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Multi isotopic tools to understand selenium origins in groundwaters of the Chalk aquifer in Northern France

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Four field wells exploiting the Chalk aquifer supply Lille city in water. The little catchment area is submitted to quantitative and qualitative pressure from industrial, urban and agriculture origins. Selenium (Se) concentrations are often higher than EU standards (0.12 μmol.L-1) for potable drinking water and can reach 0.4 μmol.L-1 leading to exploitation restrictions. An integrated study was settled to determine the water sources and dynamics of elements, with a focus on Se, with the goal of managing both water quality and quantity. After a large chemical characterisation of the system, a monthly sampling campaign was held in 2012 in four wells and in the close Deûle channel. In situ physical and chemical parameters, chemical analysis of major and trace elements with a special focus on redox-sensitive elements including SeIV, SeVI, FeII, stable water isotopes (δ18O, δ2H) and δ34S and δ18O of sulphates measures were undertaken. The chemical composition of solids sampled at various depths at vicinity of the four wells was analysed.

Se concentrations in groundwaters and in the solid phase vary significantly. In the northern part of the Ansereuilles north of the Deûle channel, where the highest Se concentrations in solids was found in a 13 m alluvial clay deposit above the chalk, a first main type of waters can be defined with the variable and locally highest Se concentrations (0.19 to 0.4 μmol.L-1), relatively high and stable sulphate concentrations (2.5 μmol/L), no nitrates, dissolved Fe and Mn, negative δ34S (around -20 ‰ and δ18O typical of evaporated waters. A second main type of waters can be described at Houplin, south of the Deûle channel, where the geological profile show less than 1 mg/kg of Se, with intermediate Se concentrations (0.1 to 0.2 μmol/L), variable nitrate concentrations (0.4 to 1.2 mmol/L), not quantified dissolved Fe and Mn, sulphate concentrations close to 1.5 mmol/L, variable negative δ34S (-8 to -24 ‰ and δ18O in the same trend as previously described. Groundwaters from the two other wells have characteristics relatively close to the Houplin's type. All sampled groundwaters show a variation of the stable isotopes signatures in winter indicating the contribution of evaporated of waters from a different source. Given the negative δ34S, the role of redox processes, and especially of pyrite oxidation, is expected. These two types of groundwaters can be linked to the two local hydrogeological entities of the Chalk aquifer; in the northern edge of the Deûle, the chalk groundwater flux is rather limited under the influence of the Louvil clays. On the contrary, on the southern edge of the Deûle where Houplin and the two other wells are located, the flux gradient is high and the vulnerable groundwaters drain a large cultivated, industrial and urban area.

Se may at least have two origins: the lithology in the Ansereuilles can be a clear source of Se whereas different influences can be suggested for the Houplin site in connexion with the hydrogeological and anthropogenic context.