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Continental weathering and river transport of suspended and major dissolved elements in the Niger upper basin

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During the period january 1990-july 1993, 85 water samples were collected twice a month on the Niger river at Bamako (Mali). Concentrations of major dissolved elements were determined at the CGS using classical techniques. The study period appears to be very dry compared to the 90 last years. The drainage area of the Niger upper basin is about 117 000 km^2 at Bamako.

Variations of dissolved elements concentration seem very similar for the different species (Na^+, K^+, Mg^{2+}, Ca^{2+}, HCO_3^-) and show the same seasonal pattern for the 3 years 1990-91-92 . Highest concentrations approximatively correspond to lowest river discharges, and vice versa. For dissolved silica, a similar pattern can be noticed, but the range of variations is less important. For TSS otherwise, maximum concentrations (50-60mg/l) occur about 6 weeks before the peak discharge.

Specific fluxes of dissolved or suspended matters (in kg/km^2 . year) could be calculated using a partial budget method. A correction for atmospheric contribution (rainwaters) could be made using the molar ratio given by MEYBECK (1984) for the different major elements, corresponding to wet tropical and savanna areas. Corrected values are very close to crude values (see table below), showing that the atmospheric imports must be very low.

fluxes	Na^+	K^+	Mg^{2+}	Ca^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	SiO_2	TDS	TSS
crude	461	249	200	439	3637	72.8	59.7	2957	8075	4867
corrected	406	223	186	406	3637	0	0	2957	7815	4867

fluxes exprimed in kg/km^2 . year

Major dissolved species are bicarbonate and silica. TSS appear here very low compared to other tropical rivers. For dissolved iron and aluminium, specific fluxes could be approximatively estimated to 20 and 15 kg/km^2 . year. Chemical compositions of cations (Na^+, K^+, Mg^{2+} + Ca^{2+}) and anions (HCO_3^-, Cl^-, SO_4^{2-}) only show minor seasonal and annual variations in the Nigers' waters.

According to values obtained for the weathering coefficient RE (TARDY, 1969), with $RE = 3(Na^+) + 3(K^+) + 1.25(Mg^{2+}) + 2(Ca^{2+}) - (SiO_2)/0.5(Na^+) + 0.5(K^+) + 0.75(Mg^{2+}) + (Ca^{2+})$ the dominant type of weathering in the study area belongs to the kaolinisation (mean annual RE = 1.83).

The mechanical erosion rate is estimated to 2.4 m/My (if soil density = 2.0). The chemical weathering rate may be calculated from the total flux of silica exported by the Niger river, considering that weathering profiles are mainly composed of kaolinite (neoformed) and of quartz (residual). Different calculations of weathering rates have been performed using different proportions of quartz and kaolinite. When the ratio quartz/kaolinite increases, the weathering ratio increases also; for example, if one considers 30% of quartz ,the weathering rate can be estimated to 3.9m/My . In this case, the thickness of soil profiles increases from about 1.5 m/My, which means that even in the present rather dry conditions, laterites continue to be developed in the upstream part of the Niger basin.

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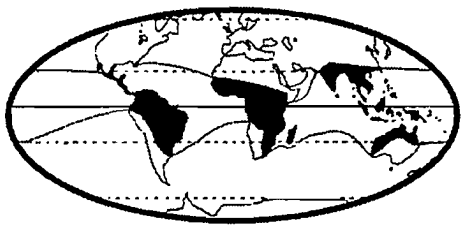

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