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Tracking selenium behaviour in chalk aquifer (northern France): Sr and ^{34}S -sulphates isotopes constraints.

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Groundwaters in parts of the Paris Basin (France) are facing increasing selenium (Se) contents that can exceed the drinking water limit of 10 µg/L according to the European Framework Directive in the field of water policy (2000/60/EC). To better understand the groundwater origins and the selenium dynamics, the water chemistry of the Chalk aquifer supplying drinkable water to Lille city was studied. This area is submitted to quantitative and qualitative pressure from industrial, urban and agriculture origins.

An integrated study was settled to determine the water sources and dynamics of elements, with a focus on Se. After a large chemical characterisation of the groundwater chemistry in the four field wells, a monthly monitoring was held in four wells and in the Deûle channel. Chemical analysis of major and trace elements, stable isotopes ($\delta^{18}\text{O}$, $\delta^2\text{H}$), strontium isotopes, and $\delta^{34}\text{S}$ and $\delta^{18}\text{O}$ of sulphates were realised. The chemical composition of solids sampled at various depths at vicinity of the four wells was also analysed.

The specific geochemical signature of groundwater as revealed by Sr isotopes, in addition to element concentrations ratios like Mg/Sr and Se/Sr, highlighted mixture of three main groundwaters bodies: (1) the upstream groundwaters in the recharge area with the most radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic signature; (2) the confined groundwaters with high Sr concentrations due to water-rock interactions and the lowest $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic signature close to the one of the chalk in Paris and London basins; (3) the Se-rich formations of Tertiary and Quaternary.

The contents of Se, mainly present as Se^{VI} (and locally as Se^{IV}), displayed spatial and temporal disparities that can be explained by geological and hydrogeological conditions. Se-rich clayed sediments originating from the dismantling of Se-rich tertiary formations (i.e. Ypresian) overlay the chalk formation and can be found in saturated conditions depending of the water table level. Oxidation of Se₀, Se-pyrite and Se linked to organic matters happens according to two pathways. The first one is oxidation of Se species present in the reductive clayed sediments by oxidizing groundwaters during periods of high piezometric levels. The decrease of the piezometric level induces a decrease of the Se contents in groundwaters. Negative $\delta^{34}\text{S}$ (0 to -28 ‰) coherent with pyrite oxidation are observed in groundwater. The second one is linked to the infiltration of nitrate-rich recharge waters through quaternary loess which also contain Se. In this case, $\delta^{34}\text{S}$ of groundwaters are slightly positive and close to the signature of fertilizers. Denitrification by pyrite or Se₀ oxidation plays a great role in enhancing Se mobility in a very reactive system.

To limit the Se content in groundwaters, a precise water management is needed, e.g. mainly maintaining low piezometric levels in the chalk aquifer or avoiding mixings between contaminated wells, together with a precise knowledge of the geology of the quaternary clayed sediments.