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Water quality map in the southern part of Mt. Fuji

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We summarized the quality of spring waters in the southern part of Mt. Fuji in map for the purpose of estimating the origin and recharge area of these springs. The study area is the foot of Mt. Fuji in Shizuoka Prefecture, including surrounding mountains (e.g. Mt. Ashitaka, Mt. Hakone, Tenshu Mountains). This area is an important industrial region, expected as a greenfield site for companies using high-quality groundwater. On the other hand, the problem of saline groundwater in coastal area arose in 1960s due to excess-pumping, not being solved completely today. Moreover, recently the amounts of spring waters tend to decrease at the foot of Mt. Fuji. The stable use of groundwater is important for the sustainable development of this area, and it is necessary for developing strategy for groundwater conservation and use to elucidate the mechanism of groundwater flow in the basin.

We collected 133 spring water samples from the study site in early winter (November to December 2009). Water samples were analyzed for major ions, trace elements and hydrogen, oxygen, and strontium isotopes. Geographic Information System was used to make the water quality map, which also contains information of e.g. geology, vegetation, land use and social conditions, in the study area.

The isotopic composition of oxygen and hydrogen in spring waters shows a linear relationship between d^{18}O values and dD values. The d-values in Mt. Ashitaka area, facing Suruga bay, and in the southwestern foot which altitudes are between 300 and 500 meters above sea level, are relatively low ($<$12). The low values indicate that the precipitation in both areas would be strongly affected by water vapor from the Pacific Ocean. The isotopic composition of oxygen in spring waters shows that low d^{18}O values between -8 and 10 permil are observed in the foot of Mt. Fuji except for spring waters in the southwestern foot, which represent -8 permil or less. The isotopic enrichment of these springs is probably caused by the superficial aquifer recharged by precipitation in the vicinity.

The spring waters in the basaltic rock area (Mt. Fuji, Mt Ashitaka and Mt. Hakone) display low ^{87}Sr/^{86}Sr values under 0.7040. In contrast, the ^{87}Sr/^{86}Sr values of spring waters in sedimentary rock area (Tenshu Mountains) are much higher (over 0.7055). The high Sr isotopic signature in the western foot of Mt. Fuji (Inokashira springs) suggests that the groundwater recharged in Tenshu Mountains would partly flow into the area.

The principal component analysis of the 19 components dissolved in the spring water was conducted. The first principal component can be regarded as an index of human activity, because its scores were low for springs in the southern foot of Mt. Ashitaka and the southwestern foot of Mt. Fuji, where tea plantation predominates. We consider the high concentrations of NO_3 observed in these areas to be of agricultural origin. The concentration of Cl is also high in the areas, probably caused mainly by airborne salt. We can also separate oxyanion-forming elements (e.g. V, P, As, Mo) from other dissolved components on the basis of their distribution on the second principal components. The concentrations of these elements are negatively correlated with d^{18}O values. The high concentrations are interpreted as resulting from the elution of the elements by long-term interaction between rock and groundwater recharged at high altitude of Mt. Fuji. The third principal component separates trace elements (e.g. Cs, Ba, Rb) from the other components, relatively low in the eastern foot and high in the western foot of Mt. Fuji.

As described above, we can clarify the regional characteristics of spring water through the analysis of stable isotopes and dissolved elements. Mapping the information of water quality with GIS made it possible to analyze factors which contribute to the regional variations and, in addition, to form a basis for building a groundwater governance in the study area.

Keywords: water quality, spring, stable isotopes, principal component analysis, GIS, Mt. Fuji