Introduction to TRANSKARST (Transdisciplinary Research on Karst) Project – 2020/2023

Arthur Boudon[1], Hélène Celle-Jeanton[1], Xavier Bertrand[1], Julie Albaric[1], Philippe Amiotte-Suchet[2], Flavien Choulet[1], Nadia Crini[1], Didier Hocquet[1], Frédéric Huneau[3], Victor Klaba[1], Philippe Le Coustumer[4], Christophe Loup[1], Olivier Mathieu[2], Cécile Miege[5], Vanessa Stefani[1], Marc Steinmann[1], Christian Sue[1], Mathieu Thevenot[2], and Pierre Trap[1]

[1]*Université de Bourgogne-Franche-Comté, UMR 6249 Chrono-environnement, Besançon, France*
[2]*Université de Bourgogne-Franche-Comté, UMR 6282 Biogéosciences, Dijon, France*
[3]*Université de Corse Pascal Paoli, UMR 6134 SPE, Corte, France*
[4]*Université de Bordeaux, EA 4592 Géoressources et environnement, Bordeaux, France*
[5]*INRAE, Lyon, France*

Presentation and Main goals

TRANSKARST (TRANSdisciplinary research on KARSTic water) is an interdisciplinary research project with scientists and regional water resource administrators. This 3 years project (2019-2022) is set up on Arcier's karstic watershed used for the drinking water supply of 60 000 inhabitants of Besançon, France. Using this instrumental basin, as a part of Jurassic Karst French observation system, the project aims at defining pathways of mineral, organic and microbiological contamination in karst. The project is build on 3 assignments: 1) establishing a geological and hydrogeological model, 2) evaluating the multi-contaminations and their interactions, 3) understanding contamination pathways through dissolved, colloidal and particular phases.

Arcier spring

Creux-sous-Roche sink hole

Bergeret spring

The study area concerns Arcier karstic spring and its watershed located in the south-eastern part of France, near Besançon. The water basin mainly consist of mid and upper Jurassic limestone and marl. This spring was used by the Roman to bring water to Besançon by an aqueduct. The modern utilization of the spring has begun at the end of the nineteenth century. Today 2/3 of Arcier's water is bring to the water treatment plant by a tunnel.

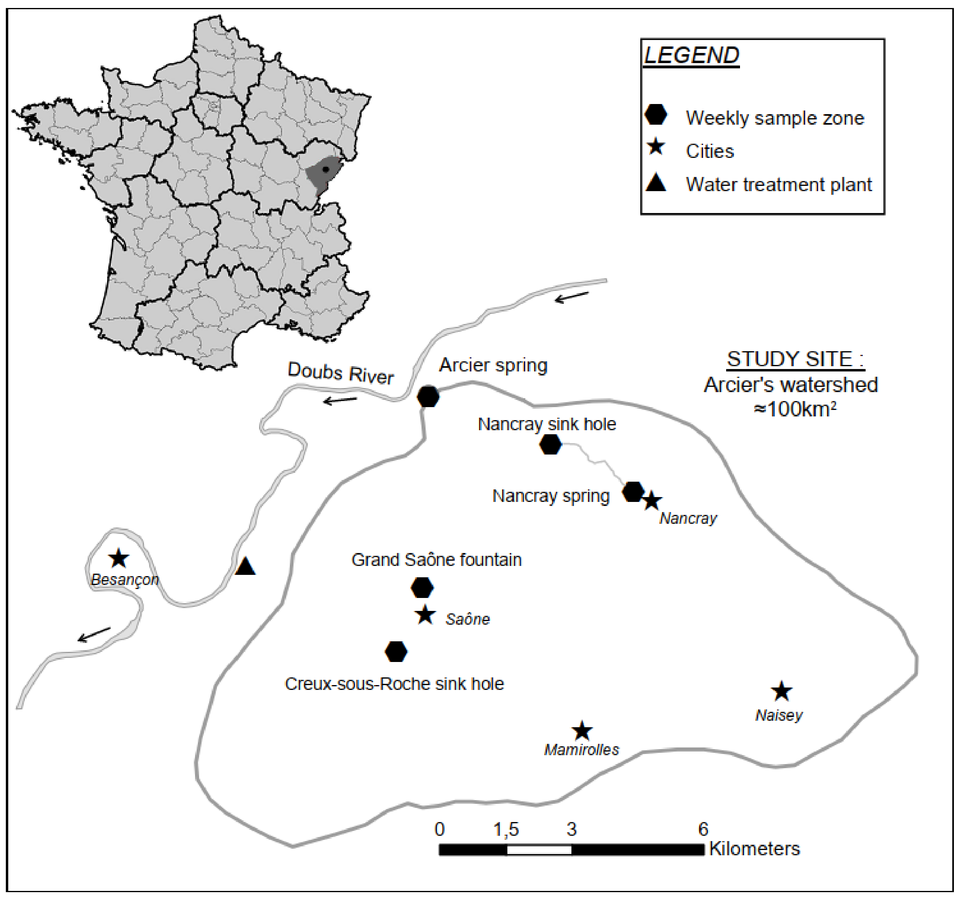


Figure 1 : location of the study area

Methodology

Different time scales monitoring are applied in order to define the temporal evolution of various parameters, to characterize input and output signal and to study the pathways of contaminants transport. In addition, punctual experimentations are made as water tracking (Fig, 3 & 4), geophysics and field geology.

Continuous measurement

- Water level
- Temperature
- Conductivity
- Turbidity
- Rainfall (Fig,2)

Weekly field campaign
On 6 sites (Fig,1)
- Mineral chemistry
- Isotopic chemistry
- Organic Chemistry
- pH
- Pharmaceutical
- Microbiology

Seasonal field campaign
On 30 sites
- Mineral chemistry
- Isotopic chemistry
- Organic Chemistry
- pH
- Pharmaceutical
- Microbiology

Flood events monitoring
On Arcier spring
- Mineral chemistry
- Isotopic chemistry
- Organic Chemistry
- Microbiology

Figure 2 : Meteorological station

Figure 3 : Fluorescein injection in Nancray sink hole

Figure 4 : Restitution in Arcier spring

Geological and hydrogeological model

The main goals of the study is to actualize the geological and hydrogeological cross-section (Fig. 5), to localize recharge areas within the watershed, to determine the size of the reservoir, to define the preferential circulations within karstic compartments and to precise the relation between the mid and upper Jurassic aquifer. All the geophysical, geological, and chemical results will be associated and translated through a conceptual and then a numerical model.

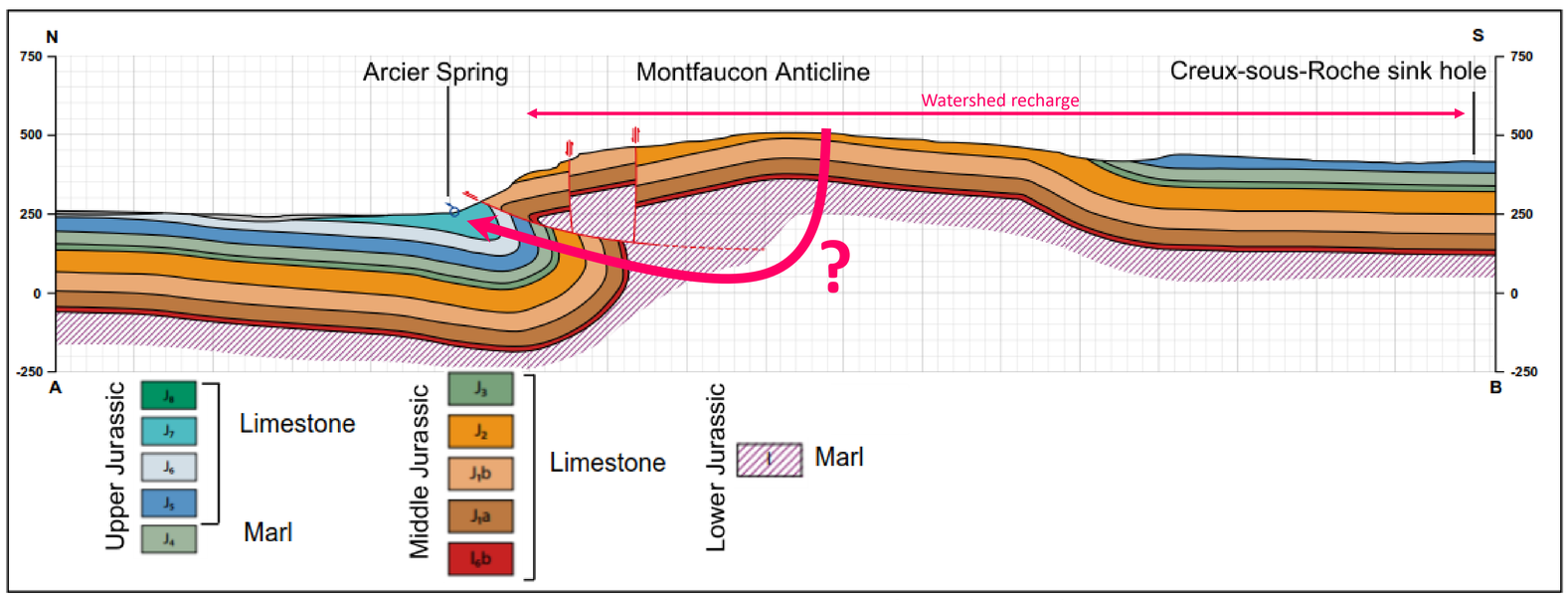
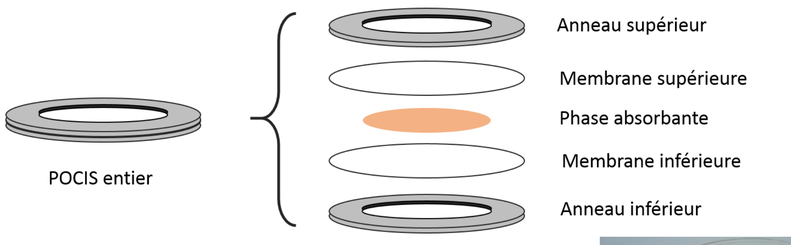


Figure 5 : Geological cross-section of Arcier's watershed

Multi-contamination

The second part is dedicated to multi-contamination. The purpose is to define which contaminants, in which concentrations affect Arcier's groundwater and what are the interactions between contaminants. Using bulk and integrative sampling (Fig.6) on water and sediment, we aim at estimating monthly/annual fluxes and evaluating some molecules relevance to discriminate low and fast transfers. We will analyze simultaneously trace metals, organic matter, pharmaceutical and microbiology. A particular attention will be paid to emerging pollutants, for they, even at low concentrations, may have a high environmental persistence, bioaccumulation potential and toxicity (Meinert et al., 2016 ; Vidal et al., 2013 ; Wiedmann et al., 2015) and affect bacteriological and fungal contents of groundwater (antibioresistance).



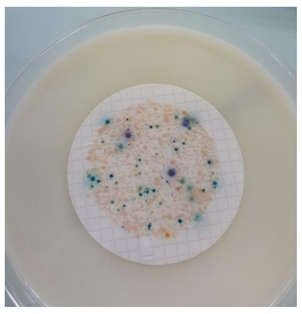


Figure 6 : POCIS (above) used to quantify pharmaceuticals in order to see their effect on ESBL E. Coli (on the right) for instance

Contamination pathways

The third part concerns the characterization of different types of pollutants transport within karstic systems and to understand the role of dissolved organic matter, suspended matter and colloids (Fig.7). Indeed, most of trace metal and organic molecules are not or slightly soluble in water for the typical pH for karstic water (≈7). Thus, most of the transport (Hartland et al., 2012 ; Morasch, 2013) of this molecules is induced by colloids and suspended matter. Also bacteria arrival in a karst system is often correlate with suspended matter (Laroche et al., 2010). Therefore colloids and suspended matter are important vectors for the spread of contaminant. Flood events will be peculiarly studied in this purpose for they provide the main part of the suspended matter during hydrological cycle.

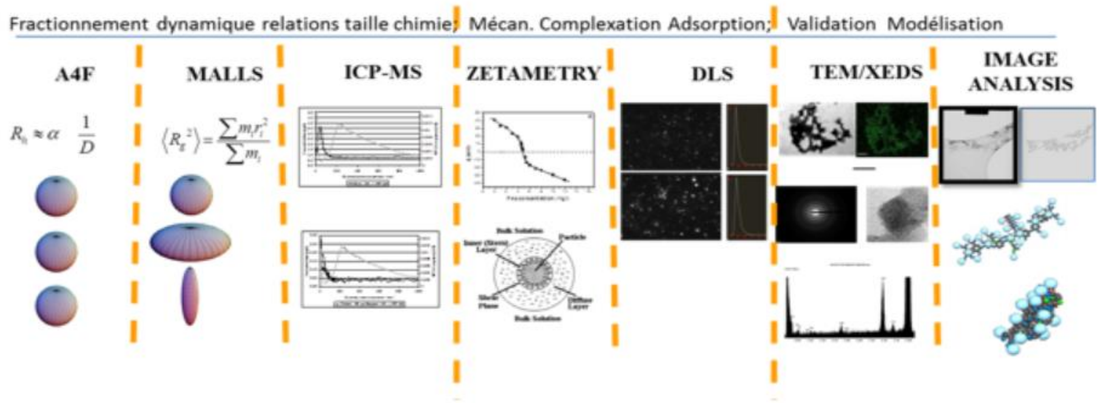


Figure 7 : TSS analysis methods desdicated to the discrimintation of transport pathways (dissolved, collîds and suspended matter)