Geochemical and isotopic map of water toward the sustainable diagnosis of aquifer environment

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In order to elucidate the recharging area and human impact on the groundwater in the plain of Saijo city of western Japan, we determined the major and trace elements and four stable isotope ratios (H, O, S, Sr) of groundwater and surface water in different seasons. We made the analyzed data of each component as the geochemical and isotopic map. The map of 87Sr/86Sr ratios and d34S values are well correspondent to that of the watershed geology except high elevation sites above 1500 masl, indicating that most Sr and S in the water is derived from watershed rocks. Positive relationship among Ca, Sr, and SO4 suggests that sulfides in the rock are oxidized to form sulfuric acid, which has accelerated the dissolution of Ca-containing minerals with Sr.

The dD and d18O values in the surface water in the mountainous area tend to decrease with elevation, as well as the concentrations of alkali elements, alkali-earth elements, SO4, and Cl. The amount of precipitation, which is depleted in dissolved elements, increases with elevation. In contrast to the altitudinal decrease of Sr and SO4, the 87Sr/86Sr ratio and d34S value are less dependent on elevation. This result indicates that the contribution of rock-derived elements into the water decreases in accordance with that of atmosphere-derived elements.

Groundwater in the plain shows a different quality between the eastern Saijo plain and western Shuso one, indicating that each groundwater constitutes an independent aquifer system. Groundwater in the Shuso plain is enriched in NO3 due to the agricultural activity in the alluvial fan, whereas that in the Saijo plain is low in dissolved solutes. This difference in the groundwater quality is ascribed to the presence of impermeable sediments between the two plains.

Groundwater under the eastern Saijo plain is divided into three zones from southern mountains to northern coast, spring water, artesian groundwater, and coastal groundwater subjected to enchroachment of seawater. The geochemical and isotopic compositions of spring water were similar to those of adjacent Kamo river, but were different from those of the artesian water, which are indistinguishable from those of surface waters in the mountainous area of the Kamo river watershed. We assume that the coastal water originates from the artesian water, which is recharged through fissures in the basement rocks of mountainous areas.

The geochemical and isotopic map is useful not only for researchers to elucidate the genetic link between the surface and ground waters but also for policy maker and citizens to realize the human impact on both waters. Based on this map which provides diagnostic information on the whole water quality in Saijo, we have started collaborative monitoring with the Saijo municipality on the quantity and quality of surface and groundwater at 10 important sites every week. The flow rate of shallow groundwater estimated from this monitoring is 1.2x10-2cm/sec. This value is very fast compared to previous studies, but is consistent with the flow rate of the aquifer rocks in the Saijo plain which is dominant of conglomerate.