Carbon isotope constraint on the provenance of dissolved inorganic carbon in carbonate rock aquifer system

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We used $d^{13}C$ values and chemical compositions of groundwater to investigate the influences of carbonate dissolution and of decomposition of organic matter in Miyakojima Island, where carbonate aquifer system is well developed and sugarcane (C4 plant) is widely cultivated.

Most of groundwater was Ca-HCO_3 type, while a part of groundwater exhibited Na-Cl type attributed to seawater intrusion. This fact indicates an occurrence of carbonate dissolution. Deducing from the relationship between pH and DIC contents of the groundwater, aquifer condition is open system for CO_2 with 10^{-1}-$10^{-2.5}$ P_{CO2}. Assuming pH of the groundwater is mainly controlled by two processes; carbonate dissolution and of decomposition of organic matter, DIC originated from carbonate rock occupies 32-47%. Moreover, by using $d^{13}C$ values as tracers, the remaining DIC originated from decomposition of organic matter is divided into two components; one is supplied at sugarcane field and the other is at forest (which is mainly consisting of C3 plant). Then, percentage of two components can be calculated with following assumptions:

(1) $10^3 \ln a_{H2CO3-CO2(g)}$=-1.068 (@ 25 C) and $10^3 \ln a_{HCO3-CO2(g)}$=7.954 (@ 25C).

(2) $d^{13}C$ of carbonate rocks, C4 and C3 plants are -4.5, -20.8 and -37.5 permil (mean measured values), respectively.

(3) Carbonate carbon takes HCO_3^- form in the groudnwater.

Consequently, up to 75% in the remaining DIC is likely derived from C4 organic matter, indicating the groundwater in the Miyakojima Island is mainly recharged in sugarcane field.