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Geochemical and isotopical approach to assess fluvial annex – groundwater relationships in an agricultural environment: example of the Auzon oxbow (Allier River, Auvergne, France)

Mélanie Quenet (1), Hélène Celle-Jeanton (2), Aude Beauger (1), Olivier Voldoire (1), Frédéric Huneau (3), Elisabeth Allain (1), Alexandre Garreau (1), and Jean-Luc Peiry (4)

(1) Laboratoire GEOLAB - UMR 6042 UBP & CNRS - 4 Rue Ledru, 63000 Clermont-Ferrand. France. (melanie.quenet@uca.fr), (2) Laboratoire Chrono-environnement - UMR 6249 CNRS-UFC - 16 Route de Gray, 25000 Besançon. France., (3) University of Corsica, Hydrogeology Dept. - CNRS UMR 6134 SPE, Corte. France, (4) CNRS, UMI3189 "Environnement, Santé, Sociétés", Université Cheikh Anta Diop, Dakar. Senegal.

Oxbows are part of wetlands and form important transition zones between terrestrial and aquatic environments, which can be determinant especially in the ecological domain. The location of the fluvial annex between the main stream and the riparian area leads to transversal flows which can modify both hydrodynamic and waters quality. Taking into account the connection of the oxbow with both main stream and alluvial groundwater, land occupations within the whole watershed may impact the oxbow water quality, and then its ecological function. The objectives of this study are so: 1) to identify the interactions between Allier River, Auzon Oxbow and alluvial groundwater; 2) to assess the impact of agriculture on the surface and groundwater quality.
Auzon oxbow has been monitored, as part of the SOAHAL Observation System (Système d'Observation d'une Annexe Hydraulique de l'ALlier), since July 2014. This oxbow is connected to the Allier River only in its downstream part. Eight surface water points (6 in Auzon oxbow, Allier River, La Vendage River – a tributary to Auzon oxbow), 8 near surface piezometers (between 0,92 and 1,85 m deep), 6 observation boreholes drilled ten meters deep in the alluvial aquifer, and one spring draining neighboring hills aquifer, have been sampled on a monthly time step. Water samples have been measured for physico-chemical parameters, and analysed for major elements and stable isotopes of the water molecule.
The hydrochemical and isotopic database is used to study the hydrodynamic and the water quality impact of the main stream and of the alluvial groundwater on the Auzon oxbow. Water chemistry shows a left bank (alluvial aquifer) – right bank (Allier River) dynamic, especially illustrated by the mean concentrations in HCO_3^- (since this species is not affected by agricultural practices) and stable isotopes signatures. On the right bank, Allier River presents a low concentration in HCO_3^- (28.78 mg.L^{-1}) and a depleted isotopic signature (-8.62 ‰ δ^{18}O VSMOW, -55.18 ‰ δ^2H VSMOW). On the left bank, boreholes, drilled deep in the alluvial aquifer in the alluvial plain, show a higher concentration in HCO_3^- (329.14 mg.L^{-1}) and a more enriched isotopic signal (-7.60 ‰ δ^{18}O VSMOW, -51.83 ‰ δ^2H VSMOW). The oxbow is characterized by signatures in bicarbonates and stable water isotopes falling between these two end-members ([HCO_3^-] = 98.86 mg.L^{-1}, δ^{18}O = -8.03‰ VSMOW; δ^2H = -53.22 ‰ VSMOW).
Geochemical and isotopic analyses also show that the upstream end of the oxbow seems to remain connected to the main stream below the soil surface since the Allier River signature is there found. Finally, traces of agricultural pollution are observed in all the water families with important Cl-, NO_3^-, SO_4^{2-} and K^+ contents while the first three are not coming from the dissolution of local rocks (respectively up to 477.54, 120.59, 635.29 and 63.13 mg.L^{-1}).