Physical and biogeochemical limits to internal nutrient loading of meromictic Lake Kivu

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Running head: Lake Kivu internal nutrient loading

Abstract

Lake Kivu is one of the large African Rift lakes situated between the Democratic Republic of Congo and Rwanda. In its permanently stratified hypolimnion, unusually high methane concentrations have increased further in recent decades. As methanogenesis is limited by supply of organic material, it is essential to quantify the nutrient fluxes from the saline and nutrient-rich deep waters to the photic zone. These upward fluxes are mainly driven by advection due to subaquatic springs. Biogenic calcite precipitation drives surface-water depletion and deep-water enrichment of Ca^{2+}, Sr^{2+}, and Ba^{2+}. Methane is mainly oxidized aerobically at the redox interface at 60 m, with a small contribution of anaerobic methane oxidation. A subaquatic spring that sustains the major chemocline at 250 m depth was depleted of N, P, and CH_4, while concentrations of major ions were slightly lower than in the lake water of the same depth. Enrichment of the deep waters with nutrients and CH_4 are driven by mineralization of settling organic material, whereas SiO_2 is influenced by uptake and mineralization of diatoms and inputs through subaquatic springs. DIP and Si fluxes supplied by internal loading through upwelling were found to be lower than the estimations for Lakes Malawi and Tanganyika. In contrast, N flux was within the lower range for Lake Malawi, while it was assumed to be totally lost by denitrification in Lake Tanganyika. In Lake Kivu, nutrient uptake by primary production is four times higher than nutrient upward fluxes.