

## Contaminated soils, stream sediments and waters close to an abandoned uranium mine from central Portugal

A. M. R. NEIVA<sup>1</sup>, P. C. S. CARVALHO<sup>1</sup>,  
I. M. R. H. ANTUNES<sup>2</sup>, M. M. V. G. SILVA<sup>1</sup>,  
A. C. T. SANTOS<sup>1</sup>, M. M. S. CABRAL PINTO<sup>3</sup> AND  
P. P. CUNHA<sup>1,4</sup>

<sup>1</sup>Department of Earth Sciences, University of Coimbra, Portugal (neiva@dct.uc.pt, paulacscarvalho@gmail.com, mmvsilva@dct.uc.pt, antsantos@portugalmail.com, pcunha@dct.uc.pt)

<sup>2</sup>Polytechnic Institute of Castelo Branco, Portugal (imantunes@ipcb.pt)

<sup>3</sup>Department of Geosciences, University of Aveiro, Portugal, & CNC-Centre of Neuroscience and Cell Biology, University of Coimbra, Portugal (marinacp@ci.uc.pt)

<sup>4</sup>MARE-Marine and Environmental Sciences Centre

A quartz vein containing autunite and torbernite was exploited at the Pinhal do Souto mine and produced 93,091 kg  $U_3O_8$  between 1978 and 1989. It was then closed down and two dumps, partially covered by natural vegetation, were left in the area. Soils tend to have higher Cu, Mn, Pb, Sb, U and W concentrations and a lower Fe concentration than stream sediments, because soils contain vermiculite that adsorb metals and the metalloid Sb. The Fe-oxides precipitate has higher As, Cd, Co, Fe, Sr, W, Th and U concentrations than soils, because it also has higher concentrations of iron-oxides and organic matter than soils, which adsorb metals and the metalloid As. Uranium is up to 485.20 mg/kg in Fe-oxides precipitate, 336.79 mg/kg in soils and 35.68 mg/kg in stream sediments. Metals and metalloids are released from the mine dumps, leaching through the mine area and are retained in soils, Fe-oxides precipitate and stream sediments. An evidence is the uranium concentration in water that increases up to 104.42  $\mu\text{g/L}$  in the wet season, because secondary minerals are dissolved and uranium is released into water. But metals and As concentrations in water increase during the dry season due to the evaporation. Under neutral to alkaline pH,  $UO_2^{2+}$  is abundant and complexed with  $CO_3^{2-}$  in water. Surface water and groundwater have a slightly acid-to-alkaline pH. Soils, stream sediments and waters are contaminated and must not be used. The median concentrations of Fe, As, Cd, Pb, Sb, Th, U, W and Zn in soils are higher than in European soils of the FOREGS data.

This mine area caused a lower environmental impact than the Portuguese abandoned uranium mine area of Vale de Abrutiga, attributed to it having lower sulphide concentration and mineral alteration than the Vale de Abrutiga area.