# Preliminary insights into the lithospheric structure of the Iberian Pyrite belt in Portuguese terrains through magnetotelluric research

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## Abstract

The Iberian Pyrite Belt (IPB), located in the South Portuguese Zone (SPZ) of the Iberian Massif, is one of the most prominent sections of the Variscan orogenic belt in western Europe. It extends over a length of about 250 km and a width of 60 km, forming an arc-shaped belt that includes several series of asymmetric basins, tectonically controlled. These basins reflect the process of heterogeneous continental thinning triggered by the left-lateral transpressive convergence with the Iberian Terrane. Within the IPB lies the IPB Volcanic Sedimentary Complex (VSC), hosting one of the world's largest concentrations of massive sulphide deposits, including well-known areas such as Rio Tinto (Spain) and Neves-Corvo (Portugal). Despite numerous hypotheses about the origin of these massive sulphides in the IPB, many aspects remain poorly understood, especially regarding the deep lithospheric structure and the true extent of the IPB. Given the importance of the region for the exploration of mineral deposits, numerous geophysical surveys have been conducted in the area over the years limited to shallow depths. In this study, we present preliminary results from 60 broadband magnetotelluric stations recorded along the IPB in Portuguese terrain. To improve the analysis, we used a combination of previous and new data. Impedance data were analysed at different frequencies and we present here the phase tensor analysis. Preliminary results reveal the presence of a conductive area WNW-ESE oriented in accordance with the geological information supporting the presence of massive sulphide deposits. extending to depth. In summary, our study provides promising insights into the subsurface characteristics of the IPB and constitutes an essential basis for further research to constrain the geological structures controlling the distribution of massive sulphide ore systems in the region.

## 1. Introduction and Geological settings

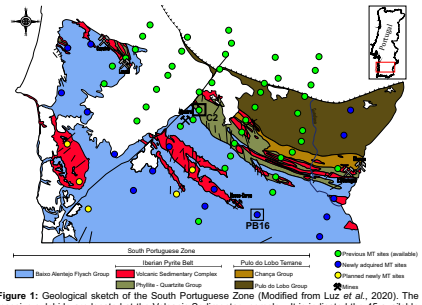


**Figure 1:** Geological sketch of the South Portuguese Zone (Modified from Luz *et al.*, 2020). The massive sulphide are located at the Volcanic Sedimentary complex. It is indicated the 45 available magnetotelluric sites (green) and the 21 new magnetotelluric stations (blue/yellow).

- The Iberian Pyrite Belt is considered one of the most outstanding ore provinces in the Earth's crust.
- It contains over 100 massive sulphide and stockwork deposits, as well as many smaller deposits.
- Knowledge of the lithospheric structure at depth is crucial for ore exploration in the IPB and is still unknown.
- For this purpose, the magnetotelluric (MT) method is the most suitable geophysical technique.

## 2. Resistivity and Phase curves

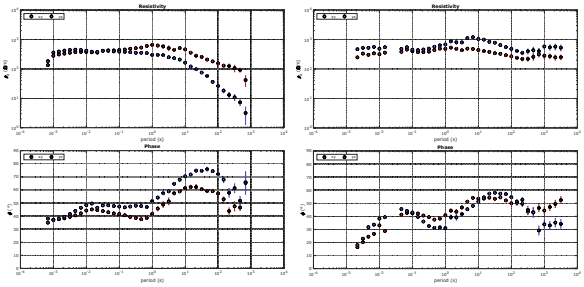


**Figure 2:** resistivity (top) and phase (bottom) curves from sites C2 (previously data collected with ADU06) and PB16 (newly collected with ADU07 in 2022). The location is indicated in Fig. 1. The data were processed with Mapros and plotted with FFMT (Hearing, 2019)

## 3. Phase Tensor profile

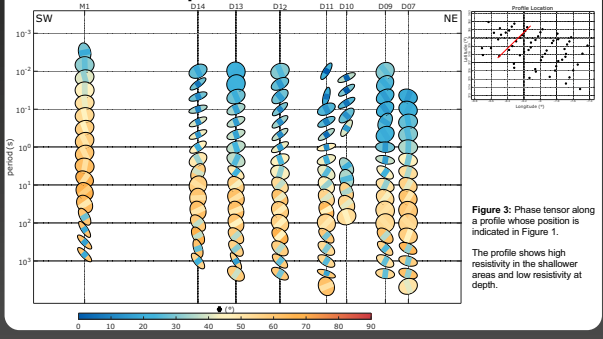


**Figure 3:** Phase tensor along a profile whose position is indicated in Figure 1.

The profile shows high resistivity in the shallower areas and low resistivity at depth.

## 4. Phase Tensor maps

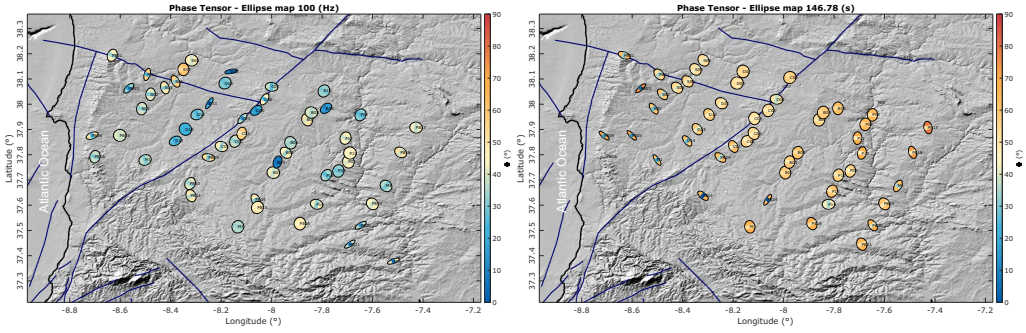


**Figure 4:** maps showing the phase tensor of the acquired MT sites at 100 Hz (left) and 146.78s (right).

The shallower map show a high resistivity belonging to the schist of the SPZ and the deeper map goes to lower resistivity probably matching with the presence of the massive sulphides.

## 5. Discussion and conclusions

- The preliminary results obtained in the SPZ and the Ossa Morena Zone (OMZ) show a resistivity contrast between the shallowest and deeper areas, indicating the presence of a conductive body. This is consistent with the mapped position of the pyrite belt.
- In the shallowest map, there are some areas of low resistivity (e.g. PB10-11-14-15-16) recorded on the top of the mapped IPB that extend to depth.
- Previous data (acquired with ADU03 and ADU06) and the new data were processed with Mapros (Metronix) and gave promising results. However, the same data are still being processed with FFMT software (Goethe Universität Frankfurt) to refine the results.
- Although the data show the influence of the sea, some insights into IPB can be seen in these preliminary results.

## 6. Future perspective and challenges

The future prospects of the PyBe project are:

- New acquisition of BBMT sites in areas of interest (up to 5 more as per project proposal). These sites could change the proposed location depending on the preliminary results.
- Processing of time series with the FFMT software.
- Determination of the influence of the ocean and bathymetry on the transfer functions through 3D modelling.
- 3D modelling incorporating anisotropic features and the main tectonic structures.

The data presented form the data basis for a recently approved PhD thesis.

**Acknowledgements**

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