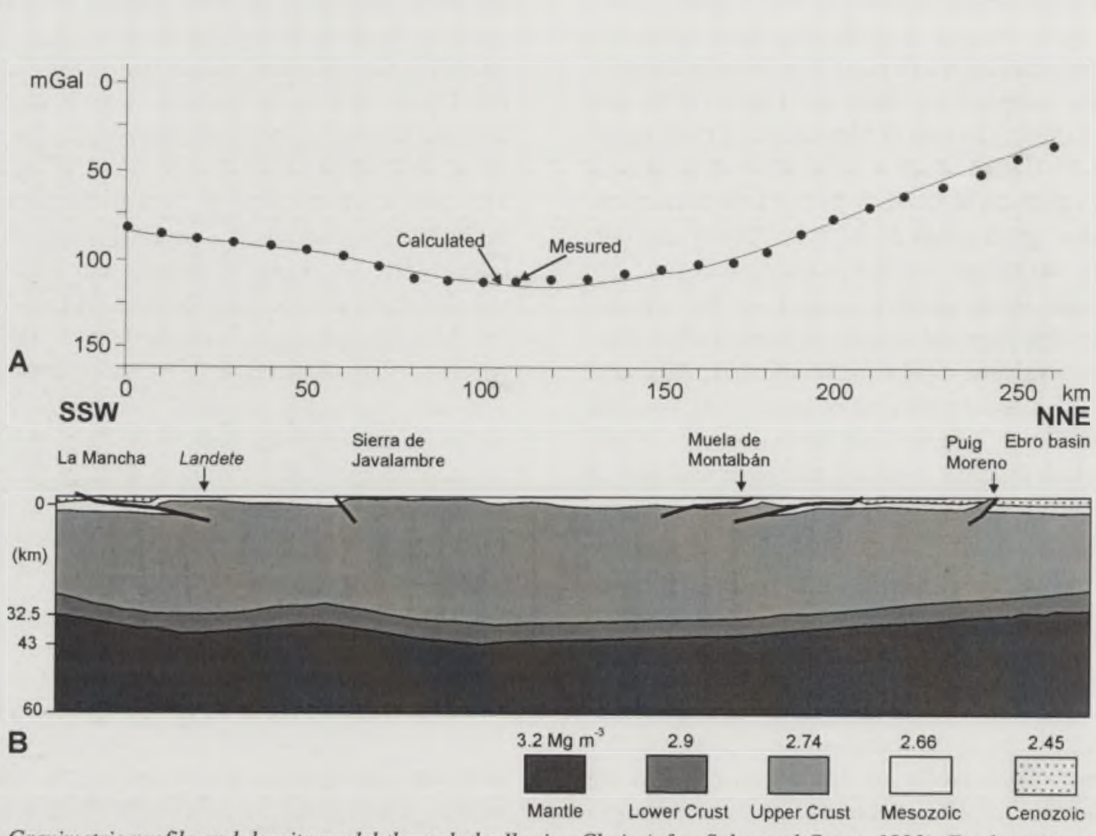

FIGURE 2. *Gravimetric profile and density model through the Iberian Chain (after Salas and Casas, 1993). For location see figure1.*

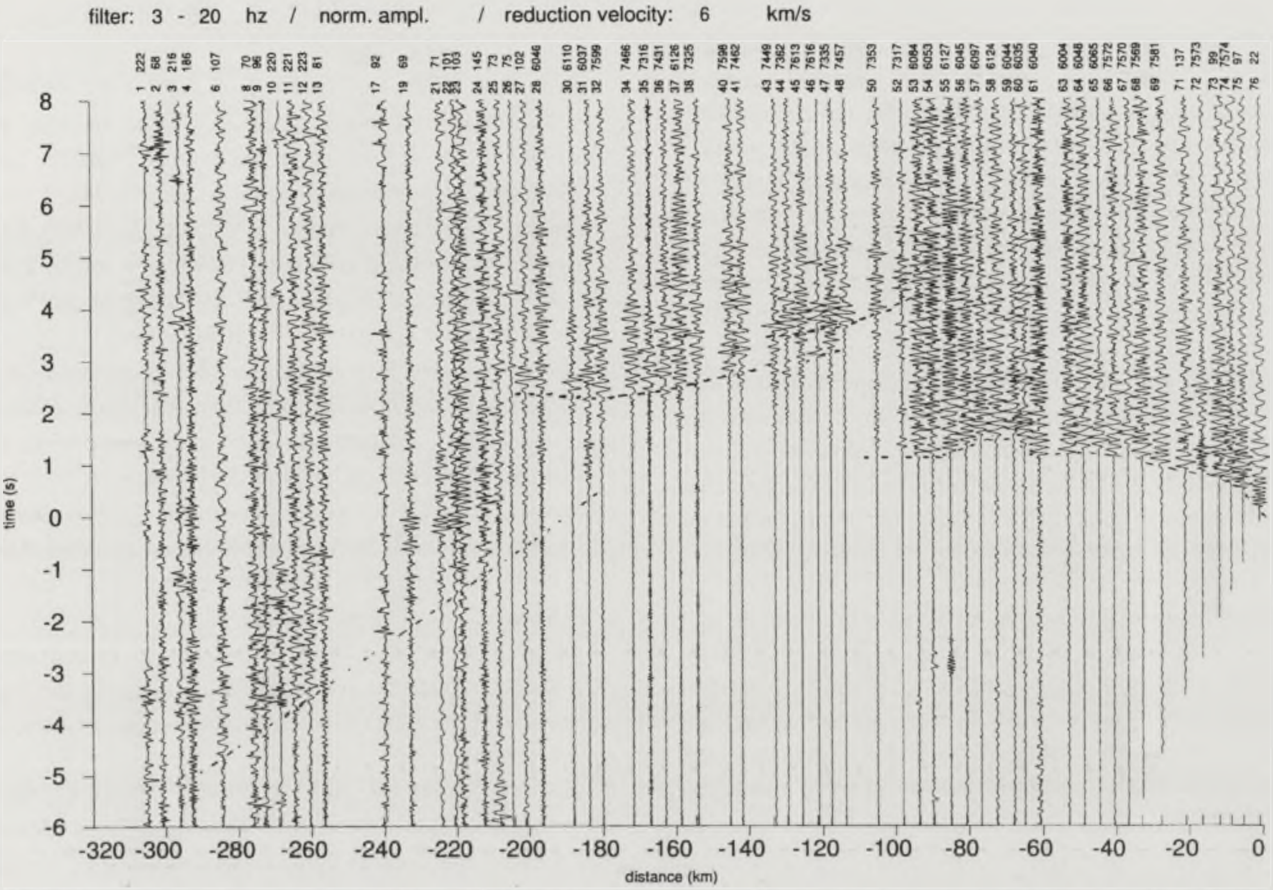

FIGURE 3. *Record-section from the shot 1, at the NE end of the seismic profile (see figure 1 for location). Main seismic phases are correlated.*

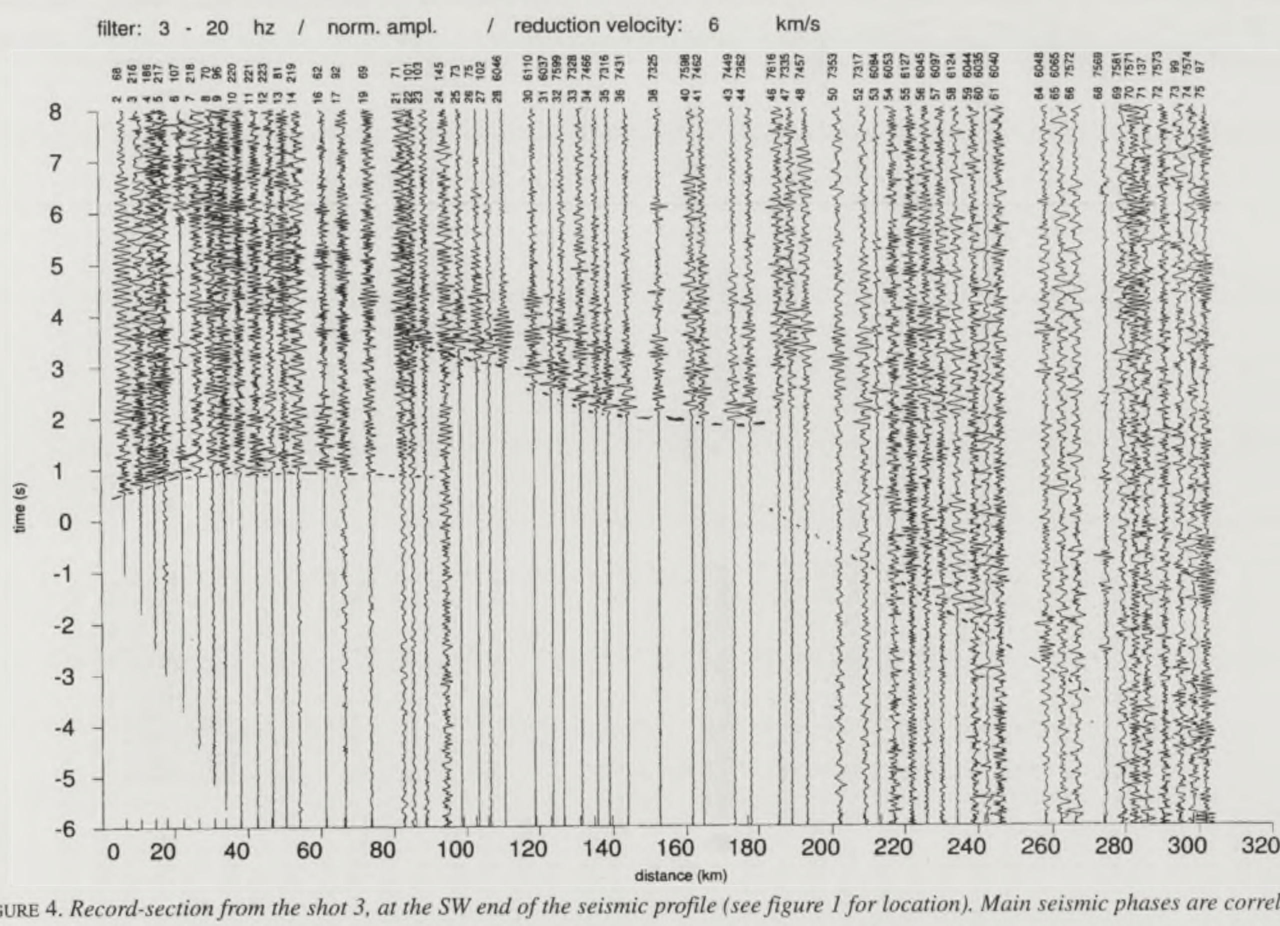

FIGURE 4. *Record-section from the shot 3, at the SW end of the seismic profile (see figure 1 for location). Main seismic phases are correlated.*

and from the uppermost mantle. Up to offsets of 100 km, clear first arrivals are observed between 0 and 1 s of reduced time, with apparent velocities increasing from about 4.5 to 6 km/s. They correspond to waves propagated and refracted across the upper layers of metasediments and crystalline basement. Between 100 and 200 km distances, most conspicuous arrivals are observed later on, between 4 and 2 s of reduced times, corresponding to very energetic reflected phases at the deep part of the crust. The correlation of these strong arrivals does not define a single hyperbola but rather suggest two main reflections, coming most likely from the top of the lower crust and the Moho. At offsets greater than 200 km much less energy is present on the sections, although first arrivals delineating an apparent velocity around 8 km/s could be nicely observed in selected sites, especially from shot 1 (Fig. 3), and correspond to refracted waves from the uppermost mantle.

These data set, complemented by the section from the shot in the mid part of the line recorded in both senses, will allow to constrain a detailed seismic crustal modelling along this transect. A very preliminary interpretation undertaken lead us to infer a crustal thickening beneath the central part of the profile, where Moho depths of at least 40 km should be reached, thus confirming the gravity modelling aforementioned.

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