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Diel cycling, flux, and fate of HCO_3^- in a typical karst spring-fed stream of southwestern China

Zhang, C.[1,2], Wang, J.[1,2] and Jiang, Z.[1,2]

[1]Key Laboratory of Karst Dynamics, MLR/GZAR, Institute of Karst Geology, CAGS, Guilin 541004 China, first author email: chzhang@karst.ac.cn
[2]International Research Center on Karst under the Auspices of UNESCO, Guilin 541004 China

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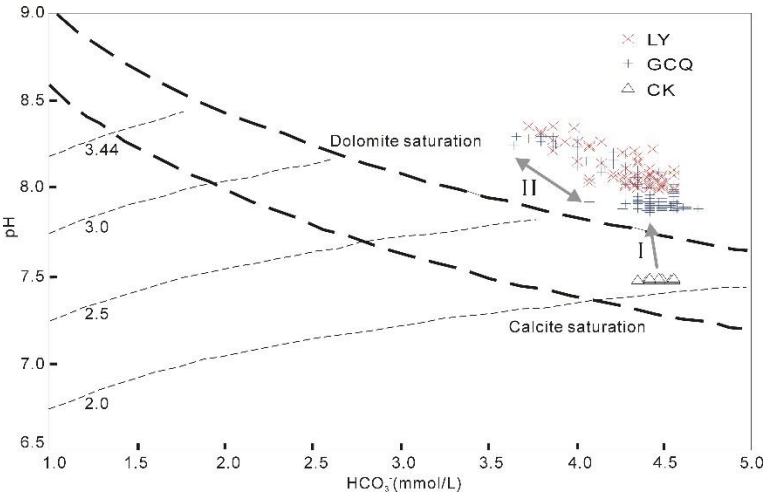
The research on diel variations in hydrochemistry and biogeochemical processes in surface rivers of karst areas can not only reveal controlling factors for diel cycling of hydrochemical inorganic compositions, but also help us better understand the rapid transfer of inorganic and organic carbon in karst processes.

With a case study on a karst spring-fed stream at Guangcun Village, Guangxi, Southwest China, this paper investigates the diel variations of the dissolved inorganic carbon, isotope, and partial CO_2 pressure from the outlet(CK) of the underground stream to the 1,350m downstream section(LY), and estimates the carbon loss and CO_2 exchange flux at the water-gas interface.

The results showed that the pH value and DO vary regularly on a daily basis with the temperature of stream water, suggesting that the photosynthesis of aquatic plants and algae is indeed the controlling factor for the diel variations of the pH and DO at LY.

During the monitoring period, the DIC (mainly in HCO_3^-) input (at CK) was relatively stable of about 4.46 mmol/L. The concentrations of HCO_3^- and Ca^{2+} at LY showed a diel cycle of daytime decrease and nighttime increase, with the same amplitude of 22.4%, the CO_2 degassing mainly occurred in the upper reaches of the surface stream right after groundwater exposed to the surface, the total CO_2 exchange flux of the entire monitoring stream section (from CK to LY) was calculated to be 29.83 kg/d, accounting for 24.5% of the DIC loss. It means that approximately 3/4 of the loss was converted into organic carbon.



Compared with the total carbon input at CK, this carbon loss only accounts for 4.7% of the total carbon amount (3.9% of which was converted into organic carbon and 0.8% of which was degassed to the atmosphere), indicating that the DIC of the karst groundwater in low order surface steams is stable in general, with less than 1% being lost to the atmosphere.

Figure 1 Relation between pH and HCO_3^- concentrations in stream water
Note: The two bold dashed lines indicate the saturating curves of calcite and dolomite respectively. The fine dashed line represents the equilibrium line of CO_2 (-log pCO_2), and the arrow I and the two-headed arrow II indicate the variations of pH and HCO_3^- along the flow path and in daily respectively.