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Key Points:

- 2-D magnetotelluric imaging of the Iberian autochthon domain of NW Iberia (Central Iberian Zone), heretofore unavailable for this region
- The MT model reveals two main tectonic blocks of a large-scale D2 extensional shear zone (i.e., Pinhel shear zone), a wavy structure
- The revealed wavy structure is explained by superimposed crustal shortening, later defected and refolded by a D4 strike-slip shear zone

Supporting Information:

- Supporting Information S1

Correspondence to:
J. Alves Ribeiro,
jaribeiro@fc.ul.pt

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Magnetotelluric Imaging of the Lithosphere Across the Variscan Orogen (Iberian Autochthonous Domain, NW Iberia)

J. Alves Ribeiro[1], F. A. Monteiro-Santos[1,2], M. F. Pereira[1,3], R. Díez Fernández[1,4], Í. Dias da Silva[1], C. Nascimento, and J. B. Silva[1,5]

[1]Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal, [2]Departamento de Engenharia Geográfica, Geofísica e Energia, Universidade de Lisboa, Lisbon, Portugal, [3]Departamento Geociências, ECT, Universidade de Évora, Évora, Portugal, [4]Departamento de Geodinâmica, Universidad Complutense de Madrid, Madrid, Spain, [5]Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal

Abstract A new magnetotelluric (MT) survey comprising 17 MT soundings throughout a 30 km long N30°W transect in the Iberian autochthons domain of NW Iberia (Central Iberian Zone) is presented. The 2-D inversion model shows the resistivity structure of the continental crust up to 10 km depth, heretofore unavailable for this region of the Variscan Orogen. The MT model reveals a wavy structure separating a conductive upper layer underlain by a resistive layer, thus picturing the two main tectonic blocks of a large-scale D2 extensional shear zone (i.e., Pinhel shear zone). The upper layer represents a lower grade metamorphic domain that includes graphite-rich rocks. The lower layer consists of high-grade metamorphic rocks that experienced partial melting and are associated with granites (more resistive) emplaced during crustal thinning. The wavy structure is the result of superimposed crustal shortening responsible for the development of large-scale D3 folds (e.g., Marofa synform), later deflected and refolded by a D4 strike-slip shear zone (i.e., Juzbado-Penalva do Castelo shear zone). The later contribution to the final structure of the crust is marked by the intrusion of postkinematic granitic rocks and the propagation of steeply dipping brittle fault zones. Our study demonstrates that MT imaging is a powerful tool to understand complex crustal structures of ancient orogens in order to design future prospecting surveys for mineral deposits of economic interest.

1. Introduction

In the Variscan Orogen, granites are anomalously voluminous in space and extensive in time. It is well established in the literature that the emplacement and deformation of granitic bodies are mostly related to the development of crustal-scale structures (Brown & Solar, 1999; Crawford et al., 1999; Weinberg et al., 2004) (e.g., faults and shear zones). However, the relationship between these large-scale structures and granites is not yet properly recognized through all orogenic belts. The identification and characterization of such relationship can be proven economically interesting in the case of shear zones hosting mineral deposits (Bursnall et al., 1989; Micklethwaite et al., 2010).

The magnetotelluric method (MT) imaging has been successfully used to investigate the structure of the lithosphere in regions with a complex geological history (Zhao et al., 2012), including major fault zones systems (Almeida et al., 2001; Pous et al., 2004; Ritter et al., 2005; Vieira da Silva et al., 2007). This geophysical method was successfully used to preliminary study the rheological behavior of the Variscan basement in SW Iberia (Monteiro Santos et al., 1999). The intent of this study is to provide information on the deep structure of the lithosphere across the Variscan Orogen in NW Iberia (Figure 1).

The Variscan Orogen resulted from the collision of Laurussia and Gondwana during the assembly of Pangea supercontinent (e.g., Matte, 1991). The building of this orogenic belt took place during the Devonian and Carboniferous and, in the Iberian Massif, it was the result of successive stages of contractional and extensional deformation (Arenas et al., 2014; Díez Fernández et al., 2016; Martínez Catalán et al., 2009). In NW Iberia, the Iberian autochthonous domain (e.g., Central-Iberian Zone) represents a section of the Gondwanan margin that experienced a complex geological history from Ediacaran to Carboniferous (e.g., Gutiérrez Marco et al., 1990; Martínez Catalán et al., 2016; Valladares et al., 2000)