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Crustal deformation styles along the reprocessed deep seismic reflection transect of the Central Iberian Zone (Iberian Peninsula)

Siddique Akhtar Ehsan [a,*], Ramon Carbonell [a], Puy Ayarza [b], David Martí [a], Andrés Pérez-Estaún [a], David Jesús Martínez-Poyatos [c], Jose Fernando Simancas [c], Antonio Azor [c], Luis Mansilla [d]

[a] Department of Structure and Dynamics of the Earth, Institute of Earth Sciences Jaume Almera, ICTJA-CSIC, Lluis Sole i Sabaris s/n, 08028 Barcelona, Spain
[b] Department of Geology, University of Salamanca, 37008 Salamanca, Spain
[c] Department of Geodynamics, Faculty of Science, University of Granada, E-18071 Granada, Spain
[d] School of Industrial Engineering and Mining of Almaden, University of Castilla-La Mancha, Almaden, Spain

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ABSTRACT

The multichannel normal incidence (230 km long) deep seismic reflection profile ALCUDIA was acquired in summer 2007. This transect samples an intracontinental Variscan orogenic crust going across, from north to south, the major crustal domain (the Central Iberian Zone) and its suture zone with the Ossa–Morena Zone (the Central Unit) both build up most of the southwestern part of the Iberian Peninsula basement. This high resolution (60–90 fold) profile images about 70 km depth (20 s TWTT) of the continental lithosphere. A new data processing flow provides better structural constraints on the shallow and deep structures resulting in an image that reveals indentation features which strongly suggest horizontal tectonics. The ALCUDIA seismic image shows an upper crust c. 13 km thick decoupled from the comparatively reflective lower crust. The shallow reflectivity of the upper crust can be correlated with surface geological features mapped in the field whereas the deep reflectivity represents inferred imbricate thrust systems and listric extensional faults. The reflectivity of the mid-lower crust is continuous, high amplitude, and horizontal to arcuate though evidences of deformation are present as ductile boudinage structures, thrusting and an upper mantle wedge, suggesting a transpressional flower structure. The image reveals a laminated c. 1.5 km thick, subhorizontal to flat Moho indicating an average crustal thickness of 31–33 km. The Moho shows laterally variable signature, being highly reflective beneath the Central Iberian Zone, but discontinuous and diffuse below the Ossa–Morena Zone. The gravity response suggests relatively high density bodies in the mid-lower crust of the southern half of the transect. The seismic results suggest two major horizontal limits, a horizontal discontinuity at c. 13–15 km (corresponding to the brittle–ductile transition) and the Moho boundary both suggested to act as decoupling surfaces.

1. Introduction

The Iberian Massif is the largest outcrop of the Late Paleozoic Variscan/Alleghanian Orogen in western Europe (Fig. 1a). It was formed by the convergence and collision of the continental plates of Laurentia–Baltica and Gondwana (Franke, 2000; Matte, 2001). The shortening generated by this transpressional collision was mostly accommodated by relatively large and localized deformation belts (suture zones) at the edges of the involved continental domains. In addition, a more distributed deformation zone between sutures accommodates the residual deformation in a typical intra-continental scenario. The structures within the main collision zone are relatively well constrained with the development of well-defined thrusts faults and folds, resulting in the imbrication of the crust at the plate boundaries involved in the collision. These structural features developed mainly depending on the existing stress field coupled with the physical properties and/or lithologies of the crustal units involved in the collision. The Variscan Orogen has been targeted by deep seismic reflection experiments, such as BIRPS (Freeman et al., 1988; Klemperer and Matthews, 1987; Onken et al., 2000), and DEKORP (Carbonell et al., 1996, 1998, 2000; Echtler et al., 1996; Friberg et al., 2002; Juhlin et al., 1998; Tryggvason et al., 2001) through most of the Eurasian continent. In the southwestern part of Iberia the Variscan Orogen was unravelled by the IBERSEIS

Abbreviations: CIZ, Central Iberian Zone; OMZ, Ossa–Morena Zone; SPZ, South Portuguese Zone; CU, Central Unit; TF, Toledo Fault; MF, Mora Fault; MaF, Matachel Fault; AF, Azuaga Fault; UC, Upper crust; MC, Middle crust; LC, Lower crust; DL, Decollement level; HW, Hanging wall; FW, Footwall; DLCR, Dense lower crustal reflectivity; DFWR, Dense footwall reflectivity; VP, Vibroseis point; CDP, Common midpoint; NMO, Normal moveout; DMO, Dip moveout; IRB, IBERSEIS Reflective Body.

* Corresponding author. Tel.: +34 93 4095410; fax: +34 93 4110012.
E-mail addresses: sakhtar@ictja.csic.es (S.A. Ehsan), ramon.carbonell@csic.es (R. Carbonell), puy@usal.es (P. Ayarza), dmarti@ictja.csic.es (D. Martí), andres@ictja.csic.es (A. Pérez-Estaún), djmp@ugr.es (D.J. Martínez-Poyatos), simancas@ugr.es (J.F. Simancas), azor@ugr.es (A. Azor), luis.mansilla@uclm.es (L. Mansilla).

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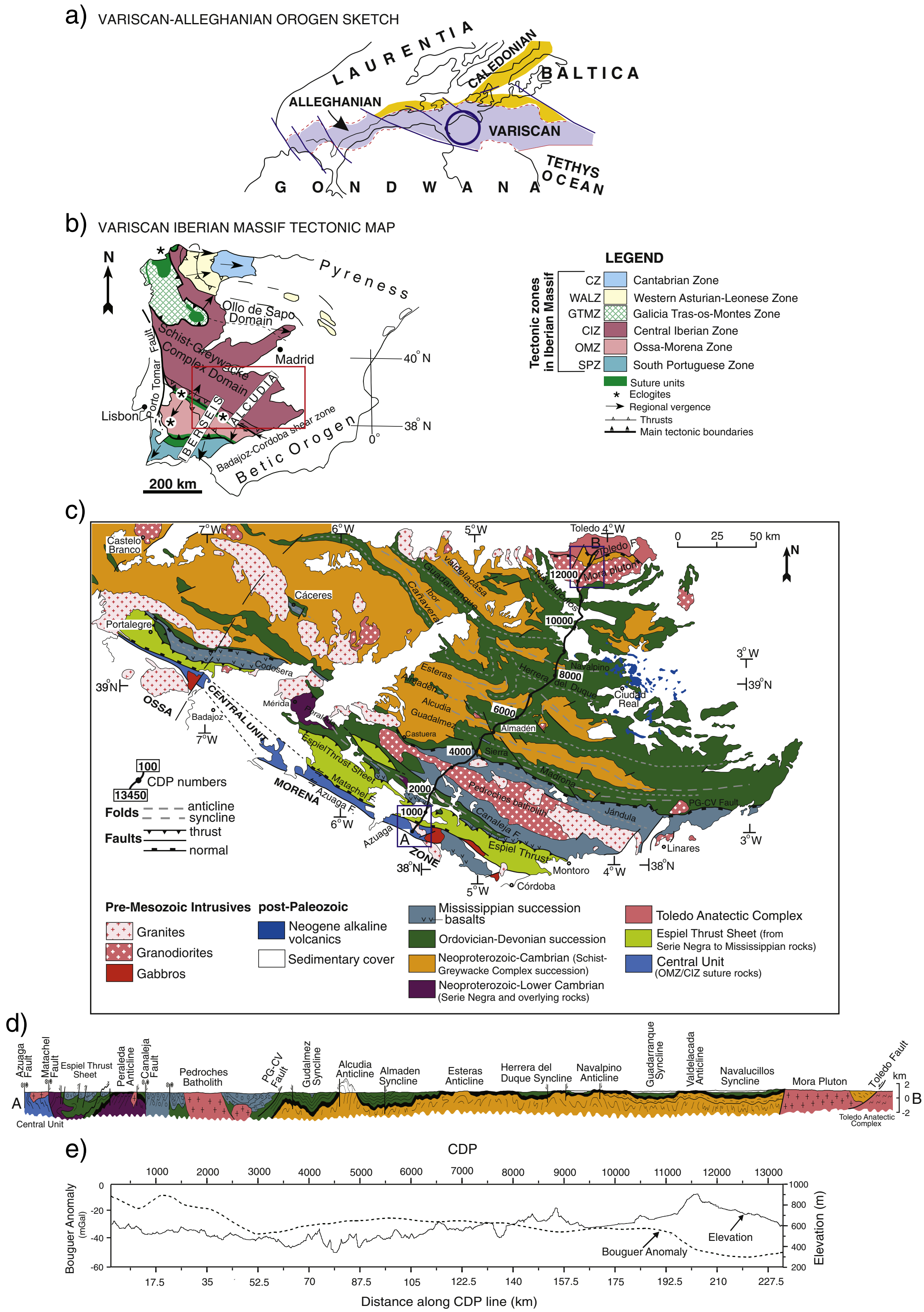

Fig. 1. (a) Sketch illustrating the extension of the Variscan–Alleghanian Orogen. The blue circle indicates the location of the Iberian Massif. (b) The tectonic map of the Iberian Peninsula with the main zones of the Iberian massif and the location of normal incidence deep seismic reflection transects. The red rectangle indicates the location of the study area and it is expanded in (c). (c) Geological map in the survey area showing location of the ALCUDIA deep seismic reflection profile. The blue rectangles at the ends of the ALCUDIA transect are presented in Figs. 5 and 7. The CDPs are indicated along the transect. (d) The structural cross section derived from surface geology. (e) The Bouguer gravity anomaly and the topographic profiles along the ALCUDIA deep seismic reflection profile (modified from Martínez-Poyatos et al., 2012).