

Interactive comment on “Groundwater compartmentalisation: a geochemical analysis of the structural controls on the subdivision of a major aquifer, the Sherwood Sandstone, Merseyside, UK” by E. A. Mohamed and R. H. Worden

Anonymous Referee #1

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Revision of the article

“Groundwater compartmentalization: a geochemical analysis of the structural controls on the subdivision of a major aquifer, the Sherwood Sandstone, Merseyside, UK”

Authors: E. A. Mohamed and R.H. Worden

GENERAL COMMENT

The article addresses an interesting case study in an aquifer of strategic hydraulic inter-

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est near Liverpool (UK) combining an important amount of both head and geochemical data, well distributed in space and time. However, I do not think the manuscript is ready for revision and still need much extra work by the authors on it before publishing it in an international journal. The paper does not focus in a single aspect, ending in a lack of consistency between title, objectives and discussion. It is not clear which are the significant contributions of these work to the international scientific community. It looks more like a conference communication extended in some degree, rather than a full-length article for a journal. The methodology in the study is correct but data and information are not presented clearly and much information and details are missed in a report of such level. Figures are small, thus not very clear making it very difficult to follow the discussion; I found myself problems to interpret most of them (e.g. to differentiate between contours and faults). I think the authors can present a much better work with the available information and it is not clear which are the relevant scientific questions the paper addresses within the scope of HESS. Therefore, I recommend rejection for publication on HESS. My suggestion is to re-write the article clearly focusing in only one or two aspects (to me it should be a case study of the Sherwood sandstone aquifer), and discussing in detail all the data available. Contrarily to what I believe is the authors' intention, I think there is not enough material for two first-line publications, but one nice article could result if the authors would include all the information together in a single paper. Consider also that publication in a local journal may be more likely.

See detailed comments below.

SPECIFIC COMMENTS

1.The methodology used in this study is correct and the authors give some insights to proceed in a case study involving aquifers involving sealed faults. The article based conclusions on the interpretation of head and concentration data. Thus, special care should be taken to explain quality of measurements, techniques used in sampling, details on space (also depth of sampling) and time distribution of the data. I missed a table containing the results from the geochemical analysis.

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2.The paper lacks focus but try to support the same general conclusion (compartmentalization of the aquifer) from different type of data. However, the geochemistry part is poorly presented (Figure 8 is not even discussed in the text), thus not supporting data interpretation and conclusions. In fact, geochemistry data is presented in plots (e.g., Fig 9 and 10) as average data, assuming a compartmentalization a-priori.

3.The writing style is not fluent and needs full revision both in English grammar and expression. I did notice several verb disagreements, unfinished sentences and missed words (not listed in the revision at this stage of revision since, I understand, the article will suffer important changes).

4.The Title is not clear and not consistent with what is exposed in the text. Ironically, geochemistry is a minor issue in this paper (unfortunately) and even the authors say (page 950, line 1) will be addressed in a different paper.

5.The Abstract does not provide a concise summary and would need to be reviewed. It is not sharp and includes some unnecessary details (e.g. about limits of the area of study). It does not clearly indicate the main ideas addressed and reflects the lack of focus and structure of the paper.

6.The structure of the article is appropriate in a general way but could be modified to become more logical. For example, I think it would make more sense if calling section 2 “Geology and topography”; taking “Methods” out of section 2; and combining together section 3 and 4 in “Results and discussion”. It is not clear the authors’ intention for including Section 5. To me it is more an extension of the discussion and therefore that information could be presented together.

7.Introduction: The fact that the aquifer structure (compartmentalization) can be defined from groundwater heads and chemistry characterization is not a new issue in hydrological studies. Some other works can be found in the bibliography, most in local journals. A more extended references search may help improving that section. Some times the authors extend too much in general ideas, for example when the authors uses

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20 lines of text to express the idea that most population in the world lives in coastal areas, which are threatened by different possible ways of contamination like seawater intrusion (which I think is widely known between hydrogeologists and could be reduced to a couple of sentences). Some connection is missed between paragraphs in the Introduction. It is not clear to me why the authors decided to separate some of the Introduction's information into a separate Section 1.1; I think all this goes into "Introduction" and no sub-sections are needed. Objectives are well enumerated at the end of the Introduction. Perhaps including specific partial objectives would improve also that part.

8. Section 2 is quite long. The authors describe in detail (50 lines!) all the materials in the ground, but this information is not further used in the discussion. I do not think such an explanation is needed since table 1 (very good and helpful) gives the reader most of the information he needs to know. Section 2.1, on the contrary, is necessary and very important for later discussions, so an extension of it may be interesting. I recommend the authors to focus more on the fact that the main faults are sealed, which is the key aspect on the issues discussed later in the paper. Section 2.3: time distribution of the samples should be addressed in detail by the authors. Also, it is never specified how deep is located the screen in each well, which is a key issue to support conclusions.

9. Section 3 contains many repeated ideas (some are repeated again on Section 4). The text could be improved a lot after only with an additional revision by the authors. Section 3.1: I agree the anticline modifies and constrains (as any other geological structure) the groundwater flow, but do not act as a "barrier" for flow (as the faults do). Section 3.2. I agree with authors the contour distribution of concentration helps defining the system but an explanation of the selection of Chloride and Sulphate (and not other cations) to make such contours is left. Selection of the geochemist parameter to represent is important since the discussion is conducted later based on these plots. I do not think climate is a main control of the concentration of chloride in water. I would look first for geology, seawater intrusion and human contamination.

10. Section 4: The low quality of the figures makes it difficult for the reader to follow the discussion in detail (just increasing size would help a lot!) (see comments about figures below). Also discussion is quite confusing since they first refuse to discuss the chemical aspects (page 950, which I think is basic to make this article more interesting and worthy to be published), and after they present three figures with some treatment of the geochemical data. But finally they reduce discussion of these figures to about 10 lines. I think the authors may take much more advantage of the 250 geochemical analyses (It is hard to say since we do not know in detail what type of chemical parameters do they have). Simple description on what is observed in Fig 9 and 10 is not enough, and a wider discussion of the results is needed to support conclusions. I think you should plot ALL the data in the diagrams (e.g. the Piper diagram), not only the average of the samples in each structural block discussed before. By doing that you are assuming a priori a certain compartmentalization of the aquifer before representing the chemical results. There is no way to test if this is true or not if only the average is plotted. In addition, faults are not the “reason of the differences” in geochemistry; rather, faults highlight those differences.

11. Section 5: from the data and discussion presented by the authors in the manuscript, I think comparing their study in Sherwood sandstone with a full study in an oil field is going too far. I agree with the authors that much can be done on aquifer characterization with head and concentration data (as I believe they will show better after revision).

12. Terminology: authors use the terms “water table height”, “groundwater height” and “groundwater levels”; some consistency with the terminology is needed. Using simply “heads” will reduce confusion for the reader.

13. Table: be careful with the format. Text must be centered in the cells, use 1- >35 instead of >1-35, >1500 instead of >1500m, etc.

14. Figures: as exposed above, these are hard to read mainly due to their small size. Different type of lines must be used to show the coast line, contours and faults. Oth-

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erwise it is completely unreadable. I am still wondering where the River Mersey and the coast line are located. Cross sections need to be enriched adding the geological formation limits (at least the aquifer limits). I never found out if the main aquifer body is fully confined or acts as a non-confined because of the depression of groundwater level. Symbol for B6 is missed in the diamond of Figure 10. Figure captions do not include all the information needed to understand the figure: what B1, B2, etc, means on Fig7? Legend on Fig 8? What the crossed lines mean on Fig 9?? I agree with the authors that contour lines must be drawn by hand in that case, but that implies being specially when drawing (e.g., some contours are missed on figure 6d). I also think observation points should also be included in the contour plots.

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