

# Photolysis of organic micropollutants by UV-C and identification of degradation by-products

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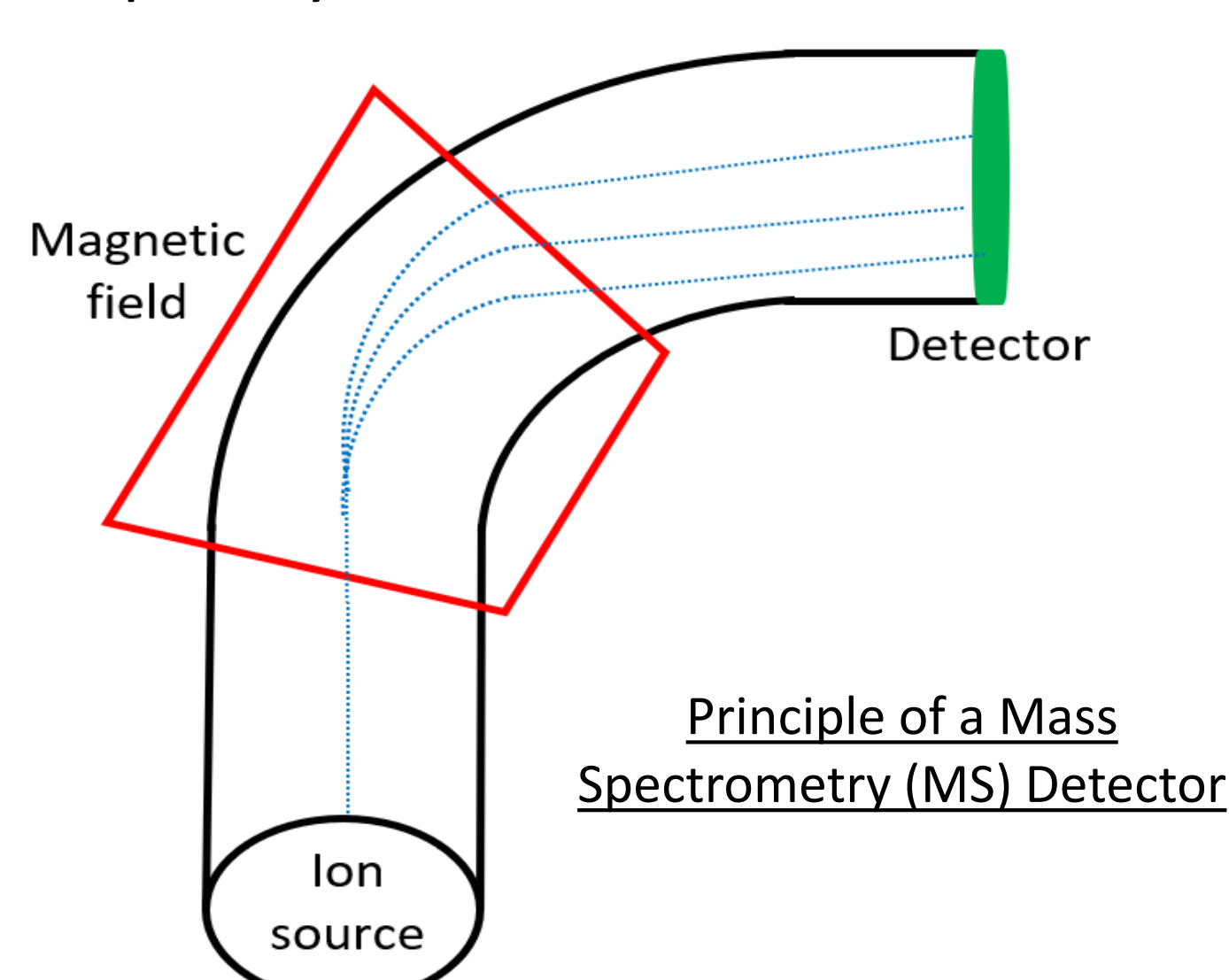
<https://projet-soap.fr>

The pollution of the natural environment is mainly caused by human activities and is characterized by the presence of organic micropollutants. These organic micropollutants stem from various sources such as drug residues, pesticides, and industrial waste. The SOAP project focuses on mollusk development, which involves using a UV lamp to disinfect seawater.

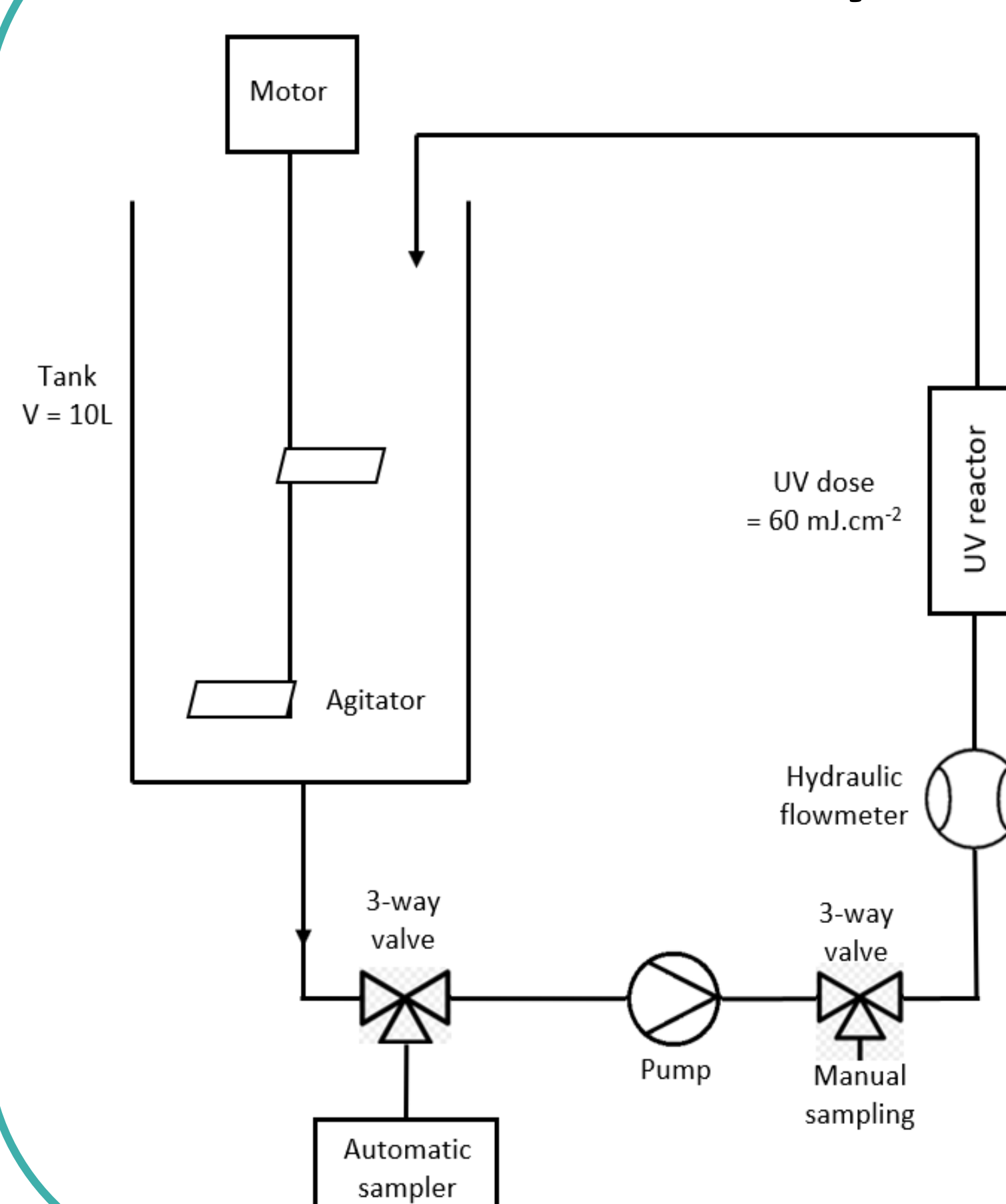
Within this project, we aim to investigate the potential degradation of organic micropollutants using UV-C radiation, with a particular emphasis on ketoprofen, caffeine, and nicosulfuron. We will conduct these experiments in three different matrices: Ultra-Pure Water (UPW), Reconstituted Sea Water (RSW), and Natural Sea Water (NSW), in order to observe the effects of salinity and dissolved organic matter (DOM). Once the photosensitive organic micropollutants have been identified, we will proceed with the identification of their degradation by-products (BP). [1][2]

## LC-MS/MS analyses for kinetic monitoring

A Waters Quattro Premier Micromass LC-MS/MS is used with Acquity UPLC System (UPLC, T3, 1,8µm C18 on silica) and a SPE-online (OASIS HLB 20µm). It's a triple quadrupole system in MRM detection.



## Pilot assembly for photolysis

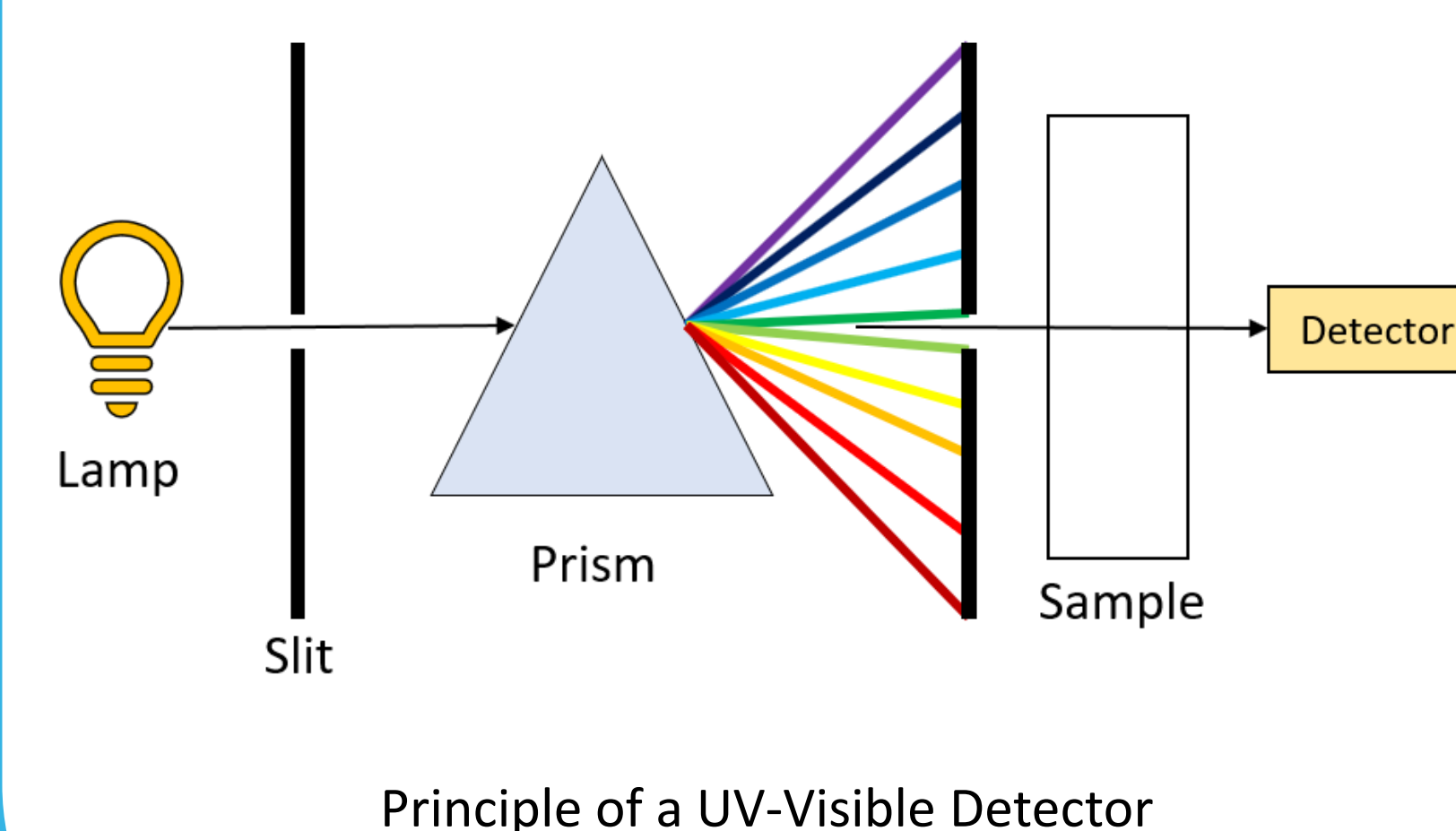


### Operating conditions:

- 10L of water (UPW, RSW or NSW)
- 2 µg.L<sup>-1</sup> of each micropollutants
- pH = 8,2
- Flowrate = 90 L.H<sup>-1</sup>
- Automatic sampling every 15 min

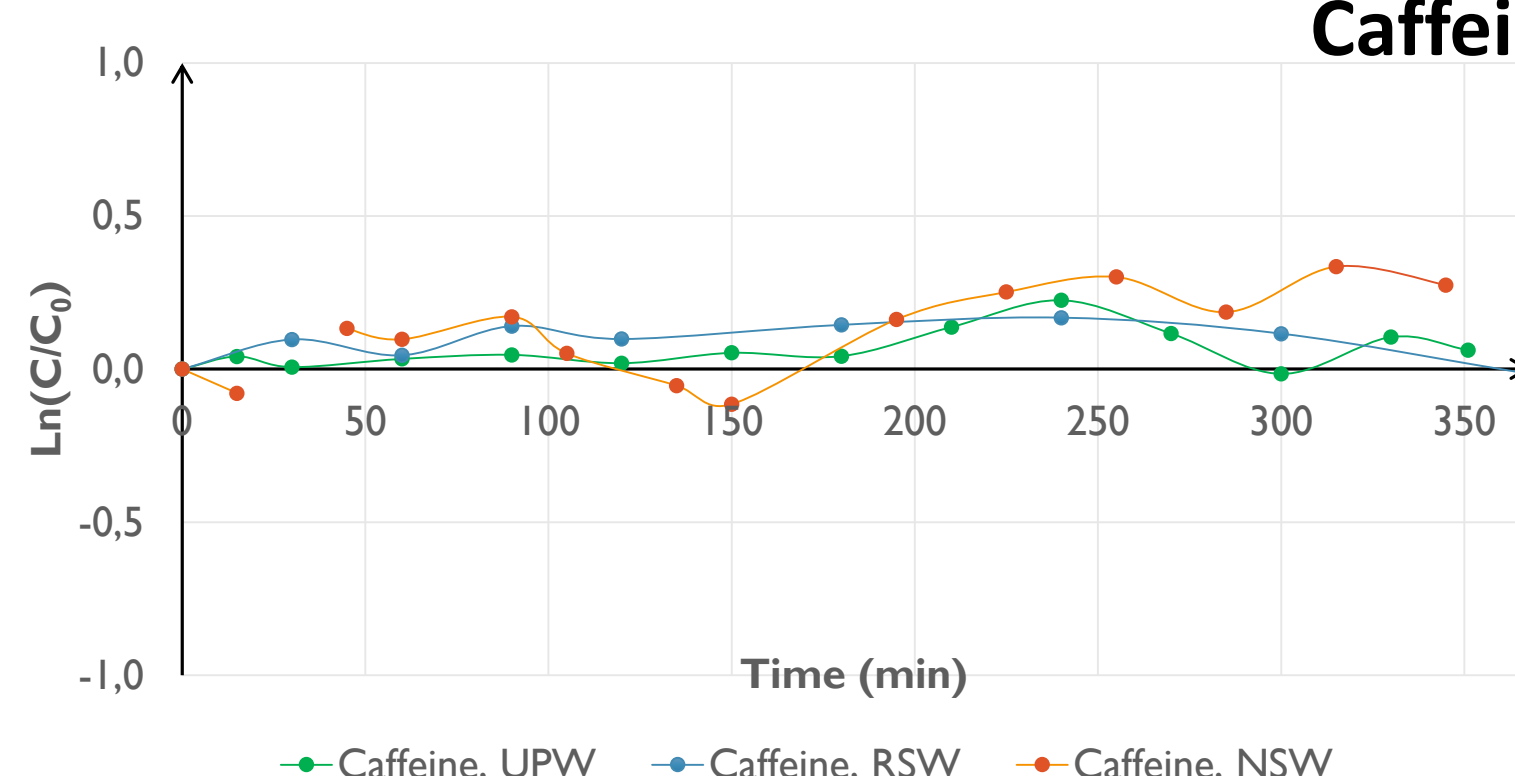
## UPLC/UV-Visible analysis for by-product detection

A Waters UPLC is used with Acquity UPLC H-Class System (UPLC, BEH 1,7µm C18 on silica). It's a triple quadrupole system with an UV-Visible detector.



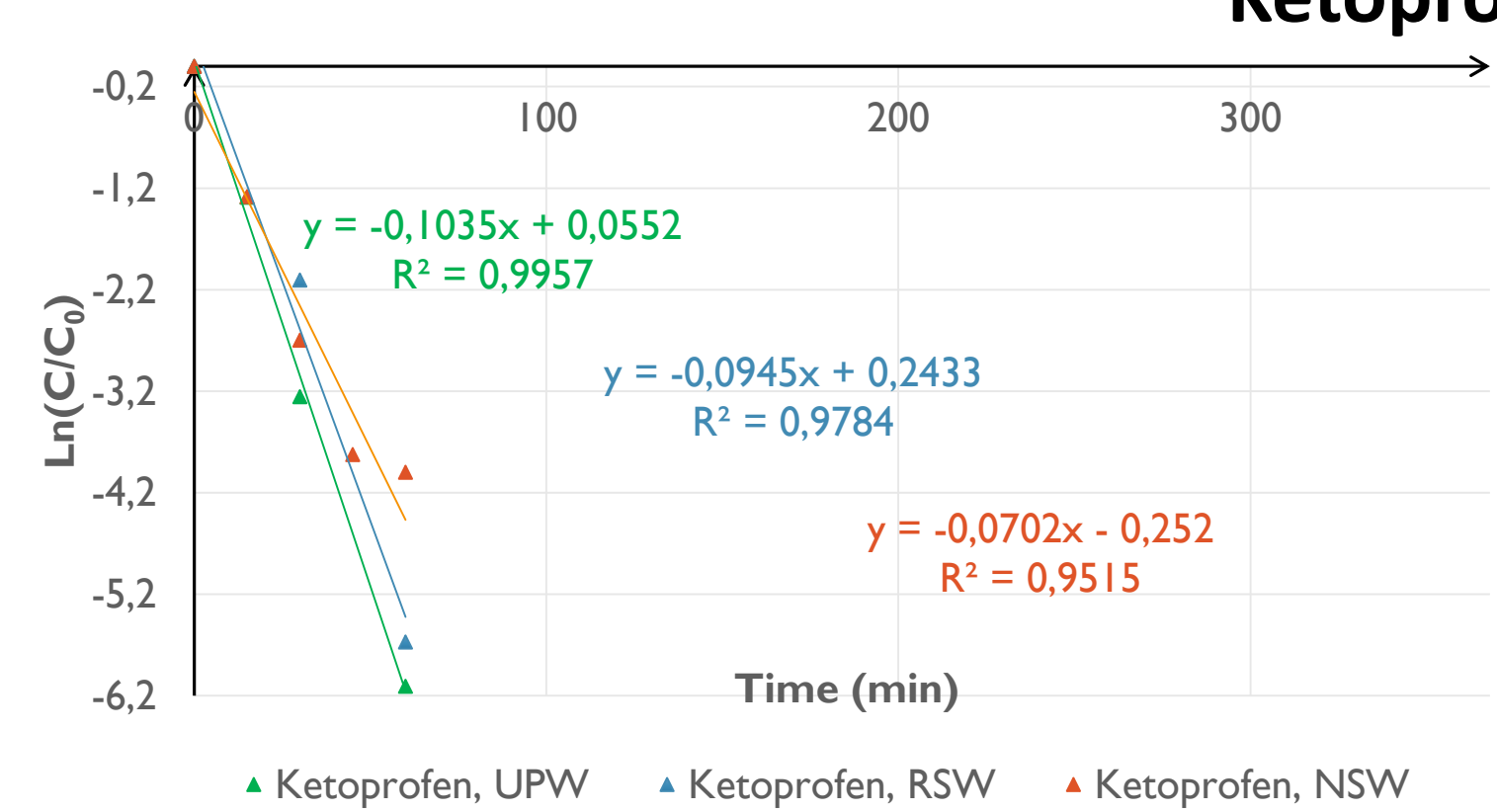
## Results of photolysis kinetics degradation

### Caffeine



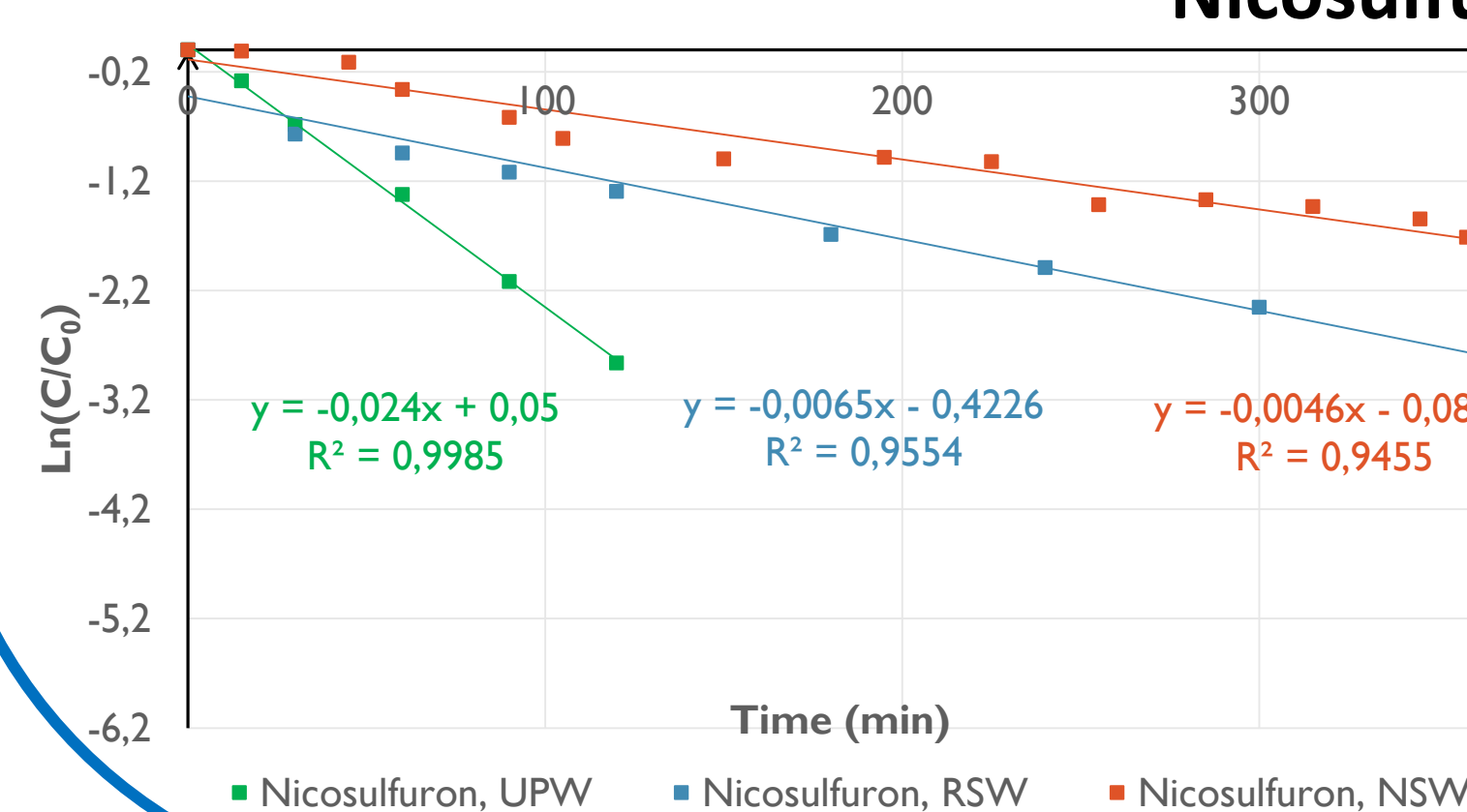
- Degradation does not occur in all matrices.
- Not degradable by UV-C.

### Ketoprofen



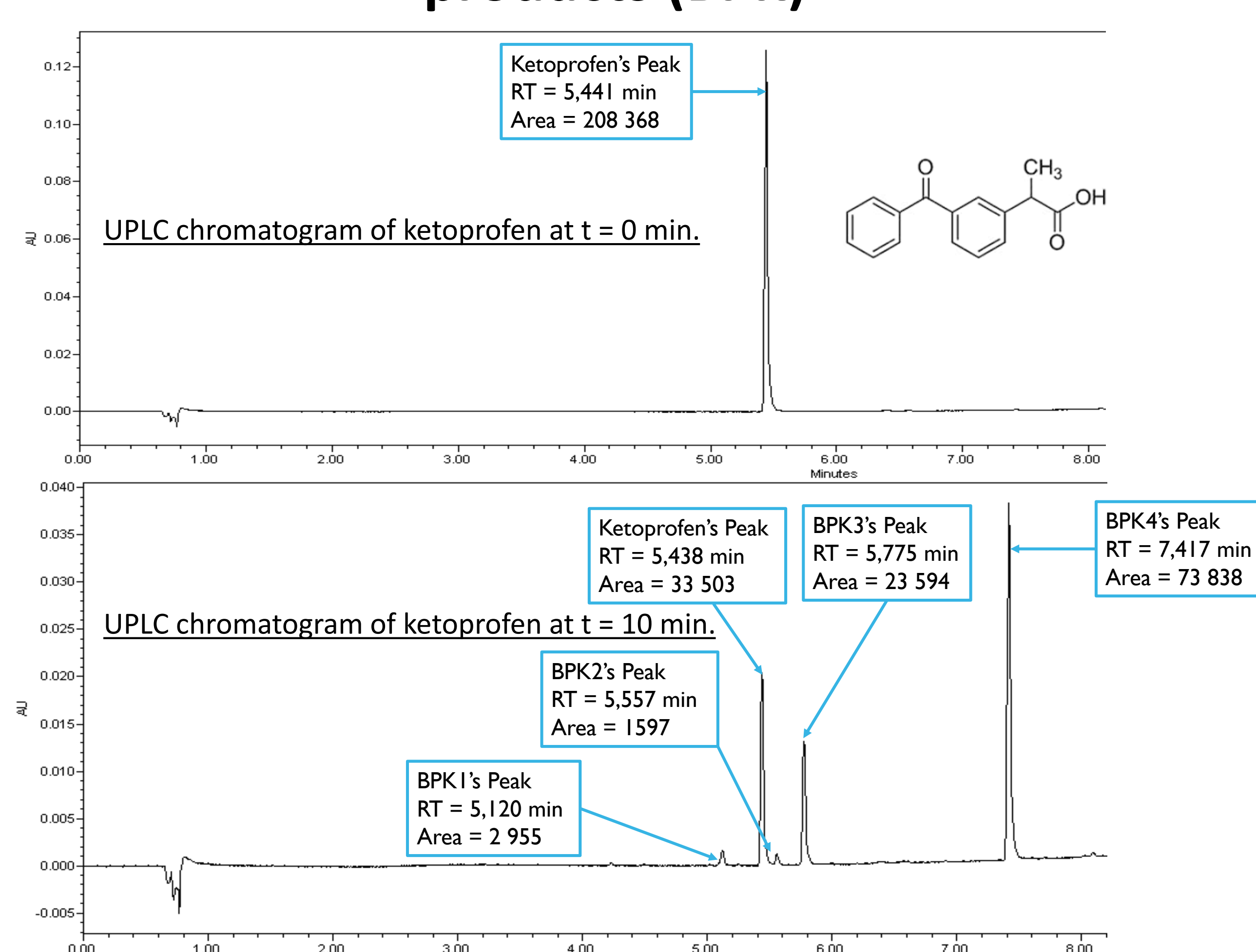
- Degradation occurs in all matrices.
  - Degradable by UV-C.
  - Degradation rate approximately equal between each matrices.
- $k_{UPW} = 0,1035 \text{ min}^{-1}$   
 $k_{RSW} = 0,0945 \text{ min}^{-1}$   
 $k_{NSW} = 0,0702 \text{ min}^{-1}$

### Nicosulfuron

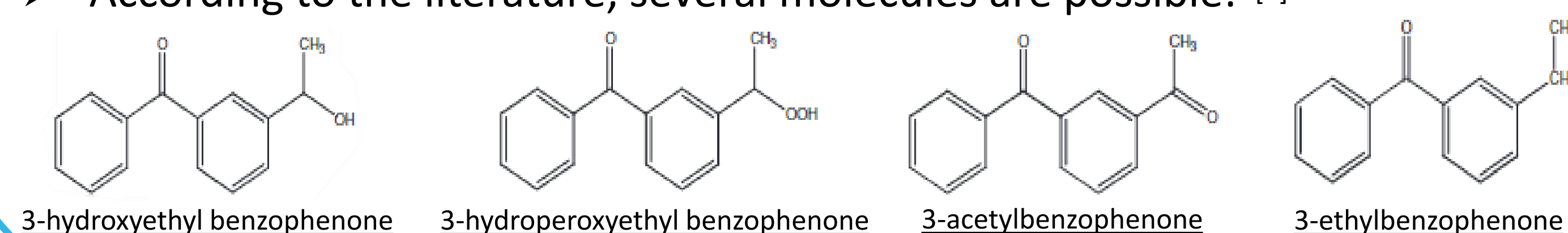


- Degradation occurs in all matrices.
  - Degradable by UV-C.
  - Degradation rate different between each matrices.
  - Salinity and DOM have a role.
- $k_{UPW} = 0,0240 \text{ min}^{-1}$   
 $k_{RSW} = 0,0065 \text{ min}^{-1}$   
 $k_{NSW} = 0,0046 \text{ min}^{-1}$

## Detection of Ketoprofen degradation by-products (BPK)



- Formation of several by-products.
- According to the literature, several molecules are possible: [3]



## Conclusion/Perspectives

- Not all organic micropollutants react in the same way to UV-C radiation.
- For those which are photosensitive, a study on the by-products formed will be carried out.
- The use of a LC-QTOF HRMS will allow to validate structures.
- A study on the ecotoxicity of stable by-products could be considered.

### Bibliographic references

1. Mathon B., Vandycke A., Coquery M., Bados P., Daval A., Crétollier C., Masson M., Arhror M., Miegé C., Choubert J.M., « Photodégradation de micropolluants organiques sous rayonnement solaire en zone de rejet végétalisée de type bassin. Rapport final ». [Rapport de recherche] Irstea-ONEMA (2017), 63 pages.
2. Tien-Hsi F., Chen-Wei L., Chih-Hsiang K., « Occurrence and distribution of pharmaceutical compounds in the Danshuei River Estuary and the Northern Taiwan Strait ». Marine Pollution Bulletin (2019), Volume : 146, Pages : 509-520.
3. Koumaki E., Marmas D., Noutsopoulos C., Nika M-C., Bletsou A.A., Thomaidis N.S., Eftaxias A., Stratogianni G., « Degradation of emerging contaminants from water under natural sunlight: The effect of season, pH, humic acids and nitrate and identification of photodegradation by-products ». Chemosphere (2015), Volume 138, Pages: 675-681.