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Facing geological heterogeneity impact on reciprocal coastal systems

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In western Mediterranean areas, seawater intrusion (SWI) used to be a major issue during the 1970s decade due to the agricultural exploitation of the fertile lands located near to the coast. Proper pumping management nearly solved the problem, but the later economic development carried out by industries and tourism added an extra pressure to these sensitive systems, reactivating SWI in some cases.

A good example of this situation can be found in the northeastern coast of Spain. In this area, the topographic configuration is controlled by medium reliefs and sloped piedmonts that discharge precipitation through ephemeral streams towards the sea. These torrential flows have a groundwater component that generates a coeval submarine groundwater discharge (SGD) with the intrusion of seawater. SGD strongly determines the health of marine environments, reason why is classically neglected in SWI research: in this area, SGD has been characterized measuring natural radioactive tracers (223Ra, 224Ra, 226Ra, 228Ra) in open sea campaigns, but the impact of mixing of this seaward flow and SWI within the aquifer remains unknown. Moreover, the presence of different lithologies also determines the kind of geochemical reactions that modify the conservative behavior of the tracers used to measure SGD, as well as the localization of preferential flowpaths, making hard to quantify and predict both types of reciprocal flows (SGD and SWI).

To be able to understand these interactions, a detailed characterization of the solid and liquid phase of the aquifer at different scales has been performed. To do so, we built a dedicated experimental site in a coastal alluvial aquifer in the Maresme coast line (Barcelona, Spain): the Argentona experimental site. Different types of geophysical logging have been deployed to delineate the different layers of sand and clay, their thickness and other properties such as Th and U content and magnetic properties. Electrical logs have been used to identify the vertical distribution of fresh and saline water. The identification of clay and sand layers will also help to calibrate geophysical measurements and be able to obtain realistic salinity patterns. Also, the lithology and the geochemistry of discrete samples recovered from the drilling stage were determined at smaller scale using X-ray diffraction, rock total analysis for chemical composition, cation exchange capacity, surface area, 226Ra and 228Ra content and grain size distribution. Aditionally, groundwater composition was characterized performing mayor and minor elements analysis and radium and radon isotopes quantifications.

This heterogeneity characterization of a real world aquifer will provide powerful datasets for further realistic modelization and serve as a basis for the interpretation of field tests performed on the Argentona experimental site such as tidal analysis, heat dissipations tests and cross-hole electrical tomography. The lessons learned will also be applicable to other alluvial coastal aquifers.

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