

Analysis of Influencing Factors on the Variation of Soluble Inorganic Carbon in Reservoirs in Wujiang River Basin

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ABSTRACT

Carbon cycle plays a very important role in geochemical biological processes, there are a large number of lost carbon sinks in the process of calculating carbon sinks, and the carbon sinks after river damming are part of the lost carbon sinks, mainly soluble inorganic carbon (DIC). Select the Wujiang River Basin as the study area, with the help of carbon isotope labeling method to express the change law of carbon elements in the reservoir, and analyze the change law of the vertical profile of DIC. It is concluded that the change law of DIC is affected by dam construction, dissolution of carbonate rocks and aquatic organisms.

KEYWORDS

Damming; Soluble Inorganic Carbon; Carbonate Rock; Carbon Isotope

1. INTRODUCTION

As a link between the earth's circles and layers, the carbon cycle plays a key role in controlling the earth's climate system and ecological environment system, and is considered to be the most important element geochemical cycle in the surface system[1, 2]. At present, one of the most important challenges facing the global carbon cycle is the imbalance of global CO₂ revenue and expenditure, and there is a large "surplus terrestrial carbon sink". In the fifth climate change assessment report (AR5) of the Intergovernmental Panel on Climate change (IPCC), this value reaches 2.5PgC/a[3].

Rivers act as important transport channels in terrestrial ecosystems and play a key role in material migration and exchange. In recent years, the influence of human activities on the natural process of rivers is becoming more and more serious. Among them, the construction of water conservancy dams has become one of the most important and significant interference factors to the flow interception and regulation of the river, and they have an important impact on the river transport flux and material state. The construction of water conservancy dam leads to the siltation and interception of river water, which leads to the slowing down of water flow and the accumulation of sediment. These changes have had a far-reaching impact on the material cycle and biodiversity of river ecosystems. In the reservoir area, the deposition and accumulation of sediments will cause the enrichment of dissolved and suspended carbon elements in the water body, thus changing the flux and morphological distribution of carbon. Through a series of chemical and biological processes, carbon elements are transformed and migrated, and have an impact on the ecosystem function of water bodies. The chemical and biological processes in the reservoir area have an important influence on the flux and form of carbon in the river water.

The karst area in southwest China is a continuous concentrated distribution area of carbonate rocks with the largest area and the most typical karst development in the world[4, 5]. The severe weathering of carbonate rocks has an important effect on the dissolved inorganic carbon in the watershed. The

Wujiang River Basin in Guizhou Province is an important area in the southwest karst area. In this study, the Wujiang River Basin is selected as the study area, and the cascade reservoirs in the basin as the research object. Analysis of the influence mechanism of dam construction on dissolved inorganic carbon and the mechanism of its influence on carbon cycle.

2. STUDY AREA

The Wujiang River is the largest river in Guizhou Province. The right bank tributary of the upper reaches of the Yangtze River has a total length of 1037 km, a basin area of 87900 km², a natural drop of 2123.5 m and an average annual flow of 1650 m³/s, but it is unevenly distributed throughout the year. 80% of the runoff is mainly concentrated in the summer flood season. The rocks in the basin are mainly carbonate rocks and clastic rocks. It is one of the important components of the southwest karst area, and it is the most typical karst development area in the world. This area has dense inland river network and rich water resources. This area is a subtropical monsoon humid climate, with an average annual temperature of 12.3C, an extreme maximum temperature of 35.4 °C, an extreme minimum temperature of -10.1C, an average temperature of 3.5C in the coldest month (January) and a mean temperature of 26 °C in the hottest month (July). The average annual rainfall is 1100,1300 mm, mainly from May to October, accounting for about 75% of the total rainfall[6-9].

3. DISTRIBUTION CHARACTERISTICS OF DIC CONTENT AND $\delta^{13}\text{C}_{\text{DIC}}$

The occurrence form of DIC in freshwater body is determined by pH value, when $\text{pH} < 6.4$, CO_2 and H_2CO_3 are dominant, when $\text{pH} > 10.3$, CO_3^{2-} is dominant, and when $\text{pH} < 10.3$, HCO_3^- is dominant[10]. In this study, the published literature data were collected and processed. Through the pH analysis of the study area, HCO_3^- can be used to characterize the concentration of DIC.

3.1. Range and distribution characteristics

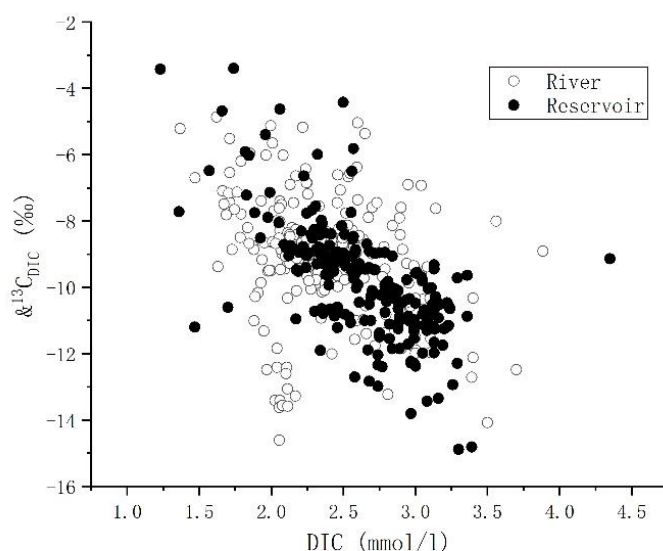


Fig. 1 changes of DIC and $\delta^{13}\text{C}_{\text{DIC}}$ in water body

Generally speaking, the concentration of dissolved inorganic carbon (DIC) and carbon isotope ($\delta^{13}\text{C}_{\text{DIC}}$) vary greatly, the range of DIC concentration is 1.23~4.35 mmol/L, and the range of carbon isotope is -14.89 ‰ ~ -3.40 ‰. The variation range of different water bodies is very large. The range of DIC concentration in rivers is 1.36~3.88mmol/L, and the range of carbon isotopes is -

14.60 ‰ ~ -4.86 ‰. The range of DIC concentration in the reservoir is 1.23~4.35mmol/L, and the range of carbon isotope is -14.89 ‰ ~ -3.40 ‰. The variation range of different water bodies is very large. The DIC concentration and carbon isotope in the reservoir vary greatly. The carbon isotope in the reservoir is more positive than that in the river.

3.2. Spatial distribution characteristics of DIC

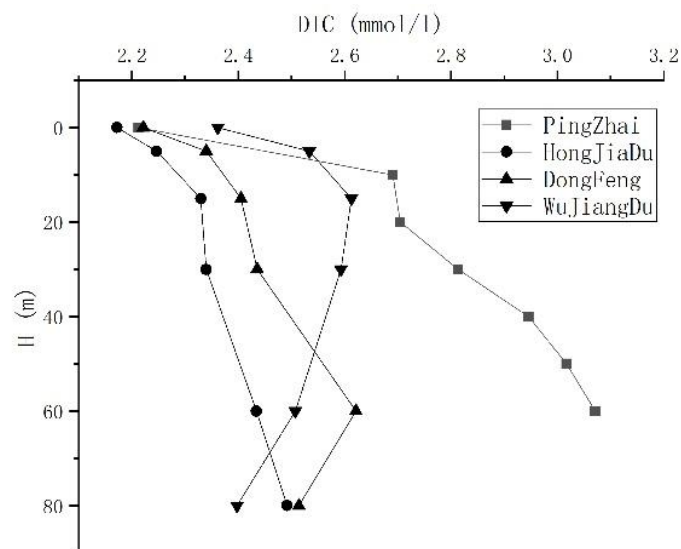


Fig. 2 variation of water body DIC and reservoir depth H

The DIC concentration showed an upward trend from the surface to the deep layer, and the DIC concentration in Pingzhai Reservoir increased from 1.36mmol/L to 3.11mmol/L. The DIC concentration in the surface layer of Hongjiadu Reservoir is between 1.822.49mmol/L and DIC concentration in spring-lt; autumn-lt; winter-lt; summer. It is also an increasing trend in the vertical direction. The DIC concentration in the surface layer of Dongfeng Reservoir is between 1.88 and 2.21mmol/L, and the DIC concentration is from spring to lt; autumn to lt; winter to lt; summer. It is also an increasing trend in the vertical direction. The concentration of DIC in the surface of Wujiangdu Reservoir is between 2.122.55mmol/L in four seasons, and the concentration of DIC in autumn-lt; spring-lt; winter-lt; summer. It is also an increasing trend in the vertical direction. Generally speaking, the concentration of DIC in reservoirs in Wujiang River Basin is the highest in summer.

3.3. Spatial distribution characteristics of $\delta^{13}\text{C}$ DIC

On the whole, the carbon isotope shows a negative trend from the surface to the deep layer. The isotope variation range of Pingzhai Reservoir is the largest, and the fluctuation is the largest from the surface depth to 10m. The variation range of Hongjiadu Reservoir is small, but the overall range is also negative with the increase of depth. The isotopes of Dongfeng Reservoir, Wujiangdu Reservoir and Hongjiadu Reservoir all follow the same law. With the increase of depth, the isotope becomes more negative. In the range of depth variation, Pingzhai is the most negative, followed by Wujiangdu Reservoir, Hongjiadu Reservoir and Wujiang Reservoir above 40m.

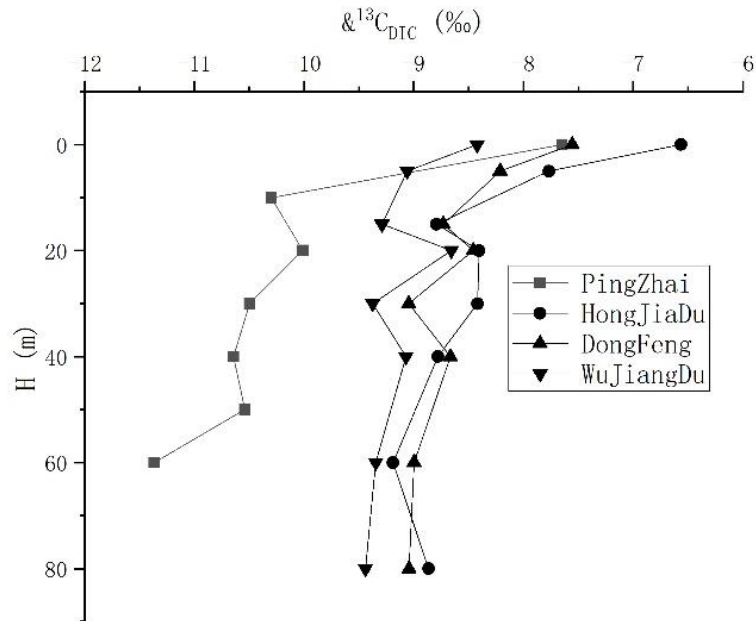


Fig. 3 variation of water body $\delta^{13}C_{DIC}$ and reservoir depth H

4. INFLUENCING FACTORS OF DIC

Wujiang River is located in the karst area of southwest China, which belongs to the typical carbonate area. The main sources of river DIC are atmospheric CO_2 , aquatic respiration, carbonate rock dissolution, soil CO_2 , rainfall and so on. Atmospheric CO_2 participates in the dissolution of carbonate rocks with rainfall, and the rainfall pH in southwest karst area is small and contains less hydrogen carbonate, so the contribution is very small and can be ignored. The main sources of DIC are carbonate weathering and soil CO_2 . Due to the factors of dam construction, the retention time of the water body increases, and the respiration of aquatic organisms in the water body is one of the factors affecting the DIC of the water body.

5. RESULT

After the dam construction of the Wujiang River, the flow of the water body becomes slower, the chemical and biological activities in the water body become faster, and the depth characteristics of DIC and isotopes in the water body are obvious. The main results are as follows:

- (1) under the influence of human factors such as dam construction, the variation range of DIC and isotopes of reservoirs is larger than that of rivers.
- (2) there is a significant negative correlation between DIC and isotopes in the reservoir with the change of water depth.
- (3) the main influencing factors of DIC in reservoirs in Wujiang River basin are the weathering of carbonate rocks and the biological action of water organisms.

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