Dear Editors and Reviewers:

Thank you for your letter and for the reviewers' comments concerning our manuscript entitled “Hydrochemical characteristics and hydrogeochemical simulation research of groundwater in the Guohe River Basin (Henan Section)”. Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have made correction which we hope meet with approval. Revised portion are marked in blue in the paper. Based on your most helpful comments,after the article was revised, further changes were made to its voice as a way to meet the requirements of the journal. The results of their revision have been marked in red in the original article.Language changes are marked in red in the original text.The main corrections in the paper and the responds to the reviewer’s comments are as flowing:

Reviewer:

1. Maybe add the word "groundwater" in the title of the article? ”

Thank you for your kind suggestions,after redefining the overall content of the article, we decided to revise the title to “ Hydrochemical characteristics and hydrogeochemical simulation research of groundwater in the Guohe River Basin (Henan Section)”

2. In the Introduction, the authors have perfectly outlined the history of the development of hydrogeochemistry in China, but, in our opinion, it would be nice to also provide references to hydrologists from other countries in this section.

Thank you for their suggestions.In the introduction, we point out the main development process of hydrogeochemistry in China, and also find that we ignore the introduction of the research status of hydrogeochemistry in other countries in the world. We apologize here. We have made more detailed corrections and modifications in the introduction to ensure that the introduction of the article can better show the current research status of hydrogeochemistry in the world.The modification results are as follows:

The chemical composition of groundwater is mainly affected by geological conditions, the extent of chemical weathering of rocks, characteristics of aquifers, and human activities [1,2]. Its formation and evolution are the long-term result of groundwater diagenesis. With the circulation of groundwater, the process is more complex and changeable [3]. The quality of groundwater in an area depends on the chemical composition of rock stratum and make-up water, the interaction between soil and water, the rock present in unsaturated areas and its interaction with make-up water, the recharge time of the aquifer and the action of the aquifer itself [4,5]. The definition of hydrogeochemistry was proposed 1979, as a science with which to study various chemical interactions and physical phenomena between the hydrosphere and its surrounding natural environment [6]. In 1993, Shen Zhaoli *et al.* [7] compiled the basis of hydrogeochemistry and established the discipline system of hydrogeochemistry.

The relevant information of groundwater circulation characteristics from different angles can be acquired by studying the chemical composition and distribution characteristics of groundwater can obtain [8,9]. Lloyd, S. Adams and others used a variety of conventional statistical methods (such as mathematical statistical analysis, factor analysis, *etc.*) to conduct mathematical statistical analysis and interpretation [10-11].

Hitchon *et al.*, Gupta *et al.*, and S. Kumar added multivariate analysis to the interpretation of groundwater chemistry [12-14]. After decades of development, hydrogeochemical theory has been continuously improved, and research methods such as ion proportion coefficient method and water rock interaction type have been continuously enriched [15,16]. Rabelani M. studied the hydrogeochemical characteristics of groundwater in Grand Giani City, Limpopo Province, South Africa by using the Piper diagram, Gibbs diagram, and ion ratio [17]. Kaur L. *et al.* investigated the chemical composition of groundwater in the Panipa special district (semi-arid alluvial area) of Haryana, India by using a Piper diagram and ion proportion relationship [18]. N. M. Refat Nasher used factor analysis and ion ratio to analyze the hydrogeochemical characteristics of groundwater in three basins in Bangladesh [19]. The depth of ion ratio analysis is adopted to describe the interpretation of calcite and dolomite to the traditional hydrogeochemical concept [20]. Remy R. used groundwater and surface water samples collected in different seasons to explain the hydrogeochemical process of Kattumannarkoil Taluk, India [21]. Aher S. et al. explored the hydrogeochemical characteristics of the Pravara River Basin using groundwater samples collected on the cross-section of the basin [22]. Accurate assessment of groundwater hydrogeochemical characteristics and groundwater quality is helpful and necessary for sustainable groundwater protection and management [23,24].

In recent years, scholars have used isotope analysis and hydrogeochemical simulation methods to study hydrochemical characteristics to good effect [25-27]. Ren *et al*. found that groundwater in any area has a unique chemical composition, which is caused by many processes such as the interaction between water and rock during recharge and groundwater flow through the aquifer and the long-term water storage of the aquifer [28]. Wei *et al.*, Subba Rao *et al.*, and Wu *et al.*, aimed to delineate the process responsible for the geochemical changes of aquifer water environment [29-32]. Prasanna *et al.* used the method of digital system analysis to calculate the saturation index of groundwater [33]. Parkhurst et al. began the classification of mineral saturation index in groundwater samples using PHREEQC in 2013 [34].

3. Unfortunately, Figures 1-4 and 6, 7 are not presented in very good quality in the manuscript. It would like their quality to be the same as that of Figure 5.

Indeed, as you said, There are some problems in the quality of the Figures 1-4 and 6, 7.We improve the accuracy of the picture to 600*dps*.And send the Figures 1-7 to you in the form of attachment to ensure the accuracy of the Figures 1-7 is clearly visible.

4. In Figure 5, it is better to place the symbols below the diagrams.

Thanks for your suggestion,We have corrected the label position of the picture and the quality of the picture.(See its annex)

5. The number of sets should be entered in table 1, and not only mentioned in the text.

Indeed, as you said,we did not show the data of sampling points in the form of charts.According to sample collection and testing,We collected 108 groups of shallow groundwater, 34 groups of middle groundwater and 38 groups of deep groundwater. There are too many data sets, so the data sets are not reflected in the table, and they are displayed in the form of mathematical statistics.

In order to strengthen the main characterization contents in Table 1, we decided to add the

correlation analysis of C.V. to the analysis of 3.1. At the same time, the addition of data sets shows the difference of mineralogy between this paper and Zheng Tao *et al*. The main contents are as follows:

The coefficient of variation (C.V.) can represent the dispersion degree of various indexes in groundwater and the complexity of influencing factors of groundwater chemical composition and its evolution. The coefficient of variation of $K^+$, $Cl^-$, $SO_4^{2-}$ in the shallow layer is large, indicating that the shallow layer is strongly affected by human activities. It can be seen that the coefficient of variation of $Na^+$, $Ca^{2+}$, $Mg^{2+}$ in the middle and deep layer is large. This phenomenon may be affected by the recharge of shallow groundwater or cation exchange adsorption.

6. The values of the standard deviations given in Table 1 are questionable.

Thanks to the reviewers for revising this article, we have made further accounting and accurately revised table 1. The results are as follows:

***Table 1.*** *Concentration and content statistics of main hydrochemical indicators (unit: mg/L)*

| Type | Project | $K^+$ | $Na^+$ | $Ca^{2+}$ | $Mg^{2+}$ | $Cl^-$ | $SO_4^{2-}$ | $HCO_3^-$ | Hardness | TDS | TDS[36] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shallow | Mean | 2.55 | 147.66 | 89.77 | 73.84 | 117.25 | 126.50 | 686.91 | 528.12 | 917 | 823 |
| | S.D. | 4.79 | 158.94 | 49.31 | 32.68 | 122.55 | 159.28 | 191.52 | 225.39 | 507 | 321 |
| | Min. | 0.30 | 15.90 | 15.30 | 24.90 | 12.30 | 3.82 | 359.00 | 141 | 400 | 289 |
| | Max. | 41.80 | 1420.00 | 384.00 | 205.00 | 696.00 | 1287.00 | 1640.00 | 1780 | 4372 | 1620 |
| | C.V.[1] | 1.88 | 1.08 | 0.55 | 0.44 | 1.05 | 1.26 | 0.28 | 0.43 | 0.55 | 0.39 |
| Interme diate | Mean | 1.58 | 203.01 | 18.18 | 16.26 | 77.86 | 76.28 | 398.59 | 112.35 | 622 | 1322 |
| | S.D. | 0.37 | 71.45 | 21.08 | 18.66 | 65.99 | 52.01 | 114.69 | 126.74 | 178 | 264 |
| | Min. | 0.60 | 37.00 | 3.30 | 1.70 | 21.50 | 21.50 | 251.00 | 15 | 366 | 869 |
| | Max. | 2.40 | 353.00 | 87.80 | 88.90 | 320.00 | 211.00 | 807.00 | 585 | 1080 | 1710 |
| | C.V.[1] | 0.24 | 0.35 | 1.16 | 1.15 | 0.85 | 0.68 | 0.29 | 1.13 | 0.29 | 0.20 |
| Deep | Mean | 11.16 | 8.19 | 60.80 | 64.73 | 372.61 | 61.63 | 560.00 | 1.56 | 200 | 792 |
| | S.D. | 15.10 | 10.13 | 42.35 | 40.39 | 60.51 | 78.82 | 136.33 | 0.33 | 58 | 139 |
| | Min. | 1.00 | 55.10 | 3.00 | 1.40 | 18.80 | 22.10 | 244.00 | 13 | 347 | 561 |
| | Max. | 2.40 | 330.00 | 94.60 | 57.90 | 188.00 | 193.00 | 490.00 | 475 | 950 | 970 |
| | C.V.[1] | 1.35 | 1.24 | 0.70 | 0.62 | 0.16 | 1.28 | 0.24 | 0.21 | 0.29 | 0.18 |

[1](The coefficient of variation is dimensionless)

Annexes:

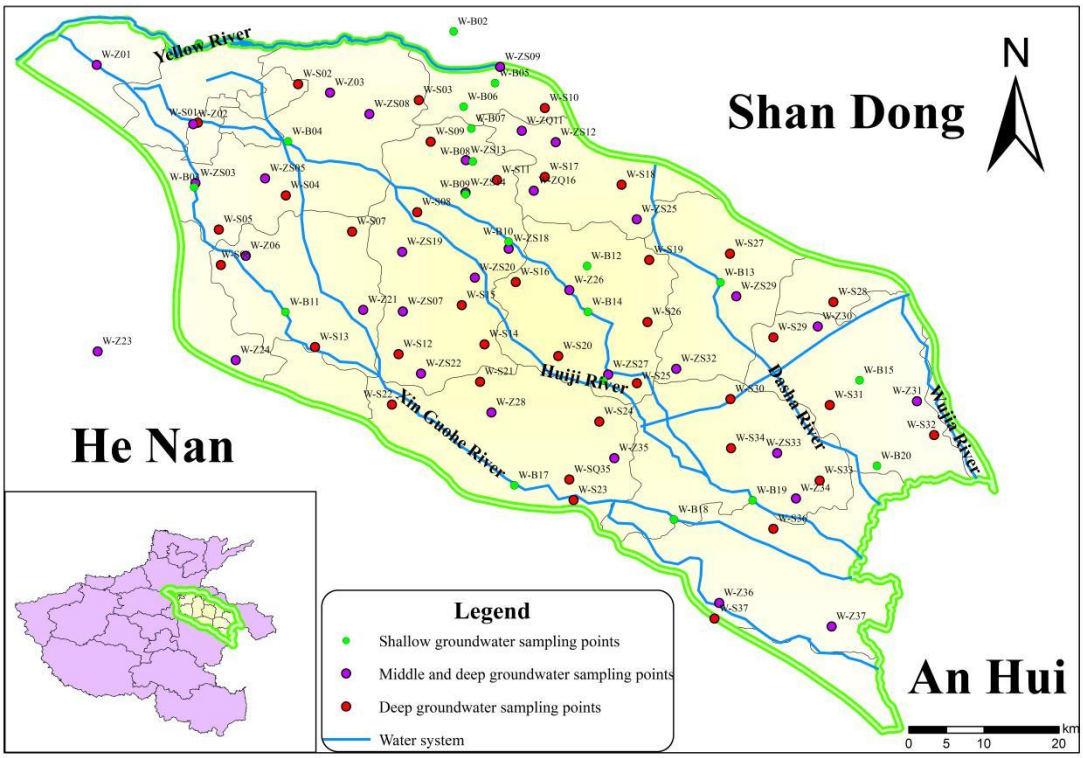



Figure 1. Distribution of hydrochemical sampling points in the Guohe River Basin.

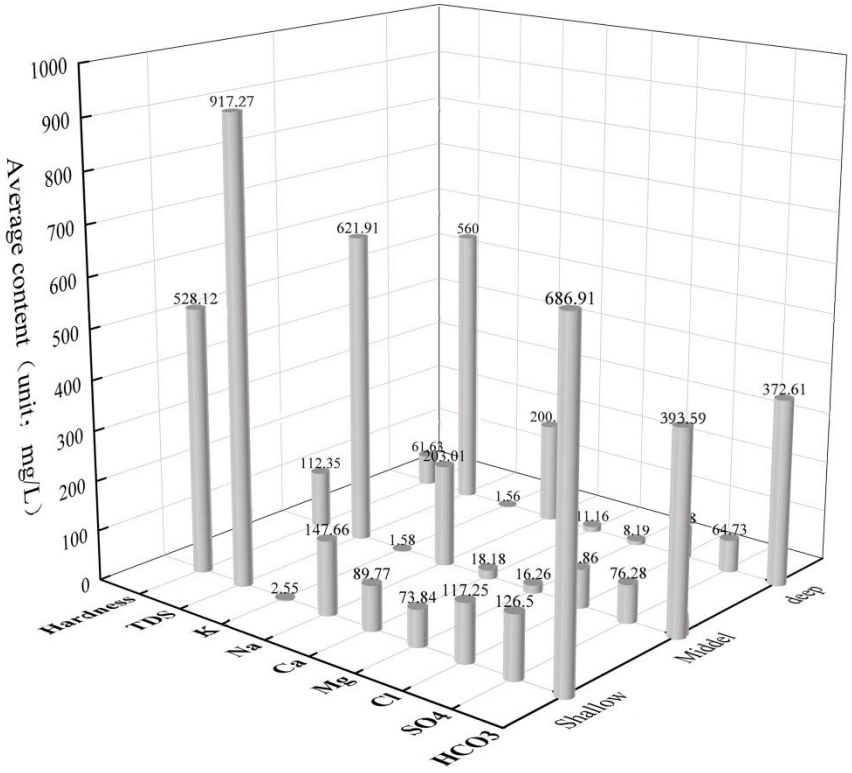



Figure 2. Average content distribution of main ions and indicators in the three-layer aquifer.

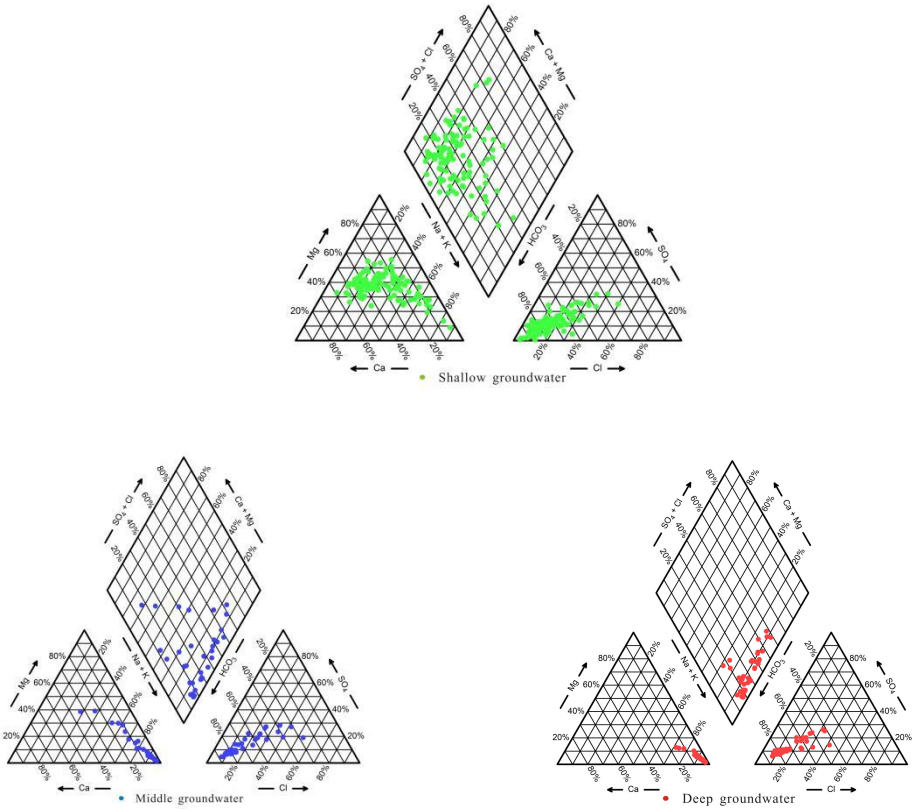



Figure 3. Piper tri-maps: shallow, intermediat, and deep groundwater in the Guohe River Basin (Henan Section)

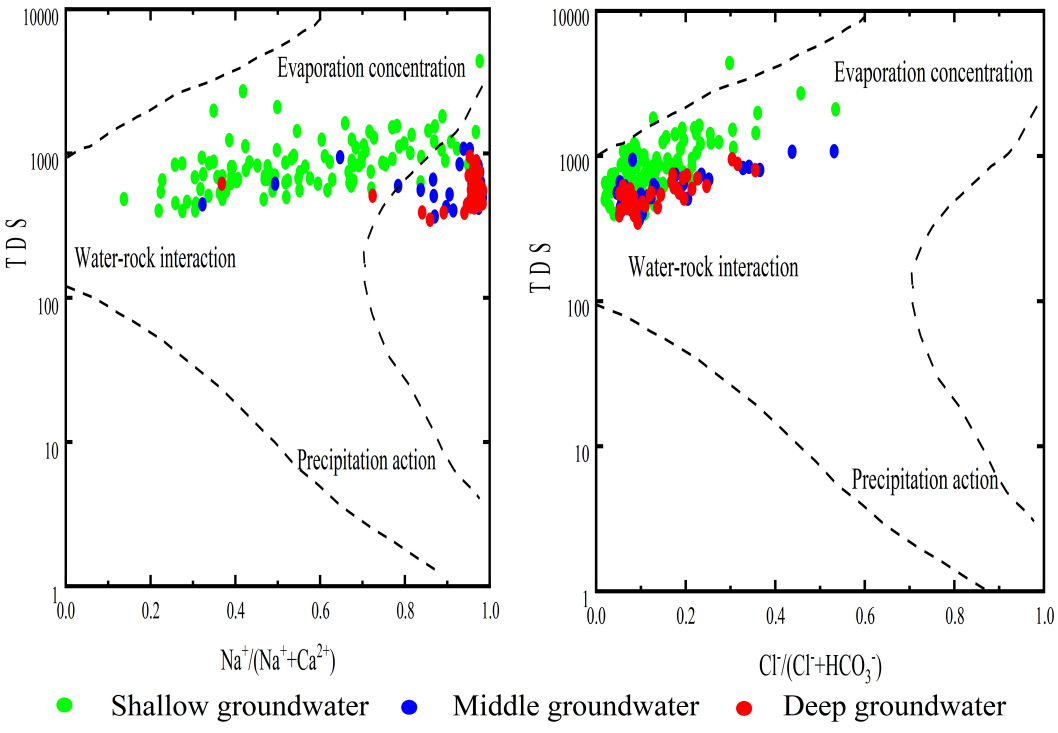



Figure 5. Gibbs diagram of shallow, intermediate, and deep groundwater in the study area.

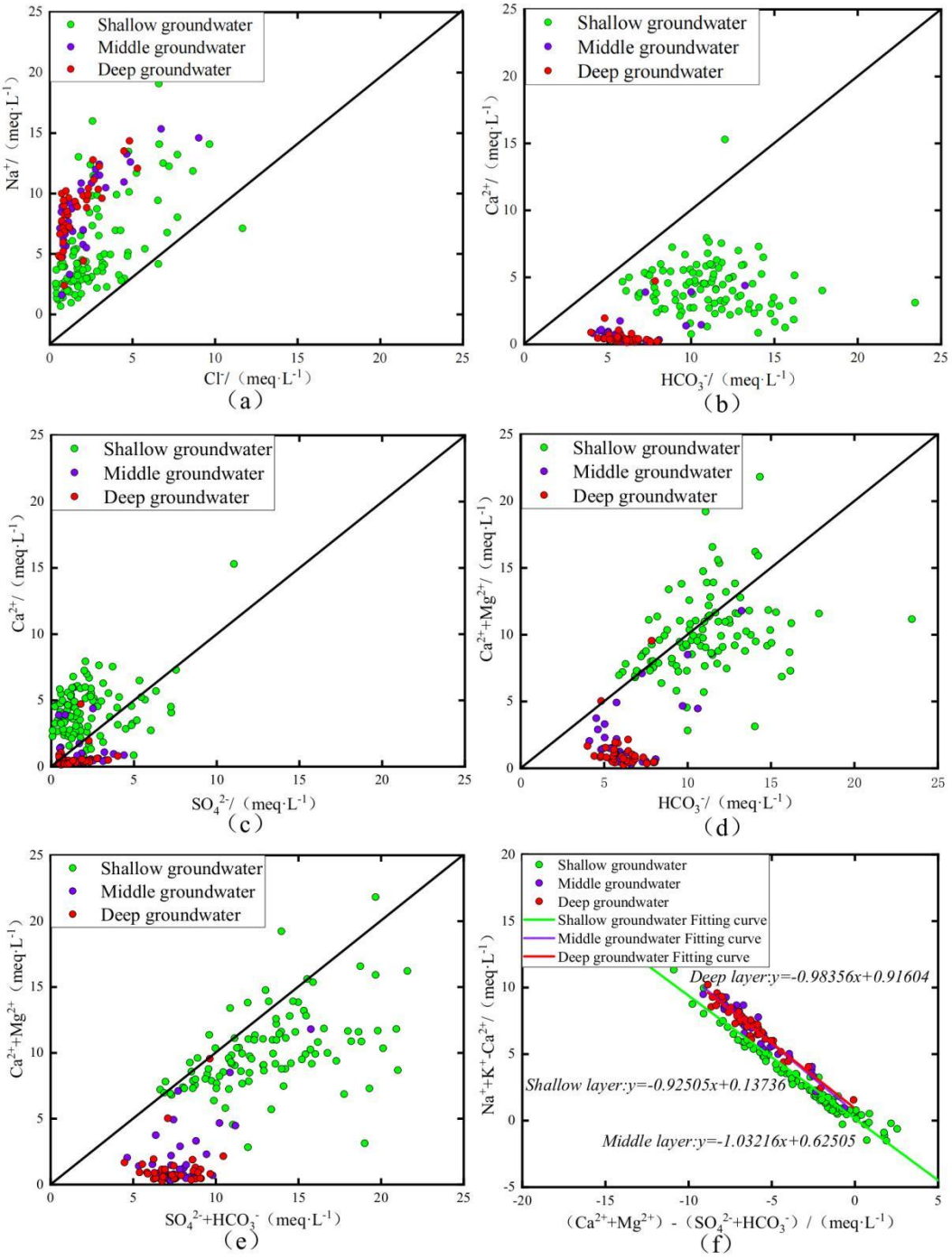



Figure 4. Ion proportion coefficients of shallow, intermediate, and deep groundwater in the study area.

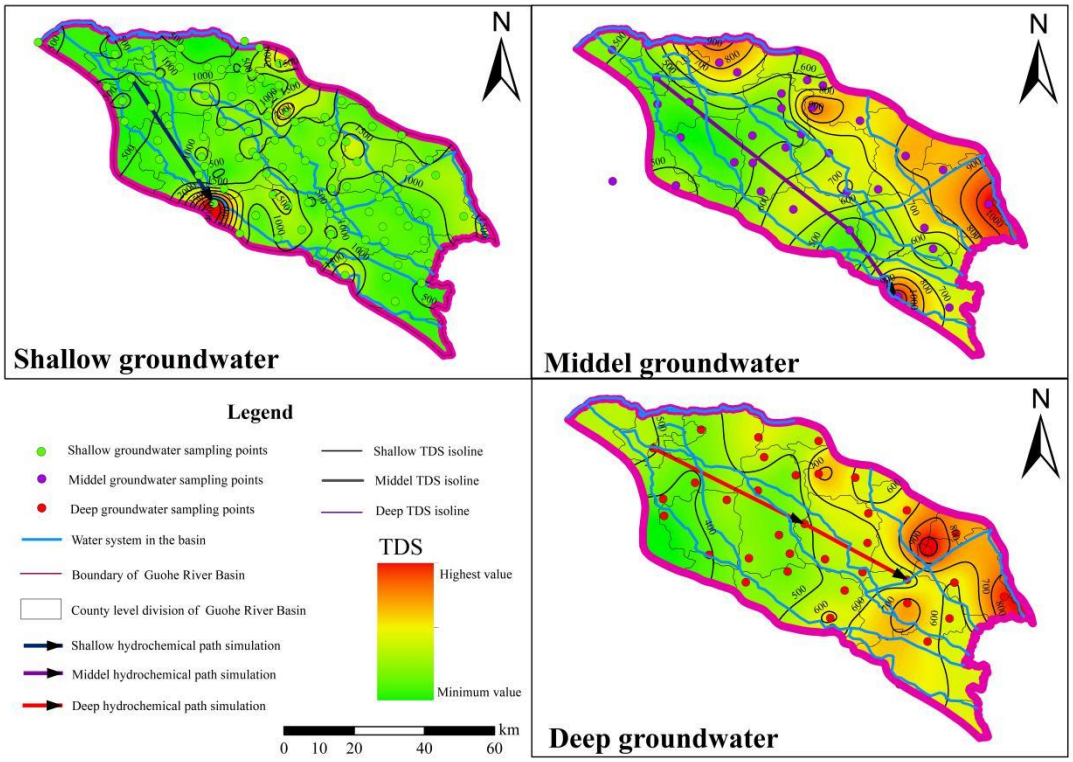



Figure 6. Shallow, intermediate, and deep simulation paths of Guohe River Basin (Henan Section)

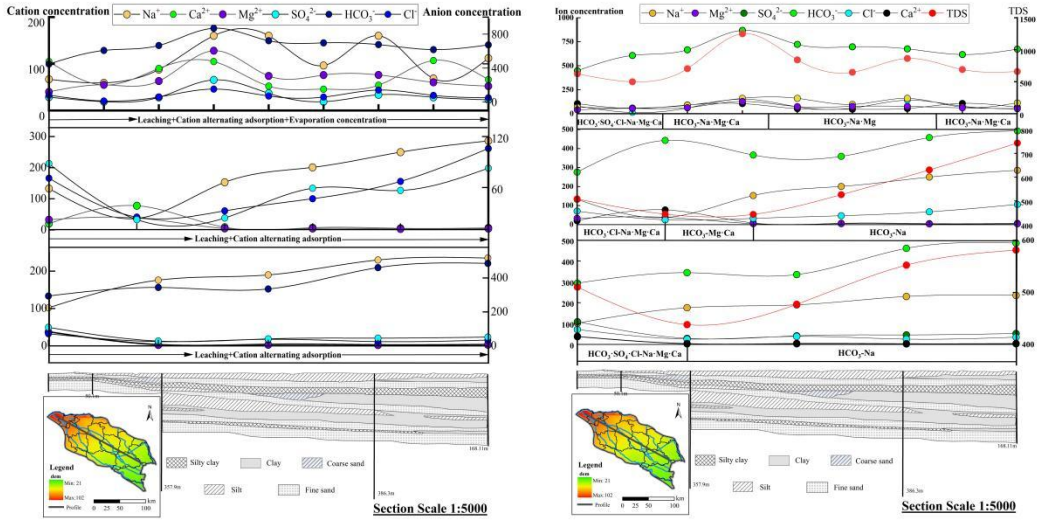



Figure 7. Hydrogeochemical evolution model of the three-layer groundwater aquifer along the chosen profile in the Guohe River Basin (unit mgL).