On the radioecological issues of natural radionuclides in water and sediment of a highly contaminated lagoon from Mexico

C.D. Mandujano-García [1,2,*], A.R. Nava-Huerta[2], N.A. Santibañez[2], O.R. Hernandez-Montoya[3], D.R. Luna-Méndez[3], J. Huerta-García[3], J. Bluhm-Gutierrez[4] and R. García-Tenorio[1]

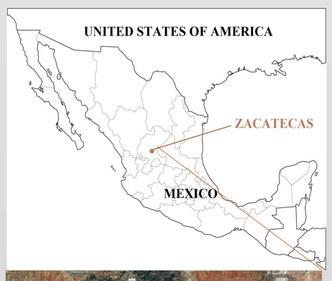
[1]Departmento de Física Nuclear Aplicada II, Universidad de Sevilla, 41012 Sevilla, España
[2]Departmento de Recursos del Mar, Cinvestav, 97310 Mérida, Yucatán, México
[3]Laboratorio de Biología Ambiental y Molecular, Universidad Autónoma de Zacatecas, 98060 Zacatecas, México
[4]Unidad Académica de Ciencias de la Tierra, Universidad Autónoma de Zacatecas, 98058 Zacatecas, México

INTRODUCTION

Some aquatic ecosystems from Mexico, such as rivers and lagoons, are affected by wastes enriched with potentially toxic elements generated by precious metal mining activities [Iskander, 1994]. Contamination of water, sediment and affected biota has produced several environmental issues, including biological effects in some species of flora [Huerta-García, 2016]. On the other hand, mineral processing activities may also generate effluents containing high activity concentration levels of natural radionuclides and, in this case, the wastes may be considered as technologically enhanced naturally occurring radioactive materials (TENORM). The release of TENORM in the aquatic environment may represent a radiological and ecological contamination issue [USEPA, 1999]. Therefore, the need for monitoring and assessing the radioecological impact of mining activities has been increased. In this study, measurements of the activity concentration levels of natural radionuclides in water and sediment from a continental lagoon in Central Mexico are performed.

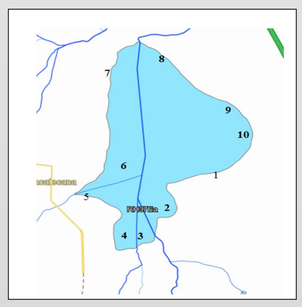
METODOLOGY

Study Area



Map of Zacatecas city

Sampling



El Pedernalillo lagoon is located in Central México, within the mining district of Zacatecas. 10 samples of water and 10 samples of sediment were collected from the shore.

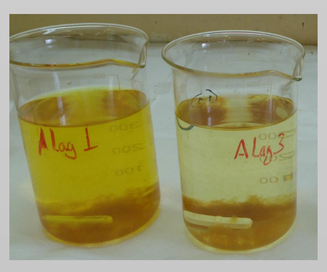
Sediment preparation

Sediment was dried, grinded and sieved. A representative alicuote of sediment was packed in cilindrical geometry

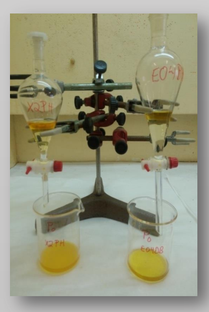
Analysis of water by alpha spectrometry

Radiochemical processing of water samples

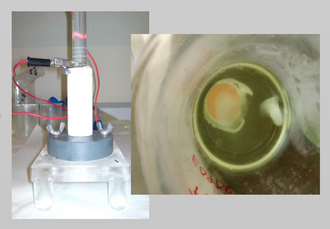
Preconcentration → U-Po Separation → Source preparation



Actinides coprecipitation with iron hidroxide

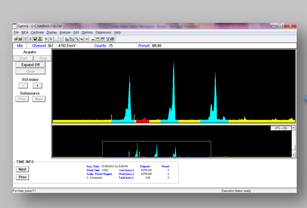


Liquid-liquid solvent extraction (TBP)



Electrodeposition (U) or self-deposition (Po) in metalic plates

Measurement with PIPS detectors in a Canberra Alpha Analyst System



Spectrum Analysis with Genie 2000

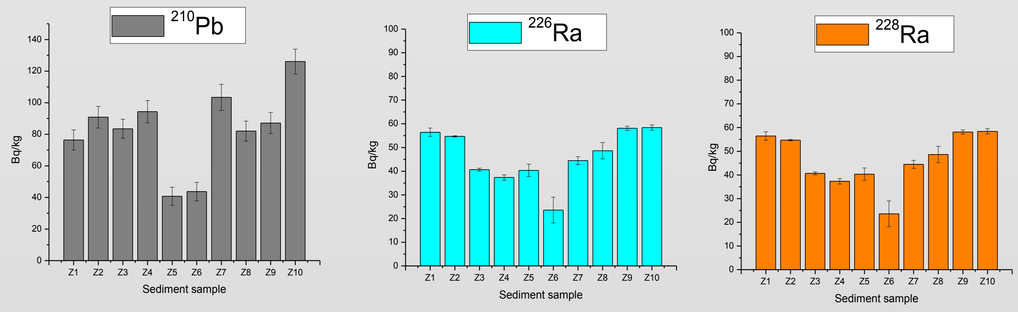
Analysis of sediment by gammma-ray spectrometry

Gamma-ray spectrometry system used in this study: HPGe detector and lead shielding.

High resolution gamma-ray spectrometry was used to perform the radiometric characterization of the sediment samples in a Canberra HPGe (Hyperpure Germanium) detector type XtRa (extended range), with a relative efficiency of 40% and resolution of 1.77 keV for the 1.33 MeV photopeak of 60Co. Efficiency calibration was performed using IAEA reference materials (RGU1, RGTh1). Self-absortion corrections were done for ^{210}Pb calculations.

RESULTS AND DISCUSSION

Activity concentration of ^{210}Pb, ^{226}Ra and ^{228}Ra in the sediment samples of the studied lagoon presented an average value of 83±26, 46±11 and 62±12 Bq/kg, respectively. This values are very similar, but also higher than levels in soil from the cities of Zacatecas and Guadalupe, which present ranges of 11-38 and 8-38 Bq/kg for radionuclides from the ^{238}U and ^{232}Th natural decay series, respectively [Mireles, 2003].



Activity concentration of natural radionuclides in sediment of the studied lagoon

Regarding alpha-particle spectrometry measurements in water, uranium isotopes presented activity concentration average values of 155±104, 380±252 and 7.0±4.2 mBq/L for ^{238}U, ^{234}U and ^{235}U, respectively. Average concentration of ^{210}Po in water was 25±19 mBq/L. Uranium levels in the studied lagoon are lower than U levels in surface water from the Arizona cupper belt (2960~3100 mBq/L) [USEPA, 1999], but higher than U levels in water from and estuary influenced by acid mine drainage in the Iberian Pyrite Belt (1.8~131 mBq/L)[Villa, 2011].

CONCLUSION

Activity concentrations of natural radionuclides in water and sediment from the lagoon El Pedernalillo have been determined. Levels of radium isoptopes and ^{210}Pb in sediments are within reference levels of the studied region. On the other hand, uranium concentration levels in water are high, specially ^{234}U exceed the USEPA guidelines levels for total uranium in natural waters (185 mBq/L). Because water from the suited lagoon is used for irrigation of nearby crops and animal consumption, radioecological implications may emerge from uranium bioaccumlation in the food chain. It is necessary to extend this study to the radioanlysis of biota and continue monitoring the levels of U in the Zacatecas environment.

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