Seasonal variations of trace elements and organic carbon in dissolved and particulate phases of tropical river waters (Nyong basin, Cameroon)

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In recent years, there have been a large number of field studies aimed at improving our knowledge of weathering mechanisms in humid tropical landscapes (Viers *et al.*, 1997; Braun *et al.*, 1998; White *et al.*, 1998). The present study focusses on the seasonal variations of organic carbon and trace elements in a series of rivers flowing through tropical forests in south Cameroon, Africa. These variations have been observed in the dissolved (<0.22 μm) and bulk (i.e. unfiltered) river waters composition. Indeed, the relative proportion of the dissolved and particulate phases to the bulk river water composition and their respective temporal variations in response to water discharge fluctuations give indications on the mechanisms which control the concentration of these trace elements.

Firstly, we worked at the scale of the small Mengong river (1 km length) which drains the Nsimi-Zoétélé site (100 ha) southern Cameroon. Secondly, we attempt to enlarge our observations to a set of three rivers (Awout, Soo, and Nyong) characterized by a gradual increase in their drainage surfaces and water discharges.

Study area

Each of these rivers, sampled monthly during a three year period (1994-1997) belongs to the Nyong river basin. This basin (27,800 km^2) is considered to be representative of a humid tropical landscape covered by a rain forest. It is exposed to a humid tropical climate characterized by two variable wet and dry seasons. The mean annual rainfall and air temperature is 1793 mm and 24°C, respectively. The landscape is a succession of convex rounded hills separated by flat swamps of variable sizes.

Seasonal behaviour of DOC and trace elements in the Mengong river

The dissolved load of the Mengong river waters is characterized by high concentrations of dissolved organic carbon (6<DOC (mg/L)<25), aqueous silica (mean value of H_4SiO_4 of 10.8 mg/L) and refractory dissolved elements (e.g. Al, Fe, Zr, *REE*s, Th). Al and Fe can be considered as major cations since their concentrations (150–550 μg/L) are similar to those reported for base cations (e.g. Mg, K). These river waters have an midly acidic pH 5.3. A good positive correlation obtained between pH and DOC content (Fig. 1) suggests that DOC concentration controls the acidity of these waters.

Particulate organic carbon concentrations represent less than 20% of the dissolved organic carbon concentrations. For the other elements, it appears that the bulk river waters composition is mainly dominated (50–90%) by the dissolved load.

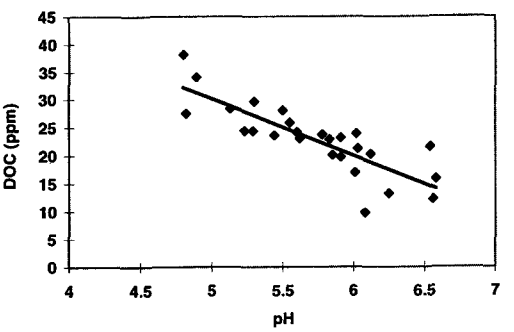

FIG. 1. DOC-pH relationship for thirty Nyong basin rivers.

The seasonal variations show that dissolved trace elements concentrations vary in phase with DOC concentration. The highest concentrations of both organic and inorganic compounds are systematically measured during the period of high water level. Interestingly, the same response in DOC and trace elements concentrations was observed during a storm event. Furthermore, the same temporal variation are observed when considering only the bulk water composition.

Figure 2 illustrates the dissolved temporal variation for the case of iron during the 1994-1997 period. The very good agreement between DOC and some element concentrations (e.g. Al, Fe, *REE*s, Th) show the strong influence of organic substances on metal transport. Based on a combined study of soil and water samples carried out at the Nsimi-Zoétélé watershed, Dupré *et al.* (this volume) demonstrate that chemical weathering takes place predominantly in the swamp zones. Therefore, the presence of organic matter in the swamp zones enhances mineral dissolution (e.g. kaolinite, iron hydroxide) and consequently the release of elements into the watershed.

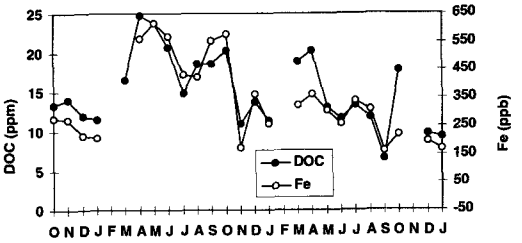

FIG. 2. Variation of DOC and Fe dissolved concentrations as a function of time (1994-1997). The letters O,N,D...stand for the monthly chronological order (i.e. October, November, etc) during the three year sampling period.

Comparison with the other rivers

In the case of the Mengong river, each element concentration in the dissolved load varies with DOC concentration where the highest were measured during the wet seasons. Even when these rivers present contrasting hydrologic features, they all exhibit similar water chemistry. This observation indicates that the weathering and tranport mechanisms identified at the scale of the swamp zone in the Mengong brook site can be extended to the whole Nyong basin.

In these 'organic-rich' rivers, the bulk water chemistry is mainly dominated by the dissolved phase. This observation suggests that in these weathering settings, physical erosion is not important relative to chemical erosion. For this reason, the thick soils are isolated from the granitic basement due to the relative absence of physical erosion. Therefore, the soil profile exposed to chemical erosion have been extensively weathered and is mainly composed of weathered products.

References

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