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Analysis of dissolved gas and fluid chemistry in mountainous region of Goaping river watershed in southern Taiwan

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Annual rainfall in Taiwan is up to 2500 mm, about 2.5 times the average value of the world. However due to high topographic relief of the Central Mountain Range in Taiwan, groundwater storage is critical for water supply. Mountain region of the Goaping river watershed in southern Taiwan is one of the potential areas to develop groundwater recharge model. Therefore the target of this study is to understand sources of groundwater and surface water using dissolved gas and fluid chemistry. Four groundwater and 6 surface water samples were collected from watershed, 5 groundwater and 13 surface water samples were collected from downstream. All samples were analyzed for stable isotopes (hydrogen and oxygen), dissolved gases (including nitrogen, oxygen, argon, methane and carbon dioxide), noble gases (helium and radon) and major ions.

Hydrogen and oxygen isotopic ratios of surface water and groundwater samples aligned along meteoric water line. For surface water, dissolved gases are abundant in N_2 (>80%) and O_2 (>10%); helium isotopic ratio is approximately equal to 1 R_A (R_A is $^3He/^4He$ ratio of air); radon-222 concentration is below the detection limit (<200 Bq/m^3); and concentrations of major anions and cations are low (Na^+ <20 ppm, Ca^{2+} < 60 ppm, Cl^- <2 ppm). All these features indicate that surface waters are predominately recharged by precipitation.

For groundwater, helium isotopic ratios (0.9∼0.23 R_A) are lower and radon-222 concentrations (300∼6000 Bq/m^3) are much higher than the surface water. Some samples have high amounts of dissolved gases, such as CH_4 (>20%) or CO_2 (>10%), most likely contributed by biogenic or geogenic sources. On the other hand, few samples that have temperature 5° higher than the average of other samples, show significantly high Na^+ (>1000 ppm), Ca^{2+} (>150 ppm) and Cl^- (>80 ppm) concentrations. An interaction between such groundwater and local hot springs is inferred.

Watershed and downstream samples differ in dissolved gas species and fluid chemistry for groundwater and surface water. The higher hydrogen and oxygen isotopic ratios for surface water from downstream are most probably caused by evaporation. Low radon-222 concentrations of some groundwater from downstream may represent sources from different aquifers. Therefore, we conclude that surface water from downstream are recharged directly from its watershed, but groundwater are influenced by the local geological environment.

Keywords: groundwater, dissolved gas, noble gas, radon in water, $^3He/^4He$