Ranking and testing of contamination risk assessment methods for toxic elements from mine waste sites

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Poor environmental management practices of mine waste facilities have left the legacy of thousands of contaminated sites like in the historic mining areas in the Carpathian Basin. Associated environmental risk has triggered the development of new EU environmental legislation to prevent and minimize the effects of such incidents. The Mine Waste Directive requires the risk-based inventory of all mine waste sites in Europe by May 2012. In order to address the mining problems a standard risk-based Pre-selection protocol has been developed by the European Commission. This paper discusses the heavy metal contamination risk assessment (RA) in acid mine drainage (AMD) along the Source-Pathway-Receptor chain using decision support methods which are intended to aid national and regional organizations in the inventory and assessment of potentially contaminated mine waste sites. Several recognized methods such as the European Environmental Agency (EEA) standard PRAMS model for soil contamination, the US EPA-based AIMSS and the Irish HMS-IRC models for RA of abandoned sites are reviewed, compared and tested for the mining waste environment. In total 34 mine waste sites (including tailing lagoons and heaps of both abandoned and active mines) have been selected for scientific testing using the EU Pre-selection protocol as a case study from Hungary. Over 93 field samples have been collected from the mine sites including: Ore (Andesite and Ryolite), Coal (Lignite, black and brown coals), Peat, Alginite, Bauxite, Clay and Limestone. Laboratory analyses of the total toxic element content (aqua regia extraction), the mobile toxic element content (deionized water leaching) and the analysis of different forms of sulphur (sulphuric acid generation potential) have been performed on the basis of the Hungarian government decree implementing the Mining Waste directive. A detailed geochemical study together with spatial analysis and GIS has been performed to derive a geochemically sound contamination risk assessment of the mine waste sites. Key parameters such as heavy metal and sulphur content, in addition to the distance to the nearest surface and ground water bodies, or to sensitive receptors such as settlements and protected areas are calculated and statistically evaluated using STATGRAPHICS® in order to calibrate the RA meth-

ods. The total risk scores for each site and key parameters are provided in separate tables and GIS maps. Results of the risk-based Pre-selection protocol are consistent with those of the pre-screening PRAMS model, thus risk ranking of sites is insensitive to the selected RA method in this case. The proportion of uncertain or unknown geochemical and environmental parameters such as size of waste rock dump calculated for each site gives an insight of specific and overall uncertainty in the data used for contamination RA pre-screening.

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