

Geochemical and isotopic map of spring water and surface water in Yuza town of Yamagata prefecture

Takanori Nakano^{1*}, Shin Kichoel¹, Yoshihiro Yamada²

¹Research Institute for Humanity and Nature, ²Faculty of Agriculture, Kagawa University

Yuza town is located in the northern part of Shounai plain, which develops in the northwestern area of Yamagata prefecture. This town faces Japan Sea in the west and Mt Choukai in the north. Mt Choukai is 2236 m in height and is known to be rich in rain and snow, whose annual amount is estimated to reach 12000 mm per year. Owing to the large amount of precipitation, many springs occur in the foot of mountain, plain, coast, and seafloor. *Pungitius sinensis*, an endangered species, lives in the freshwater spring, and oyster on rock, a specialty of this town, distributes around the seafloor spring. Groundwater in Mt. Choukai and plain is used for drinking, agriculture, and salmon culture, supporting daily lives and industries. Preservation and sustainable use of groundwater is indispensable for Yuza town and other areas in the watershed of Mt. Choukai. Yuza town is examining to develop regulations for the preservation of groundwater and spring. We collected surface water and groundwater from the whole area of Yuza town. We also collected monthly rainwater at three sites with different elevation from 2010 to 2011. We determined the concentrations of dissolved components and stable isotope ratios of H, O, and Sr in the water. The result is summarized as follows.

The water quality of precipitation showed a large temporal variation. Winter precipitation is rich in Cl, Na, and Br due to the supply of sea-salt component from Japan Sea. It is also high in heavy metals such as Pb, Cd, and Zn, largely transported from the Asian continent by westerly winds. The seasonal variations of δH and $\delta^{18}O$ values in precipitation are less distinct, but the δ -value is high in winter and low in summer irrespective of sites. These components can be utilized as a powerful atmosphere-derived index.

The geochemical components and isotopic ratios of spring water and surface water did not show a temporal variation. But they showed a large geographical variation and the waters are classified into 8 areas. The δH and $\delta^{18}O$ values of freshwater showed an altitude effect, but those of groundwater and artesian water in the central part of Yuza town are low compared to waters in the surroundings. The comparison of isotope ratio and quality in the water shows that the groundwater is recharged largely from Gakkou river and from nearby watersheds.

The concentration of Cl and Na in the coastal water also showed an altitude effect. It is notable that water in the northern rocky area is high in sea-salt components compared to the water in the southern sandy beach. This result indicates that sea-salt particles are productive in the rocky coast.

Snow-melt water in the high elevation area of Mt. Choukai and swamp water around summit plateau of Mt Yoshide are characterized by low δ -values, showing a contribution of summer precipitation. The δ -value of other waters shows a geographical variation and the water of the eastern area of Mt. Choukai has high δ -value, suggesting large input of winter precipitation. This result is consistent with high amount of snow in the eastern Choukai.

Groundwater is low in heavy metals (Pb, Cd), which are high in the snow-melt and swamp water, indicating the contribution of precipitation. It is also notable that these water is characterized by high $^{87}Sr/^{86}Sr$ ratios (>0.707). Most waters in mountainous area and plain area, which are composed of andesite and their clastic sediments, have low $^{87}Sr/^{86}Sr$ ratios (0.704-0.705), indicating andesite-derived Sr. Water with high $^{87}Sr/^{86}Sr$ ratio indicates the dominant contribution of precipitation-derived Sr. It is considered that groundwater in mountain foot and plain is characterized by low contents of Pb and Cd, indicating that atmospherically-derived heavy metals are mostly adsorbed in the soil.

Groundwater in coastal hill has high contents of NO_3 , Mg, B, and As, which are presumably derived from fertilizer. Water

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