

Acidification process of shallow groundwater in an alluvial fan in Ueda City, Nagano, Japan

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The Koganezawa River water in Ueda City, Nagano Prefecture, has strong acidic nature under the influence of pyrite ore deposits once mined in its upstream reach. Sulfate-rich acidified shallow groundwater with pH range of 5 to 6 in the Koganezawagawa River alluvial fan has long been attributed to the infiltration of river water into shallow aquifers beneath the fan (Akutsu, 1958). This study, with the help of a multi-tracer method, aims to improve the information on the present hydrological environment of the Koganezawa River alluvial fan and to clarify its groundwater quality formation process with emphasis on the acidification process of shallow groundwater.

Survey on the Koganezawa River water and shallow groundwater (well water and spring water) of the alluvial fan was conducted from August to November 2018. As a result, 1) groundwater acidity is associated with nitrate and sulfate ions for the left and right banks of the river, respectively, 2) groundwater in the right bank shows lower pH than that in the left bank, and 3) oxygen ($\delta^{18}\text{O}$) and hydrogen (δD) isotopic ratios are low for the groundwater in the right bank, compared with that in the left bank. These results strongly suggest the sulfate-rich acidified and isotopically depleted river water infiltrates mainly into the right bank, affecting its shallow groundwater quality. The two end-member mixing analysis, based on the concentration of sulfate (SO_4^{2-}) and nitrate (NO_3^-) ions, indicates a contribution of the infiltrated river water to the formation of the groundwater in the right bank is in the range 8 to 31 %. Furthermore, from the nitrogen ($\delta^{15}\text{N}$) and sulfur ($\delta^{34}\text{S}$) stable isotopic ratios, it is estimated that nitrogen and sulfur in groundwater in the left bank is likely to be of manure origin. It can be concluded that acidification of shallow groundwater in the Koganezawa River alluvial fan is due to river water infiltration for the right bank, while manuring for the left bank.

Keywords: acidified river water, alluvial fan, river water infiltration, shallow groundwater, groundwater acidification, multi-tracer method