Talk 4.1

Biogeochemical behaviour of tellurium (Te) and caesium (Cs) at the continent - ocean interface: preliminary scenarios for accidental radionuclide releases

Teba GIL-DÍAZ[1,2*], Maëva LABASSA[2], Lionel DUTRUCH[2], Cécile BOSSY[2], Frédérique POUGNET[2], Melina ABDOU[2], Antoine LERAT-HARDY[2], Clément PERETO[2], Alexandra COYNEL[2], Nicolas BRIANT[3], Joël KNOERY[3], Gérard BLANC[2], Jörg SCHÄFER[2]

[1]Institute of Geosciences (IGW), Friedrich-Schiller-Universität Jena, Burgweg 11, 07749 Jena, Germany; [2]Université de Bordeaux, UMR CNRS 5805 EPOC, Allée Geoffroy Saint-Hilaire, 33615 Pessac, France; [3]IFREMER – RBE/BE/Laboratoire de Biogéochimie des Contaminants Métalliques, BP 21105, Nantes F- 44311, France

Email:teba.gil-diaz@uni-jena.de

Radioactive tellurium (Te) and caesium (Cs) are fission products in nuclear power plants (NPP) emitted during accidental events (i.e., Chernobyl-1986, Fukushima-2011)[1]. Post-accidental models describing their fate and dispersion in natural environments require the understanding of the biogeochemical behaviour of their stable homologues. However, stable Te and Cs are poorly studied in aquatic ecosystems due to analytical challenges (i.e., ultra-trace levels of Te), and low research interest in non-radiological isotopes of Cs[2]. This work presents (i) long-term records (2014-2017) of dissolved and particulate Te and Cs concentrations along a major European fluvial-estuarine system, the Gironde Estuary, and (ii) historical records of Cs and Te bioaccumulation in oysters living at the estuary mouth (RNO/ROCCH, 1984-2017). All samples were analyzed with the new generation ICP-MS-MS (Thermo® iCAP TQ). Riverine monitoring showed a synchronous seasonal cycle of concentrations for dissolved and particulate Te, resulting in constant $\log_{10}$ Kd along the year (~4.75 L kg^{-1})[3]. Estuarine reactivity in flood and drought conditions suggests a reactive behaviour of Te, potentially dominated by mineralization and re-adsorption processes. In contrast, the fluvial $\log_{10}$ Kd of Cs increased downstream from
~4.54 to 6.17 L.kg^{-1}, showing conservative behaviour along the estuarine salinity and turbidity
gradients. A time series of bioaccumulation of Te and Cs in wild oysters showed no clear long- term trends (average 2.08 µg kg^{-1} and 114 µg. kg^{-1} dry weight, respectively)[3], and bioaccumulation factors (BAFs) of one to two orders of magnitude below those observed for essential elements (BAF Te = ~30 à 70 L. kg^{-1}; BAF Cs = ~ 386 à 1220 L. kg^{-1}). This study provides the first conceptual scenarios for environmental fate of Te and Cs radionuclides in case of hypothetical accidental releases from the Blayais NPP located in the Gironde Estuary. Based on the dynamics of the Maximum Turbidity Zone (MTZ; >1g. L^{-1} of suspended particulate matter, SPM) and SPM estuarine residence times, accidental releases during flood conditions would cause the highest sorption of Te and Cs radionuclides in the MTZ. It is expected that during the following dry season, desorption of particulate Cs (MTZ acting as a secondary source of radionuclides to the ocean) and transport towards the coastal area may occur, whereas radioactive Te particles may be transported upstream towards the city of Bordeaux.

Keywords: Technology Critical Element, temporal series, environmental risk assessment

References

[1]. Steinhauser, G., Brandl, A. Johnson, T.E., *Sci Total Environ.* 2014, 470, 800-817.

[2]. Filella, M., Reimann, C., Biver, M., Rodushkin, I., Rodushkina, K., *Environ Chem*. 2019, 16(4), 215- 228

[3]. Gil-Díaz, T., Schäfer, J., Dutruch, L., Bossy, C., Pougnet, F., Abdou, M., Lerat-Hardy, A., Pereto, C., Derriennic, H., Briant, N., Sireau, T., Knoery, J., Blanc, G., *Environ Chem.* 2019, 16(4), 229-242.