

# Secular variations of river water chemistry from 2001 to 2005 in the Tanzawa and Kofu Mountains

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As a consequence of atmospheric pollution and related strong acid deposition, surface water and soil acidification has been considered to be a major environmental problem in the forest regions adjacent to densely populated cities. This study is devoted to the monitoring solute concentrations in river water (from May 2001 to January 2005) at the two contrasting watersheds, one in the Tanzawa Mountains and another in the Kofu Mountains. The Tanzawa Mountains is located about 50 km west of the Great Metropolitan Tokyo and an area receiving higher amounts of pollutants through atmospheric deposition than the Kofu Mountains. In addition, the areas have received considerably high SO<sub>2</sub> deposition emitted from Mt. Miyake volcano since August 2000. All water samples were filtered (0.45 mm pore diameter membrane filter) and concentrations of SiO<sub>2</sub>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Al<sup>3+</sup>, PO<sub>4</sub><sup>3-</sup> were analyzed by ICP, Na<sup>+</sup> and K<sup>+</sup> by AA, and Cl<sup>-</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup> by IC. HCO<sub>3</sub><sup>-</sup> was determined by the 0.1N-H<sub>2</sub>SO<sub>4</sub>-titillation method.

Compared to the average composition of river water in Japan [Kobayashi (1960)], the Tanzawa water samples have higher Ca<sup>2+</sup> and NO<sub>3</sub><sup>-</sup> and comparable concentrations of other solutes analyzed. The sample waters in the Kofu Mountain area is characterized by higher K<sup>+</sup> and lower NO<sub>3</sub><sup>-</sup> (below 2mg/l) and Cl<sup>-</sup> than the Tanzawa sample waters.

The Cl<sup>-</sup> concentrations in the river water samples in both Tanzawa and Kofu mountains show well defined negative correlation with distance from the seashore of Sagami Bay to the sampling point, suggesting that sea salt is the main source of Cl<sup>-</sup>. We estimate about 38%~65% of Na<sup>+</sup> in the water samples is derived from airborne sea salt. The concentrations of solutes and Sr isotope compositions in the river water samples mutually correlate to the chemical and Sr-isotope compositions of bedrock in the watersheds. The (Ca<sup>2+</sup>+Mg<sup>2+</sup>) and HCO<sub>3</sub><sup>-</sup> concentrations in water samples of both Tanzawa and Kofu Mountains show well defined 1 to 1 correlation, suggesting that Ca<sup>2+</sup>, Mg<sup>2+</sup> and HCO<sub>3</sub><sup>-</sup> derived mainly from carbonates in the bedrock. The average Ca<sup>2+</sup> concentration in the Tanzawa river water samples is about 1.5 times higher than that in the Kofu mountains, suggesting higher rate of carbonate dissolution in the Tanzawa Mountains. This difference would be attributed to higher uplifting rate in the Tanzawa Mountains associated with active tectonic in this area. During the monitoring period, we observed nearly constant SiO<sub>2</sub>-normalized values of Ca<sup>2+</sup>, Mg<sup>2+</sup>, and K<sup>+</sup> in the water samples collected from the riversheds in both Tanzawa and Kofu Mountains. This suggests that bedrock dissolution is the predominant mechanism providing SiO<sub>2</sub>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, and K<sup>+</sup> in river water in both watersheds. On the contrary, SiO<sub>2</sub>-normalized values of NO<sub>3</sub><sup>-</sup> and SO<sub>4</sub><sup>2-</sup> show a wide range of variation during the monitoring period, suggesting that atmospheric pollution and related acid deposition are the main sources for NO<sub>3</sub><sup>-</sup> and SO<sub>4</sub><sup>2-</sup>. In addition, the secular variation of SO<sub>4</sub><sup>2-</sup> in the river and spring water samples in the Tanzawa Mountains apparently correlate with that of SO<sub>2</sub> discharge from Mt. Miyake volcano. Significant amounts of Al<sup>3+</sup> are detected in the river water samples in both Tanzawa and Kofu Mountains. In the water samples collected from 2003 to 2005 from the Tanzawa Mountains, we observe considerable increase in pH (from ~7.0 to ~8.0). This pH change apparently negatively correlates with the concentration of Al<sup>3+</sup>. During the same period, the average concentration of Al<sup>3+</sup> in the water samples in the Tanzawa Mountains decreased from 0.03 to 0.01 mg/l. Similar variation in the Al<sup>3+</sup> concentration is noted in the river water samples of the Kofu Mountains, in which the average concentration of Al<sup>3+</sup> decreased from 0.03 mg/l in Dec. 2002 to 0.012 mg/l in Dec. 2004.