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Constraints of costal aquifer functioning in a deeply antropized area through a multi-isotope fingerprinting (Recife, Brazil)

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The Metropolitan Region of Recife (RMR) went through large changes of water and land uses over the last decades due to an increasing demographic pressure (1.5 M of inhabitants). These evolutions gave rise to numerous environmental consequences, such as a dramatic decline of the water levels, groundwater salinization and contamination. This degradation of natural resources is linked to the increase of water demand that is also punctually amplified by drought periods, inducing the construction of thousands of private wells.

Recife city was built on an estuarine area, at the geological limits of the two sedimentary basins of Pernambuco (north of the city) and Paraíba (south of the city) separated by a famous shear zone (the Pernambuco lineament). Tectonic and sedimentary events involved in the genesis and evolution of these basins were mainly controlled by the opening of the Atlantic Ocean leading to the deposition of cretaceous sediments which now constitute the two main exploited aquifers, the Beberibe and Cabo aquifers. These two deep aquiferous formations are topped by the unconfined Boa Viagem aquifer of quaternary sediments. It is the most directly exposed to contamination, since it is connected to mangroves, rivers, estuaries and highly urbanized areas. Both the Beberibe and Cabo aquifers contain large clay levels and are separated by a rather continuous clayed formation which seems to play a consistent role of screen and to interfere in the hydraulic connections between the three aquifers. Previous isotopic studies have shown that recharge processes are similar in the aquifers, suggesting that exchanges may occur and may be modified or amplified by overexploitation.

This very complex aquifer system is studied through more than 60 water samples, including some surface water samples from the main rivers. A methodology based on multi-isotopes fingerprinting is applied, including stable isotopes of the water molecule, strontium isotopes, boron isotopes, sulfur and oxygen isotopes of sulfates, together with major and trace elements. The main objectives are to better constrain (1) the recharge processes and connections between aquifers, and (2) the water quality degradation by exploring the salinization processes with direct seawater intrusion, paleo-seawater and/or recharge with salty water in the mangrove area, and also contamination due to urban activities.
The first results highlighted the complexity of salinity sources and processes in the system. An important compartmentalization between aquifers and within the same aquifer units was observed with very distinct water signatures (87Sr/86Sr, d11B) at the same depth for wells located in the same street block. Groundwater residence time seems to indicate that some groundwaters were recharged under a colder climate, i.e 10-15 ky, with locally a very limited modern recharge. This point is of primary importance in terms of groundwater management of this strategic and fragile resource.