

Impact of mining activity in Panasqueira (Central Portugal): environmental and occupational exposure to heavy metals

Carla Candeias¹, Patrícia Coelho², Eduardo Ferreira da Silva¹, Rita Salgueiro¹, Paula Freire Ávila³, João Paulo Teixeira²

¹University of Aveiro, Geosciences Department, GeoBioTec - Geobiosciences, Geotechnologies and Geoengineering Research Center; Campus de Santiago, 3810-193 Aveiro, Portugal; candeias@ua.pt

²INSA - Portuguese National Institute of Health, Environmental Health Department; R. Alexandre Herculano, 321, 4000-055 Porto, Portugal; pcscoelho@gmail.com

³LNEG - National Laboratory of Energy and Geology; S. Mamede Infesta, 4466-956, Portugal

Panasqueira minelabouring since 1888, has a Tin-Tungsten deposit reported as the largest quartz vein in Europe and one of the largest in the world. The deposit is an example of a Sn-W hydrothermal mineralization associated with the Hercynian plutonism. The mining activity results on a huge volume of wastes deposited in tailings - Rio (~1200000m³), Vale da Ermida (100000m³), Panasqueira (1000000m³) and Barroca Grande (~7000000m³, active) - and 3 mud dams - Rio (~731034m³) and Barróca Grande (2 dams ~1193885m³, one active). The exposure of those materials to atmospheric conditions for long periods of time resulted in their weathering. As mentioned in previous studies the percolation of rain waters through the tailings materials originates acid mine drainage which contaminates soils, local streams sediments and waters, in the vicinity of Zêzere River (this river is very important since it feeds Castelo de Bode Dam, the main water supplier of Lisbon metropolitan area). Some previous studies reported that some high values of As, Cu and Fe were observed in Zêzere river. The objective of this study is to evaluate environmental and occupational exposure of some potential toxic elements (PTE).

For this study soils samples were collected (according to a grid of 400m x 400m), in two depths (122 superficial samples (A) and 116 samples collected at 15cm depth (B)). Type A samples aiming to characterize superficial contamination and type B samples to establish the geochemical background values. Biological monitoring was also performed by analysing biomarkers of exposure and effect in individuals exposed to this contamination. Study group consisted of 41 individuals environmentally exposed, 41 individuals occupationally exposed and 40 individuals without know exposure to metal(loid)s (controls). Biomarkers of exposure included quantification of several metal(loid)s - As, Cd, Cr, Mn, Pb- in blood, urine, nail (finger and toe), and hair samples by ICP-MS. Micronucleus and chromosomal aberrations test were the selected biomarkers of effect.

Principal Component Analysis (PCA) was applied in order to identify the association of elements with antropogenic origin, allowing to evaluate the enrichment of the study area on those PTE. They calculated Enrichment Index (EI) revealed in both depths a high degree of trace metal contamination around Rio and Barroca Grande tailings. Values in superficial soils are in general higher. Contamination factor (Cf) was also calculated. Arsenic presented very high values in both depths.

Results obtained in biomarkers of exposure confirmed that individuals are exposed to significantly higher concentrations of some metal(loid)s, mainly As, when compared to controls. The environmentally exposed group is being particularly affected by this contamination. This exposure is leading to genotoxic effects, specifically in the environmentally exposed group, as significant increases in the frequencies of micronucleus and chromosomal aberrations were found (when compared to controls).

Altogether our results emphasize the need to implement preventive measures, remediation, and rehabilitation plans in the area as soon as possible in order to reduce the risk of these populations. This is extremely important not only for these particular populations but for all populations worldwide exposed under similar conditions.

Key words: Mining activity, Panasqueira, heavy metals; environmental and occupational exposure