Application of Multiple-indicator to groundwater flow and chemistry study in the alluvial fan

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The Tedori River Alluvial fan between the Tedori and Sai Rivers in central Japan contains abundant groundwater resource and it supplies the region drinking and industrial water. The paddy and crop-rotated paddy fields occupy 45% of its total area (140km^2). To maintain sustainable groundwater use and prevent groundwater contamination, it is necessary to investigate the flow paths and sources of the groundwater. In this study, 83 water samples mainly from shallow groundwater, river water, and paddy water, were collected in the alluvial fan during the paddy irrigation period. We analyzed stable isotope ratios of H, O, and Sr and concentrations of major dissolved ions and trace elements.
The δ^2H and δ^{18}O values in the shallow groundwater are relatively low along the Tedori River and increased with the distance from the river; this trend would be caused by dilution effect by the river water. However, there is little contribution of the paddy water with high values reflecting the influences of the evaporation effect. Concentrations of Mg^{2+}, Ca^{2+}, Sr^{2+}, HCO_3^-, and SO_4^{2-} in the groundwater have a similar distribution trend: lower along the Tedori River and higher in the central area of the fan where paddies are relatively widespread. The $^{87}Sr/^{86}Sr$ ratios of the groundwater are related to near-surface geology. The groundwater in sediment from the Tedori River has relatively high $^{87}Sr/^{86}Sr$ ratios, whereas that from the Sai River in the north of the fan has low $^{87}Sr/^{86}Sr$ ratios. The river water of the Tedori River is also high ratio reflecting sediments in the upper river basin. The three stable isotopes indicate that the groundwater in the central and southern fans is recharged from the Tedori River, whereas recharge in the north is from the Sai River.
There are linear relationships between $^{87}Sr/^{86}Sr$ ratio and the reciprocal concentrations of Sr^{2+}, Mg^{2+}, and Ca^{2+}. These geochemical characteristics suggest that groundwater recharged from the Tedori River flows towards the central fan and then runs off the sea. It mixes with waters from precipitation and paddy water that have become enriched in these components during downward infiltration. The results obtained by application of multiple-indictor are consistent with our hydrological observation results: groundwater contour maps and river water balances, and groundwater flows reproduced by the three dimensional numerical simulation.

Keywords: Strontium isotope, Paddy field, Groundwater-river interaction

