

Geochemistry of continental rivers of the Virunga Volcanic Province, East Africa

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Between December 2010 and January 2012, monthly sampling was carried out on 13 rivers in the Virunga Volcanic Province (DR of the Congo) ; 8 of which drain into Kabuno bay (a sub-basin of Lake Kivu), the 5 others draining into Lake Edward. We analysed both in situ physico-chemical characteristics as well as a suite of biogeochemical parameters. Most parameters showed no pronounced seasonal variation, whereas their spatial variation suggests a strong control by catchment characteristics such as the geology, soil type, slope and vegetation. The maximum concentrations of nutrients such as nitrate (178 μM), nitrite (0.3 μM), ammonium (13.4 μM) and total phosphorus (14.5 μM) indicate that anthropogenic pollution is relatively limited. However, high suspended sediment concentrations (245-1467 mg L^{-1}) were recorded in rivers in the Kabuno bay catchment, indicating high soil erodibility, possibly as a consequence of deforestation.

Vegetation and relief regulate the type and concentration of organic matter; maximum concentrations for dissolved and particulate organic carbon (DOC and POC) were 1.80 and 0.57 mg L^{-1} , respectively, in rivers from lava field, while their respective concentrations were 4.92 and 26.29 mg L^{-1} in non-volcanic sub-catchments. Dissolved inorganic carbon (DIC) dominated the C pools as a result of high carbonate and volcanic rocks dissolution. Specific conductivity and total alkalinity presented high values in rivers located in the volcanic field where K^+ and Na^+ were the dominant cations as product of water interactions with the highly alkalic basalts lavas. $\delta^{13}\text{C}_{\text{POC}}$ (-27.2 to -18.2 ‰) and $\delta^{13}\text{C}_{\text{DOC}}$ (-27.2 to -21.2 ‰) signatures showed a mixed

origin of organic carbon from both C3 and C4 vegetation. $\delta^{13}\text{C}_{\text{DIC}}$ (-10.7 to 0.0 ‰) values were intermediate between those of CO_2 produced by terrestrial organic matter degradation, and those of DIC from carbonates rocks dissolution.

The rivers of the Virunga Volcanic Province were sources of carbon dioxide (CO_2) and methane (CH_4) to the atmosphere, with CH_4 and pCO_2 values ranging from 4.95 to 5051.95 nM and 3474 to 23339 ppm nM respectively. Highest pCO_2 values were found in rivers from volcanic fields and were correlated with dissolved nitrous oxide (N_2O) concentrations (24 to 68 nM). These rivers were the only sites where N_2O concentrations were oversaturated with respect to atmospheric equilibrium. Globally, CH_4 values were high in rivers located in the catchment of Kabuno bay where swamps promote CH_4 production.