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Surface Water - Groundwater Interactions in Wetlands: Sr Isotope Constraints

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This paper focuses on Strontium isotopes as a tool to better constrain hydrosystem functioning in wetlands context. Waters derive their Sr isotopic signatures ($^{87}Sr/^{86}Sr$) from interaction with rock matrix without isotopic fractionation. The isotopic signature of water draining various igneous rocks, or carbonated rocks from different ages are clearly distinct, in that way Sr isotopes are a good tracer of the water-rock interactions as and thus a good tracer of water origin in a watershed. The measured differences in $^{87}Sr/^{86}Sr$ ratios are the result of mixing of Sr from different sources with different isotopic compositions, the signature variations within the hydrosystem can provide information concerning the sources of Sr and the different mixing processes involved. Complex relations between surface and groundwater in the specific context of wetlands are illustrated through the Sr isotopic tool. Examples presented were selected from various geological and hydrogelogical contexts in order to highlight the Sr isotopes potentialities.

For instance, the hydrosystem functioning of a small alluvial aquifer along the Allier River (France) was investigated through couple isotopic and chemical tracing and constraints to evaluate riverbank aquifer recharge and study hydraulic links with rivers and chemical transfer between surface and groundwater. The Allier River drains Eocene to Miocene sedimentary formations, including sequences of clastic and carbonate sediments. The groundwater in the riverbank alluvial aquifer drains Quaternary Allier river alluvial deposits encompassing silicate components of granitic-gneissic and basaltic origin from the Massif Central. These alluvial deposits overlie sandy-clayey deposits made up mainly of clay, sand and gravel from crystalline, metamorphic and volcanic rocks from the Massif Central and Oligocene lacustrine carbonaceous deposits. These deposits were mainly supplied by lake sedimentation owing to certain marine incursions evidenced by combining fossil and fauna associations and isotopic tracing. The complex local geological settings favour large variations of Sr isotopic signatures in both groundwaters and surface water. Sr isotopic compositions measured in surface and groundwater can be explained by at least three end-members in a $^{87}Sr/^{86}Sr$ versus 1/Sr diagram. The three end-members can be identified according to the drained lithologies, and the water samples, that plot along mixing lines within this type of diagram can be explained by mixings of water from different origins. In optimal conditions, especially when all the possible sources of Sr are well constrained, it is possible to quantify the water proportions of the mixing and thus to better constrain the hydrosystem functioning for a better management.