

# THE LNEG ATLANTERRA SOUTH PORTUGUESE ZONE GEOSITE CHARACTERIZATION PROGRAM

J.X. Matos<sup>1\*</sup>, Z. Pereira<sup>2</sup>

<sup>1</sup> Laboratório Nacional de Energia e Geologia, UI. Recursos Minerais e Geofísica, Beja, <sup>2</sup> LNEG, UI. Geologia e Cartografia Geológica, S. Mamede de Infesta)

\*[joao.matos@lneg.pt](mailto:joao.matos@lneg.pt)

**Keywords:** *Geosites, South Portuguese, Iberian Pyrite Belt, Upper Paleozoic*

Included in the Atlanterra European Interreg Space Atlantic Project the LNEG is presently developing a geosite characterization program dedicated to the South Portuguese Zone (SPZ) territory, one of the major geological domains of the Variscan terrain. The work is carried out using a regional database with ~100 sites selected for their scientific interest, considering the following categories: geomorphology, Atlantic coast, Guadiana, Chança and Sado rivers, fossils and microfossils, tectonic, geological formations (Flysch, Volcano-Sedimentary Complex and Phyllite-Quartzite Group), ore exploitation (pyrite, copper, manganese), aggregates exploitation and geological gardens and geomonuments. The site characterization follows the Progeo methodology (Brilha, 2005, 2012), considering also the Iberian Pyrite Belt (IPB) initial framework of 7 proposed geosite program. The LNEG team applied the expertise and know how developed during the mapping surveys performed at different scales. The database output will be complemented by a regional map with the geosite distribution and possible route networks. This approach also considers the previous work developed in the Pyrite Belt, including the Pyrite Route (Matos et al. 2008) based in interpretation centers, located at Lousal (Science Center), Aljustrel (Municipality Museum) and São Domingos (miners house). The project objectives are the geological heritage promotion, locally inserted in the main mining scenarios, the identification of geoheritage routes considering their sustainable exploitation. The LNEG team wants to collect the existing information and show the SPZ geodiversity as a scientific argument to substantiate future geopark and geological garden project proposals.

## THE SPZ GEOLOGICAL FORMATIONS, AN UPPER PALEOZOIC GEODIVERSITY

In Portugal the SPZ is represented in the Alentejo and Algarve (north) regions. The SPZ includes Devonian and Carboniferous formations (Oliveira et al. 2006, Pereira et al. 2008) represented by the Pulo do Lobo Domain, the IPB and by the Baixo Alentejo Flysch Group. The Pulo do Lobo Domain is an antiformal structure located in the northern sector of the SPZ. In the structure core outcrops the Pulo do Lobo Fm. (age unknown) formed by phyllites, quartzites and amphibolites (MORB-type basalts, Munhá 1983). The north limb of the antiform is represented by the sedimentary formations of the Ferreira-Ficalho Group Ribeira de Limas (lower Frasnian), Santa Iria and Horta da Torre (upper Famennian). The southern limb of the antiform is represented by the Chança Group represented by the sedimentary formations Atalaia (age unknown), Gafo (lower Frasnian) and Represa (upper Strunian). The IPB includes the Phyllite Quartzite Group (PQG) and the Volcano Sedimentary Complex (VSC). The PQG forms the IPB basal detritic sedimentary unit and consists mostly of phyllites, quartzites and quartzwackes with a thickness is in excess of 200m (base not known). It is dated as lower Givetian to late Strunian age (Mid to Upper Devonian), by ammonoids, conodonts and palynomorphs (Oliveira et al., 2006, Pereira et al., 2008). The VSC incorporates several episodes of volcanism, with dominant rhyolites, dacites, basalts and minor andesites, and intercalations of black shales, siltstones, minor quartzwackes, siliceous shales, jaspers and cherts and a purple shale member at the upper part of the complex. The thickness is variable, from few tens of meters to more than 1000m. The VSC is dated as Upper Devonian to upper Viséan age based on palynomorphs and rare conodonts. Overlaying the VSC are the turbidites of the Baixo Alentejo Flysch Group (BAFG) that consists of mostly gravity flow sediments that form a continuous southward



prograding turbiditic successions, that includes from base to top, the Mértola (upper Viséan), Mira (Namurian) and Brejeira (Bashkirian to upper Moscovian) formations (Oliveira et al. 2006, Pereira et al. 2008). The SPZ geological formations are characterized by short geological time period (middle Givetian to upper Moscovian) and by a significant geodiversity represented by different volcanic and sedimentary units and by important base metals mineralizations of massive sulphides, Mn-Fe oxides, carbonates and silicates and by Cu, Pb-Ba and Sb vein type structures. The massive sulphide deposits (~93 deposits) and related hydrothermal systems are associated with the VSC felsic volcanic and/or black shales represents the main geodiversity, with world class deposits as Neves Corvo and Aljustrel (both active mines). These deposits characterise the IPB as one of the main European metallogenic base metal province.

#### GEOSITES, MINING AREAS AND NATURAL LANDSCAPE

The SPZ has an exclusive natural heritage characterised by environmental, geological, biological distinctiveness, as well as outstanding seaside coastal landscapes and an inland flat morphology, the typical landscape of Alentejo, and the smooth Andalusia mountains. This region is a significant geodiversity examples, not only due to the variety of the sedimentary and volcanic stratigraphic sequences, very well represented in Portugal by classical cross-sections along the Guadiana, Chança and Sado river valleys and in the Pomarão, Ourique, Castro Verde and Cercal antiformal structures, but also by the massive sulphide deposits and associated hydrothermal systems, exposed in old mines open pits such as Lousal, Caveira, Montinho, São Domingos and Chança and the active mines of Neves Corvo and Aljustrel (world class VHMS deposits) Matos et al. 2011. The significant mining activity changed the IPB landscape and the culture of the region, leaving a rare industrial archaeology heritage that includes exploitation open pits, industrial systems, railway trails, river harbours for the ore transport mining villages and a mining cultural memory of the populations promoted as the Pyrite Route (Matos et al. 2008, Gómez & Martinez 2009). The IPB mining scenarios are an excellent way to access to the local stratigraphy and to the understanding of the geological process related with ore metalogeny (hydrothermal systems) and their later evolution during deformation and late supergene alteration and erosion. In these and natural contexts upper Paleozoic sequences are exposed, showing variety of volcanic and sedimentary facies, mainly marine environments, showing the SPZ as a regional basin were related with volcanic bimodal activity a unique metalogenetic environment was developed. The SPZ fossil record of the SPZ extends from middle Givetian age to upper Moscovian age and is represented by microfossils (miospores, acritarchs and prasinophytes), *Posidonia becheri*, ammonoids and conodonts (Pereira et al. 2008). Several palynostratigraphic studies are being carried out for exploration companies, to identify key horizons favourable to the presence of massive sulphide mineralization - e.g. Strunian age black shales (Matos et al. 2011, Pereira et al. 2012).

#### DISCUSSION: THE IPB GEOLOGICAL HERITAGE VALORIZATION

The SPZ presents a large number of well documented geosites related with Devonian and Carboniferous times, including the Iberian Pyrite Belt, a unique European metalogenetic province, with world class mineral deposits. The sustainable promotion and valorization of the SPZ heritage must be considered and developed according the local Alentejo and Andalusia landscapes. The Atlantic coast and the Guadiana/Chança rivers present the most favourable scenarios to be well documented and to aspire a future Geopark projects. The geosite SPZ LNEG inventorying database will help to define the best rout planning activities, showing the most studied areas, some of them unique. Municipalities are key entities to promote future geological gardens and geopark projects. Other themes can complement the geological and mining heritage, supporting the Geopark concept, for instance the natural landscape and ecologic agriculture, biodiversity, archeology and the Alentejo's culture (rich gastronomy, ethnography and music).

Acknowledgments: This work has been supported by the Interreg Space Atlantic Program.