



Tracing the fate of atmospheric nitrate deposited onto a forest ecosystem in eastern Asia using triple oxygen isotopes

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The stable isotopic compositions of nitrate in precipitation (wet deposition) and groundwater (spring, lake, and stream water) were determined for the island of Rishiri, Japan, so as to use the ^{17}O anomalies ($\Delta^{17}\text{O}$) to trace the fate of atmospheric nitrate that had deposited onto the island ecosystem, which is a representative background forest ecosystem for eastern Asia. The deposited nitrate had large ^{17}O anomalies with $\Delta^{17}\text{O}$ values ranging from +20.8 ‰ to +34.5 ‰ (n = 32) with +26.2 ‰ being the annual average. The maximum $\Delta^{17}\text{O}$ value of +34.5 ‰, obtained for precipitation on the 23rd to 24th of February 2007, was an extraordinarily large value among values for all the samples of precipitation in the island. Most nitrate in the sample might have been produced through the heterogeneous reaction in a highly polluted air mass that had been supplied from megacities on the eastern coast of the Asian continent. On the other hand, nitrate in groundwater had small $\Delta^{17}\text{O}$ values ranging from +0.9 ‰ to 3.2 ‰ (n = 19), which corresponds to an average mixing ratio of atmospheric nitrate to total nitrate of 7 %. Comparing the inflow and outflow of atmospheric nitrate in groundwater within the island, we estimated that the direct drainage accounts for $(10.5 \pm 5.2)\%$ of atmospheric nitrate that has deposited on the island and that the residual portion has undergone biological processing before being exported from the forest ecosystem.