Dear Reviewer,

We would like to extend our thanks to Anonymous Referee #2 for providing useful and detailed feedback on our paper, which certainly helps us improve our paper. We hope that our replies clarify all points raised by Referee #2. Reviewer's comments are shown in italic; authors' reply is shown in regular text and all the relevant changes are highlighted in blue in the revised manuscript.

General comments:

1. While I think I agree with most of the interpretations, the paper is almost wholly parochial and describes processes in one small part of a regional-scale basin. The interpretation of the geochemistry is relatively straightforward and follows a recipe that has been well described in many papers and textbooks; there is nothing in this interpretation that provides geochemical researchers with any better general understanding of processes or how to interpret them.

Reply: (1) In recent years, with the fast development of Ordos energy base, more and more well fields have been built in some lake basins (including Haolebaoji well field newly built in Subei lake basin) in order to meet the increasing demand of water resources, but due to lack of adequate hydrogeological knowledge about these specific lake basins, groundwater over-exploitation has taken place and posed a threat to groundwater-dependent ecosystems around these lakes. In addition, intensive groundwater exploitation could remarkably influence hydrodynamic field and hydrochemical field of groundwater system and may influence geochemical processes inherent in groundwater flow system. So studies about these lake basins are urgently needed so as to obtain a comprehensive knowledge of the hydrochemical and isotopic characteristics, and geochemical evolution of groundwater under the background of intensive groundwater exploitation.

(2) There is no doubt that the research methods of geochemistry are important, but the purpose of this study is to identify the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities. What matters is research findings rather than research methods in this paper. As long as the research methods can help us gain new and significant findings, they are reasonable and valuable. Just as these familiar geochemical methods have been successfully applied to assess geochemical processes and geochemical evolution in complex systems of many other places in the world, these techniques are also used to ascertain the origin of groundwater and determine the geochemical factors and mechanisms controlling the chemical composition of groundwater in the present study. The research methods and techniques of this study could be applied to other similar work. The present study could also provide better general understanding and some geochemical methods how to interpret geochemical processes for geochemical researchers.

2. The paper commences with a discussion of the study area and then proceeds to look at data from a small part of it. Even if it is accepted that it is important to understand processes in that particular area (which is not justified), then it needs to be explained at the end of the paper how the results from this study fit in with the broader

hydrogeology of the region. As it is, the paper just describes processes in this small sub-basin in isolation. It is also mentioned that this work is required to manage the water resources, but it is never explained how.

Reply: (1) In recent years, more and more well fields have been built in some lake basins (including Haolebaoji well field newly built in Subei lake basin) in order to meet the increasing demand of water resources for regional development, but due to lack of adequate hydrogeological knowledge about these specific lake basins and reasonable groundwater management strategy, groundwater over-exploitation has taken place in these specific lake basins and caused a series of negative impacts on the groundwater-dependent ecosystem around these lakes. It becomes more urgent as large-scale and intensive groundwater exploitation could remarkably influence groundwater flow field and may influence geochemical processes inherent in groundwater flow system. Therefore, it is very important to understand geochemical processes and geochemical evolution of groundwater in Subei lake basin.

(2) We have tried to make some explanations that relate the results from this study with the broader hydrogeology of the region in the conclusion section in the revised manuscript.

(3) The primary focus of the study was to identify the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities. The reasonable management strategy of water resources needs the support from the assessment of both water quantity and water quality in the study area, currently we only have mastered hydrochemical data, so we think it is necessary to conduct the evaluation of water quantity with water balance method or numerical simulation technique in the next step, and further analyze groundwater exploitation effects of Haolebaoji well field in Subei lake basin on its adjacent ecological environment. In that case, a scientifically reasonable groundwater resources management policy could be designed.

3.There is also a reliance on geochemistry alone. Figure 3 shows a flow map, but this is only used as background. It would be much better to discuss the geochemistry in the context of flow within the aquifers.

Reply: Thank you for your kind advice. The aim of the research is to recognize the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities rather than focusing on the research on hydrogeochemistry. We acknowledge that it is necessary to discuss the geochemistry along flow path, but we intended to discuss this section in another paper in view of the progress of this work. Thus, we only have to use the flow map as background of Fig.3.

4.If the paper put the results from the hydrogeology of the Subei Basin into a broader regional framework then it would be better, but I still can't see how it would be of interest to researchers working in other areas and as such it probably belongs in a regional journal.

Reply: (1) We have complemented some explanations that relate the results from the

hydrogeology of Subei lake basin with a broader regional framework in introduction and conclusions sections. The present study has its focus on identifying the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities. In the context of a large number of well fields built in some lake basins in order to meet the increasing demand of water resources, the results of the present study will be valuable in obtaining a deeper insight into hydrogeochemical changes caused by human activity, and providing significant information such as water quality situation and geochemical evolution of groundwater to decision makers so that they can make sustainable groundwater management strategies for other similar small lake basins and even the Ordos energy base. The research methods and techniques of this study could be applied to other similar work.

(2) The highlights of our paper lie in the uniqueness of Subei lake basin, it is very especial and different from most basins in the world. The three issues, namely water resources, energy and ecological environment, appear simultaneously in Subei lake basin. Specifically, with the fast development of Ordos energy base, more and more well fields have been built in some lake basins, of which, Haolebaoji well field has been built in Subei lake basin and acts an important source of water-supply in Ordos energy base. But due to lack of adequate hydrogeological knowledge about Subei lake basin and reasonable groundwater management strategy, groundwater over-exploitation has taken place and caused a series of negative impacts on the groundwater-dependent ecosystem around the Subei lake. Thus, it becomes very urgent to coordinate the relationship among water resources, energy and ecological environment. This can't do without the present study. We believe the case study is useful for decision makers and researchers to have comprehensive understanding of Subei lake basin typical of lake basins in discharge area where significant changes in groundwater system have taken place under the influence of human activity, and it is of interest to the HESS readership because it gets the three hottest topics together: namely water resources, energy and ecological environment, and it can also provide an important direction of similar research in other areas in the world.

Specific Comments:

Abstract

The abstract is a clear summary of what the paper addresses, however, try to put a few more results in here. For example, by how much do the stable isotopes differ between the groundwater from the various aquifers? How much evaporation do you think has taken place? In general, where possible avoid qualitative descriptors such as higher, lower, strong etc as they are not that meaningful. Also, there are a couple of probably superfluous pieces of information in here; is it really necessary to say that the water is meteoric (99.9% of groundwater is)?

Reply: Thank you for your kind suggestion. We have made some modifications on the abstract and tried to put a few more results in here in view of your kind advice. Specifically, (1) as to the difference of stable isotopes between the groundwater from the various aquifers, we have introduced this part in section 4.2 and summarized the analytical results about the isotopic difference in the abstract section. (2) We have

recognized that it is necessary to estimate the evaporative losses because the mean annual potential evaporation is 2349.1mm yr^{-1} (from 1985 to 2008), but we intended to discuss this section in another paper in consideration of the progress of this work. (3) We have avoided qualitative descriptors as far as possible in the abstract section. (4) We think it still needs to be confirmed in the study area, while almost all groundwater is of meteoric origin as a common sense. In the present study, we found that groundwater follows the LMWL, therefore, we can assert that groundwater is of modern local meteoric origin rather than the recharge from precipitation in paleo-climate conditions.

1. Introduction

The introduction starts off with a description of the study area and aside from a few sentences (lines 12-17) that outline the general background, it is almost entirely focused on the Ordos Basin. Given that HESS is an international journal with a broad readership, you need to add a few lines showing what is of general importance (i.e. what is the relevance of this study to researchers who are not interested in this area); as it is the study is framed very parochially. Try to outline what you think the major general scientific questions are that you are answering and make sure that they are addressed within the paper.

Reply: Thank you for your advice. We have added a few lines showing what is of general importance in the introduction section according to your valuable advice.

The content newly added in the revised manuscript is as follows:

"The origin and behavior of major ions in groundwater can enhance understanding of geochemical evolution of groundwater, measurement of the relative concentration of major ions in groundwater from different aquifers can provide information on the geochemical reactions within the aquifer and the possible evolutionary pathways of groundwater(Cook and Herczeg, 1999)."

We try to outline the following major general scientific questions we addressed within the paper: (1) the investigation of groundwater chemistry and isotope characteristics; (2) identifying the origin of groundwater by measuring the data of stable isotopes; (3) determining the geochemical factors and mechanisms controlling the chemical composition of groundwater so as to explore the geochemical evolution of groundwater under the background of intensive groundwater exploitation.

There seems to have been a considerable amount of work done on this area, is the study of a small region within this basin really going to improve the scientific understanding and water management. I flicked through to the conclusions and can see no discussion of how this study fits into the bigger picture of the Ordos Basin – at the very least this needs to be discussed. At the moment, the paper is written from the viewpoint that it is important to understand processes in individual small basins to provide a better overall understanding of hydrogeology. However, this does not seem to have been followed through with in the paper and what comes across is a small-scale study with little context that has been done without much consideration of the larger picture.

Reply: Thank you for your kind advice. The discussion about how this study fits into the bigger picture of the Ordos Basin has been added into the revised manuscript.

With the fast development of Ordos energy base, more and more well fields have been built in some lake basins (including Haolebaoji well field newly built in Subei lake basin) in order to meet the increasing demand of water resources, but due to lack of adequate hydrogeological information about these specific lake basins and reasonable groundwater management strategy, water resources in these specific lake basins are currently subject to increasing pressure from altered hydrology associated with water abstraction for regional development and groundwater-dependent ecosystems associated with these lakes may become vulnerable to any interruptions to flow and changes to the water table, thus we think much more accurate information could be obtained by conducting this study on Subei lake basin, which will further enhance the knowledge of geochemical evolution of groundwater system in the whole Ordos basin and gain comprehensive understanding of Subei lake basin typical of lake basins in discharge area where significant changes in groundwater system have taken place under the influence of human activity. More importantly, it could provide valuable groundwater information for decision makers and researchers to formulate scientifically reasonable groundwater resources management strategies in these lake basins of Ordos basin so as to minimize the negative impacts of anthropogenic activities on the water system.

Some minor comments:
Pg 5711, several places. Researches (should be research) – change throughout the paper.
Reply: They have been revised.

Pg 5711, lines 18-20. Why is the research on the lake basins urgently needed? (needs more context).
Reply: We have complemented more context and highlighted them in blue in the revised manuscript.
The relevant content is as follows: “In recent years, with the fast development of Ordos energy base, more and more well fields have been built in some lake basins (including Haolebaoji well field newly built in Subei lake basin) in order to meet the increasing demand of water resources, but due to lack of adequate hydrogeological knowledge about these specific lake basins and reasonable groundwater management strategy, water resources in these specific lake basins are currently subject to increasing pressure from altered hydrology associated with water abstraction for regional development and groundwater over-exploitation has taken place. If it continues, it may cause a series of negative impacts on the groundwater-dependent ecosystem around these lakes. So studies about the lake basins are urgently needed so as to obtain a comprehensive knowledge of the hydrochemical and isotopic characteristics, and geochemical evolution of groundwater under the background of intensive groundwater exploitation.”

2. Study area

There is a lot of comprehensive information here, but some of it (such as the location: Pg 5713, lines 5-10) duplicates the early part of the introduction. Try to group this material a little better.

Reply: Thank you. We have tried to group this material in the revised manuscript.

The revised content is as follows:

"The study area is situated in the northern part of the Ordos Basin, which is located at the junction of Wushen County, Hangjin County and Yijinhuoluo County in Ordos City and is mainly administratively governed by Wushen County of Ordos City. It almost covers an area of 400 km^2, ranging within latitudes 39°13′30″-39°25′40″N and longitudes 108°51′24″-109°08′40″E. Its length is 23km from east to west and its width is 22km from north to south (Fig.1)."

Pg 5713, lines 24-26. I am confused what is meant by "geomorphic types here". Are you describing the basin as a whole, different lakes, or features around an individual lake?

Reply: Yes, as the study area is a small-scale lake basin, we briefly stated the main geomorphic types, which exist in Subei lake basin from an overall perspective in terms of Fig. 1.

Pg. 5714, lines 1-5. Are there ephemeral rivers feeding the lakes during wet periods, or is all the surface water inputs via more diffuse overland flow?

Reply: According to Wang et al.(2010) and the report "Groundwater investigation in the Ordos Basin" from China Geological Survey Bureau, there is no rivers in the study area. In response to precipitation, diffuse overland flow and groundwater recharge the only surface water body, namely Subei lake and Kuisheng lake.

Pg 5714, line 8. What is "relatively closed" – either it is closed or it is not.

Reply: According to Wang et al.(2010) and the data from Inner Mongolia Second Hydrogeology Engineering Geological Prospecting Institute, Subei lake basin is a closed hydrogeological unit except a small part of southern boundary. As is indicated by groundwater flow field in Fig.3, a small quantity of lateral outflow occurs in a small part of southern boundary, so we described that "Subei lake basin is a relatively closed hydrogeological unit" in consideration of the accuracy of language.

Section 2.2 (Pgs 5714-5716) is not very clearly written. It oscillates between describing the stratigraphy and the hydrogeology. I suggest that you re-order this. Discuss the stratigraphy first and then the hydrogeology. Also there is a lack of referencing in much of this section (e.g. for the statements about recharge and discharge, confined vs. unconfined aquifers, groundwater flow directions).

Reply: Thank you for your kind advice. We have already re-ordered this section, the stratigraphy is discussed first and then the hydrogeology is described in the revised manuscript. Given that some hydrogeological statements originate from a secret geological report, we have to only describe "the data from Inner Mongolia Second

Hydrogeology Engineering Geological Prospecting Institute". In addition, a relevant reference has been added in the reference list as follows:

Wang, W., Yang, G., and Wang, G.: Groundwater numerical model of Haolebaoji well field and evaluation of the environmental problems caused by exploitation, South-to-North Water Transfers and Water Science & Technology, 8, 36-41, 2010(in Chinese).

Section 2.2 (Pgs 5714-5716). Some more hydrogeological details are also needed. Please include information on hydraulic conductivities, head gradients, porosities etc as these are important for understanding flow. I presume that such data exist given the amount of work done on the area.

Reply: According to your valuable suggestion, we have added more hydrogeological information as far as possible in section2.2 of the revised manuscript.

The hydrogeological information newly added in section2.2 is as follows:

"The specific yield of unconfined aquifer varies from 0.058 to 0.155."

"The hydraulic conductivity of confined aquifer changes between 0.14m/d and 27.04m/d. The hydraulic gradient varies from 0.0010 to 0.0045 and the storage coefficient changes between 2.17×10^{-5} and 1.98×10^{-3}."

3 Methods

Pg 5716. Some more details on the bores would be useful. Specifically, what are the typical screened intervals? Domestic and irrigation bores commonly have long and/or multiple screens and are a poor choice for obtaining geochemical samples as they may sample across multiple aquifers. Can you provide details so that we can be sure that your bores sample what you think that they do?

Reply: In the field work, by questionnaire survey, we had acquired the information about the location of screen pipes of the sampling wells so as to go on with the classification of groundwater. The length of screen pipes in all sampling wells ranges from 1m to 10m and every sampling well has only one screen pipe rather than multiple screens. The distance between the bottom of screen pipe and the total well depth ranges from 0 to 3m in the study area. In the present study, Quaternary groundwater was defined on the basis of the distribution of Quaternary sediments thickness (as is shown in Fig.3) and depth of sampling wells, as the depths of all sampling wells of Quaternary groundwater are less than 20m and the locations of screen pipes must be in Quaternary sediments, so we grouped these samples into Quaternary groundwater. In view of the analytical results of hydrochemical data and the achievements acquired by the previous studies, 120m is adopted as the maximum circulation depth of local groundwater system and it is used to divide the Cretaceous groundwater samples into two groups. The locations of screen pipes in wells shallower than 120m are all distributed in shallow Cretaceous formations, so these samples are classified as shallow Cretaceous groundwater. Likewise, the locations of screen pipes in wells deeper than 120m are all distributed in depth more than 120m, so those samples taken in wells deeper than 120m are classified as deep Cretaceous groundwater.

Pg 5716, lines 16-17. It is not the total depth that is important but the screen depths (are these the same) and how did you assign depths to your samples (bottom of screen, middle of screen, top of screen?).

Reply: Yes, we agree with your idea that the screen depths are important rather than the total depth. In the present study, we assign the bottom of screen pipe to the water samples. The distance between the bottom of screen pipe and the total well depth ranges from 0 to 3m in the study area.

Pg 5717. Lines 18-19. In alkaline samples (pH > 8 or 9) there are two components to the alkalinity – the CO_3^{2-} and HCO_3^-. These are normally titrated separately (this is discussed in many common Geochemistry texts such as Drever). Alternatively, since we know the speciation of C well, you can assign the relative HCO_3^- and CO_3^{2-} activities from the pH. However, it is incorrect to assume that all alkalinity is HCO_3^-.

Reply: Yes, we agree with your idea. In reality, bicarbonate and carbonate concentrations were titrated separately, methyl orange and phenolphthalein were used as indicators for HCO_3^- and CO_3^{2-} respectively in the titration experiment. However, during the process of experiment, we found that CO_3^{2-} concentration in groundwater samples is zero or too tiny to identify, so we ignored the CO_3^{2-} in groundwater samples. As is shown in Table 1, unlike groundwater samples, the significant content of CO_3^{2-} can be seen in lake water samples characterized by high alkalinity.

We have complemented relevant description in section 3.2 of the revised manuscript as follows:

"CO_3^{2-} concentration was also analyzed by titration method, phenolphthalein was used as an indicator of endpoint titration."

4 Results

This section is presented in a logical manner but suffers from the geochemistry being described only in relative terms. For example Na & Cl are described as being the dominant ions (Pg 5718, lines 9-10), but we have to look at Fig. 6 to understand what is meant by that. Similar with the description of pH as being relatively stable (Pg 5718, lines 11-12), downward trends in major ions (Pg 5718, lines 19-20) etc. While I can see that the data are in the various figures and tables, this section would be much easier to read with key values quoted in the text (especially where you are describing something as stable or varying).

Reply: Thank you for your kind advice. We have made some modifications and some key values were quoted in the text, we wish these changes will improve the readability of the paper.

Here are the revised content:

"The chemical composition for lake water showed that Na^+ averagely accounted for 93% of total cations and Cl^- averagely accounted for 58% of total anions. So Na^+ and Cl^- were the dominant elements (Fig.6),"

"The pH of lake water varied from 8.86 to 10.25 with an average of 9.74 in August and changed from 8.49 to 10.47 with an average of 9.23 in December, it can be seen

that the pH was relatively stable and was always more than 8.4 without obvious seasonal variation, which indicated the dissolved carbonates were in the HCO_3^- and CO_3^{2-} forms simultaneously."

"Dissolved oxygen concentration of lake water showed an upward tendency from August (mean value: 11.50mg/L) to December (mean value: 14.27mg/L),"

"The average value of ORP ranged from 15.1mV in August to 26.8mV in December, which was in accordance with the upward tendency of DO. It showed that lake water had stronger oxidation in December than that in August and there is a close relationship between DO and ORP. The average values of major ions concentrations showed a downward trend except Ca^{2+}, Mg^{2+} from August to December. Specifically, the average values of Ca^{2+} and Mg^{2+} increased from 6.50 to 15.30mg/L, 25.15 to 102.20mg/L, respectively, other ions concentrations reduced in different degree."

Pg 5719 (lines 1-13). I am not sure of the value of classifying the waters in this way. Unless you use it later to describe the processes, it seems a bit unnecessary. If you do want to include this classification, you can skip the explanation of how a Piper Diagram works and also you do not need Hardness measures as well.
Reply: Thank you for your kind suggestion. From the view of hydrochemical facies, Piper diagram shows that the predominant hydrochemical types are Ca-HCO_3, Na-HCO_3 and mixed Ca·Na·Mg-HCO_3 types in the study area. Meanwhile, it also indicates that there are three groups of groundwater in Subei lake basin: the Quaternary groundwater, shallow Cretaceous groundwater, and deep Cretaceous groundwater. The analytical results of hydrochemical data are in consistent with the classification method according to actual hydrogeological conditions and the achievements acquired by the previous studies. Geochemical processes were described later in view of the classification method. According to your valuable advice, the explanation of how a Piper Diagram works and Hardness measures have been removed in the revised manuscript.

Pg 5720 (line 1-5). As with the previous section, you need not introduce stable isotopes as tracers here (you did so in the introduction). Just go ahead and tell us about your data.
Reply: Thank you for your advice. The first sentence of section 4.2 has been moved to the introduction section in the revised manuscript.

Pg 5720 (lines 17-18). Unnecessary – all groundwater is expected to be meteoric.
Reply: Although almost all groundwater is of meteoric origin as a rule, we think it still needs to be confirmed in some specific place. In the present study, we found that groundwater follows the LMWL, therefore, we can assert that groundwater is of modern local meteoric origin rather than the recharge from precipitation in paleo-climate conditions.

Pg 5720-5721. Quote isotope data with appropriate decimal places given the precision of the analyses (i.e., 1 decimal place for 18O, whole numbers for 2H).
Reply: Thank you for your kind reminder. They have been revised in the revised manuscript and Supplementary Table S1.

Page 5721 (lines 9-16). The slope of the regression line from the lake water is very low. Theoretically, the slope decreases with humidity, but even at 0% it is 4 (this is discussed in Clarke & Fritz). Do you have an explanation for this; is it possible that the line is a combination of mixing and evaporation rather than just mixing?
Reply: We have complemented an explanation in the revised manuscript. As is discussed in the book of "environmental isotopes in hydrogeology" written by Clarke & Fritz, humidity is a critical factor in studying the effects of extreme evaporation in lakes. However, Subei lake basin is a very especial area in the world, it is located in discharge zone of local groundwater system, extremely arid climatic conditions and the unique characteristics of discharge zone control the evolution of the small-scale basin and result in extremely high TDS values in lake water. In the present study, more than half of lake water samples are brines. In this case, solute concentration plays an important role in effects of extreme evaporation of brines. The brines of Subei lake, which encrusts the shores with salt, has undergone a nonequilibrium process. From the perspective of water balance in an individual lake with long mean residence times, Subei lake only receives recharge from precipitation, groundwater and diffuse overland flow, so mixing effect takes place for sure, no outflow exists, the only discharge way of Subei lake is strong evaporation. Therefore, we believe that the low slope of the regression line from lake water could be ascribed to a combination of mixing and evaporation under conditions of low humidity.

5. Discussion
In many ways this is a disappointing section. The interpretation of many of the parameters has been done in a standard textbook way (as the authors state on Pg 5721, lines 17-20, most groundwater systems behave the same). While looking at geochemical processes in this way is a necessary part of chemical hydrogeology, it shouldn't be the major part. Aside from a relative straightforward interpretation of processes, how does this information help us understand anything more broad or wide-ranging about the hydrogeology of this area or processes in groundwater in general?
Reply: (1) The primary priority of this study is to identify the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities. What matters is research findings rather than research methods in this paper. As long as the research methods can help us gain new and significant findings, they are reasonable and valuable. Just as these traditional geochemical methods have been successfully applied to assess geochemical processes and geochemical evolution in complex systems of many other places in the world, these techniques are also used to ascertain the origin of groundwater and determine the geochemical factors and mechanisms controlling the chemical composition of groundwater in this study. Given

that the major parts need to be in consistent with the title and objectives of the paper, we think the discussion about geochemical processes should be important components of the paper.

(2) With the fast development of Ordos energy base, more and more well fields have been built in some lake basins (including Haolebaoji well field newly built in Subei lake basin) in order to meet the increasing demand of water resources, but due to lack of adequate hydrogeological knowledge about these specific lake basins, groundwater over-exploitation has taken place and the drastic changes in groundwater level maybe pose a threat to groundwater-dependent ecosystems around these lakes. It becomes more urgent as large-scale and intensive groundwater exploitation could remarkably influence groundwater flow field and may influence geochemical processes inherent in groundwater flow system. So it is of great significance to identify the origin and geochemical evolution of groundwater in Subei lake basin under the influence of human activities. More importantly, it could provide valuable groundwater information for decision makers and researchers to formulate scientifically reasonable groundwater resources management strategies in these lake basins of Ordos basin so as to minimize the negative impacts of anthropogenic activities on the water system. In addition, the research methods and techniques of this study could be applied to other similar work.

Pg 5722, lines 6-7. If you are going to make these conclusions, you need to specify what the slope is and what the reaction is that you envisage. Also it would help to plot the major ions on Fig. 8 in moles/L as that makes it simpler to relate the trends to the reactions.

Reply: Thank you for your advice. Figure 8 has been revised and the potential reactions we envisage have been added in the revised manuscript.

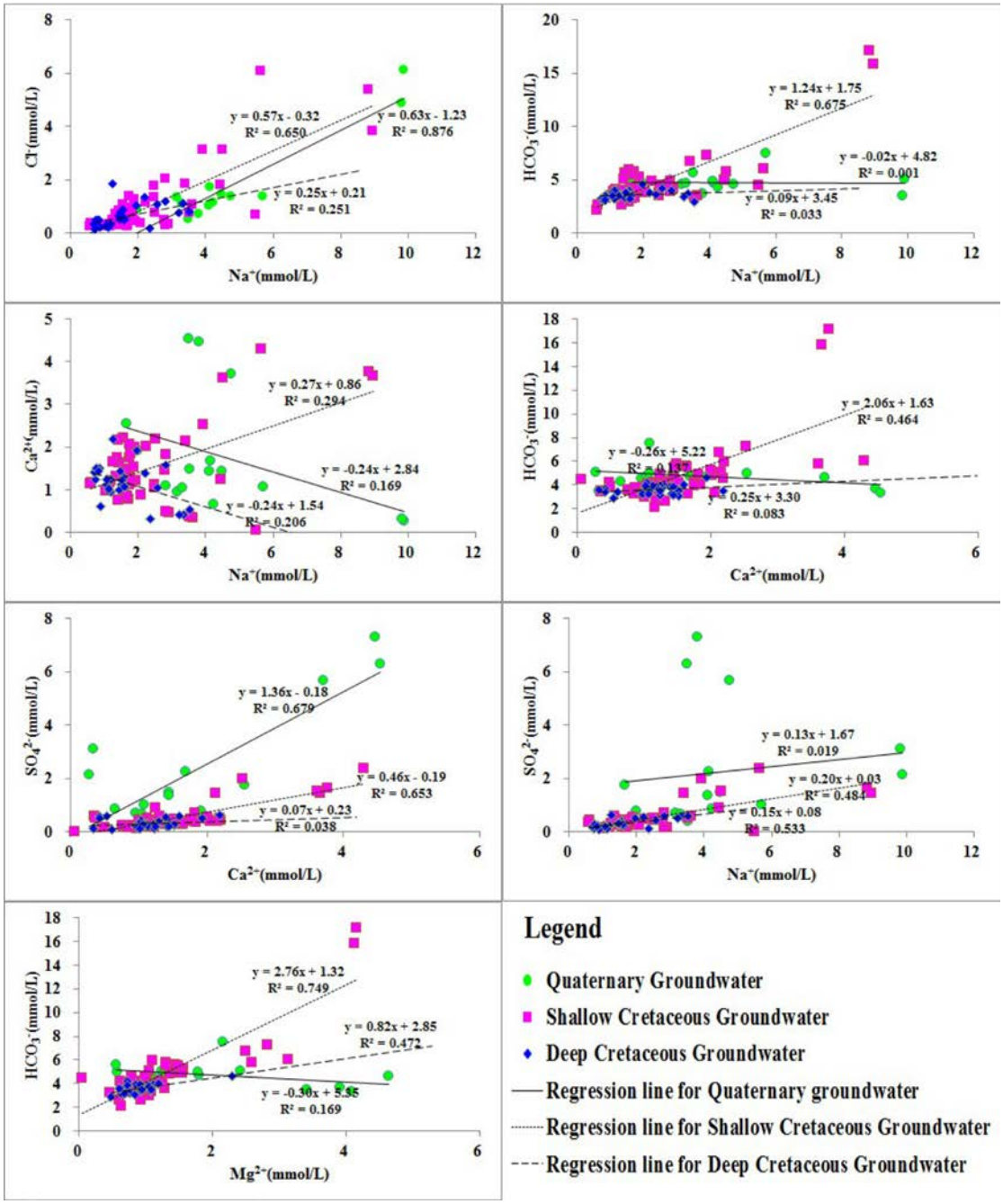
Here are the revised content:

It could be judged from the above analysis that during groundwater flow, the following reactions are very likely to take place in the study area:

$$CaMg(CO_3)_2 + 2CO_2 + 2H_2O \Leftrightarrow Ca^{2+} + Mg^{2+} + 4HCO_3^- \quad (R1)$$

$$CaSO_4 \Leftrightarrow Ca^{2+} + SO_4^{2-} \quad (R2)$$

$$CaCO_3 + CO_2 + H_2O \Leftrightarrow Ca^{2+} + 2HCO_3^- \quad (R3)$$



Revised Fig.8 Inter-ionic relationships between ions in groundwater.

Pg 5722, lines 7-20. The same comment applies to the rest of this discussion; it is not just the correlations but the particular slopes that are important.
Reply: Figure 8 has been revised and the particular slopes have been displayed in the revised Fig.8.

Pg 5722, lines 21-27. Na/Cl ratios are NOT a good indication of halite dissolution. Rainfall in most parts of the world has molar Na/Cl ratios of 0.7 to 0.9 and evaporation of this rainfall would produce waters with Na/Cl ratios that are similar to

those resulting from halite dissolution (Na/Cl = 1). Bearing in mind that there is always some ion exchange or feldspar dissolution, the only reliable indication of halite dissolution is Cl/Br ratios (see the geochemistry chapter in Cook & Herczeg).
Reply: We agree with your saying. For available experimental data in the present study, we try our best to discuss the correlation of geochemical parameters in various ways. Bromide concentration was measured on ion chromatography (ICS-2100, Dionex, USA). However, bromide concentration in all groundwater samples is below detection limit (0.07mg/L), so we could not use Cl/Br ratios as reliable indication of halite dissolution and have to infer that the dissolution of halite may be the major source of Na^+ and Cl^- by analyzing Na/Cl ratios. In addition, as is introduced in geologic setting, halite and feldspar are major minerals in Quaternary and Cretaceous formations, so the discussion about the dissolution of these minerals and some potential ion exchange are reasonable.

Pg 5723, lines 4-16. I don't see what the point of this discussion is. All groundwater pretty much derives some of its DIC from the soil zone (so that is not surprising). However, above you invoke dolomite and calcite dissolution so how can you say much about the details of soil-zone processes? Do you have ^{13}C data to help with this?
Reply: The title of section 5.1 is "Geochemical processes of groundwater", the partial pressure of carbon dioxide in groundwater and pH are significant parameters of geochemical study, so the point of this discussion in Pg5723, lines 4-16 is to illustrate the correlation between the partial pressure of CO_2 in groundwater and pH, and further confirm that as an important geochemical process, the dissolution of feldspar does take place along groundwater flow path. As is shown in Fig.9, the pCO_2 values are negatively correlated with pH values, the partial pressure values of CO_2 decrease as pH values increase, subsequently we made some reasonable explanations for this phenomenon. We acknowledge that all groundwater pretty much derives some of its DIC from the soil zone and above the dissolution of dolomite and calcite is regarded as sources of HCO_3, but it is a pity that we did not make an analysis of ^{13}C data in all water samples in this work. We think it is necessary to obtain ^{13}C data to know much about the details of soil-zone processes in the next step.

Pg. 5723. R1. As written this reaction does not change pH (lines 19-20).
Reply: This reaction can consume CO_2 and produce Na_2CO_3, Na_2CO_3 is an alkaline material, so the pH will increase by this reaction (R1).

Pg. 5724. Again I am unsure of what the purpose of the cation exchange discussion is. Why are the CAI values calculated (i.e., what do they tell us). All groundwater and surface water undergoes some cation exchange, so all of this is unsurprising.
Reply: (1) Although the cation exchange is widespread in geochemical evolution of all groundwater, it is essential to know and identify the various changes undergone by water during their traveling processes in groundwater system under the influence of anthropogenic activities. Just as the cation exchange is an important factor affecting the constituents of groundwater, it has become an important topic for hydrogeologists.

In this paper, the purpose of the cation exchange discussion is to confirm that the cation exchange is one of the major contributors for higher concentration of Na^+ in the groundwater and it is still an important geochemical process of groundwater in Subei lake basin under the influence of human activities.

(2) Cation exchange between the groundwater and its host environment during residence or travel can be studied in terms of the chloro-alkaline indices (CAI-I and CAI-II) proposed by Schoeller. When both of CAI values are negative, an exchange of Ca^{2+} or Mg^{2+} in groundwater with Na^+ or K^+ in aquifer materials takes place. At the same time, negative value indicates chloro-alkaline disequilibrium and the reaction is known as cation-anion exchange reaction. During this process, the host rocks are the primary sources of dissolved solids in the water. In another case, if the CAI values are positive, the inverse reactions possibly occur and it is known as base exchange reaction. In the present study, almost all groundwater samples had negative Schoeller index values (Supplement Table S1), which indicates cation-anion exchange (chloro-alkaline disequilibrium). This further confirms that the cation exchange is one of the major contributors for higher concentration of Na^+ in the groundwater and it is still an important geochemical process of groundwater in Subei lake basin under the influence of human activities. We have reorganized the cation exchange discussion and complemented some necessary explanations in the revised manuscript.

6. Conclusions

This is just a brief summary of the specific conclusions. After reading through the whole paper I cannot see how this study advances our understanding of the hydrology of this region as a whole, much less how it would be relevant to researchers working elsewhere. As with the introduction, there is no context for the study and no indication that the researchers are answering any questions that are great scientific importance. Without this general discussion, this paper does not belong in an international journal such as HESS.

Reply: According to your kind advice, the conclusions section has been revised in the revised manuscript. The specific conclusions are organically integrated into this section and the scientific significance of this research how to advance our understanding of the hydrology in the whole Ordos basin is also illustrated in the revised manuscript.

The revised conclusions section is as follows:

The present study examines the hydrochemical and isotopic composition of the groundwater and surface water in Subei lake basin with various methods such as correlation analysis, saturation index, Piper diagram and Gibbs diagrams. The combination of major elements geochemistry and stable isotopes ($\delta^{18}O$, δD) has provided a comprehensive understanding of the hydrodynamic functioning and the processes of mineralization that underpin the geochemical evolution of the whole water system. The hydrochemical data show that three groups of groundwater are present in Subei lake basin: the Quaternary groundwater, shallow Cretaceous groundwater and deep Cretaceous groundwater. The analysis of groundwater chemistry clarifies that the chemistry of lake water was controlled by strong

evaporation and recharge from overland flow and groundwater; meanwhile the major geochemical processes responsible for the observed chemical composition in groundwater are the dissolution/precipitation of anhydrite, gypsum, halite and calcite, the feldspar and dolomite weathering. Furthermore, the cation exchange has also played an extremely vital role in the groundwater evolution. The absolute predominance of rock weathering in the geochemical evolution of groundwater in the study area is confirmed by the analytical results of Gibbs diagrams. The stable isotopic data indicate that groundwater is of modern local meteoric origin rather than the recharge from precipitation in paleo-climate conditions. Unlike significant difference in isotopic values between shallow groundwater and deep groundwater in Habor lake basin, shallow Cretaceous groundwater and deep Cretaceous groundwater have similar isotopic characteristics in Subei lake basin. Due to evaporation effect and dry climatic conditions, heavy isotopes are more enriched in lake water than groundwater. The low slope of the regression line of $\delta^{18}O$ and δD in lake water could be ascribed to a combination of mixing and evaporation under conditions of low humidity. By comparison of the regression line for $\delta^{18}O$ and δD, lake water in Subei lake basin contains more heavily isotopic composition than that in Habor lake basin, indicating that lake water in discharge area has undergone stronger evaporation than lake water in recharge area.

Much more accurate groundwater information has been obtained by conducting this study on Subei lake basin, which will further enhance the knowledge of geochemical evolution of groundwater system in the whole Ordos basin and gain comprehensive understanding of Subei lake basin typical of lake basins in discharge area where significant changes in groundwater system have taken place under the influence of human activity. More importantly, it could provide valuable groundwater information for decision makers and researchers to formulate scientifically reasonable groundwater resources management strategies in these lake basins of Ordos basin so as to minimize the negative impacts of anthropogenic activities on the water system. In addition, given that there have been a series of ecological environment problems, more eco-hydrological studies in these lake basins are urgently needed to do from the view of sustainable development of natural resources environment in the future.