Water Chemistry Characteristics and Their Controlling Factors in Dou River Basin

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KEYWORD: Dou River Basin; water chemistry; riverbank; human activity

ABSTRACT: It is important to study the temporal and spatial distribution of water chemistry for the regional water resources management. In this study, in order to obtain the water chemistry distribution of Dou River Basin, collection and test works have been done for surface water and groundwater, and the results show that, the surface water showed less influence of evaporation effect, but the effect of the sewage makes part of surface water classed from the HCO3 type to SO4 type water, the groundwater far from the riverbank, Ca2+ and HCO3-, NO3- are the main contributors for the TDS increasing in groundwater, which means that, the groundwater far from riverbank affected by the human activities, and the groundwater near riverbank affected the dissolution of limestone and gypsum after the infiltration, and the evaporation and human activities also make important controlling effects on groundwater chemistry.

INTRODUCTION

Water shortage is one of the most important con strain factors of social economic development and construction of ecology and environment, the groundwater quantity and quality assessment works is the base of local water resources evaluation and management. Safe drinking water is the basic need for every citizen for sustaining life, groundwater is safer than surface water under normal conditions, as its natural protection from the contamination by the infiltration of recharge water through soil cover (Katz et al. 1997; Ghislain et al. 2012; Du et al. 2013; Su et al. 2014a, 2014b). Groundwater has become the major source of water supply for domestic, industrial and agricultural sectors of many countries (Garg et al. 2009; Zhang et al. 2010; Wayland et al. 2003; Fu et al. 2014).

The groundwater resources monitoring and assessment would be very useful for the social development, especially for the groundwater quality assessment works should be done for the water supply. In this area, both for drinking as well as irrigation purposes substantial amount of groundwater is being used. Hence, evaluation of groundwater resources for development requires an understanding of the Hydrogeological and hydrochemical properties of the aquifers (Rao et al. 2012; Nazzal et al. 2014).

In this study, in order to know the current state of local surface water and groundwater, water samples have been collected, the quality test results have been discussed for the groundwater quality spatial distribution, which would be important support for the local water sustainability in Tangshan City, which one of the most important economic centers.

Study area and Samples

Study area

Dou River Basin located in the western part of Luan River Delta, which is one of the most important economic centers in China. The area is about 1340 km^2, the length of Dou River is about 120 km, and flow through Tangshan City. The Dou River Reservoir is the biggest surface water body in the study area.

There are four aquifers in the study area, which could be named as Ⅰ, Ⅱ, Ⅲ and Ⅳ aquifer, the bearing formation are Q_4, Q_3, Q_2, Q_1 respectively. In the north part of study area, there are only 3 aquifers, including Ⅱ, Ⅲ and Ⅳ aquifer

Sampling methods

In order to know the water quality in Dou River Basin, 14 surface water samples and 41groundwater samples have been collected. The depth, longitude and latitude of sampling wells have been recorded

during the sampling process, and the temperature, pH, EC, TDS have been monitored at the sampling field. Blank samples and parallel samples are also collected in order to guarantee the water sample test results.

results and discussionS

Based on the water samples test results, the Piper Chart of surface water and groundwater in Dou River could be drawn as figure 1. From the figure, it could be seen that, the changes of ions is not big, but the differences is obvious between samples of surface water groundwater. The percentage of HCO_3^- decreasing with TDS increasing, the SO_4^{2-} with higher increasing rates at the riverbank area, but the SO_4^{2-} and Cl^- have the same increasing percentages at the area far away from Dou River.

The surface water samples have different characteristics between that collected from urban area and irrigation area, the concentration of SO_4^{2-} in irrigation area is higher than that from urban area.

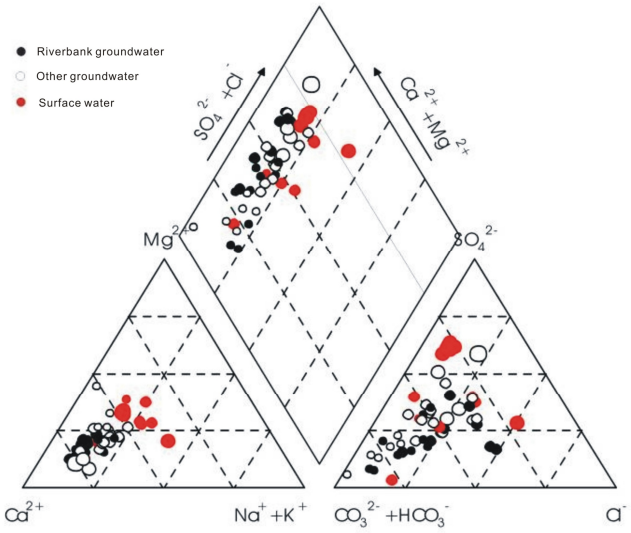

Figure 1 Piper Chart of surface water and groundwater in Dou River Basin

Surface water quality characteristics

The correlation between ions and TDS in surface water samples from Dou River Basin could be seen in

figure 2. From the figure, it could be seen that, the concentration of main ions increasing with that of TDS, Ca and Na are the main cations, HCO_3^- and SO_4^{2-} are the main anions, which indicate that the surface water quality controlled by the effect of evaporation after the leaching effect.

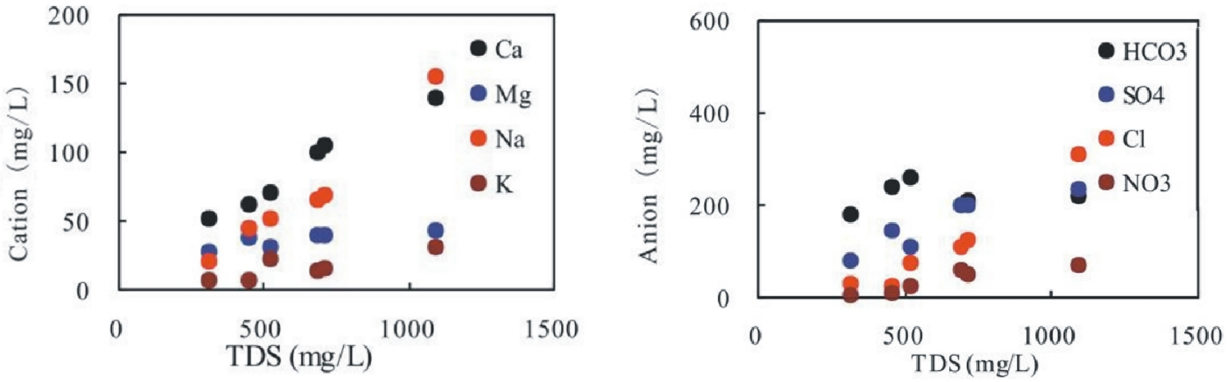

Figure 2 Relationship between ions, cations and TDS in surface water

Spring water quality characteristics

Springs in Dou River Basin located in the mountain area, which is far away from human activities impact areas, the water quality characteristics reflect the groundwater quality characteristics without pollutant. The concentration of TDS is low in springs (about 398 mg/L), the water type is HCO_3-Ca·Mg, which means that the spring water origin from the direct infiltration of precipitation. The ratio of Ca/Mg is about equal to 1, which means that the spring water quality controlled by the dissolution of calcite in the mountain area. The concentration of NO_3^- is about 6.9 mg/L, is much lower than the background concentration (14.5 mg/L), which means that the spring water has low effect by human activities and with good water quality.

Groundwater quality characteristics at riverbank area

The correlation between ions and TDS in samples from Dou River Basin could be seen in figure 3. From the figure, it could be seen that, the concentration of main ions increasing with that of TDS, Ca and HCO_3^- are the main species at riverbank area, the contribution of Na^+ and SO_4^{2-} increased obviously, which indicate that the surface water quality controlled by the effect of evaporation. From the concentration of NO_3^- and TDS, it could be seen that, the four samples with TDS >800mg/L are highly affected by human activities at the riverbank area.

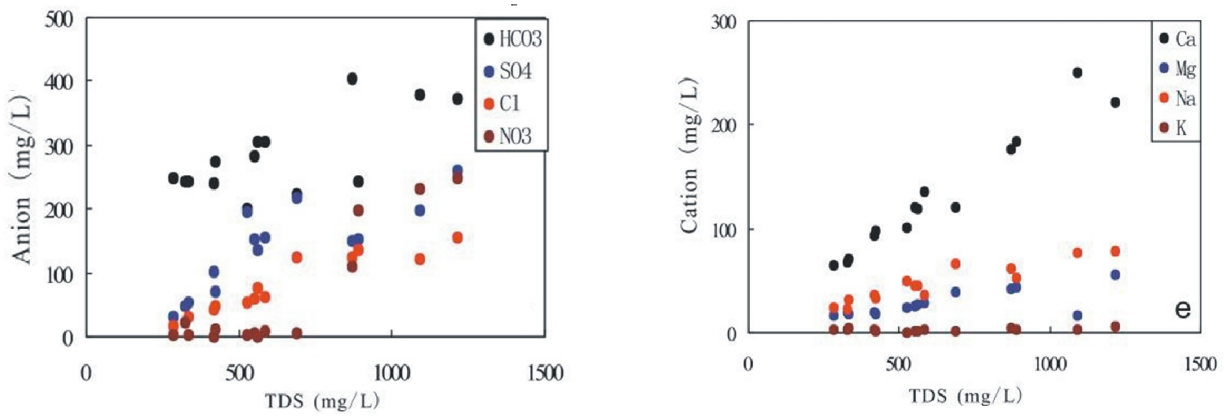

Figure 3 Relationship between ions, cations and TDS in groundwater at riverbank area

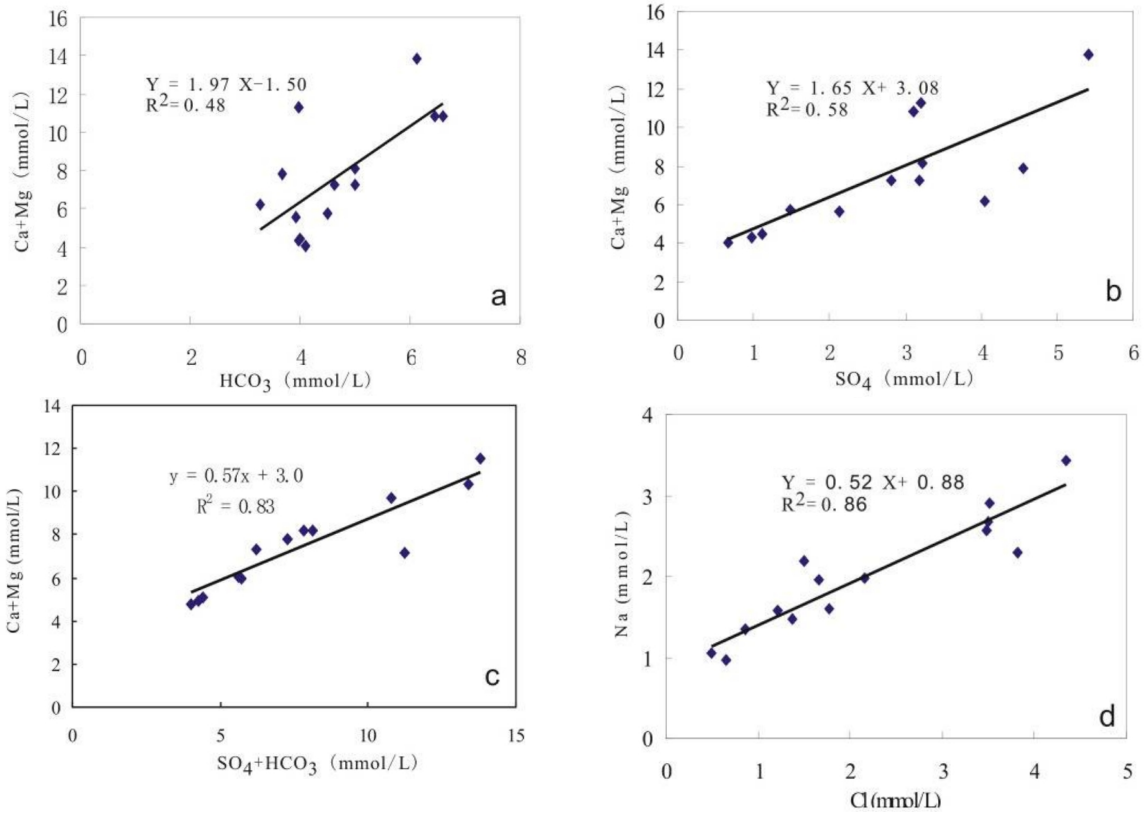

Figure 4 Relationship between ions, cations in groundwater at riverbank area

The correlation between different species could be used to study the origin and controlling factors of groundwater (Ravikumar et al. 2011; Kura et al. 2013), the correlation between (Ca + Mg) and HCO_3^- could be used to indicate the limestone original groundwater, the correlation between （Ca+ Mg）and SO_4^{2-} could be used to indicate the gypsum original groundwater, the correlation between Na and Cl could be used to indicate the evaporation effect during the groundwater runoff.

According to the monitoring results of water samples in Dou River Basin, the correlation between different species could be seen in figure 4. From the figures, it could be seen that, the R^2 of (Ca + Mg) and HCO_3^- is 0.48, which mean that there is no obvious correlation, and the groundwater quality is controlled by other effects; the R^2 of (Ca + Mg) and SO_4^{2-} is 0.58, which mean that there is no obvious correlation, and the groundwater quality is controlled by other effects; the R^2 of (Ca + Mg) and (HCO_3^-+SO_4^{2-}) is 0.83, which mean that there is obvious correlation, and the groundwater quality is controlled by the dissolution of limestone and gypsum; the relation between Na and Cl show that, the ratio of Na/Cl is 0.52, which mean that groundwater quality is controlled by evaporation; the concentration of Cl- enriched higher than that of Na, which mean that groundwater quality is impact by fertilizer with high Cl element.

From the correlation of different species, it could be concluded that, the groundwater quality is controlled by dissolution of limestone and gypsum, and some impacted by evaporation and human activities.

Groundwater quality characteristics far away from riverbank area

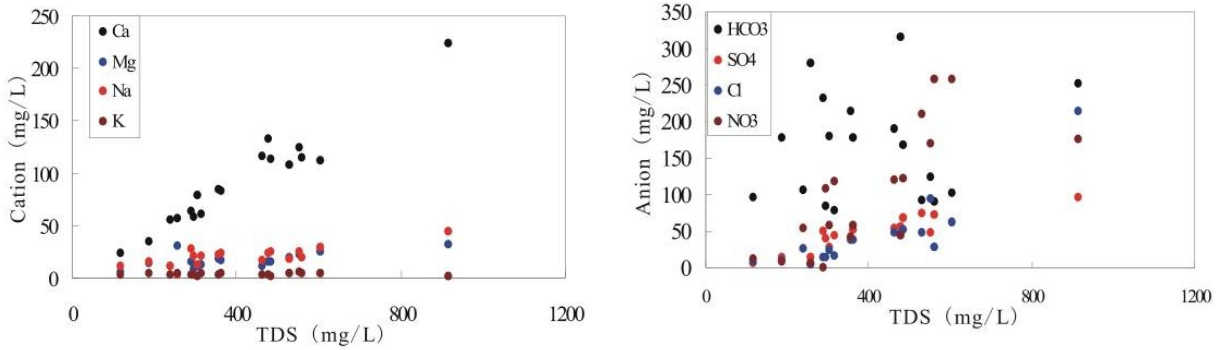

Figure 5 Relationship between ions, cations and TDS in groundwater far away from riverbank area

The correlation between ions and TDS in groundwater samples from Dou River Basin could be seen in figure 5. From the figure, it could be seen that, the concentration of main ions increasing with that of TDS, Ca and HCO3- are the main species in groundwater at far away from riverbank area, the contribution of Ca increased obviously and becoming the main species. When the concentration of TDS is less than 400 mg/L, HCO3 is the main contribution for the concentration of TDS, when the concentration of TDS is higher than 400 mg/L, NO3- becoming the main contribution for the concentration of TDS, which means that the groundwater quality has obvious evidence of human activities impact.

As discussed above, Ca is the main cation contribution for the increasing concentration of TDS, HCO3- and NO3 is the main anion contribution for the increasing concentration of TDS, which mean that the groundwater is impacted by human activities far away from riverbank area.

Conclusion

(1) The surface water quality characteristics indicate that, there is no obvious evidence of evaporation effects, the pollution discharge from plants convert the water type from HCO3 type to SO4 type;

(2) From the correlation of different species, it could be concluded that, the groundwater quality is controlled by dissolution of limestone and gypsum, and some impacted by evaporation and human activities;

(3) Ca is the main cation contribution for the increasing concentration of TDS, HCO_3^- and NO_3^- is the main anion contribution for the increasing concentration of TDS, which mean that the groundwater is impacted by human activities far away from riverbank area.

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