Ra end-member variability in a dynamic subterranean estuary of a microtidal Mediterranean coastal aquifer

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ABSTRACT

Submarine Groundwater Discharge (SGD) in coastal aquifers has been recognized as an important source of nutrients and dissolved compounds to the ocean, which is having a large influence on coastal biogeochemical cycles. Ra isotopes (^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra) are widely used to quantify SGD because they are enriched in groundwater relative to seawater and provide time information due to their different half-lives. Their application requires the proper characterization of their concentrations in the discharging groundwater, which strongly depend on the salinity of the fresh-saltwater transition zone. It is still challenging to understand the spatial and temporal variability of the Ra end-members, even though it is a crucial term for SGD and associated chemical input estimations. In this work, we present the results of 3-year Ra isotope evolution (2015 – 2017) in a dynamic subterranean estuary of a microtidal Mediterranean coastal aquifer (north of Barcelona city, Spain) that experiences large displacements of the fresh-saltwater interface. The experimental site is located at a distance of 30 and 90 m from the shoreline. The temporal and spatial distribution of the Ra isotopes are investigated at 11 monitoring piezometers partially screened in the deepest portion of the alluvial aquifer with depth ranging between 15 and 25 m. The observed spatial variability of Ra concentrations was related to changes on groundwater salinity and/or variations in the geological matrix. Their activities correlated with salinity (3 < S < 25 g/l) reaching maximum concentrations in the deeper part of the aquifer (20 m) with salinities >25 g/l, while lower Ra concentrations were recorded in freshwater (S<3 g/l), in shallow depth. During a strong rainfall event (73 mm in 2 days), the monitored Ra concentrations in the different piezometers decreased between 20 – 80% in relation to the initial concentrations and recovered the initial values after 10 days. This study emphasizes the need to properly understand the spatial and temporal evolution of Ra concentrations in coastal aquifers in order to obtain accurate estimates of SGD and SGD-driven chemical fluxes.

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