

## Transformation of riverine organic matter from sinking stream recharge to spring discharge in a karst aquifer

P. Albéric

UMR 6531 & FR09, Université d'Orléans, France

In the Val d'Orléans, recharge of the karst aquifer (Calcaires de Beauce) does almost totally by stream sinks in the River Loire. In Orléans, the river is in its middle course and carries noticeable amounts of organic matter, either of terrigenous or planktonic origin, according to the river regime. This particular feature induces the anoxia of the discharge waters on their three days' and 10–15 km underground movement. Rates of organic carbon oxidation of about 5 mg/L have been deduced from mass balances of dissolved oxygen and nitrates (Albéric and Lepiller, 1998). Dissolution of limestones in the karst aquifer is strictly dependant of the riverine organic matter oxidation which supplies for the small dissolution power of the River Loire waters.

In this note are described some transformations of whole organic matter during its underground transit.

### Experimental

Dissolved and particulate organic matter (DOM, POM) were studied in the River Loire and discharge spring waters ('Bouillon' spring of the River Loiret). Suspended matters were collected by filtration on

fibreglass filters. Dissolved organic carbon (DOC), UV absorbance and fluorescence were used to characterise DOM, particulate organic carbon (POC), C/N ratio and Rock-Eval pyrolysis (Espitalié *et al.*, 1985) for POM.

Controlled in vitro aerobic biodegradation of the river Loire suspended matter was performed in BOD (biological oxygen demand) devices. Characterisation of DOM and POM during BOD experiments was made as described above.

### Results

Variations of the water level in the River Loire lead to changes in the DOC concentration (Fig. 1). These changes are transmitted to the discharge waters about 3 days later, and about 1 mg/l is regularly consumed whatever the concentration in the recharge river waters is. UV absorbance and fluorescence of DOM do not seem to be affected by the underground transit, except during the flood interval (November 9–18).

POC ranges from 2 to 12 mg/L and less than 0.5 mg/L respectively in River Loire and spring waters

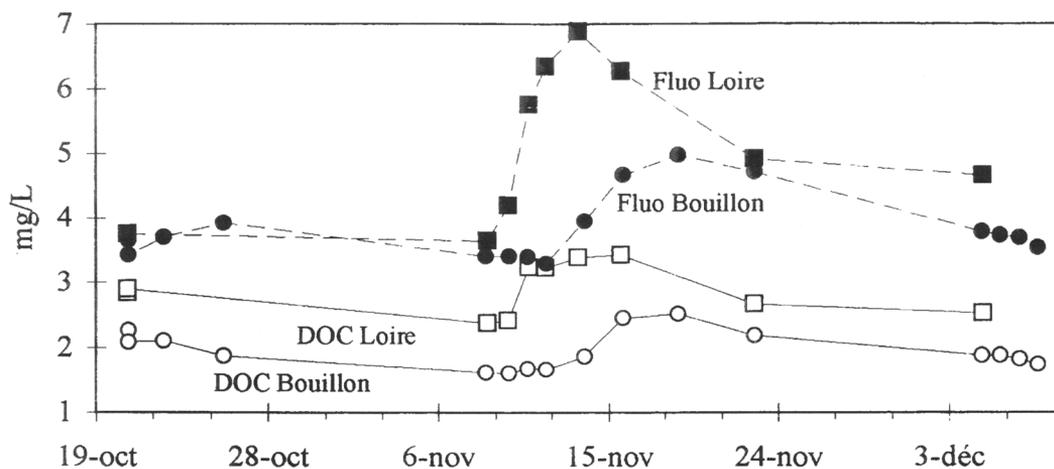


Fig. 1. DOC and fluorescence (mg/L salicylic acid) in River Loire and discharge waters (autumn, 1997).

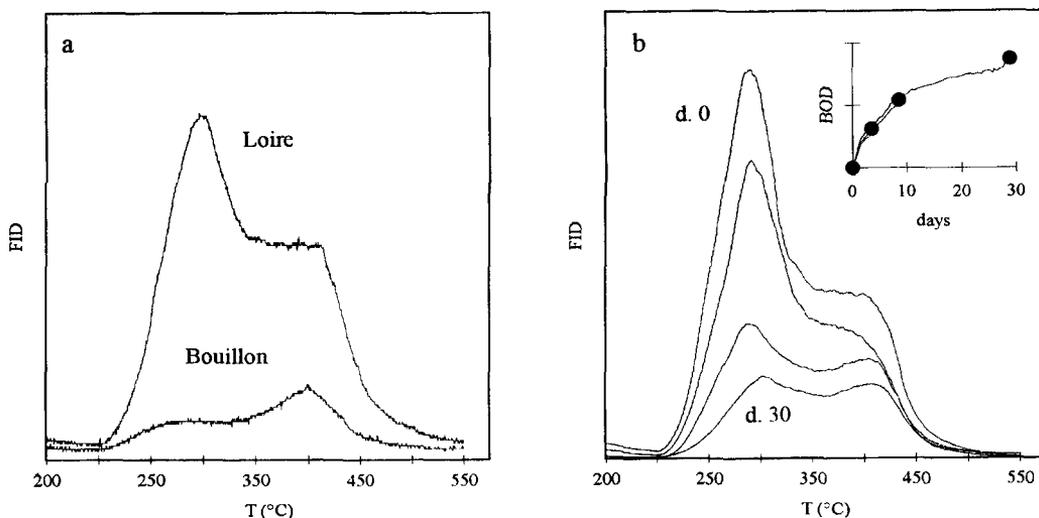


FIG. 2. (a) Rock-Eval pyrograms (flame ionization detector, FID) of aquagenic POM from River Loire and discharge waters (Bouillon). (b) Variation of pyrolysis yield along *in vitro* BOD maturation.

(Albéric and Lepiller, 1998).

Rock-Eval pyrograms of POM for River Loire and discharge waters are compared in Fig. 2a. The bimodal distribution of the pyrolysis products can be noticed for both samples, but the maximum yield is centred around 300°C for the former and 400°C for the later.

The BOD maturation of the River Loire particles (mainly algae) reproduces the same trend as the *in situ* underground transformation (Fig. 2b). The production of DOC was noticed only at the beginning of the BOD experiment and was consumed later. No fluorescent dissolved matter appeared.

### Discussion - conclusion

The fluorescence of riverine organic matter is assumed to reflect its pedogenic origin (Zumstein and Buffle, 1989). This fraction of DOM is generally assumed to be refractory to biological decomposition as observed in this work. The fraction of DOC which contributes to redox reactions in the aquifer must be found in the non fluorescent part. Supplementary fluorescent load during flood periods seems however more reactive.

It is in the particulate fraction that most of the organic stock for redox reactions in the karst aquifer has to be found. The fractions which are most metabolisable are mostly located in the '300°C Rock-Eval peak', but higher temperature pyrolysable

products have also to be considered. Compared to POM of aquatic origin (algae), terrigenous matter has a higher '400°C Rock-Eval peak' (Scribe *et al.*, 1995; Albéric and Lepiller, 1998) and is known to contain smaller amounts of very labile fractions (amino acids, sugars) (Ittekkot, 1988). Relation between amino acid amounts and Rock-Eval pyrolysis product yield has been described for the River Congo annual particulate discharge (Scribe *et al.*, 1995). Identification of the different biochemical fractions and their transformation during the underground transit in the Val d'Orléans hydrological unit is in progress. This site is a natural dynamic reactor particularly suitable for the study of the reactivity of riverine organic matter of different origins (algal in summer or low water levels, pedogenic during flood).

### References

- Albéric, P. and Lepiller, M. (1998) *Wat. Res.* (in press).
- Espitalié, J., Deroo, G. and Marquis, F. (1985) *Rev. Inst. Fr. Pét.*, **40**, 563–79.
- Ittekkot, V. (1988) *Nature*, **332**, 436–8.
- Scribe, P., Pèpe, C., Albéric, P., Barreau, C., Fillaux, J., Saliot, A. and Bricket, J.-P. (1995) In: *Grands bassins fluviaux périallantiques: Congo, Niger, Amazone* (Eds: J.-C. Olivry and J. Boulègue), pp. 83–95. ORSTOM, Paris.
- Zumstein, J. and Buffle, J. (1989) *Wat. Res.*, **23**, 229–39.