Analysis of hydrogeological conditions in the middle and upper reaches of the Xinachuan River Basin of the Huangshui River

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Abstract: Groundwater resources provide the basis for the development of industry and agriculture. It also plays a role in promoting urbanization. Groundwater investigation and hydrogeological research in the Xinachuan Basin of the Huangshui River can provide a hydrogeological basis for the development of urbanization. This study takes the middle and upper reaches of the Huangshui Xinachuan River Basin as an example. Based on field investigation data, this paper passes through hydrogeological mapping, hydrogeological drilling, pumping test, sample collection and other work. The hydrogeological conditions in the middle and upper reaches of Xinachuan River have been basically identified. Zone the loose rock pore water-rich section of the river valley. It is calculated that the amount of water inrush is greater than 5000m^3/d. The degree of mineralisation is less than 0.5g/L. Excellent quality and abundant quantity. It can be used as urban drinking water and farmland irrigation water.

1.Introduction

Groundwater is a precious natural resource. At the same time, it is also a basic element of the environment [1]. Groundwater resources refer to the water resources that exist underground and can be used by human beings. Groundwater is an important part of global water resources. It is closely related to and transformed with atmospheric water resources and surface water resources. For example, the water holding capacity in the basin is closely related to the change of local atmospheric water resources [2]. Groundwater participates in the natural water cycle. It has obvious seasonality and spatiality. It is affected by various factors such as river flow and water resource utilization [3]. At the same time, groundwater resources are characterised by liquidity and recoverability. Interannual climate variability leads to extreme local variability in groundwater recharge [4]. Groundwater resources provide the basis for the development of industry and agriculture. It will play a role in accelerating the process of urbanization and expanding the scale of cities. Its role is particularly important in the Huangshui River Basin in the northeast of Qinghai Province [5-6].

The Huangshui River originates in Honghuriniha, northern part of Baohutu Mountain, Haiyan County, Haibei Tibetan Autonomous Prefecture, Qinghai Province. The Xinachuan River is a first-class tributary of the north bank of the middle and upper reaches of the Huangshui River. The main geomorphological features in the Xinachuan River valley are floodplains, river terraces and alluvial platforms. The population of this place is relatively concentrated. It is a major agricultural development area. It conducts groundwater surveys and hydrogeological studies in the Xinachuan River Basin of the Huangshui River in this area. This is of great significance for urbanization and agriculture. Many scholars have discussed the hydrogeological conditions and groundwater resources in the Huangshui River Basin. They have achieved some results and awareness. Barryshou et al. investigated and evaluated the groundwater resources of the Heicheng River and other ditches in the upper reaches of the Yellow River. It can provide reference for the evaluation of groundwater resources in the Huangshui River Basin [7-10]. In the Huangshui River Valley area, Zhang Shuheng et al. investigated and evaluated groundwater resources. The results they have achieved have pointed out the direction for the water supply of people and livestock in urban and rural areas. This also provides water resources protection [11]. Cao Deyun et al. carried out statistics on the groundwater parameters of different geomorphic units and aquifer formations in the Huangshui Basin. This provides basic information for the development and utilization of regional groundwater resources [12]. Xue Jianjun completed the investigation and evaluation of groundwater resources in the Huangshui Beichuan River Basin [13]. The existing hydrogeological work mainly focusses on the main area of Huangshui. There are few studies on groundwater in the Xinachuan River, a tributary

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of Huangshui River. In this paper, we take the Huangshui Xinachuan River Basin as an example. This paper passes through hydrogeological mapping, hydrogeological drilling, sample collection and other work, etc. The hydrogeological conditions of the Xinachuan River Basin were studied and analyzed. The purpose of this study is: First, the collation and analysis of hydrogeological data in the Xina River Basin of Huangshui River. Second, the quality of drinking and agricultural water in the research area is evaluated based on the existing conditions. Provide a hydrogeological basis for the construction and development of cities and towns in the area.

2. Research area overview

The Xinachuan River Basin is located in the central and northern part of Huangzhong District, Xining City, Qinghai Province. Its geographical location is 100°58′48"~102°01′26"E, 36°24′40"~37°03′33" N. The location of the study area is shown in Fig. 1. The Xinachuan River is a first-class tributary of the north bank of the upper reaches of the Huangshui River. The Xinachuan River originates two kilometers northwest of Hongshanzhang in the eastern part of Haiyan County. It flows through Shangwuzhuang Town, Balongkou Town and Duoba Town from northwest to southeast. It joins the Huangshui River in the town of Toba.

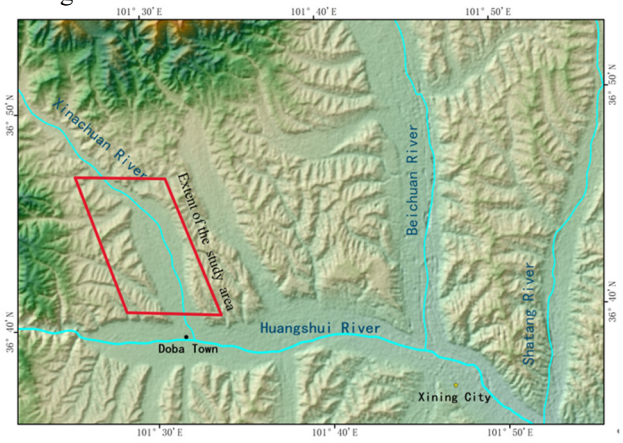

Fig. 1 Overview of the research area

The Xinachuan River Basin is located north of the Riyue Mountains. It is in the middle and upper reaches of the Huangshui Basin. It is located in the transition zone from the Qinghai-Tibet Plateau to the Loess Plateau. The topography is characterized by the fact that the plains meet the mountains. The mountains in the basin are undulating. The valley is crisscrossed. The overall topography is high in the northwest and low in the southeast.

The research area is a continental semi-arid climate type. The climate is cold. The four seasons are not distinct. Winters are long and cold. Summers are short and cool. There is a large temperature difference between day and night. It is characterized by low rainfall and high evaporation. According to the data of Huangyuan 1980-2020 weather station. The average annual temperature is 3.8°C. The average annual precipitation is 433.2mm. The evaporation capacity is 1325.3mm.

The whole research area is in the Zhongqilian plot belt. The stratigraphic division belongs to the Qinqikun stratigraphic area of North China. Zhongqilian Mountain Layer Partition. The tectonic position is located in the middle-south Qilian rock land block in the middle-south Qilian arc basin system. The direction of the main structure line is mainly NW-SE. The basins in the research area are all tectonic fault basins. The area is piled up with thick debris from the Sesoic Jurassic system.

3. Methods

3.1. Data source

The Xinachuan Valley is widely distributed with Quaternary loose rock formations. Floodplains and Class I and II terraces are favorable areas for the occurrence of loose rock pore water. The lithology of the aquifer is Pleistocene and Holocene alluvial sand gravel and argillaceous gravel. The aquifer is coarse-grained. It is highly porosity. This creates a good space for groundwater to exist.

The structural characteristics of the valley control the distribution, burial, recharge and discharge conditions of the valley phreatic aquifer. The river valleys in the upper reaches of the Huangshui Xinachuan River are dominated by inner terraces. The layer of loose clastic deposits is thicker. This is conducive to the occurrence and enrichment of groundwater. The thickness of Quaternary loose sediments in the valley zone is positively correlated with the thickness of loose rock pore phreatic aquifers. The water-rich grade of the loose rock pore diving groundwater in the river valley is divided according to the calculated water inflow. This work makes full use of the previous hydrogeological borehole information and the results of pumping tests. Then, the borehole water inflow is uniformly converted. The study was carried out in the valley plain area where hydrogeological boreholes were more distributed. According to the results of the pumping test. The borehole water inflow is uniformly converted to the water inflow when the diameter of 10 inches is reduced to a depth of 5 m. The water richness of loose rock pore water in the study area was evaluated.

3.2. Loose rock pore diving conversion model

Due to the inconsistent porosity judgement standards of various loose rocks. Therefore, the loose rock pore diving conversion model is adopted. The calculated amount of inrush is compared with the actual quantity. Calculate it. The calculation formula is as follows:

$$Q = \frac{Q_2(2H - S_2)S_2}{(2H - S_1)S_1}$$

$$Q_2 = Q_1 \frac{0.73\frac{D_2}{D_1} + 1.27}{2}$$

In the formula:

Q—Unified depth reduction, unified caliber borehole water inflow (m^3/d);

Q_1—The amount of water inflow when the original borehole was pumped (m^3/d);

Q_2—The amount of water inflow of a uniform caliber (m^3/d);

S_1—The water level drops to the depth corresponding to Q1 (m);

S_2—Converted uniform water level drop depth (m);

D_1—The original diameter of the borehole (m);

D_2—Converted borehole diameter (m)，The value of the caliber is as follows 254mm;

H—Aquifer thickness (m).

3.3. Classification of water richness

In order to further clarify the classification of groundwater rich in water in Xinachuan. The water-rich grading method can be adopted. After unified conversion, the pore diving water-richness of the gravel pebble layer in the Xinachuan valley area is divided into four levels according to the calculated water inflow of a single borehole. Extremely rich water: $Q > 5000$ m^3/d, Rich water: $1000 < Q \leq 5000$ m^3/d, Moderate water content: $100 < Q \leq 1000$ m^3/d, Water poverty: $Q \leq 100$ m^3/d.

(1) Extremely rich water: it is distributed in the floodplain from Qiaoxi Village to Shangsi Village and the terraces of Class I and II. It is 0.2-0.8km wide from east to west. It is about 3.6 km long from north to south. The lithology of the aquifer is gravelly pebbles. It is an infiltration charge that receives water from the Xinachuan River. The water level in this area is buried to a depth of 2.38m. The thickness of the aquifer is 19.01m. The depth was 2.83m. The actual water inflow is 2863.3m^3/d. The calculated water inflow is 5860.46m^3/d. Mineralisation was 0.33g/L. The water quality is good.

(2) Rich water: it is distributed in a ring on the periphery of an area with very abundant water. It is also distributed from Baiyangkou Village to Qianhuying Village. The landform belongs to the I and II terraces of the Xinachuan River. The lithology of the aquifer is gravelly pebbles. It has good water permeability. It is recharged by the infiltration of the river water. According to the previous survey data, the data of the area from Balongkou Village to Baiyangkou Village were obtained. The water level is buried at a depth of 2.56-5.92m. The thickness of the aquifer is 23.57-26.74m. The calculated water inflow is 1048.56-2191.12m^3/d.

(3) Moderate water content: the area from Lanlongkou Village to Shangsi Village and Baiyangkou Village to Xiakou Village. It has a wide distribution area. The landform belongs to the level I terrace of the Xinachuan River and flood accumulation platform. The lithology of the aquifer is gravel pebble layer and argillaceous gravel pebble layer. It mainly receives infiltration recharge from river water. According to the borehole, the I terrace data between Baiyangkou Village and Xiakou Village were obtained. The water level is buried at a depth of 1.92-5.58m. The water level of the alluvial platform is buried to a depth of 7.86-35.91m. The thickness of the aquifer is 9.31-23.84m. The calculated water inflow is between 371.1-565.32m^3/d. Relevant data were obtained according to the ZK6 borehole downstream of Lashagou. The water level is buried to a depth of 12.6m. The thickness of the aquifer is 17.65m. The actual water inflow is 391.39m^3/d. The calculated water inflow is 390.1m^3/d. Mineralisation 0.35g/L. The water chemistry type is HCO_3-Ca type. The water quality is good. As shown in Table 1 and Fig. 2.

Table 1 Drilling data table of the middle section of loose rock pore water volume in the Xinachuan River Valley

Hole number	Hole depth (m)	Geomorphological parts	Thickness of the aquifer (m)	The diving position is deep (m)	Depth (m)	Actual water inflow (m3/d)	Calculate the amount of water inflow (m^3/d)	Salinity (g/L)
ZK6	230.0	The left bank of the Lasha ditch in the Xinachaun River	17.65	12.6	4.41	391.39	390.1	0.35

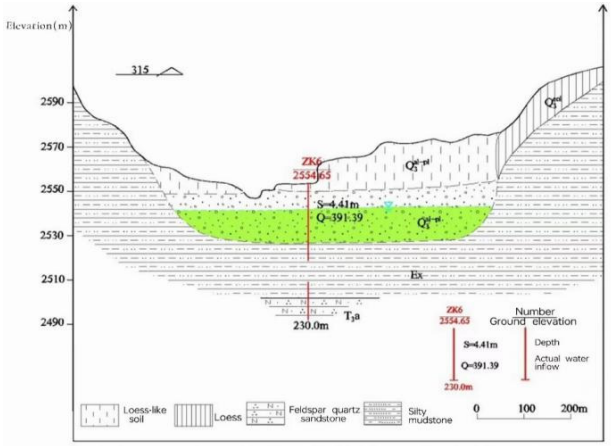

Fig.2 Hydrogeological section of Lashagou Ethnic Village in Xinachuan

(4) Water poverty: The area is mainly distributed in the edge of the river valley and the piedmont area of the small branch ditches on both sides of the valley and the hilly and mountainous areas on both sides. The aquifer is thinner. Aquifers are generally between 3-8 m. The place has poor permeability. Stay away from the supply zone. Poor supply conditions. Therefore, the water-rich performance is poor. The calculated water inflow of a single hole is less than 100m^3/d.

4. Results and Discussions

4.1. Groundwater recharge, runoff, excretory characteristics

The diving in the Xinachuan Valley and the river water supply and drain each other. They have a close relationship with each other. The Xinachuan River valley is recharged with groundwater by river water seepage from Shangwuzhuang to Xilake. Narrowing in the valley from Xilake to Lanlongkou. Its basal bulge. The water table becomes shallow. Groundwater is discharged in the form

of springs or concealments in the area above the mouth of the dam. The section of the river from Lanlongkou to Tiejiaying leaks to recharge groundwater. The river valley has a large hydraulic slope. All have relatively smooth runoff conditions. Groundwater runoff increases with runoff pathways.

4.2. Dynamic characteristics of groundwater

The groundwater level of the Xinachuan floodplain, Class I terraces, Class II terraces and alluvial platforms is affected by river recharge. It has typical hydrographic features. Alluvial platforms are continuously distributed on the right bank. Groundwater is mainly recharged by river water. Changes in groundwater levels are closely related to the seepage recharge of river water. According to the relevant data of the ZK5 monitoring point in the upper reaches of the Xinachuan River. The annual variation of water level in the floodplain is 0.2-0.4m. The water level can reach a maximum of 1.66m. The water level fluctuated significantly during the year. The water level is significantly affected by the flow of the river. Overall, the water table is displayed from June to October every year. When the river flow reaches its maximum, the corresponding groundwater level also peaks. In November, the flow of the river decreased. The groundwater table is beginning to show a downward trend. This is shown in Fig. 3. Relevant data were obtained from the D17 monitoring well in the middle reaches of the Xinachuan River. The water level at the front edge of the I terrace is shallow. The water level changed by 0.4-0.5m during the year. The maximum water level is 1.56m. The water level varied greatly during the year. Groundwater is mainly formed by river seepage recharge. This is shown in Fig. 4. Overall, the water table is displayed from August to November every year. When the river flow reaches its maximum, the corresponding groundwater level also peaks. In December, the flow of the river decreased. The groundwater table is beginning to show a downward trend. The low water level occurs from December to May of the following year.

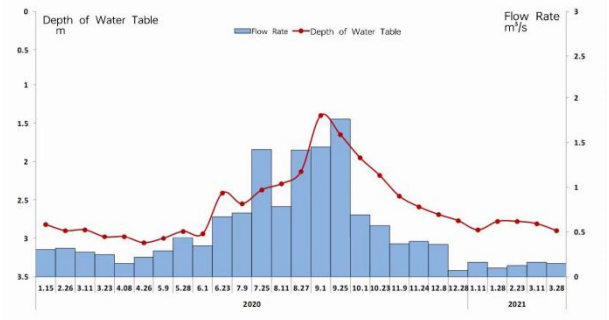

Fig.3 Dynamic variation curve of groundwater level with river flow in monitoring point ZK 5

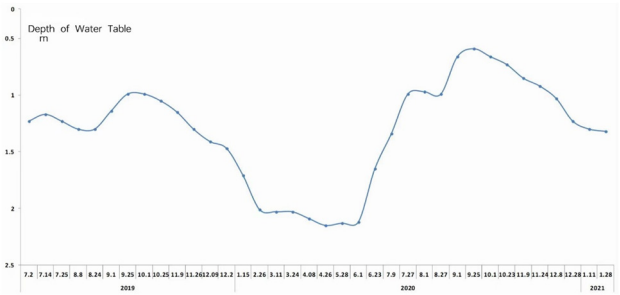

Fig.4 Dynamic curve of groundwater level of D17 monitoring well in the middle reaches of Xinachuan

4.3. Water chemistry characterization

(1)Surface water

The chemical composition of river water depends on factors such as supply source, climate, strata and river water dynamic characteristics. The longer the river, the more rock formations that pass through different chemical compositions, and the greater the change of water chemical composition. The water in the middle and upper reaches of the Huangshui Xinachuan River Basin is generally colorless, transparent or translucent. The sediment content is higher during the flood period. The water is generally yellowish-brown in color. The temperature of the river water varies with the change in air temperature. The water temperature is generally between 5-20°C. The water temperature decreases with altitude. The total hardness of the Xinachuan River water (in terms of $CaCO_3$) is 115-180mg/L. The pH range was 8.38-8.49. The PH is weakly alkaline. The salinity of the river water is 0.13-0.19g/L. The water chemistry type is HCO_3-Ca type. The water quality is good.

The Xinachuan River flows from northwest to southeast through the middle and high mountains and the red bed hilly areas. In hilly areas, river water interacts with groundwater to continuously dissolve soluble salts in the red layer on the surface. As a result, the content of Cl^- and SO_4^{2-} ions in the river water continued to increase. It also makes its salinity and total hardness show an upward trend.

The existing survey data analyze the Huangshui River Basin. The surface water quality of the Xinachuan River is less affected by human activities. In both 2020 and 2021, the water quality compliance rate was 91.7%. Water quality meets or exceeds Class III standard water quality. The surface of the study area can be used as drinking water, boiler water and farmland irrigation water.

(2)Groundwater

According to the sample test and analysis results, it is found. The physical properties of groundwater such as temperature, colour, transparency, smell and taste are intuitive to a certain extent. It qualitatively reflects the degree of mineralisation of groundwater. The complexity of ion composition and the quality of water. Temperature, buried depth and altitude affect the diving water temperature. It usually changes between 3-9°C. Diving at different altitudes in different geomorphological units, different aquiferous rock formations and different altitudes have different hydrochemical characteristics.

The loose rock pore water in the Xinachuan River

valley is freshwater. According to the survey data, the salinity of groundwater in the middle and upper reaches of the river is 0.28-0.37g/L. The hydrochemical classification of groundwater is based on the Shukarev taxonomy. Organize through data analysis. The hydrochemical type of loose rock pore water in the study area is HCO_3-Ca type. The water quality is good. It can be used as a source of drinking water. It is good irrigation water.

5. Conclusion

This study adopts hydrogeological surveying and mapping, hydrogeological drilling, pumping test, sample collection and other work in the Xinachuan Valley area. The main conclusions are as follows:

(1) The aquifer thickness of the floodplain and the I and II terraces from Qiaoxi Village to Shangsi Village is 19.01m thick and the depth is 2.83m. The actual water inrush is 2863.3m^3/d. Calculate the amount of water inrush 5860.46m^3/d. This is a very water-rich section; the mineralisation degree is 0.33g/L. Hydrochemical type HCO_3-Ca, HCO_3-Ca·Mg. Meet national standards. It is of good water quality.

(2) In the Xinachuan River floodplain, Class I terraces and alluvial platforms, the groundwater level of loose rock pore water is affected by river water recharge, which has typical hydrological characteristics. They feed and excrete each other. They have a close relationship with each other. When the river flow reaches its maximum, the corresponding groundwater level also peaks. High water levels began to appear in June, July and August. In November and December, the amount of water in the river decreased. The groundwater level is on a downward trend.

(3) Loose rock pore water in the Xinachuan River valley area. The water chemistry type is HCO_3-Ca, HCO_3-Ca·Mg type. Salinity is less than 0.5g/L. The water quality is good, and it can be used as drinking water and farmland irrigation water.

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