Study on Hydrochemical Ion Characteristics in the Upper Reach of Tao River

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Abstract. In this paper, the water in the upper reach of the Tao River was selected as the research object, the chemical characteristics of water environment in the upper reach of Tao River were studied and the water quality was evaluated based on the comparative analysis of the data of two monitoring stations for one year. The results show that the contents of HCO$_3^-$, SO$_4^{2-}$ and Ca$^{2+}$ are high in the upper reach of the Tao River, and the water quality belongs to alkaline medium salinity water, and the salinity increases with the increase of HCO$_3^-$. 

1. Introduction
Geochemical studies of the river can obtain important information about Watershed basin chemical weathering, climate, average chemical and isotopic composition of the upper crust, and the processes of chemical elements in the continental-river-ocean system [1]. The study of the characteristics of ionic chemical content in water bodies can be used to determine the relationship between the source of river hydrochemical ions and regional natural conditions, as well as the relationship between regional chemical weathering and hydrogeochemical characteristics, and to determine a variety of factors that control changes in the geochemical composition of river water. Therefore, the characteristics of ionic runoff in a watershed and its temporal and spatial variation cannot only reflect the hydrogeochemical dynamic process, but also reflect the mechanism of water-rock interaction process. At present, the hydrochemistry of river water in China is mostly concentrated in Yangtze River, Yellow River, Pearl River and other large water systems [2-5], but there is a lack of systematic research data for some small watersheds. The research of Tao River mainly focuses on the development of water resources and ecological protection. The basic chemical composition and environmental background value of the river have been discussed by hydrochemistry research.

In order to improve the drought and water shortage in the central part of Gansu, the water supply project of the main body of the Jiudianxia Water Control Project has been started, and the development and utilization of water resources in the Tao River watershed will usher in a new challenge, and the water environment quality and the water ecological system safety problems will become a major problem. Therefore, it is important to study the hydrochemistry of the river water in Tao River watershed, and analyse the physical and chemical properties of the river, the composition of the main ions and its temporal and spatial changes, which is also of great significance in the evaluation of water resources and environmental protection.
2. Overview of the study area
The Tao River watershed is located in the south of Gansu Province, between 101°52’ N-104°19’ N and 34°03’ E-35°55’ E. The four sides of the river watershed are adjacent to the river watershed and the river watershed of the Yangtze River, and the Longling Mountain and the Daxia River watershed are the boundaries of the river watershed, and the north and south are adjacent to the main stream of the Yellow River. Tao River, as the largest tributary of the upper reach of the Yellow River, has a total watershed area of 25527km² and an average runoff of 4.92 billion m³, which carries the important function of water resources allocation in western China, especially in central Gansu, and directly affects the economic and social development of central Gansu and its surrounding areas.

In this study, the sampling data of two monitoring stations in the upper reach of Tao River are Luqu Water quality Monitoring Station and Xiabagou Hydrological Monitoring Station (Fig. 1). The sampling time is from February 2018 to December 2018 and sampling every two months, and the sample analysis method is the Water and Wastewater Monitoring and Analysis method of the State Environmental Protection Bureau.

3. Research results and analysis
3.1. Main ions in the water of the upper reach of Tao River
According to the monitoring data of two monitoring stations in the upper reach of the river, the main water chemical composition in the upper reach of the river is HCO₃⁻ > Ca²⁺ > SO₄²⁻ > Mg²⁺ > CO₃²⁻ > Na⁺ > Cl⁻ > K⁺ > MnO₄⁻.

3.1.1. HCO₃⁻. HCO₃⁻ is the main anion in the upper reach of Tao River. The annual HCO₃⁻ of Luqu Water quality Monitoring Station was 164–276mg/L, the average value was 235mg/L; The annual HCO₃⁻ of Xiabagou Water quality Monitoring Station was 194–256mg/L, the average value was 232mg/L (Fig.2(a)). H₂CO₃-HCO₃⁻-CO₃²⁻ in natural water is generally in equilibrium, but when pH value is about 8.5, carbonate ions in river water mainly exist in the form of HCO₃⁻, and its content will directly affect the total salt content, and then affect the chemical stability of water.

3.1.2. Ca²⁺. Ca²⁺ is one of the main cations in the upper reach of the river. The annual Ca²⁺ of Luqu Water quality Monitoring Station was 44.3–68.8mg/L, the average value was 58.43mg/L; The annual Ca²⁺ of Xiabagou Water quality Monitoring Station was 48.9–65.6mg/L, the average value was 56.4mg/L (Fig.2(b)).
HCO$_3^-$ and Ca$^{2+}$ mainly come from the dissolution of carbonate rocks such as marl, limestone, dolomite and so on. The dissolution process is related to the content of CO$_2$ in water. The anions in the upper reach of Tao River are mainly HCO$_3^-$, while the cations are mainly Ca$^{2+}$, Mg$^{2+}$ and K$^+$. The reason is that the rocks with more carbonate minerals are distributed in the upper reach of Tao River, and the hydrothermal conditions are sufficient, which creates good conditions for carbonate dissolution. It also leads to the accumulation of enough HCO$_3^-$ and Ca$^{2+}$ in the water, which occupies an absolute advantage in hydrochemistry, and the proportion of HCO$_3^-$ and Ca$^{2+}$ in the river increases gradually with the passage of time.

3.1.3. Mg$^{2+}$. The annual Mg$^{2+}$ of Luqu Water quality Monitoring Station was 10.8~18.0mg/L, the average value was 14.6mg/L; The annual Mg$^{2+}$ of Xiabagou Water quality Monitoring Station was 9.48~18mg/L, the average value was 14.65mg/L (Fig. 2(c)).

3.1.4. CO$_3^{2-}$. The annual CO$_3^{2-}$ of Luqu Water quality Monitoring Station was 5.02~9.95mg/L, the average value was 7.58mg/L; The annual CO$_3^{2-}$ of Xiabagou Water quality Monitoring Station was 6.70~7.50mg/L, the average value was 7.26mg/L (Fig. 2(d)).

3.1.5. SO$_4^{2-}$. The annual SO$_4^{2-}$ of Luqu Water quality Monitoring Station was 6.6~22.1mg/L, the average value was 15.9mg/L; The annual SO$_4^{2-}$ of Xiabagou Water quality Monitoring Station was 11.2~18.1mg/L, the average value was 15.6mg/L (Fig. 2(e)).

3.1.6. Na$^+$. The annual Na$^+$ of Luqu Water quality Monitoring Station was 5.18~6.48mg/L, the average value was 5.79mg/L; The annual Na$^+$ of Xiabagou Water quality Monitoring Station was 6.28~8.19mg/L, the average value was 7.55mg/L (Fig. 2(f)).

3.1.7. K$^+$, MnO$_4^-$ and Cl$^-$. Through the monitoring and analysis, the proportion of these ions in the river is low, and the variation in the whole year is small, but the overall trend is that the middle reach of the river is higher than that of the downstream.
3.2 The genesis of main hydrochemical ions of the upper reach of Tao River

In the upper reach of Tao River, HCO$_3^-$, K$^+$, Cl$^-$ and Ca$^{2+}$ mainly come from the dissolution of carbonate rocks such as marl, limestone and dolomite, and their contents increase gradually with the passage of time.

4. Conclusions

The main results are as follows:

1. The water quality of the upper reach of Tao River belongs to alkaline and medium salinity water, and its salinity increases with the increase of HCO$_3^-$, and the main hydrochemical composition of the river is HCO$_3^-$, Ca$^{2+}$, Mg$^{2+}$, CO$_3^{2-}$, Na$^+$, Cl$^-$, K$^+$, MnO$_4^-$.

2. In the upper reach of Tao River, the contents of HCO$_3^-$, SO$_4^{2-}$ and Ca$^{2+}$ are high, and the chemical type is calcium and sodium bicarbonate type water.

3. In the upper reach of Tao River, HCO$_3^-$, K$^+$, Cl$^-$ and Ca$^{2+}$ mainly come from the dissolution of carbonate rocks such as marl, limestone and dolomite, and their contents increase gradually with the passage of time.

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