Evaluation of the physico-chemical behaviour of contaminants of emerging concern detected in runoff water through controlled batch experiments

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1. Background

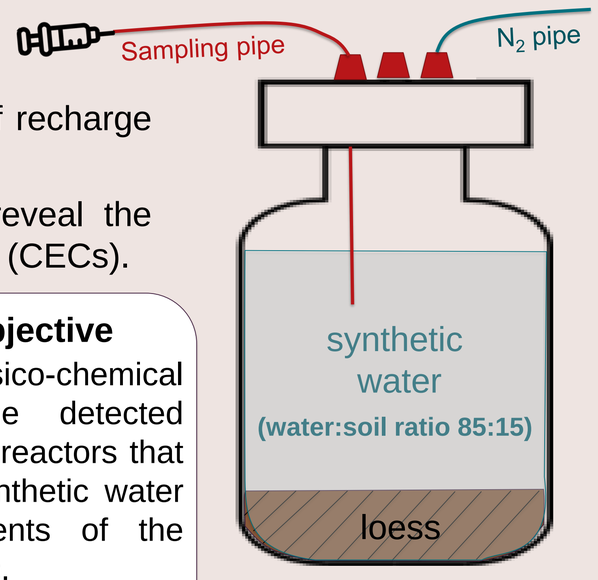
- Runoff water can be considered as a source of recharge water for managed aquifer recharge (MAR).
- Sampling campaigns of airport runoff water reveal the presence of contaminants of emerging concerns (CECs).

Research question

Would the natural filtration capacity of the soil sufficient to consider aquifer soil treatment (AST) system to recharge the aquifer without posing any contamination risk?

Research objective

Evaluate the physico-chemical behavior of the detected CECs with batch reactors that contain runoff synthetic water and the sediments of the study area (loess).



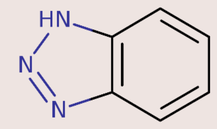
Batch reactor

Detected contaminants

- **Benzotriazoles:**

Benzotriazole

Tolyltriazole

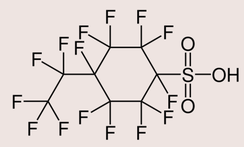


Benzotriazole

- **PFAS:**

PFOA *PFHxA* *PFECHS*

PFOS *6:2 FTS*

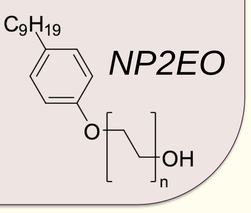


PFECHS

- **Alkylphenols:**

4-tert-octylphenol *Nonylphenol diethoxylate*

4-nonylphenol tech *Nonylphenol monoethoxylate*



NP2EO

2. Set-up

Types of reactors

3 batch reactors: runoff synthetic water (CECs, DOC, major ions) + sediments (loess).

2 control reactors: one abiotic (sorption) and one biotic (biodegradation).

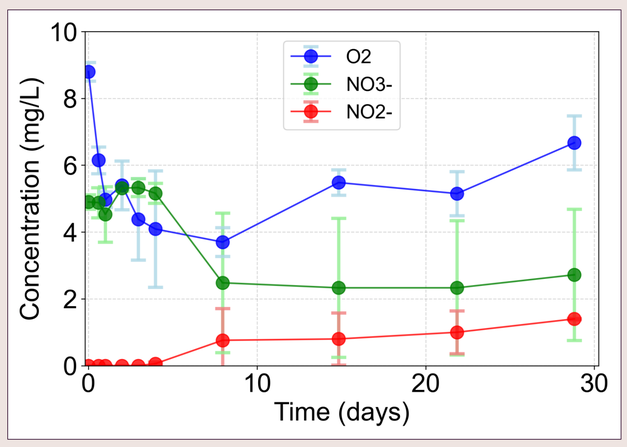
Experimental conditions

Redox evolving conditions.
14°C within an incubator.

Sampling procedure

Samples collected after 0h, 12h, 24h, 2 days, 3 days, 4 days, 8 days, 15 days and 22 days.

3. Redox conditions



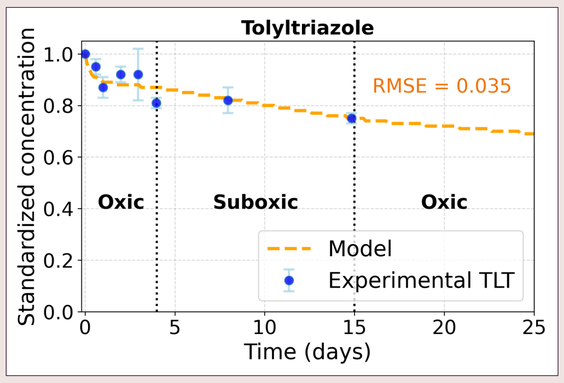
Sudden increase of O_2 concentration after 8 days inhibits NO_3^- consumption and NO_2^- production.

4. HPLC-MS/MS analysis results & modelling

Biodegradation & Sorption

Tolyltriazole

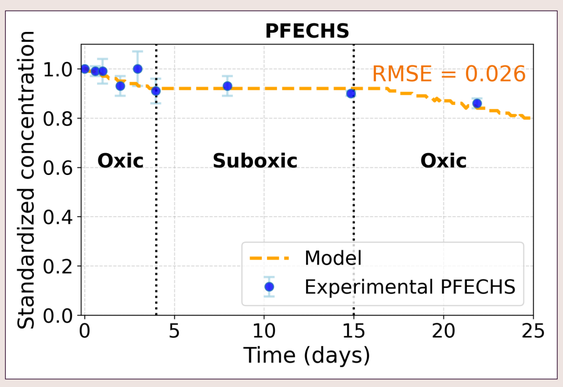
- Faster biodegradation is observed during suboxic conditions than during oxic conditions.
- The fast attenuation observed at the beginning of the batch experiment is associated to sorption behavior (24h).



Biodegradation

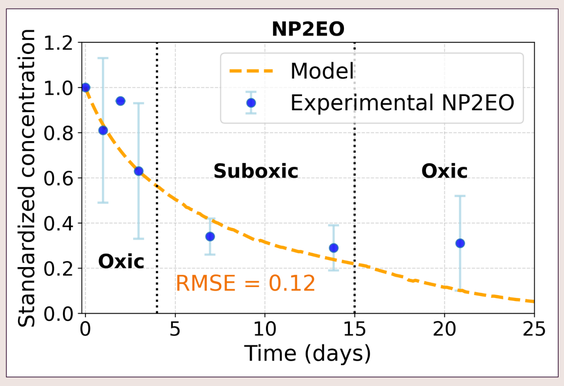
PFECHS

- Biodegradation does not occur during suboxic conditions.
- Relatively low biodegradation rate is observed during oxic conditions.
- Very low RMSE calculated between the model and the observations.



Nonylphenol diethoxylate

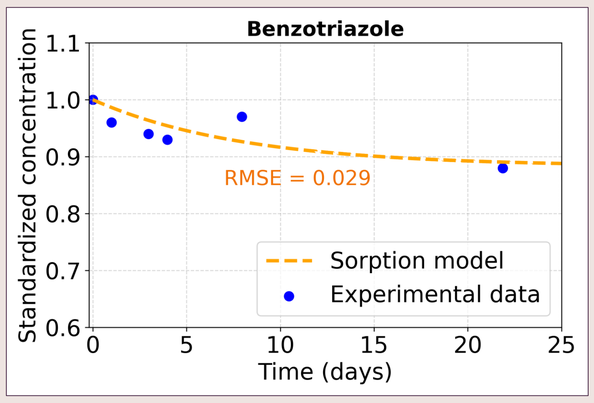
- The overall attenuation observed for nonylphenol diethoxylate compound is much higher than for the other studied CECs.
- Higher inter-variability is observed between the triplicates.



Sorption

Benzotriazole

For some of the studied CECs, a sorption model could be developed based on the abiotic control results.



$K_{d\ benzotriazole} = 3{,}64 \times 10^{-4}\ L.g^{-1}$

5. Conclusion

Batch experiments are very efficient tools to evaluate key parameters regarding the biodegradation and the sorption of CECs of interest.

Research direction

Coupling obtained PHREEQC models with transport modelling to evaluate risks of groundwater contamination during MAR operations.

Contact

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