Comparisons of oxygen isotope ratio of phosphate in river water and rocks between two watersheds in central Japan

*Jun'ichiro Ide[1], Abigail P. Cid-Andres[2], Takuya Ishida[3], Ken'ichi Osaka[4], Tomoya Iwata[5], Takuya Hayashi[5], Masanori Akashi[5], Ichiro Tayasu[3], Noboru Okuda[3]

1. Institute of Decision Science for a Sustainable Society, Kyushu University, 2. Osaka University, 3. Research Institute for Humanity and Nature, 4. Department of Ecosystem Studies, University of Shiga Prefecture, 5. Faculty of Life and Environmental Sciences, University of Yamanashi

Excess phosphorus (P) utilization by human activities has resulted in a large amount of P loss from terrestrial to aquatic ecosystems, which in turn can induce eutrophication and subsequently algal bloom in enclosed waters. To control the P loss, the phosphate oxygen isotope ratio ($\delta^{18}O_P$) technique is expected to be applied for clarifying P dynamics in terrestrial ecosystems. This is because $\delta^{18}O_P$ in river water could reflect sources of phosphate within the river watershed. However, very few studies have applied the $\delta^{18}O_P$ technique to clarifying watershed-scale P dynamics and thus little information is available about what the river $\delta^{18}O_P$ value indicates specifically within the watershed. To examine this, we compared the $\delta^{18}O_P$ values in river water and rocks between two watersheds with different land-use and geological compositions. For this, we collected river water and rock samples and analyzed their $\delta^{18}O_P$ in subwatersheds of the Ado River and the Yasu River watersheds, which were dominated by forests and covered by large areas of agricultural lands, respectively, belonging to the Yodo River system in central Japan. The river $\delta^{18}O_P$ value was significantly higher in the Ado River watershed than in the Yasu River watershed (u-test, $p < 0.05$). This could not be explained by the forest area ratio within a subwatershed. The relationship between river $\delta^{18}O_P$ values and subwatershed areas revealed that the $\delta^{18}O_P$ value tended to increase and reach a plateau as the subwatershed area increased. Additionally, the result showed that the river $\delta^{18}O_P$ value was higher in the Ado River watershed than in the Yasu River watershed at a given subwatershed area. These findings are attributable to the fact that high values of $\delta^{18}O_P$ in river water could derive from those in the accretionary complex. This is because geological compositions in the subwatershed with large area (10 km^2) contain the accretionary complex in the Yasu River watershed and also because geology in the Ado River watershed is composed mostly of the accretionary complex. On the other hand, the river $\delta^{18}O_P$ value could change not only by the geological factor, but also by biologic uptake of phosphate. It is possible that changes in the river $\delta^{18}O_P$ value with the subwatershed area resulted partly from an increase in the opportunity for the biologically-mediate oxygen isotope exchange between water and phosphate associated with the increased river length.

Keywords: Stable isotope analysis, Source of phosphate, Diffuse pollution, Lake Biwa, Accretionary complex

