Fate of radium in river and lake sediments impacted by coal mining sites in Silesia (Poland)

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Enhancing nuclear safety

GIG

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Introduction

This study focuses on assessing the long-term impact of Ra which has been trapped into river and lake sediments in the vicinity of coal mining sites in Poland. Two geochemical interfaces (Fig. 1) have been surveyed by sampling sediment, surface and pore waters downstream from coal mining sites: (1) the hyporheic zone of a river, where groundwater tends to mix with surface waters within the river bed; and (2) the water-sediment interface in a lake which was formerly used as a settling pond. Both represent redox interfaces where radium-bearing solid phases (barite, metal oxyhydroxides) can undergo various geochemical processes which have not been quantified yet.

Are these aquatic interfaces sources or sinks of radionuclides in the long run ?

Fig. 1: Aquatic interfaces surveyed in this study

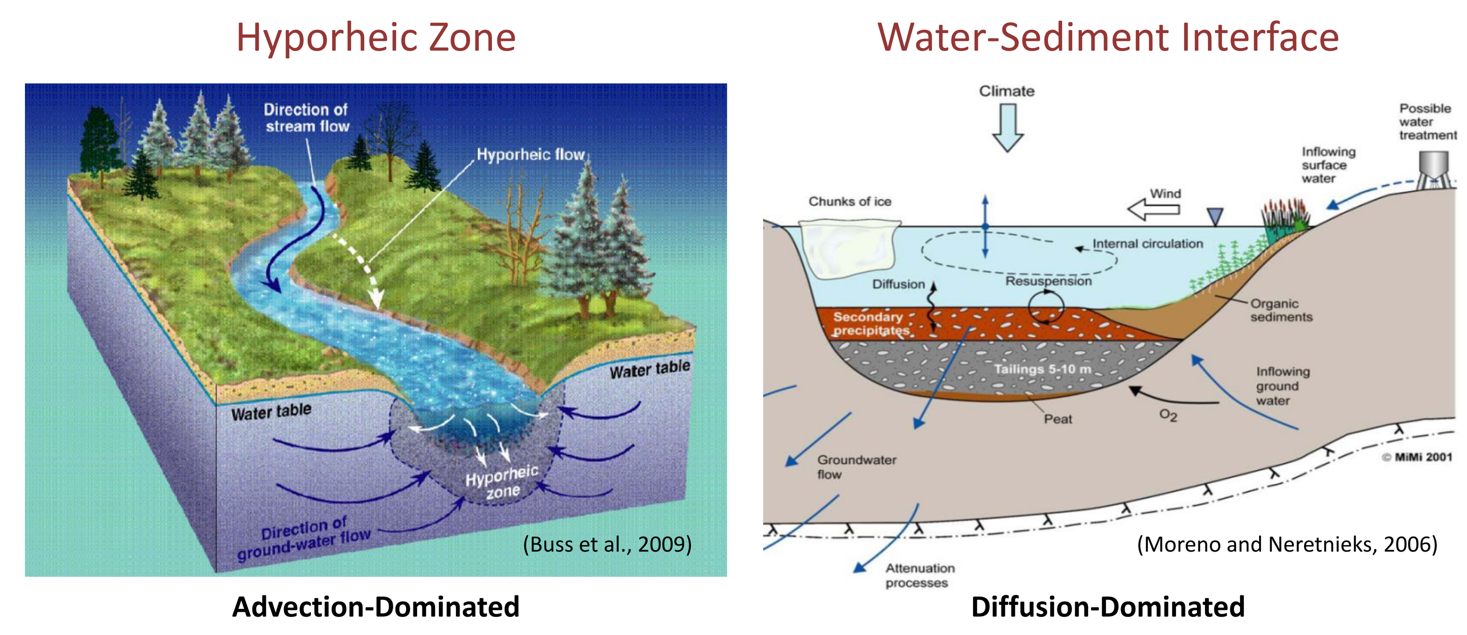
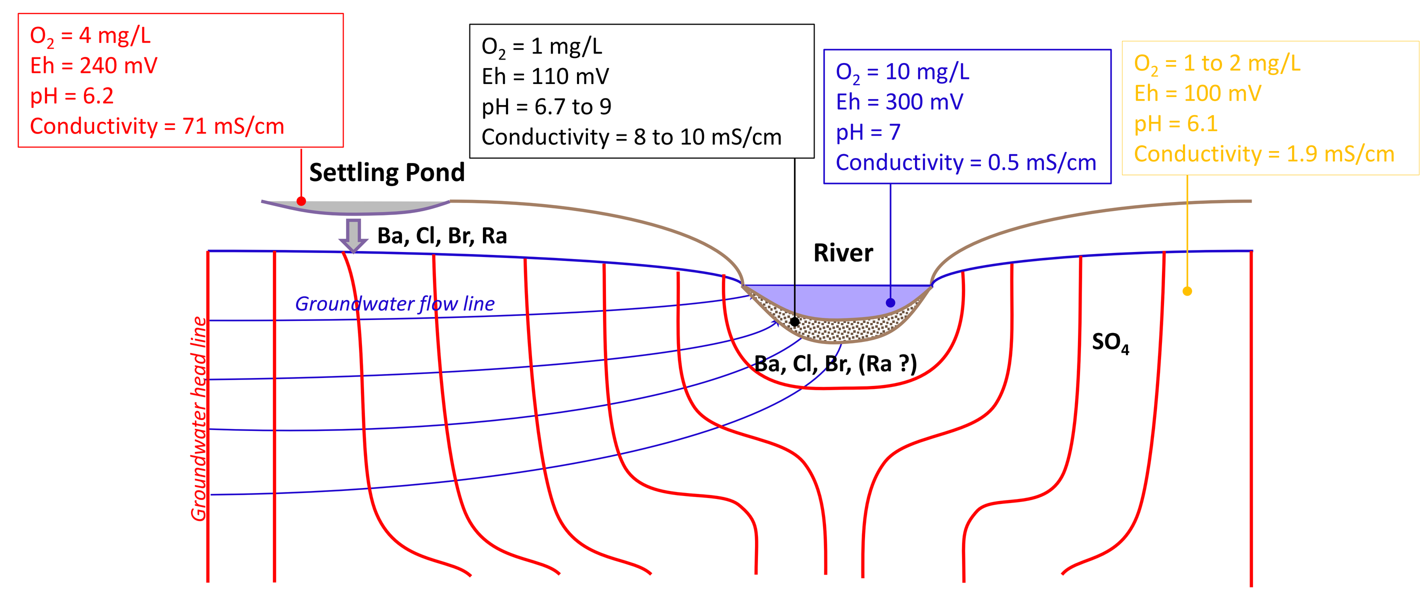


Fig. 3: Conceptual model of the water mixing within the hyporheic zone deduced from observations in May 2015



Observations in the hyporheic zone and geochemical modeling

Fig. 2: Dissolved Br and Cl content measured in water samples in Nov. 2014 and May 2015

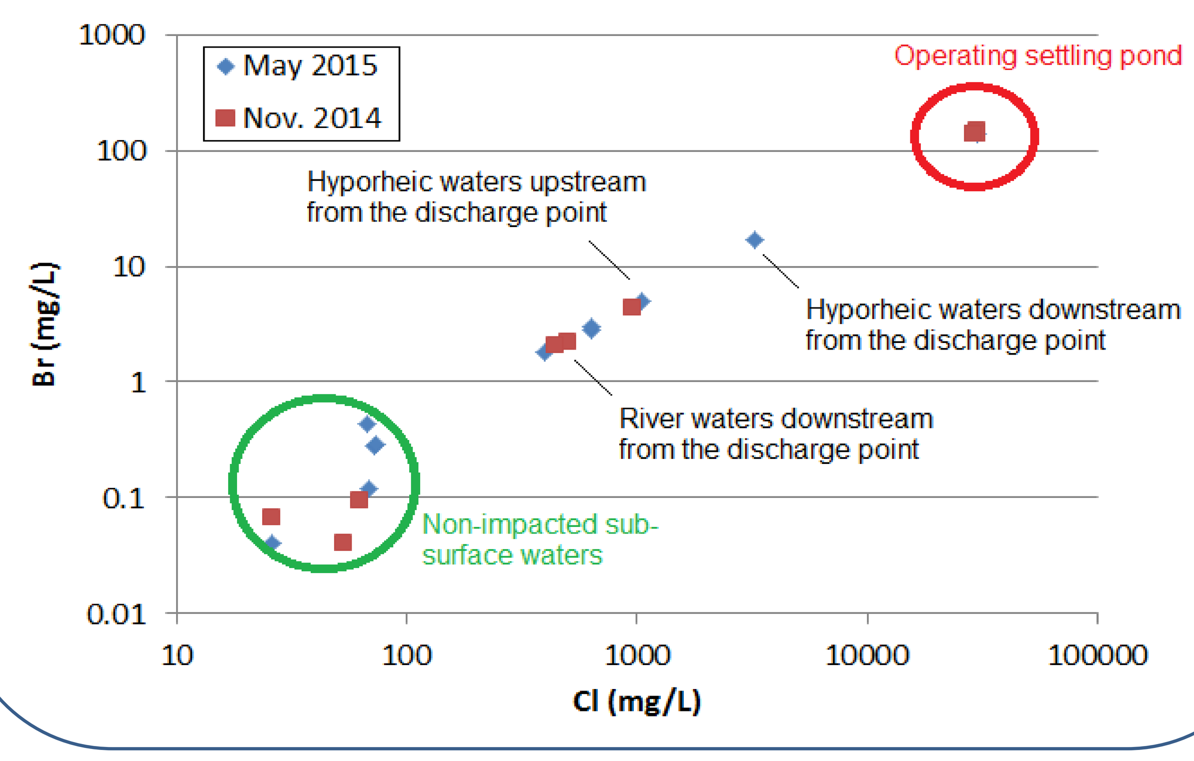
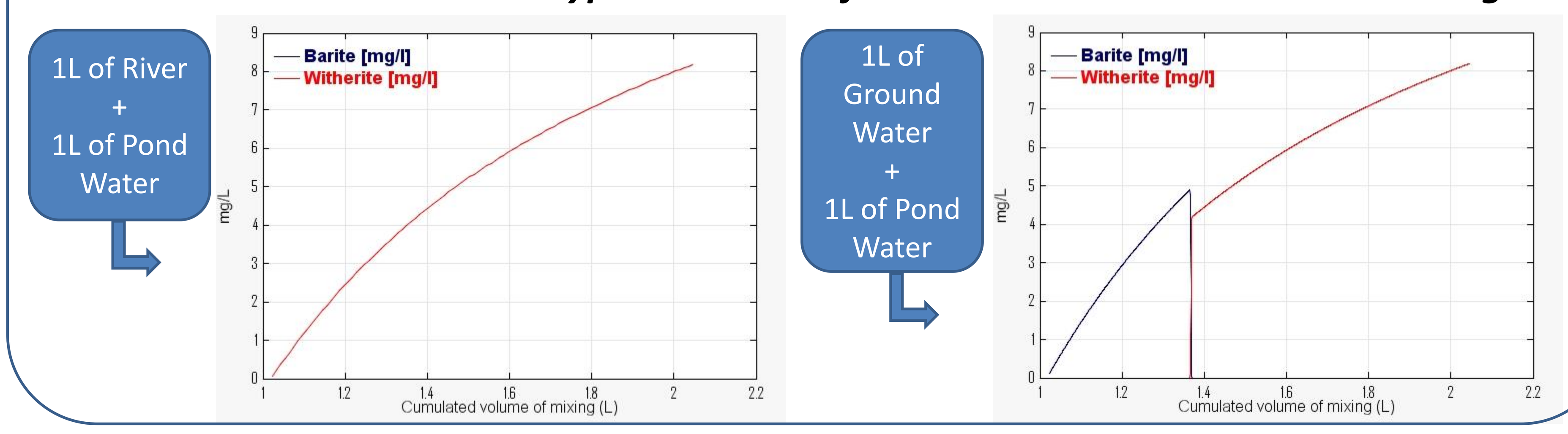


Fig. 4: Simulated precipitation of Barium minerals with JCHESS® (van der Lee, 1998) that could occur into the hyporheic zone of the studied site due to water mixing



Preliminary observations at the water/sediment interface into a former settling pond

Fig. 6: Mineralogical content (XRD) of bottom sediments in a former settling pond and comparison to the currently operated settling pond of the same mining site

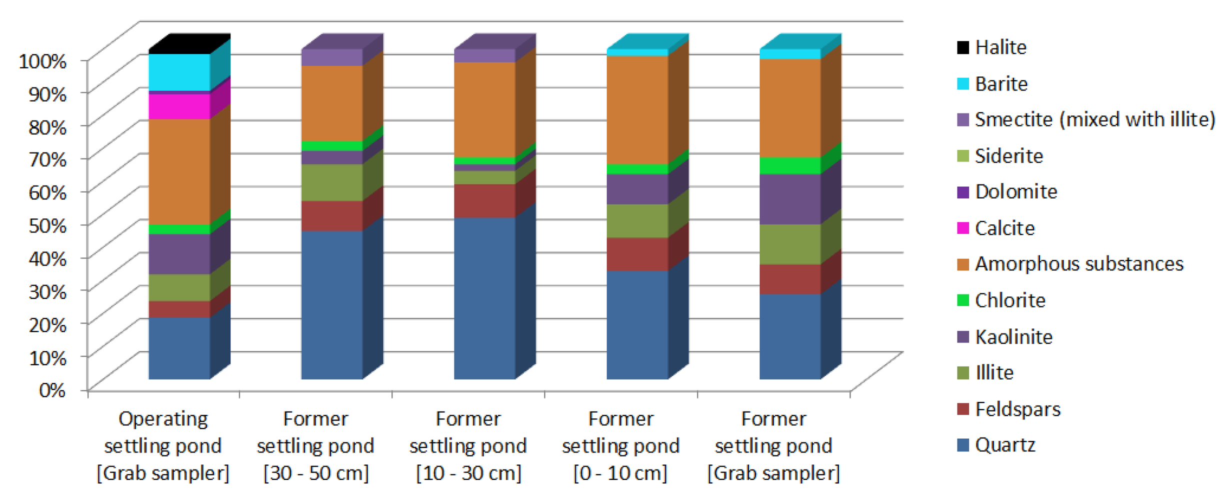
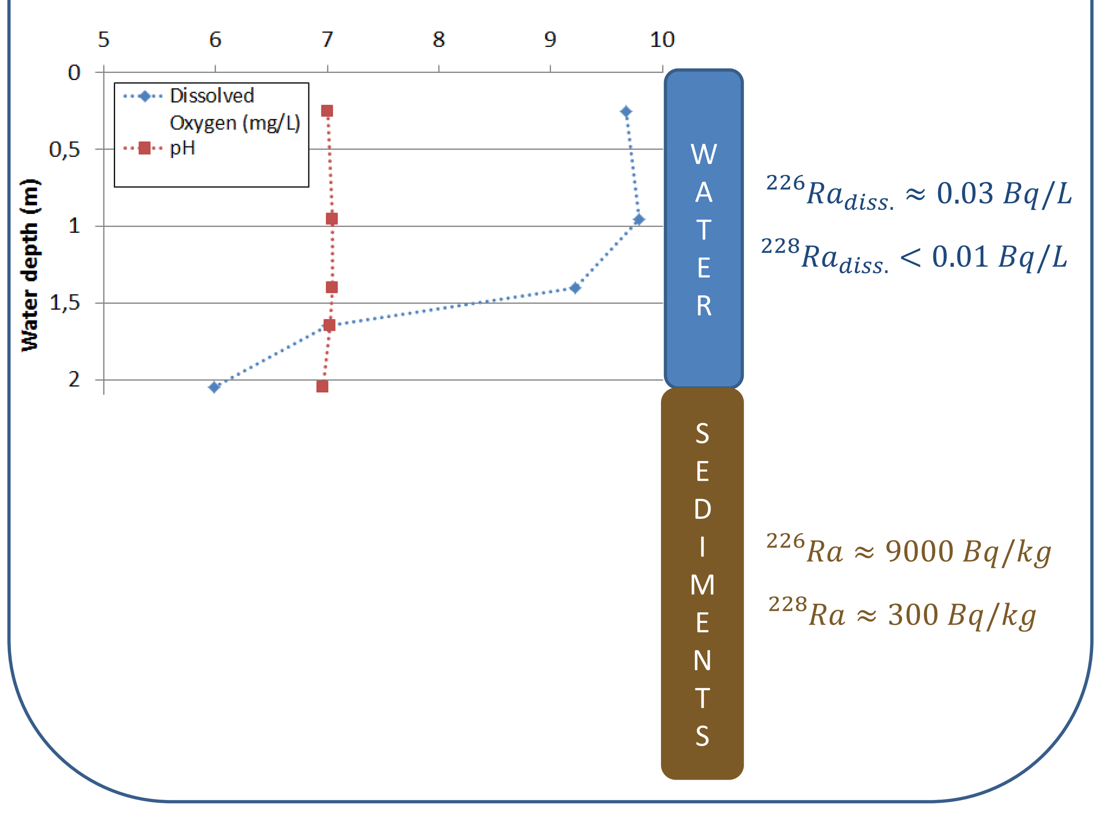
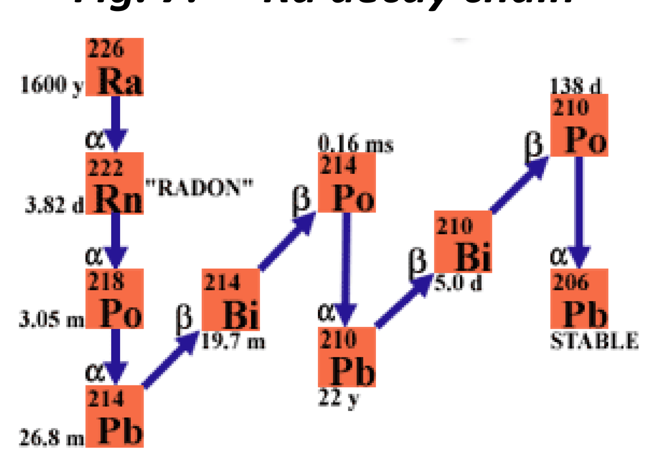


Fig. 5: Characterization of the former pond water and sediments in May 2015



Conclusion and outlooks

Fig. 7: ^{226}Ra decay chain



This study reports preliminary results of water and sediment characterization aiming at understanding the fate of Ra through aqueous interfaces usually encountered in the vicinity of mining sites. In the hyporheic zone of a river, where groundwater tends to mix with surface waters, geochemistry of pore waters shows that diffuse and direct wastewater releases from an operating settling pond impact water quality within the riverbed. A geochemical model built with JCHESS® suggests that mixing of surface waters with wastewaters favors witherite ($BaCO_3$) precipitation within the riverbed. Additional investigations are planned to assess the consequences of this suspected attenuation process on Ra behavior through the hyporheic zone. Moreover further investigations are performed for studying the fate of Ra trapped into $BaSO_4$ within lake sediments where sulfate-reducing conditions could occur with depth due to organic matter degradation and where ^{210}Po (^{226}Ra decay product; Fig. 7) is detected into surface waters.

References
Buss S., Cai Z., Cardenas B., Fleckenstein J., Hannah D., *et al.* (2009). Environment Agency of England and Wales, Science Report SC050070, Bristol, UK, 280 p.
Moreno L. and Neretnieks (2006) Long-term environmental impact of tailings deposits. *Hydrometallurgy* **83**, 176–183.
van der Lee J. (1998) *Thermodynamic and mathematical concepts of CHESS*. Technical Report No.LHM/RD/98/39. CIG Paris School of Mines, Fontainebleau (France); 1998.