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Application of stable isotopes for tracing pollutant plumes in groundwater

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Isotope hydrology and isotope hydrogeology over the last decades evolved mainly through the environmental isotopes that included principally the naturally occurring isotopes of elements found in abundance in the earth environment (e.g. H, C, N, O and S). Large developments of isotope hydrogeology were done and well-established techniques mainly applying stable isotopes of the water molecule (hydrogen and oxygen) are now used largely to trace water provenance but also recharge processes. New methods allow routine analysis of additional isotopes (multi collector ICP-MS, compound-specific stable isotope analysis CSIA…) to trace pollutant plumes in groundwater, but classical ones can also be used, like stable isotope of the water molecule.

In this study, we present data on stable isotopes O and H in an European region where electrochemistry plants occur. For confidentiality purposes, the sites remain anonymous. Actually, the industrial activities directly impact the groundwater over the site and migration of the contaminant plume out of the site is supposed. Our study intends first to characterise the recharge of aquifer that is mainly done by direct infiltration of rainwater, surface water or by subsurface inflow, and thus primary originates from precipitation. High and low altitude recharge can be demonstrated. Secondly, we used the stable isotope of the water molecule to trace over the site the impact of the Cl-rich liquor manufacturing process through large deuterium enrichment evidenced in the groundwater. These high values are related to a direct contamination of the groundwater through loss of Cl-rich liquor with δD values up to 400‰. Temporal variation of stable isotopes evidenced the remediation of the contamination as values in groundwater are now along the global meteoric water line in the wells previously reflecting the contaminant plume. No evidence of δD enrichment can be shown actually over the site. Therefore our study shows that the stable isotopes of the water molecule can also be successfully used in a way to trace pollutant plumes in groundwater.