(7) MINING HERITAGE AND ECONOMIC POTENTIAL OF THE WASTES OF THE S. DOMINGOS MINE

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Introduction

Ore minerals are valuable as sources of metals to meet society's demands; these minerals may also be viewed as environmental pollutants responsible for the generation of acid mine-waste runoff, for generating superficial acid waters, and for the release of various toxic metals into the environment. After centuries of exploitation, this activity reflects the demands of ancient societies and, in a historical perspective were always a major driving force in the development of civilizations (Craig, 2001).

Successful mining exploitation of metallic ores requires great efficiency in metal recovery, which will require good understanding of ore textures and grades distribution and their implications with regard to mineral separation. Also, good market conditions and other factors such as accessibility, energy consumption and other production costs are other key factors. This is important when looking for new products within previously exploited raw materials, especially in old 19th and 20th centuries mines, characterized by low recoveries and inefficient ore processing systems. Furthermore, a balance between the products potential of a certain raw material with its mining heritage potential and its environmental penalties, needs to be assesed. A first approach to these only related to the economical value of the wastes was made in S. Domingos mine of the Iberian Pyrite Belt (IPB), a medium-sized massive sulphide deposit with 25 Mt, exploited during Roman time and between 1857 and 1966. Along this lengthy time period, pyrite ore was mined and processed using the Orkla roasting process, ore leaching with acid waters and copper cementation tanks (Matos et al. 2006, Álvarez-Valero et al. 2008).

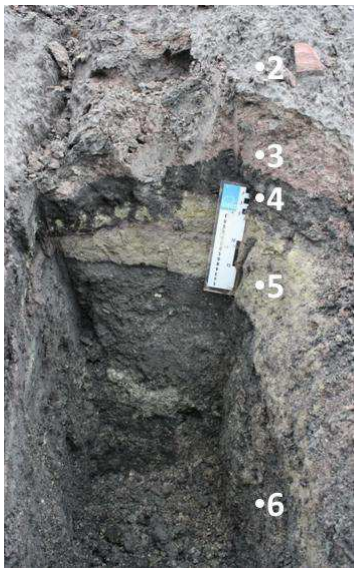
Old mining waste potential as new metal source

The significant economic profit related with ore minerals exploitation is the main objective of the mining industry. Modern mining projects are being developed considering minor environmental and social impacts as shown by several best practices examples present all over Europe and others continents (e.g. Aitik - Sweden, Neves Corvo – Portugal). However, old mining projects (especially those developed in the 19th century up until the 1970´s) are not good examples of this attitude showing dramatic environment impacts (toxic metals present in soil, air and waters, acid mine drainage, etc.) and extreme negative social impact (unemployment and human desertification). In Portugal the São Domingos mine is one example of these old mining projects, with an incomplete closure process, since the mine was abandoned in 1966. Considering the promotion of the economic development of the São Domingos mining area a mining waste study was conducted as part of the research project PROMINE -FP7-NMP-2008-

LARGE-2 (*Nano-particle products from new mineral resources in Europe),* a EU 7th Framework's Programme. Geochemical campaigns were conducted aiming the characterization of the mine's wastes/products. As such, the mine wastes present within the old mine property contain appreciable quantities of elements listed in the European List of Critical Raw Materials (EC Critical Raw Materials Report, 2010).

The S. Domingos pyrite-dominated, subvertical massive sulphide orebodyis located at the top of a Volcanic Sedimentary Complex (VSC) sequence (Matos et al. 2006). Relevant grades of Sb (above 1%), Bi (above 0.2%) and Re (until 3.4 mg kg^{-1}) minor metals and base metals were found at the Achada do Gamo sulfur plant industrial area waste pile (located south of the São Domingos mine open pit). Here, near the acid waters lake, ashes from roasted Cu-rich pyrite ore , fine milled pyrite ore and host rocks debris were deposited. In the northern São Domingos area, around the old pit and near the village, diverse type of wastes can be observed (Matos 2004, Mateus et al. 2011) reflecting the open pit excavation and mining which focused in the São Domingos gossan exploitation. Palaeoweathering of the S. Domingos orebody has resulted in an important gossan horizon which was intensely mined during the Roman occupation of Iberian Peninsula and subsequently mined out in the 19th century. Mining wastes piles of gossan and volcanic gossanized host rocks present interesting Au concentrations, locally 1 to 4 mg kg^{-1} (Batista et al., 2011). The mining waste evaluation carried out by Conasa in 1991, through 14m-deep pits and reverse circulation boreholes allowed the identification of 1 Mt of wastes with 1 mg kg^{-1} of gold (Matos et al. 2006).

(A)



(B)

Figure 1 (A) Milled gossan dump located in the southern part of the São Domingos open pit; (B) Profile in the waste pyrite ore ash pile atAchada do Gamo sulfur production area.

Mining Heritage

Detailed geological and mining mapping of the major massive sulphides mines on the Portuguese sector of the IPB at the mine scale 1:2500 was made by the Geological

Survey (LNEG) (Matos, 2004, Matos et al. 2008). The mapping of the IPB mines is integrated in a mining heritage program, developed together with local municipalities and the government entities for environment and tourism ITUR Interreg Project and updated version in the ATLANTERRA Interreg Space Atlantic Project (Matos et al. 2011). The sustainable development of the geo-mining tourism is the main goal of these activities. This mapping includes detailed waste mapping and mine infrastructures. Special attention is given to Roman excavations and industrial facilities reflecting the period of the Industrial Revolution, when industrial countries, such as England, started looking for other prospects in the neighboring countries to satisfy the increasing raw material demand for their own metal smelters (Matos et al., 2008).

The Mértola municipality implemented a General Urban Plan of the São Domingos mine in order to focus on the tourism in the area from the clean water dams upstream of the mine to the confluence with the Mosteirão stream and to the mining harbour of Pomarão in the Guadiana River, from where the ore used to be shipped to England. At the Tapada Grande old mine clean waters dam, the municipality promoted a fluvial beach dedicated to nautical tourism activities. This infrastructure is presently one of the Summer season attractions for tourists and local community. Several ONGs such as the "Liga dos Amigos de São Domingos" promote the São Domingos mine heritage near the old miners, most of them living presently outside of the region. A 6 panel circuit is present at São Domingos since 2005, supporting the site visit and exploration. Presently LNEG is developing geosite characterization associated with the Atlanterra Project (Matos et al. 2011).

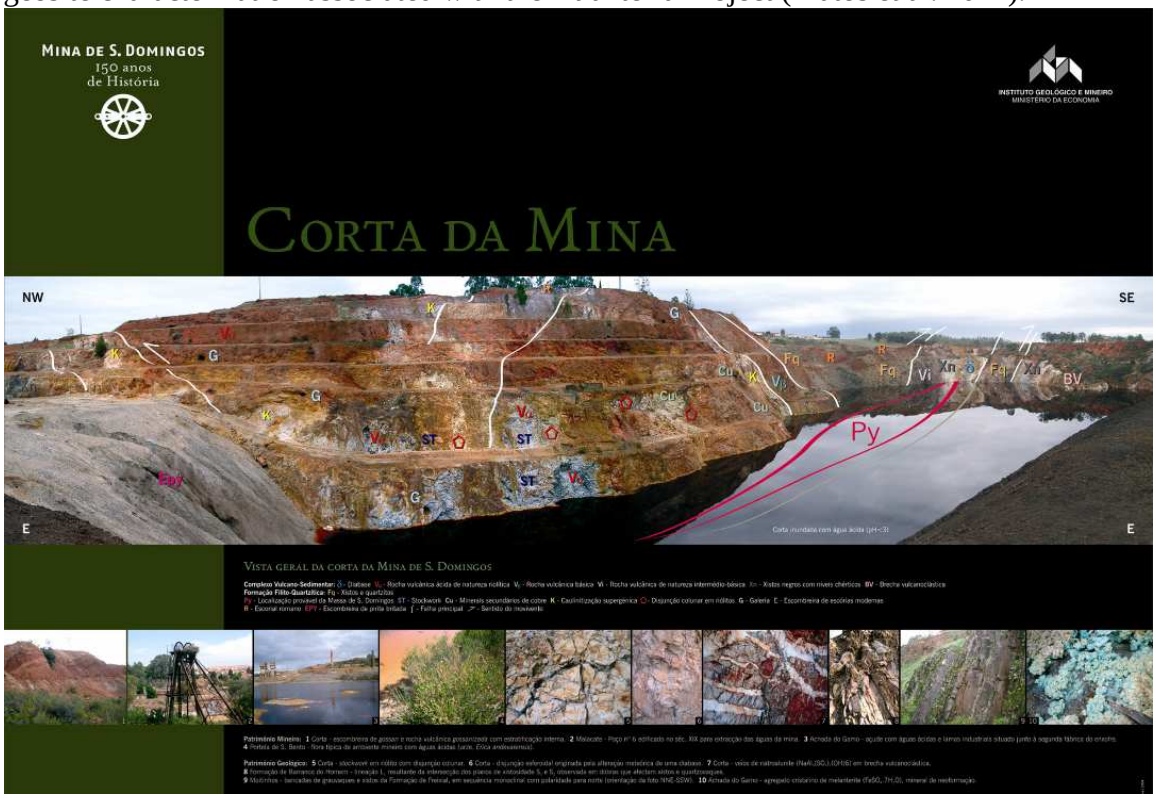


Figure 2- São Domingos mine open pit information panel, showing the local geological and mining heritage (ad. São Domingos 150 Years Exhibition – CMMértola/IGM (LNEG), author J. X. Matos.

Conclusions

In the mine life cycle re-mining operations reprocessing of the old mining wastes can be considered following the exhaustion of the underground and surface mining with new techniques or when the market is favourable to do it. Having this in mind research is developing to increase knowledge and potentiality to use of these mine waste materials. This study contributed to this knowledge, because identified interesting grades of metals such as Au in gossan, and Sb, Bi and Re in the wastes especially in Achada do Gamo milled pyrite, where the volumes are considerable. To increase the life-time of the mine site heritage projects are also an option that is an important income in S. Domingos mine village and Mértola municipality.

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