# Colloidal control at the soil/water interface

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Significant temporal variabilities of dissolved trace-elements concentration (Fe, Mn, Zn, ...) have been observed in some rivers (i.e. Shiller and Boyle, 1987). The causes of these variabilities are not clear at present. Recent studies, however, suggest that such temporal variations could be related to weathering mechanisms and hydrologic regimes upstream, at the soil/water or rock/water interface (Shiller, 1997).

Knowledge of element speciation in the soil waters is essential to determine the nature of weathering processes at the interfaces and the way where by elements in the soils are transfered to the rivers. It is now well-established that the solute fractions of samples separated using 0.2 μm membranes filters (generally studied), are often composed of a mixture of 'true' dissolved species and colloidal particles. Colloidal particles are essential phases to study because they may strongly affect the speciation of elements in waters through complexation and/or adsorption abilities. These properties arise from the very small sizes of colloidal particles, which give them a very high surface area per unit mass, hence promoting surface-area-dependent interactions between solution and solid components.

The major aims of this study are: (1) to provide such new informations on both weathering mechanisms and chemical speciation at the soil/water interface (2) to determine the control of colloids over the fate and the transport of water-borne chemicals and (3) to understand the dynamic of elements transfer from the soil/water interface to the river.

## Study area and methods

The studied site is a small agricultural catchment located in temperate oceanic climate (Central Brittany, Western France). In this catchment, two contrasted domains have been identified by previous hydrological and biogeochemical studies : (1) a hillslope zone comprising well drained soils and (2) a bottomland zone characterized by waterlogged soils. Waters have been sampled in piezometers of both domains and at the outlet of the catchment. The separation of colloidal particles from 'true' dissolved species is performed using classical tangential-flow ultrafiltration scheme (see Eyrolle *et al.,* 1996 and references therein). Three cutoffs were made: 0.2 μm, 100 kilodaltons (kD) and 30 kD. Trace-elements concentrations and rare earth elements (*REE*) were measured by ICP-MS and total organic carbon (TOC) content by a Shimazdu carbon analyser.

## Data and interpretation

Several results stem from this study:

(1) Trace-element and TOC concentrations (in the 0.2 μm filtered waters) are different in each of the two hydrological domains identified previously. In particular, Fe and TOC concentrations are higher in bottomland (Fe from 25 to 1700 ppb, TOC from 10 to 20 ppm) than in the hillslope waters (Fe from 20 to 140 ppb, TOC from 0.5 to 2 ppm). This difference in chemical composition between bottomland and hillslope waters is a constant feature which is not significantly modified by storm events.

(2) A very significant signal is shown by the *REE* (in the 0.2μm filtered waters), which are systematically higher in the bottomland ($\Sigma$*REE* from 1.5 to 21 ppb) than in the hillslope (0.3 to 7 ppb) waters. In addition, a marked negative Ce anomaly is detected in the *REE* patterns of the hillslope waters, while slightly positive Ce anomaly is observed in the bottomland waters. Decrease of *REE* concentrations in hillslope and bottomland waters has been observed during ultrafiltration steps. These variations bring into evidence the role of colloidal particles as *REE* carriers in these waters (Sholkovitz, 1995).

(3) The marked decreases of Fe concentration in hillslope waters and of Fe and TOC concentrations (not correlated) in bottomland waters during ultrafiltration suggest that: (i) iron oxi-hydroxides are the main colloidal phase present in the hillslope and (ii) iron oxihydroxides and organic compounds constitute

the colloidal fraction in the bottomland waters.

(4) Temporal variations of trace elements and TOC concentrations are observed in the waters collected at the outlet. During low flow, *REE*, Fe and TOC concentrations in these waters decrease and the negative Ce anomaly increases in the *REE* patterns. By contrast during high flow, after a storm event, *REE*, Fe and TOC concentrations increase and a slightly negative Ce anomaly appears. These result are in agreement with hydrological models developped for this catchment (Durand and Torres, 1996).

In conclusion, these results suggest that: (i) the chemical composition of draining waters depends on element speciation and on interactions at the soil/ water interface, (ii) the control exerted by the colloidal phases in the fate and transport of trace-elements in surface and groundwaters is of prime importance and (iii) the seasonal chemical variations at the outlet are due to various contributions of the two contrasted draining waters.

## References

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