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Risk Assessment of Heavy Metals in Abandoned Mine Lands as Signifcant Contamination Problem in Romania

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INTRODUCTION

Wide-spread environmental contamination associated with historic mining in Europe has triggered social responses to improve related environmental legislation, the environmental assessment and management methods for the mining industry. Pollution by acid mine drainage (AMD) from ore and coal mining is the outstanding and most important source of mining-induced environmental pollution. Younger et al. (2002) estimates that watercourses polluted by coal mine drainage could be in the order of 2,000 to 3,000 km, and 1,000 to 1,500 km polluted by metal mine discharges for the EU 15 Member States (Younger et al. 2002). Significance of contamination risk posed by mining is also highlighted by mine accidents such as those in Baia Mare, Romania in 2002 and in Aznalcollar, Spain in 1999 (Jordan and D'Alessandro 2004). The new EU Mine Waste Directive (Directive 2006/21/EC) requires the risk-based inventory of abandoned mines in the EU. The cost-effective implementation of the inventory is especially demanding in countries with extensive historic mining and great number of abandoned mine sites, like Romania. The problem is further complicated in areas with trans-boundary effects. The objective of this investigation to carry out the risk-based contamination assessment of a mine site with possible trans-boundary effects in Romania. Assessment follows the source-pathway-receptor chain with a special attention to heavy metal leaching from waste dumps as sources and to transport modelling along surface water pathways.

STUDY AREA

In this paper the Baiut mine catchment located in the Gutai Mts., Romania, close to the Hungarian border is studied. The polymetallic deposites in the Tertiary Inner-Carpathian Volcanic Arc are exposed by a series of abandoned Zn and Pb mines first operated in the 14th century. Elevation in the high relief catchment ranges from 449m to 1044m. Geology is characterised by andesites hosting the ore deposits and paleogene sediments dominating at the lower topographic elevations. Several mine adits, waste rock dumps are located along the main stream and a large tailings dump is found next to village Baiut just above the receiving floodplain. Predominant land cover is coniferous and mixed forests with agricultural lands on the downstream floodplain.

METHODS

Six samples at vaious depths were collected from the two major waste rock dumps in the headwater area, and the large tailings dump was also sampled for heavy metal source characterisation. 11 stream sediment samples were collected along the main surface water contamination transport pathway, and a further 11 soil samples were collected in 2 boreholes in the receptor floodplain in October 2008. Besides background stream sediment samples, samples from the exposed rock formations were also collected in order to capture natural background geochemistry in the studied mineralised area.

The collected waste rock, stream sediment, soil and rock samples are analysed for total chemical composition (major elements and heavy metals) by ICP-MS spectroscopy, and XRD is used for the determination of mineralogical composition. Rock sample mineralogy is further investigated in thin-sections by petrological microscopy. According to EU legislation expectations, a special emphasis is taken on the determination of metal mobility from the waste rock dumps and various leaching tests are performed and compared including US EPA, USGS and ISO methods.

A simple cathcment-based distributed sediment transport model (Jordan et al, 2005; Jordan et al. 2005, 2008) is used to decribe the pathways and quantities of particle-bound contamination.

RESULTS AND CONCLUSIONS

Results show that (1) sediments are an efficient means for the preliminary inventory of mine contamination as a preparation for the more detailed hydrological sampling and assessment, and (2) the risk-based contamination assessment of mining sites often located in diverse geological, hydrological and landcover environment requires careful and successive sampling design and a tiered assessment approach. Leaching tests are shown cost-efficient and informative methods for source (hazard) characterisation.

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