

Isotopic tracing of surface water – groundwater interactions in alluvial contexts

PETELET-GIRAUD, EMMANUELLE.¹, NEGREL, PHILIPPE.¹

¹ BRGM (French Geological Survey), Laboratory Division,
BP 36009, 45060 Orleans, France; e.petelet@brgm.fr

Since the last decades, rivers and aquifers are approached as a real continuum with strong mutual influences between river, aquifer and the interconnecting hyporheic zone. Numerous research approaches have been developed to identify and quantify the river-aquifer exchanges that can be in both directions depending on the river profile and the seasonal water levels and hydraulic gradients. The understanding of the links between hydrological, biogeochemical, and ecological process dynamics and their implications for river water quality and ecology are also of major concern for water management and decision makers.

Among the existing methods for investigating surface water and groundwater relations, isotope techniques constitute a powerful approach; stable isotopes $\delta^{18}\text{O}$ and $\delta^2\text{H}$ being the most commonly used as an intrinsic “ideal” tracers of the water molecule. In addition, isotopes of dissolved elements (Sr, B, S, ...) also constitute valuable tracers to identify and, in optimal conditions, to quantify the exchanges between surface- and ground-water bodies.

Through various examples, we present the contribution of isotopic tracers to the understanding of groundwater recharge in alluvial valley-fillings, riverbank aquifers counting worldwide among the most important water resources for drinking water supply, irrigation and industrial activities.

Sr isotopes constitute excellent tracers of water-rock interactions as $^{87}\text{Sr}/^{86}\text{Sr}$ reflect the signature of the minerals that constitute the drained aquifer lithologies. Boron isotopes also differ according to the drained lithologies, but, contrarily to strontium, signatures can be affected by secondary processes like adsorption/desorption onto clays; in urban context, they are good tracers of wastewaters whose signature are characteristic of the boron origin used in detergents. Sulphur and oxygen isotopes of sulphates are also potential tracers of drained lithologies (solid sulphates in evaporites, sulphides in igneous and sedimentary rocks) in cases where fertilizers do not provide the majority of dissolved SO_4 . The understanding of surface- and ground-water relations, gained through a multi-tracer approach, can thus explain groundwater quality but also the spatial variability of surface water quality along a river section, information of primary importance for water managers.