

NORM and heavy metal levels in former mining lakes in Sweden

Mantero J.^{1,2}, Thomas R.¹, Isaksson M.¹, Rääf C.², Forssell-Aronsson E.¹, Holm E.¹, García-Tenorio R.^{2,4}

¹Dept. of Radiation Physics. Institute of Clinical Sciences. Sahlgrenska Academy at University of Gothenburg, Gothenburg, SWEDEN;

²Department of Applied Physics II, E.T.S.A., University of Seville, Seville, SPAIN;

³Medicinsk strålningsfysik, Institutionen för Translationell Medicin, Lunds universitet, Malmö, SWEDEN;

⁴Centro Nacional de Aceleradores (CNA), Seville, SPAIN

Abstract

Historically Sweden (the major metal mining country in the European Union), with more than 2700 mines, gathers around 30000 sites that have been minor mines and quarries (according to the database of Geological Survey of Sweden, SGU). This huge activity has implied enormous quantities of generated mining wastes, considered, in some cases NORM.

Many of these sites had opencast mines. During exploitation by open-pit mining, the water table is suppressed to avoid the flooding of active mines. However, when mining activity ceases, the water table recovers its original position, flooding the open pits and giving rise to mine pit lakes.

The environmental problem arise because these waters can be affected by Acidic Mine Drainage (AMD), having high/very high concentration of heavy metals in solution. Also enhanced levels of natural radionuclides belonging mainly to ²³⁸U and ²³²Th series can be found within these water bodies. Apart from the impact to the ecosystem, these places are nearby populated areas and most of them are usually used for recreation purposes (swimming, fishing or diving) by inhabitant of these former mining areas.

In this work, a survey on 50 different abandoned pit lakes was performed. Superficial waters and sediments from the shoreline were sampled. Levels of radionuclides (²³⁸U, ²³⁴U, ²³²Th, ²³⁰Th, ²¹⁰Po) via alpha spectrometry and (²¹⁴Pb, ²¹⁴Bi, ²²⁶Ra, ²²⁸Ac, ²¹²Pb, ²¹²Bi, ⁴⁰K, ¹³⁷Cs) via gamma spectrometry were measured at these sites. Also elementary composition (major elements and traces: Fe, Mn, Cu, Zn, S, Mg, Ca, Cr) via ICP-MS in water samples and via XRF in sediments will be reported.

Regarding radiometric measurements for instance, ²³⁸U levels ranged from 2 to 1300 mBq/kg in water. Having into account that an average value of this isotope in non-affecting environmental waters is around 20-30 mBq/kg it is quite clear that some of the studied scenarios have enhanced the U levels in superficial waters.

The main conclusion is that during this survey, some places with moderated levels of natural radionuclides were found and also high levels of heavy metals were identified both in water and sediment samples at some spots.