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Quantifying nitrate dynamics in the changing lake Inawashiro

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Lake Inawashiro in Fukushima (surface area:103.3 km^2, maximum depth:94.5 m) had been characterized by low pH around 5.0. The pH, however, has been increasing for these 20 years. Present pH is around 6.8. In addition, with the neutralization, annual variation range of NO_3^- concentration in surface water increased from 3.6 μmol/L in 2007-2008 to 5.2 μmol/L in 2011-2012 (Fukushima Prefectural Institute of Environmental Reserch, 2008 and 2012), implying primary production is increasing in the lake water column. The purpose of study is to quantify both the gross assimilation rate and gross nitrification rate in the lake using $\Delta\ ^{17}O$ of nitrate.

Water sampling was carried out in both June and September, 2014. Water samples were filtered through GF/F filters and stored in cold storage until analysis. The nitrate concentration were determined with Shimadzu Prominence HIC-SP. Each isotopic composition of nitrate was determined with CF-IRMS system using the Chemical Conversion method (Tsunogai et al., 2010).

While NO_3^- concentrations in the lake water column were almost constant at 14.0 μmol/L from surface to the bottom in June, those in 0-30 m decreased to 8.0 μmol/L in September. The $\delta^{15}N$ values of nitrate increased for around +1 ‰, implying surface NO_3^- was consumed through primary production. The observed large seasonal variation range in NO_3^- at the surface (6 μmol/L) supported the past observation of the increasing trend. The total amount of nitrate in the lake water column also decreased from 79.9 to 72.7 Mmol during the period between the observations. On the other hand, the $\Delta\ ^{17}O$ values were almost costant around +3.5 ‰ inspective to the depths and seasonals. The mixing ratio of atmospheric NO_3^- were about 14 %, implying the average residence time of NO_3^- in lake was long and nitrogen nutrient is not a limiting nutrient for the primary production in the lake. The observed mixing ratio indicated that 6.2 Mmol of remineralized nitrare was fed into the water column though nitrification, while 14.8 Mmol of nitrate was simultaneousluy removed from the water column by assimilation, during the period between the observations. The assimilation amount between the observation interval (14.8 Mmol) correspond to only 30 % of the annual amount of assimilation (48.5 Mmol) caluculated assuming steady state in the lake. As a result, assimilation in the lake proceed at an almost constant rate throughout the year, otherwise the nitrogen cycling in the lake water column is not under the steady state condition.

Keywords: Inawashiro lake in Fukushima, nitrate stable isotopes, nitrogen cycling, triple oxygen isotopes, assimilation, nitrification