Analysis of Hydrochemical Characteristics and its Influences on Jiaodong Water Diversion Project

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Abstract. The water chemistry characteristics along the Jiaodong water transfer line and its impact analysis play an important role in supporting water quality safety and operation management. In this paper, the water chemistry characteristics along the Jiaodong water transfer project were studied, and the water chemistry characteristics and their influencing factors in the study area were analyzed by using Piper's trilinear diagram, Gibbs diagram and SPSS26 statistical analysis software for correlation. The results show that the surface water and groundwater along the Jiaodong water transfer project are both weakly alkaline, and the chemical type of groundwater in the traversing area is Na Ca-HCO_{-3} water, while the chemical type of surface water is Na Ca- HCO_{-3} water. The groundwater in the crossing area of Jiu Dong water transfer project is mainly controlled by rock weathering and evaporation concentration, and the water chemistry type of groundwater in different areas shows certain differences; the correlation between the channel water and groundwater and surface water along the route is weak in water quality, and surface water and groundwater basically have no influence on the water quality of channel water transfer during the normal water transfer period; the groundwater quality along the route basically has no corrosive influence on concrete, and the groundwater quality has no corrosive influence on Groundwater quality has no corrosive effect on concrete, but groundwater quality has some influence on reinforcement and steel structure in concrete.

Keyword: Jiaodong water diversion; hydrochemical characteristics; cause analysis.

1. Introduction

The Jiaodong Water Transfer Project has effectively alleviated the water shortage in the Jiaodong area and realized the joint scheduling of external water transfer and local water, which has played an important role in regional water security. The project passes through 6 prefecture-level cities along the route, with a water transmission line of 482 km. With the development of economy and accelerated urbanization, the water environment along the route changes in a complex way under the influence of human activities and the interaction of surface-underground and channel water. With the long-term operation of the project, the project management risks such as settlement, collapse and corrosion of steel reinforcement brought by the changes of water environment are gradually increasing. At the same time, whether the water environment changes along the line will have an impact on the water quality of water transmission has also gradually become a concern.

The analysis of water chemistry characteristics and evolution patterns and influencing factors plays an important fundamental role in understanding the adverse effects of water environment on engineering and proposing practical countermeasures. Currently, hydrodynamic, hydrochemical, and isotopic methods are widely used in the study of groundwater systems and geochemical evolution, and have been effective [1]. Jalali studied the quality of groundwater in the Hamadan region of the Middle East and analyzed it by the water chemistry type method, which showed that the NO- in the groundwater of this region mainly comes from sewage discharge, agricultural irrigation, and that the evolution of groundwater and its hydrochemical characteristics in this region are closely related to human activities [3]. There are also rich results and developments in groundwater chemical characteristics and impact analysis in China [4-5] In terms of groundwater chemical characteristics and impact analysis under groundwater interaction, Li Shujian [6], Zhang Xin [7], Wang Yushan [8], Kong Xiaole and Li Guo [10] used graphical method, ion correlation, isotope and other methods to characterize the spatial and temporal evolution of water chemistry of surface water and groundwater, its sources and its influencing factors The spatial and temporal evolution of surface water and groundwater, their sources and their influencing factors were studied in depth. At the same time, the evolution of water chemistry and the influence mechanism of water bodies will be influenced and intensified with the climate change and human activities [11].

This paper uses graphical method and statistical analysis to focus on the influence of complex water environment conditions along the Jiaodong water transfer project on the water quality of the project under environmental changes, and carries out analysis of chemical characteristics and causes of groundwater and surface water along the project line, and on this basis analyzes the influence of surface water and groundwater on the water quality of the transfer, which is of great significance to ensure the water quality of the transfer and water safety of the receiving area, as well as ecological environmental protection along the project line [12].

2. Project and groundwater overview

2.1 Hydrology and Geology

The area along the water transfer project has different geomorphic units, geological structures, and hydrogeological conditions, so the project can be divided into four hydrogeological zones: erosion and denudation hills, pre-mountain, inter-mountain alluvial plains, and marine plains, which are divided according to the characteristics of geomorphic rock formations, groundwater burial conditions, and distribution characteristics of aquifers [13]. Groundwater along the project line is mainly divided into three categories: pore diving, bedrock and karst fissure water, among which pore diving is mainly an aquifer composed of medium-coarse sand, soil-bearing coarse sand and gravelly coarse sand, while bedrock fissure water makes the seasonal fluctuation of groundwater level larger due to its nature. The recharge of groundwater comes from surface water infiltration, and groundwater consumption is mainly artificial water and underground slow runoff.

2.2 Project Summary

The Jiaodong water transfer project starts from Songzhuang branch sluice to create a new water transfer nullah and connects to Huangshuihe pumping station at the west of Gaojia village in Sideling, Longkou, via five cities, namely Changyi, Pingdu, Laizhou, Zhaoyuan, and Longkou, with a design flow of 22.0-12.6 m^3/s and a total length of 160.02 km. The water transfer pipeline and culvert project adopts pressure pipes, culverts, and tunnels to transfer water, with a total length of 149.88 km. The water transmission works include four sections of water transmission projects, including Wenshitang Pumping Station - Gautong Pumping Station - Xingshipo Pumping Station - Mishan Reservoir [20]. There are four pumping stations, five tunnels, three culverts and seven water pipelines in various forms and materials [14]; about 26.54km of spiral steel pipes, 74.49km of prestressed steel cylinder concrete pipes, 18.65km of FRP pipes, 29.29km of culverts and 1.40km of reinforced concrete box culverts [15-17].

The water surface of most of the canal sections from Songzhuang Diversion Gate to Huangshui River Pumping Station is near the ground level, and the design water depth of the canal is generally 2.5~3.0m. Pile numbers 0+000~6+110, 24+567~31+119, 69+424~90+474 are all shallow groundwater deposits, and there is the problem that groundwater will affect the construction operation of the project.

Some sections of the water pipeline are shallow, such as 13.68m in the center of the water pipeline pipe at the boundary taking over point of the water pipeline project between Fushan section and Laishan section, 8.0m in the center of the water pipeline pipe at the boundary taking over point of the water pipeline project between Laishan section and Muping section, 3.28m in the center of the pipe at the Muping water outlet, 5.46m in the inlet taking over point of the Xingshibo pumping station, and 5.2m in the center of the water pipeline pipe at the outlet taking over point of the pumping station. The elevation of the pipe center at the pumping station outlet receiver point is 5.2m, combined with the groundwater level data in the area, it can be seen that there is also a problem of groundwater affecting the project in the section of the water pipeline.

In terms of anti-seepage and anti-corrosion, the open channels and culverts mainly adopt prefabricated or cast-in-place concrete slab anti-seepage lining type form. Spiral steel pipe and pipe fittings inside and outside are surface pretreatment, spiral steel pipe and pipe fittings outside anti-corrosion using polymer anti-corrosion coating heavy reinforced grade (two cloth four oil). The prestressed steel cylinder concrete pipe mainly adopts the compound protection method of cathodic protection with reinforced grade and sacrificial anode [18].

3. Water quality sample collection and processing

According to the topography of the Jiaodong water transfer project and the characteristics of water transfer, considering the interaction between surface water, groundwater and channel water, 246 sampling points were set up along the Jiaodong water transfer project for water sample collection and testing, taking the hydrogeological conditions, key cross-sections, intersection of surface water and channel water, key nodes and cross-sections of channel leakage as the criteria for determining sampling points (see Figure 2 for the specific distribution of sampling points), including 14 in Boxing, Binzhou, 14 in Guangrao, Dongying, 21 in Changyi, 3 in Gaomi, 23 in Shouguang, 14 in Hanting, Qingdao, 51 in Pingdu, 11 in Jiaozhou, Qingdao, 5 in Chengyang, 22 in Laizhou, Yantai, 16 in Zhaoyuan, 15 in Longkou, Muping, Yantai, 6 in Laishan, 8 in Fushan, 1 in Qixia, Weihai, 6 in Wendeng. The water samples include well water (groundwater), channel water and river water (surface water). According to the characteristics of the water quality of river water and the corrosive effect of water quality on the water transfer project and other engineering requirements, this paper selected conductivity (25 ℃), pH, sulfate, chloride, nitrate (in N), carbonate, bicarbonate, potassium (mg/L), sodium (mg/L), calcium (mg/L), magnesium (mg/L) and alkali content (rag/L) 12 test indicators for surface and groundwater sampling The tests were conducted according to the standards of GB 8538, DZ/T 0064, GB/T 176, etc. The testing standards and accuracy of the specific items are shown in Table 1.

Table 1 Jiaodong water quality detection index detection basis and detection accuracy list

Numble	Project Name	Testing standards	Testing accuracy
1	pH	GB 8538	0.01
2	Electrical conductivity (25℃)	DZ/T 0064.6	0.01μs/cm
3	Sulfate	GB 8538	0.01mg/L
4	Chloride	GB 8538	0.01mg/L
5	Nitrate (as N)	GB 8538	0.01mg/L
6	Carbonate	DZ/T 0064.49	0.01mg/L
7	Bicarbonate	DZ/T 0064.49	0.01mg/L
8	Potassium	DZ/T 0064.27	0.01mg/L
9	Sodium	DZ/T 0064.27	0.01mg/L
10	Calcium	DZ/T 0064.13	0.01mg/L
11	Magnesium	DZ/T 0064.14	0.01mg/L
12	Alkali content	GB/T 176	0.01mg/L

The first sampling was conducted from January 13 to 18, 2021. The sampling route started from Dajujiazhang pumping station in Boxing County, Binzhou City, and went through Guangrao County, Dongying City, Shouguang, Hanting, Changyi and Gaomi in Weifang, Pingdu, Jiaozhou and Chengyang in Qingdao, and ended at the inlet of Zhanghongtan Reservoir in Chengyang District, Qingdao City. A total of 130 water samples were obtained. The second sampling period was from March 3 to 10, 2021, and the sampling route started from Songzhuang Diversion Gate in Changyi, Weifang, and went through Pingdu, Qingdao, Laizhou, Zhaoyuan, Longkou, Qixia, Fushan and Muping in Yantai, and ended at the mouth of Mishan Reservoir in Wendeng District, Weihai, with a total of 116 water samples. The two sampling routes covered the whole route of the Jiaodong Water Transfer Project and the Yellow River Diversion Project, and a total of 246 water samples were collected, including 99 channel water, 46 river water, 91 underground well water, 3 reservoir water and 7 pond water from the Jiaodong Water Transfer Project.

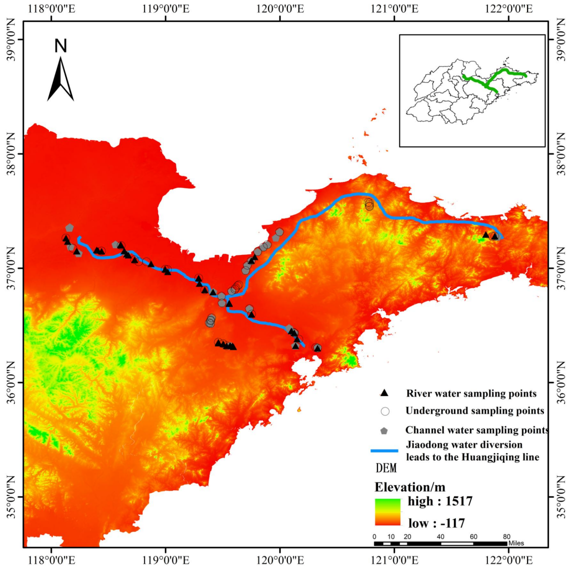


Fig. 1 Distribution of sampling points in study area

4. water transfer project along the surface, groundwater water chemical characteristics analysis

4.1 Statistical characteristics of water chemistry parameters

The water quality data of the water bodies in the area traversed by the Jiaodong water transfer project were compiled and analyzed, and the results of statistical characteristics are shown in Table 2, Table 3, and Table 4. As can be seen from Table 2, the characteristics of the main water chemical components of the channel water are clear; The characteristic values of Na^+ are not much different from Ca^{2+}; the minimum and average values of the statistical parameters of HCO_{-3} rank first among the anions; the pH value ranges from 6.970 to 8.220, indicating that the channel water along the project line is weakly alkaline, and the standard deviation and variance of pH are very small, indicating that the pH range of the channel water along the line is stable; the content of $CO_{2\text{-}3}$ is 0, and the content of Mg^{2+} mainly ranges from 21.650 to 58.930. The average concentration of $SO_{2\text{-}4}$ was 165.307mg/L; the average concentration of Cl^- was 172.552mg/L; and the average concentration of NO_{-3} was 8.842mg/L. It can be seen that the content of Cl^- was the highest, the content of $SO_{2\text{-}4}$ was the second and the content of NO_{-3} was the least. The mean value of the alkali content was 260rag/L with a low standard deviation, indicating that the alkali content is more stable and the content does not change easily. The average value of conductivity was 1076μs/cm.

As can be seen from Table 3, Ca^{2+} is the first cation in the river water and is the dominant cation, and the cations in the river water are ranked according to the mean concentration: $Ca^{2+}>Na^+>Mg^{2+}>K^+$, Ca^{2+} and Na^+ are the main cations in the river water, accounting for 44.7% and 40.4% of the total cations, respectively. 1.7%. The anions were ranked according to their mean concentrations: $HCO_{-3}> Cl^-> SO_{2\text{-}4}> NO_{-3}> CO_{2\text{-}3}$. HCO_{-3} was the main anion in the river water, accounting for 37.3% of the total anions, followed by $SO_{2\text{-}4}$ and Cl^-, accounting for 30.5% and 29.7% of the total, respectively, while NO_{-3} was smaller, accounting for only 2.3%, and $CO_{2\text{-}3}$ was almost zero. The pH of the river water mainly ranged from 7.25 to 8.26, with a mean value of 7.8, indicating that the river water was also mainly weakly alkaline.

As can be seen from Table 4, the minimum and average values of Ca^{2+} in groundwater are in the first place of cations, so Ca^{2+} is the dominant cation, and the cations in groundwater are ranked according to the average concentration: $Ca^{2+}>Na^+>Mg^{2+}>K^+$, and the cations in groundwater are dominated by Ca^{2+} and Na^+, accounting for 50.8% and 36.1% of the total cations respectively, while the content of Mg^{2+} is smaller, accounting for 12.3% of the total, and the content of K^+ is the smallest, accounting for only 0.7%. The content of Mg^{2+} was smaller, accounting for 12.3% of the total, and the content of K^+ was the smallest, accounting for only 0.7%. The anions were ranked according to their mean concentrations: $HCO_{-3}>SO_{2\text{-}4}>Cl^->NO_{-3}>CO_{2\text{-}3}$. HCO_{-3} was the main anion in groundwater, accounting for 40.3% of the total anions, followed by $SO_{2\text{-}4}$ and Cl-, accounting for 28.1% and 27.7% of the total, respectively, while NO_{-3} was smaller, accounting for only 3.8%, and $CO_{2\text{-}3}$ was almost zero. . The pH of the groundwater mainly ranged from 6.4 to 8.1, with an average value of 7.4, indicating that the groundwater was also mainly weakly alkaline.

Table 2 Statistical characteristic values of water chemical characteristics parameters of channel water

Projects	Minimum	Maximum	Average	Standard deviation	Variance
conductivity (μs/cm)	819.000	2973.000	1076.625	453.549	205706.550
pH	6.970	8.220	8.001	0.326	0.100
SO2- 4(mg/L)	121.56	242.86	165.307	27.744	769.717
Cl-(mg/L)	68.14	772.44	172.552	177.235	31412.246
NO- 3(mg/L)	4.170	28.890	8.842	8.123	65.983
CO2- 3(mg/L)	0.000	0.000	0.000	0.000	0.000
HCO- 3(mg/L)	151.70	330.77	214.732	36.785	1353.108
K+(mg/L)	1.040	8.810	3.805	1.906	3.639
Na+(mg/L)	51.15	318.50	94.428	60.447	3653.878
Ca2+(mg/L)	65.430	273.620	99.954	63.465	4027.765
Mg2+(mg/L)	21.650	58.930	33.108	9.812	97.843
Alkali content (rag/L)	140.040	872.540	260.581	165.023	27232.666

Table 3 Statistical characteristic values of river water chemical characteristics parameters

Projects	Minimum	Maximum	Average	Standard deviation	Variance
onductivity (μs/cm)	410.000	3910.000	1054.188	787.751	620551.896
pH	7.250	8.260	7.821	0.313	0.098
SO2- 4(mg/L)	51.130	349.490	141.301	65.223	4254.090
Cl-(mg/L)	31.810	1116.970	145.808	261.466	68364.583
NO- 3(mg/L)	1.420	39.020	11.450	9.585	91.872
CO2- 3(mg/L)	0.000	11.220	0.701	2.805	7.868
HCO- 3(mg/L)	79.870	269.180	177.613	58.700	3445.746
K+(mg/L)	2.260	10.950	4.558	2.026	4.104
Na+(mg/L)	37.430	492.500	88.291	108.864	11851.408
Ca2+(mg/L)	41.640	333.100	99.385	66.038	4361.005
Mg2+(mg/L)	8.420	54.120	30.218	11.237	126.267
Alkali content (rag/L)	107.710	1344.970	240.184	297.215	88334.769

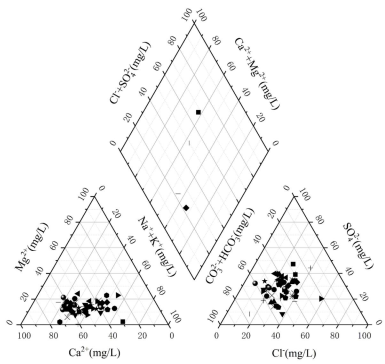
Table 4 Statistical characteristic values of groundwater water chemical characteristics parameters

Projects	Minimum	Maximum	Average	Standard deviation	Variance
onductivity (μs/cm)	503.000	3650.000	1245.600	596.363	355648.549
pH	6.400	8.170	7.486	0.409	0.167
SO2- 4(mg/L)	25.860	744.930	161.055	112.026	12549.828
Cl- (mg/L)	20.710	682.070	159.168	126.145	15912.508
NO- 3 (mg/L)	1.820	105.490	22.531	21.347	455.704
CO2- 3(mg/L)	0.000	7.850	0.131	1.013	1.027
HCO- 3(mg/L)	50.190	564.590	231.178	89.748	8054.631
K+ (mg/L)	0.190	7.300	2.265	1.711	2.928
Na+ (mg/L)	35.780	608.300	91.104	81.307	6610.887

Ca2+ (mg/L)	39.660	382.670	128.846	70.559	4978.605
Mg2+ (mg/L)	2.410	117.860	31.950	18.531	343.412
Alkali content (rag/L)	98.132	1648.012	249.169	219.714	48274.049

4.2 Water chemistry type

According to the Piper trilinear diagram, the groundwater chemistry along the Jiaodong water transfer project can be determined, and the main ionic components of surface water, channel water and groundwater in the study area are plotted in the Piper trilinear diagram, see Figs. 2-4. The ionic components of groundwater in the crossing area of the Jiu Dong water transfer project are mainly Ca^{2+}, Na^{+}, HCO_{-3} and SO_{2-4}. Therefore, the chemical type of groundwater in the crossing area is Ca-Na- HCO_{-3} and contains some Ca-Na- SO_{2-4}. SO_{2-4}+Cl^{-} is also higher, accounting for 45%. From Fig. 4, it can be seen that, compared with groundwater, the water chemistry type of surface water is less different than that of groundwater, and the water chemistry type of surface water is the same as that of groundwater, which means that there is no difference between the main anions and cations of surface water and groundwater, and the main cations of both surface water and groundwater are Ca^{2+} and Na^{+}.



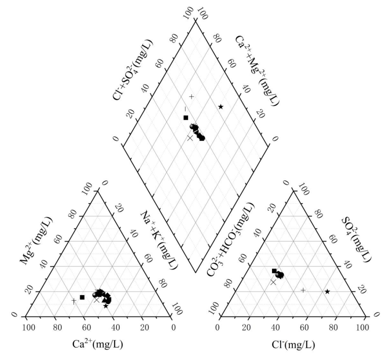


Fig.2Groundwater Piper trilinear diagram Fig.3 Surface water Piper trilinear diagram

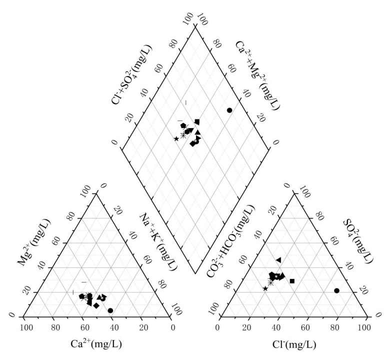


Fig.4 Piper trilinear diagram of channel water

4.3 Control factors of major groundwater ions

Gibbs diagram is often used to infer the hydrogeochemical processes of natural water, and the three end elements in this diagram are evaporative crystallization, rock weathering and atmospheric precipitation. As can be seen from Figure 6, the sample sites mainly fall in the rock weathering area, with TDS values ranging from 400 to 1000 (mg/L), Na+/(Na^{+}+Ca^{2+}) ratios ranging from 0.2-0.7, and Cl^{-}/(Cl^{-}+HCO_{-3})d ratios ranging from 0.3-0.5. The main ions of groundwater in the traverse area of the Jiaodong water transfer project mainly originate from the weathering of rocks. The types of water chemistry in groundwater in different areas show some differences.

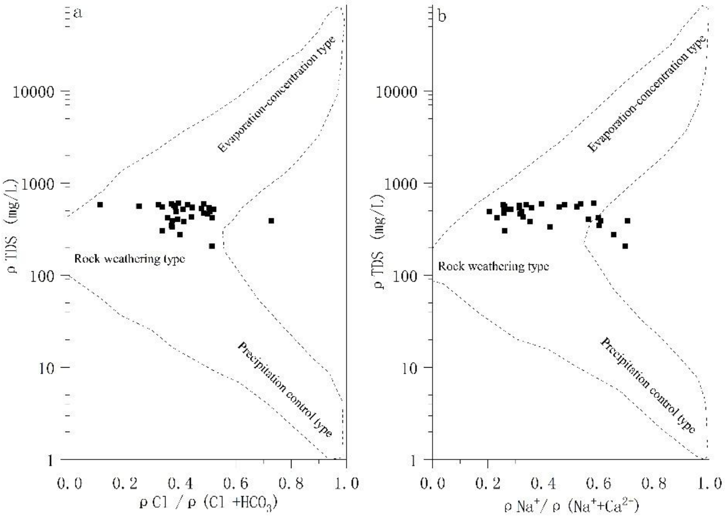


Fig. 5 Gibbs diagram of groundwater

5. Surface water, groundwater impact analysis of water transfer

5.1 Surface water, groundwater on the transfer of water quality impact analysis

Thirty representative sample points were selected at the intersection of groundwater and surface water, key cross-sections, and the interface of leaking water pipeline, including 10 each of groundwater, channel water and river water, to analyze the correlation between surface water, groundwater and channel water, and then analyze the influence of surface water and groundwater quality on channel water. Considering that the three water quality indexes of $SO_{2\text{-}4}$, Cl^- and Na^+ in the channel water vary greatly along the course, these three indexes will be selected for correlation analysis, and the ion content of surface water, groundwater and channel water will be plotted by Origin, and the ion content of surface water, groundwater and channel water will be shown in Fig. 6, and the bivariate correlation analysis will be conducted by SPSS26, which is shown in Table 5.

From the graphs and tables, the correlation coefficient of $SO_{2\text{-}4}$ between channel water and groundwater is -0.547, and that of $SO_{2\text{-}4}$ between channel water and river water is 0.327. This indicates that the correlation between $SO_{2\text{-}4}$ in channel water and $SO_{2\text{-}4}$ in groundwater and river water is weak; the correlation coefficient of Cl^- in channel water and river water is 0.431, and that of Cl^- in channel water and groundwater is -0.226, indicating that the correlation between Cl^- content in channel water and groundwater is weaker. -The correlation coefficient of Na^+ in channel water and groundwater is 0.323, and the correlation coefficient of Na^+ in channel water and river water is 0.421, which indicates that the correlation coefficient of Na^+ in channel water and both of them is also weak. Therefore, the correlation between $SO_{2\text{-}4}$, Cl^- and Na^+ in channel water and river water and groundwater is weak, and the influence of groundwater and surface water on the water quality of channel water is small during the normal water transfer period and under the condition of high project transfer flow.

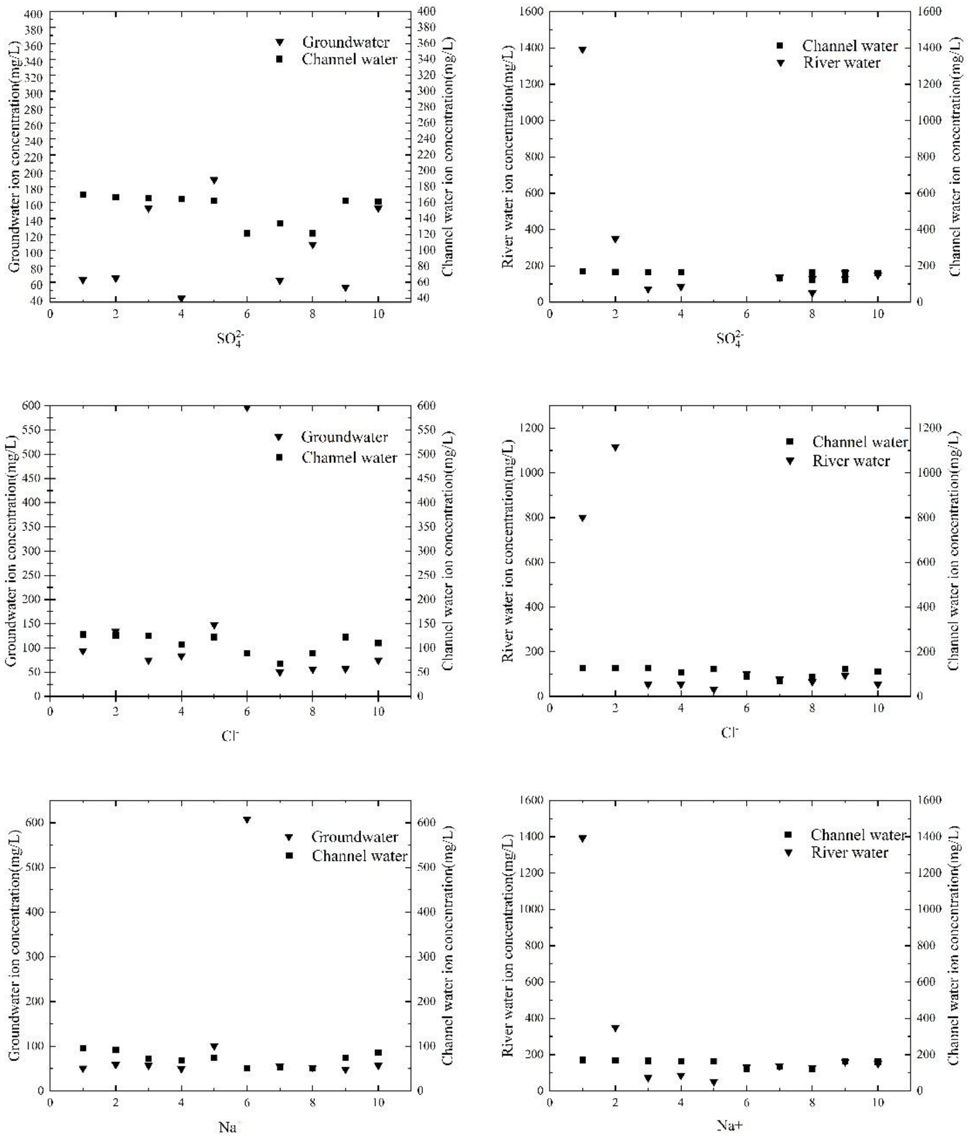


Fig. 6 $SO_{2\text{-}4}$, Cl^-, Na^+ content in surface water, groundwater and channel water

Table 5 Correlation coefficients of channel water, groundwater and river water

SO2- 4	Channel water	Groundwater	River water	Cl-	Chanel water	Groundwater	River water	Na+	Chanel water	Groundwater	River water
Channel water	1			Channel water	1			Channel water	1		
Groundwater	-0.547	1		Groundwater	-0.226	1		Groundwater	0.323	1	
River water	0.327	-0.193	1	River water	0.431	-0.034	1	River water	0.421	-0.142	1

5.2 Corrosive impact of groundwater on water transfer projects

The aqueduct will be affected by groundwater corrosion, the type of corrosion is roughly divided into corrosion of steel structure, corrosion of reinforcement and corrosion of concrete, concrete can be divided into composite, crystalline, decomposition due to different chemical reactions [19]. Corrosive ions in groundwater react chemically with concrete to make it hydrolyze and thus corrode; corrosion of steel is mainly due to electrochemical reaction in groundwater, resulting in potential difference; corrosion of steel structure is mainly acidic corrosion, water with pH < 5 is strongly corrosive to iron, and some heavy metal salts can also cause rust to iron pipes.

Groundwater corrosion evaluation criteria:

(1) Concrete corrosiveness: (SO_{2-4}>1500 mg/L) or (PH>6.5 and HCO_3^-<61 mg/L) or (Mg^{2+}+NH_{+4}>3000 mg/L and Cl^-+ SO_{2-4}+ NO_{-3}>10000 mg/L) have corrosive effects.

(2) Corrosion of steel bars and steel structures: (Cl^- >100 mg/L) or (Cl^-+ SO_{2-4}>300 mg/L) have corrosive effects. The groundwater quality along the trunk line below Songzhuang Pumping Station of the Jiaodong Water Transfer Project is generally 6.4~8.17 pH, 503~3650 μs/cm conductivity, 35.9~615.6 mg/L Na^++K^+ concentration, 39.7~382.7 mg/L Ca^{2+} concentration, 2.4~117.8 mg/L Mg^{2+} concentration, 25.9~744.9 mg/L SO_{2-4} concentration. - 4 concentration is 25.9~744.9 mg/L, Cl^- concentration is 20.7~682.1 mg/L, NO_{-3} concentration is 1.8~105.5 mg/L, HCO_3^- concentration is mainly 50.2~564.6 mg/L. The dominant anion of groundwater is HCO_3^-, followed by SO_{2-4}; Cl^- mainly plays a leading role in the corrosion of steel structures. According to the above criteria, groundwater has basically no corrosive effect on the concrete structure of the water transfer project, but there will be some effect on the steel reinforcement and steel structure.

6. Conclusion

The water chemistry characteristics and water quality influencing factors in the study area were analyzed and studied in terms of along-range variation characteristics, water chemistry types, control factors of major ions and correlation between surface water, groundwater and channel water, etc. The conclusions are as follows:

The surface water and groundwater along the route are both weakly alkaline, and the cations in both surface water and groundwater are mainly Ca^{2+} and Na^+, and the anions are mainly HCO_3^-. The chemical type of groundwater in the project crossing area is Ca-Na- HCO_3^- type, and contains some Ca-Na-SO_{2-4} type water;

2. To ion control factors to see, Jiao Dong water transfer project through the area of groundwater is mainly controlled by rock weathering and evaporation concentration, by lithology, topography, structure and groundwater recharge, runoff, drainage conditions, the impact of different areas of groundwater in the type of water chemistry shows some differences.

3. SO_{2-4}, Cl^-, Na^+ analysis, the normal water transfer period in the project transfer flow conditions, the channel water and groundwater, surface water between the weaker link, the three water quality is more independent, groundwater and surface water for the channel water quality influence is small.

4. HCO_3^-, SO_{2-4} will cause concrete corrosion, Cl^- will cause corrosion of reinforcement, so the groundwater quality along the line has basically no corrosive effect on concrete, groundwater quality has a certain impact on reinforcement and steel structure in concrete.

5. Initially, considering the small flow, surface water and groundwater may have an impact on the water quality of the transfer, can be solved by flushing the channel method.

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