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Crustal density structure in the Spanish Central System derived from gravity data analysis (Central Spain)

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Abstract

Shallow and deep sources generate a gravity low in the central Iberian Peninsula. Long-wavelength shallow sources are two continental sedimentary basins, the Duero and the Tajo Basins, separated by a narrow mountainous chain called the Spanish Central System. To investigate the crustal density structure, a multitaper spectral analysis of gravity data was applied. To minimise biases due to misleading shallow and deep anomaly sources of similar wavelength, first an estimation of gravity anomaly due to Cenozoic sedimentary infill was made. Power spectral analysis indicates two crustal discontinuities at mean depths of 31.1 ± 3.6 and 11.6 ± 0.2 km, respectively. Comparisons with seismic data reveal that the shallow density discontinuity is related to the upper crust lower limit and the deeper source corresponds to the Moho discontinuity. A 3D-depth model for the Moho was obtained by inverse modelling of regional gravity anomalies in the Fourier domain. The Moho depth varies between a mean depth of 31 km and 34 km. Maximum depth is located in a NW–SE trough. Gravity modelling points to lateral density variations in the upper crust. The Central System structure is described as a crustal block uplifted by NE–SW reverse faults. The formation of the system involves displacement along an intracrustal detachment in the middle crust. This detachment would split into several high-angle reverse faults verging both NW and SE. The direction of transport is northwards, the detachment probably being rooted at the Moho.

Keywords: Gravity anomaly; Density crust structure; Moho undulations; Spanish Central System

1. Introduction

Compressional field stress due to convergence of the African and European Plates deformed the Iberian Plate lithosphere, giving rise to intraplate mountain ranges and continental sedimentary basins (Fig. 1). One of these intraplate mountain ranges is the Central

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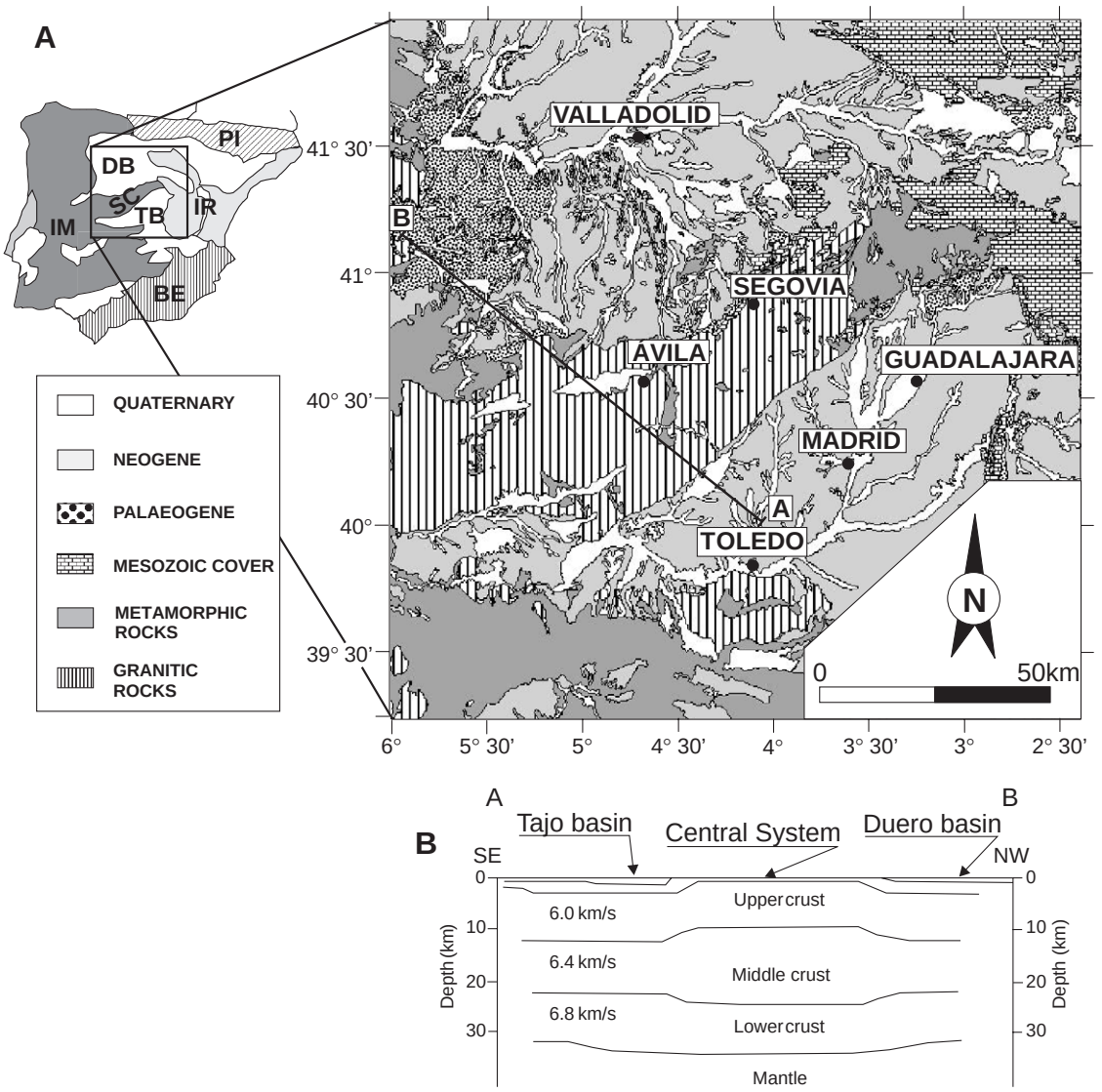

Fig. 1. (A) Main tectonic units of the Iberian Peninsula and geological map of the study area. SC: Spanish Central System; IR: Iberian Range; DB: Duero basin; TB: Tajo Basin; PI: Pyrenees; IM: Iberian Massif; BE: Betics. Geographical coordinates. A–B represents the location of the refraction seismic profile described in the text. (B) Refraction seismic profile (from Suriñach and Vegas, 1988). The geometry of the three main crustal layers, together with the P-wave velocities, is shown.

System, which is comprised of an uplifted crustal block bounded by two reverse faults separating it from the Tajo and the Duero basins. Basin depocentres occur close to the chain borders. Here, Cenozoic infill can reach 3000 m (Aeroservice, 1967; Querol, 1989). Seismic data point to the existence of a thicker crust under the central part of the Iberian Peninsula, lowering the Moho from 30 km to 34 km under the Central System (Suriñach and Vegas, 1988; ILIHA, 1993). The area is characterized by a long-wavelength gravity low (Mezcua et al., 1996) and gravity studies have related it to the Cenozoic infill of basins and to a crust thickening of up to 2 km (Tejero et al., 1996; Gómez Ortiz, 2001).

In this paper, multitaper spectral analysis of gravity data is used to investigate crustal density