

Effects of cave environmental condition on drip-water hydrogeochemical characteristics

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Speleothems contain large amount information of earth paleoenvironment change. Multi-proxies, supported by a series of hypothesis, have been used to interpret paleoenvironment change of karst. However, the records of speleothems are seldom coincident within the same cave and contradictive results have been reported. To clarify high resolution, short time scale information urged to reduce noise. Understanding hydrogeochemical processes happening in cave roof can contribute to interpret paleoenvironment change. Cave systems were monitored in Jiangjun Cave in Anshun county of Guizhou province, China, lasted for a year. NaCl was adopted to trace sources of cave drip water, time scales of drip water responding to precipitation, and processes of water dynamics in the cave. 4 drip points were monitored. The result shows that time scale of drip-water responding to rainfall was very quick (0-9 days). Drip water chemical components were directly originated from soil and greatly affected by the soil thickness. The thinner soil was; the less substances water dissolved. Water passed more quickly, which decreased the possibility of dilution happening in drip water, simultaneously, increased the contribution of rock to drip compositions. Different sources of water affected drip water dynamic process, which led to piston flow for JJD-1#, and increased drip ratio and water head pressure for JJD-2# as well while water was of much quantity. The process of rock dissolution and calcite precipitation mainly controlled elements variations of 4 drip waters while water transported in the route and acted with soil and rock. Consequently, as an important karst environmental factor, soil decides and controls drip compositions of cave drip waters, which means more attentions must be paid to soil in future study.

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Tracing natural CO₂ geological sequestration processes with noble gases

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Isotopic and elemental fractionation of noble gases can be used, together with other gases, to identify and quantify the origin, migration and sequestration processes of natural CO₂ gas deposits. The Jackson Dome CO₂ reservoir lies north east of the Jackson Dome intrusive in Mississippi, USA. The reservoir occurs between 4270m and 5180m depth and is assumed to have formed by thermal decarbonation reactions associated with the Jackson dome intrusive contact with related carbonate formations. 10 gas samples were collected and analysed for both noble gases and major gas composition. CO₂ ranges from 98.75% to 99.38%. Trace amounts of CH₄ and N₂ are correlated, and both correlate negatively to CO₂, suggesting that CH₄ and N₂ have a different source to that of the CO₂. The highest concentrations of N₂ and CH₄ are found on the crest of the trapping structure.

³He/⁴He ratios range between 4.27R_a and 5.01R_a (where R_a is the atmospheric value of 1.4×10⁶), indicating a strong mantle signature. CO₂/³He ratios vary between 1.07×10⁹ and 4.62×10⁹ and are in the range of the values found in pure magmatic samples (1-7×10⁹). The source of the CO₂ is not due to thermal decomposition of carbonates, but is dominated by magmatic gas.

The relationship among major gases (CO₂ and N₂), ⁴⁰Ar, ⁴He and Ne isotopes shows that the gases in Jackson Dome reservoir are a mixture of a fractionated air component, a magmatic end member and a radiogenic/crustal component. ²⁰Ne can be crudely used as a groundwater proxy. Anti-correlation of ²⁰Ne with CO₂/³He shows that groundwater plays a role in CO₂ sequestration and may be responsible for more than 70% of CO₂ loss. This is a common feature seen in other magmatic CO₂ rich natural gas fields (Gilfillan *et al.*, 2007)

²⁰Ne/³⁶Ar in the gas phase is higher than the groundwater ratio of ~0.16 with values of 0.798 to 1.35. CO₂/³He ratios correlate with both ²⁰Ne/³⁶Ar and δ¹³C (CO₂) values. We explore a variety of models to explain this data including: oil-groundwater partitioning; gas-groundwater partitioning; excess air dissolution and noble gas re-dissolution. A solubility controlled Rayleigh fractionation of groundwater modified by oil interaction appears to account for all correlations.

Reference

Gilfillan S.M.V., Ballentine C.J., Holland G., Blagburn D., Sherwood Lollar B., Stevens S., Schoell M. and Cassidy M. (2007), *Geochim. Cosmochim. Acta*, submitted