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# Biogeochemistry in Neves Corvo mining region, Iberian Pyrite Belt, Portugal

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**Abstract**

The study was conducted in the Neves Corvo Cu–Sn mine, and in six old Mn, Cu and pyrite mines, situated in the same volcano-sedimentary formations of the Portuguese Iberian Pyrite Belt, namely Courela das Ferrarias, Cerro da Cachaçuda, Herdade do Castelo, Cerro das Guaritas, Cerro do Algaré and Brancanes and in Lombador at the surface of a unexploited deep orebody. The objective was to compare the pathway of specific chemical elements in the present Neves Corvo mine, and in the other study areas. Consequently, soils, plants and sediments were sampled and analyzed for Cu, Pb, Zn, Fe and Mn. The pH was measured in the soils. Data compiled from other studies from soils, plants, rocks, and mine waste dumps was also used.

The Neves Corvo area is still in a reactive state, that is, acid generating minerals are released from the orebodies and mobilised into the surrounding soils both by chemical processes and wind erosion. The acidity generated in contact with water may cause mobilisation of the metallic elements, increasing the bioavailable fraction and, consequently, contributes to plants uptake.

The northwestern mines are in an intermediate state, that is, with partial mobilisation of metals from orebodies into superficial environment. Although, a natural attenuation process in the study area appears to have started in the soil–plant system in Brancanes, and in the previously mentioned northwestern mines (Cerro do Algaré, Cerro das Guaritas, Herdade do Castelo, Cerro da Cachaçuda, Courela das Ferrarias), no attenuation processes occur in waters and sediments, which have metals that are still being released from dump materials.


*Keywords:* Biogeochemistry; Metal concentrations; Bioavailability; Chemical equilibrium; Natural attenuation

## 1. Introduction

Ore minerals cause impact on the chemical equilibrium of the surrounding environment, being not so detrimental when undisturbed and confined. Chemical elements such as Cu, Pb, Zn when released from orebodies by mining are made bioavailable to the biological communities or, alternatively, in colloidal form, are able to be transported in aqueous solutions, and can be considered toxic at certain levels (Alloway and Ayres, 1994; Rüdel, 2003).

The environment in the surrounding areas of exploited mines has the capacity to recover from the exploitation disturbance, if buffering conditions exist, which are essential for the natural attenuation and establishment of equilibrium with time. The time span varies according to

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various local conditions, such as: (1) the mobility of metals to other locations through fluid phases; (2) the existence of buffering minerals with the ability to adsorb (clay minerals, oxides and hydroxides, etc.) or retain in their lattice structure (oxides and hydroxides) these metals; and, (3) the ability of complexation with organic matter. The described processes are considered abiotic, and are sensitive to the physicochemical properties of metals and soils, as well as the mineralogical characteristics of the latter (Mulligan and Young, 2004).

The biotic processes are influenced by the availability and, especially, bioavailability of metals to plants and microorganisms. This can have two main effects: the increase of the plant uptake with negative or positive consequences to ecosystems, and the increase of metals leached from soils.

Iron and Mn, usually present in large quantities in base metal orebodies, can play an important role in the behaviour of other elements in soils, such as Cu, Pb and Zn, by their natural attenuation when present as oxides or hydroxides.

The Iberian Pyrite Belt (IPB) is an important metallogenic province with a long history of mining, due to the exceptional conditions of ore formation. The Neves Corvo mine, situated in IPB, is one of the few copper and tin mines still operating in Europe (Fig. 1). This mine is the most significant mineral deposit discovered in Portugal, and one of the most important copper deposits in the world, therefore exerting an important socioeconomic and environmental impact in the region. The local conditions regarding land use, population density, historical and present day human activities are based almost exclusively on mining activities.

Biogeochemical studies were previously conducted in order to use plants as a bioindicator of buried orebodies, such as the Neves Corvo orebody (Farago et al., 1992; Grimes and Carvalho, 1994), or sources of metals upstream from Neves Corvo (Richards, 1995). In addition, Alvarenga (1997) and Batista (2003) also studied the behaviour of metals in the superficial environment of Neves Corvo and other IPB mines.

The objective of this study was to compare the pathway of the metals occurring in the mineralisation, exploited in the old abandoned mines, and in the Neves Corvo operating mine.

## 2. Materials and methods

The study area (48 km$^2$), located in "Baixo Alentejo" region, south of Portugal, includes not only the mines but also two main villages, the Lombador village in the northern part, and the Semblana village to the southern limit of the area (Fig. 1).

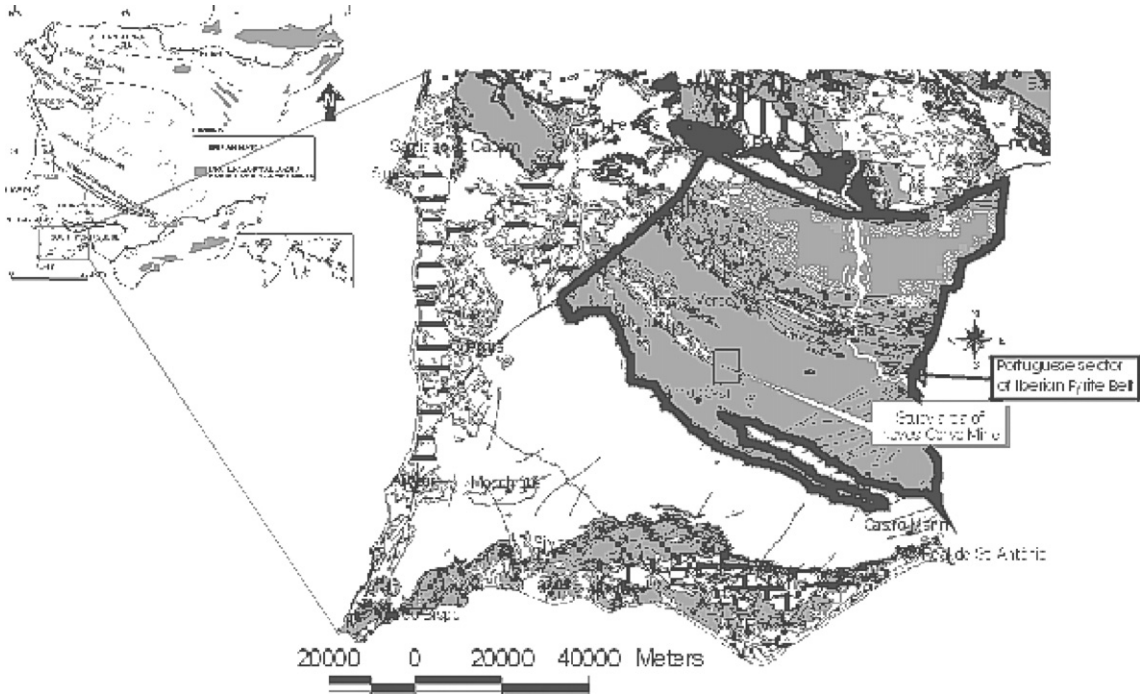


Fig. 1. Location of Neves Corvo in the Iberian Pyrite Belt and in the Iberian Peninsula (inset adapted after Quesada, 1992, main map after Oliveira, 1992).