Tracing the sources and evaluating the cycling of phosphate using $\delta^{18}O_p$ in a eutrophic tropical mariculture area

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Mariculture, or farming of fish and other marine organisms in the coastal areas has become one of the major sources of food and livelihood in both developed and developing countries, but unfortunately also a source of water quality degradation. In Bolinao and Anda, a coastal embayment in the northwestern Philippines, farming of milkfish (*Chanos chanos*) has rendered the waters eutrophic with attendant algal blooms, hypoxia, and fish kills. In this study, we applied a novel tool, the analysis of oxygen isotopes of phosphate ($\delta^{18}O_p$), to trace the different sources of phosphate, one of the decomposition products of fish feeds and other mariculture-generated wastes, and evaluated its cycling by determining the offset in the measured $\delta^{18}O_p$ values from the expected equilibrium values assuming complete oxygen isotope exchange with water. We have identified two contrasting end-member sources of phosphate based on $\delta^{18}O_p$ signatures – freshwater (rivers, 14.4 ± 0.2‰; groundwater, 14.8 ± 1.6‰) and fish feed (21.8 ± 0.4‰). Most of the samples from mariculture areas have $\delta^{18}O_p$ values closer to the fish feed signature which confirms that fish feed is the major source of nutrients to the mariculture area. The contribution of rivers is seen in the lower $\delta^{18}O_p$ of samples taken during the wet season. Measured $\delta^{18}O_p$ values were usually higher than the expected equilibrium values indicating that the source signature has not been imprinted by complete biological cycling, but variations may be related to hydrodynamic and biogeochemical processes in the area.