This master project aims to verify the potential of several micropollutants as tracers for certain hydrogeological processes. We tried to evaluate three main tracing purposes:

1. Surface water tracing of a wastewater: we will test the persistence of micropollutants in a river flowing in our study area (the Venoge). We aim to verify which molecules are suitable as tracers for a wastewater emitted by a WWTP in surface waters and for how long.
2. Surface and groundwater interactions/groundwater transport: we want to verify which sub- stances can resist the passage from a surface water body to an aquifer and thus could be used as tracers for surface water infiltration. We also aim to test the resistance of micropollutants in groundwater to see if some of them can trace a polluting plume flowing in an aquifer.
3. Source characterisation: as our area counts many different potential releasing sources, we aim to verify if certain micropollutants can act as specific source indicators.

We decided to evaluate the tracing potential in a porous aquifer in the Vaud canton (Venoge aquifer) where several surface water bodies (a river, a WWTP canal, three small streams on the Eastern hill) and several types of releasing sources (WWTPs, industries, roads, fields, etc.) occur. Two pumping wells (Cinq Sous and Graveys) exploit this aquifer to provide drinking water. The river potentially connects to the aquifer in several places and so does the WWTP canal. We concentrated on two main areas: La Sarraz and the Eclépens-Graveys well area.

We used several existing piezometers to fulfill our goals in Eclépens. However, the lack of piezome- ters in the La Sarraz forced us to install 12 new ones. We placed, in both study zones, several automatic probes to characterise the behaviors of the river and the aquifer (in terms of water level, temperature and conductivity) with time. We performed five sampling campaigns. The four first were done during (very) low flow conditions, the last one during moderate ones. The campaigns regroup:

1. One taking place in the Venoge (Objective 1).
2. Three in La Sarraz (Objective 2).
3. One covering the entire aquifer (Objectives 2 and 3).

We also used the radon activity to compare results with micropollutants. The automatic probes and micropollutants revealed several particularities.

Objective 1: All the tested micropollutants show attenuations in the river apart for carbamazepine and the pesticide metabolites. For the latter, we postulate the hypothesis that contributions from nearby fields bias their signal. Dilution seems to be moderate due to low flow conditions.

Objective 2 in La Sarraz: Water level measurements and past tracer tests reveal a groundwater flow directed towards the East-Southeast. Automatic probes and micropollutants suggest that the Venoge river contributes to the aquifer during storms on both banks. On the left bank, this occurs at a precise place (near piezometer LS9). On the right bank, it happens further upstream of the piezometers we installed. A contaminant plume flows in the groundwater downstream of the La Sarraz WWTP. Most of the micropollutants pass under the limit of quantification before 700 m of travel. Benzotriazole still reaches our furthest installed piezometer (LS4-700 m from the WWTP). Pesticides metabolites seem to persist but their signal is biased by fields covering the area. Radon activities were not very useful (partly due to low qualities in the reproduction of data) but still suggest a potential exfiltration of the aquifer downstream of the right bank meander.

Objective 2 in Eclépens: Water level measurements and past studies reveal a groundwater flow towards the South. Automatic probes and micropollutants suggest infiltrations of the Venoge near piezometer P1 and of the Eclépens WWTP canal near P14. Concentrations are very high in the canal. Again, a contaminant plume flows towards the Graveys well. Most contaminants are highly attenuated during their passage from the WWTP canal to the aquifer. Only 3 micropollutants reach the Graveys well (1400 m from the canal) in quantifiable concentrations: acesulfame, benzotriazole and carbamazepine

As for La Sarraz, the pesticide metabolites are biased by fields that seem to add large quantities of these substances to the groundwater.

Objective 3: Using a combination of many micropollutants give very good source indicating results. Some are only released by the two WWTPs (hydrochlorothiazide, iopamidol, sulfamethoxazole). Even better, some (as diuron) are only quantified downstream of one particular WWTP. Others (as acesulfame) are released by several sources. Benzotriazole and tolyltriazole reveal the contribution of the highway to the Eastern small streams. Pesticide metabolites are always found at higher concentrations in the groundwater and in the three Eastern streams compared to the Venoge and Eclépens canal. They act as excellent indicators for agriculture.

In conclusion, micropollutants can be used as tracers to fulfill the three main objectives we set. They prove to be more useful to characterise a polluting plume than major elements or radon (but this is exclusively the case for our study area). In fact, they show a higher contrast between the background waters and the polluted ones. They can also show where a contaminant plume occurs. They can trace its direction and its attenuation. But many micropollutants degrade extensively. Some show a probable persistent behavior (as the pesticide metabolites). They need a high initial (stream) concentration to be useful. Their limit of quantification strongly influences their tracing potential. They can also be biased by nearby sources (especially pesticide metabolites). Finally, the long term use of micropollutants as tracers will fade because:

1. WWTPs in Switzerland will add a stage to treat such substances. The already equipped Penthaz WWTP shows extremely good results. Thus, the concentration of micropollutants will be strongly reduced.
2. Farmers will use less pesticides (this is the case in our study area).

Micropollutants will still prove useful in case of an accidental spill or release. They can also help to monitor the long term recovery of an aquifer that experienced severe past pesticide pollutions. They will reveal leaks in industries or WWTPs (even those equipped to treat them). Finally, they can indicate potential contributions of roads to water bodies. Overall, to characterise an aquifer and its interactions, we recommend to use a combination of several techniques, as each method can bring informations not necessarily visible by the others.