The biogeochemistry of tropical lakes: A case study from Lake Matano, Indonesia

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ABSTRACT: We examined the chemical composition of the water column of Lake Matano, Sulawesi Island, Indonesia, to document how the high abundances of Fe (hydr)oxides in tropical soils and minimal seasonal temperature variability affect biogeochemical cycling in lakes. Lake Matano exhibits weak thermal stratification, yet a persistent pycnocline separates an oxic epilimnion from anoxic meta- and hypolimnions. The concentration of soluble P in the epilimnetic waters is very low and can be attributed to scavenging by Fe (hydr)oxides. Chromium concentrations in the epilimnion are high (up to 180 nmol L^{-1}), but below U.S. Environmental Protection Agency guidelines for aquatic ecosystems. The concentration of chromium decreases sharply across the oxic-anoxic boundary, revealing that the hypolimnion is a sink for Cr. Flux calculations using a one-dimensional transportreaction model for the water column fail to satisfy mass balance requirements and indicate that sediment transport and diagenesis play an important role in the exchange of Fe, Mn, P, and Cr between the epilimnion and hypolimnion. Exchange of water between the epilimnion and hypolimnion is slow and on a time scale similar to temperate meromictic lakes. This limits recycling of P and N to the epilimnion and removal of Cr to the hypolimnion, both of which likely restrict primary production in the epilimnion. Owing to the slow exchange, steep concentration gradients in Fe and Mn species develop in the metalimnion. These concentration gradients are conducive to the proliferation of chemoautotrophic and anoxygenic phototrophic microbial communities, which may contribute a significant fraction to the total primary production in the lake.

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