Biogeochemical cycling of phosphate in the Yasu River Watershed: Insight from oxygen isotope of phosphate

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1. Introduction

Phosphorus (P) is an essential element for all living organisms and can be a limiting factor for primary production in river ecosystems. Therefore, its biogeochemical cycling is very important in proper land management and understanding of natural systems. Recently, oxygen isotope ratio of phosphate ($\delta^{18}O_{PO4}$) has been used as a tool to elucidate the P cycle. Previous studies showed the possibility to evaluate P sources, metabolism by organism in some ecosystems (Paytan & McLaughlin 2011). However, there are few research to show the spatial distribution of $\delta^{18}O_{PO4}$ in the watershed scale, and it is not clear whether $\delta^{18}O_{PO4}$ is useful for evaluating the biogeochemical cycling of P in the watershed scale. The purposes of this study are to show the $\delta^{18}O_{PO4}$ distribution in the watershed scale and to examine the relationship between $\delta^{18}O_{PO4}$ distribution and environmental factors, such as P sources, land use and physical characteristics of a river.

2. Material and Method

The investigation was conducted in the Yasu River Watershed in Shiga prefecture, central Japan. River water samples were collected at 15 sites including tributaries in May 2016. As a P source to the river, rocks (granite, sedimentary rock, accretionary complex), soils from forest and paddy filed, chemical fertilizers mainly used in Shiga prefecture and wastewater treatment plant water were collected. For $\delta^{18}O_{PO4}$ analysis, phosphate in all samples was converted to silver phosphate by McLaughlin et al. (2004) procedure with solid phase extraction method to remove dissolved organic matter. The $\delta^{18}O_{PO4}$ values were measured by a TC/EA-IRMS (thermal conversion elemental analyzer connected to a Delta plus XP isotope ratio mass spectrometer via ConFlo III, Thermo Fisher Scientific). The $\delta^{18}O_{PO4}$ values of biologically cycled phosphate ($\delta^{18}O_{PO4\ Eq}$) in the river water samples were calculated by *Eq*. 1 (Longinelli & Nuti 1973):

$T = 111.4 - 4.3\ (\delta^{18}O_{PO4} - \delta^{18}O_w)$ (1)

Where T is water temperature (˚C); $\delta^{18}O_{PO4}$ and $\delta^{18}O_w$ are the $\delta^{18}O$ of phosphate and water, respectively.

3. Result and discussion

The $\delta^{18}O_{PO4}$ values in the river water samples ranged from 10.1‰ to 17.8‰. These values were different from the $\delta^{18}O_{PO4\ Eq}$ values at each site, indicating that the $\delta^{18}O_{PO4}$ values in river water samples can be used as a tracer for P sources in the Yasu River Watershed. Significant correlations were found between the $\delta^{18}O_{PO4}$ values in river water and the proportion area of the agricultural land and each rock. In addition, the direction of the regression line agreed with the $\delta^{18}O_{PO4}$ values in soil from paddy filed and each rock. These data suggest that agricultural land and rocks are main P sources to the river. Our

investigation showed that the $\delta^{18}O_{PO4}$ is useful for evaluation of biogeochemical cycling of P in the watershed scale.

Reference
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