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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A multi-tracer approach to constraining artesian groundwater discharge into an alluvial aquifer" *by* Charlotte P. Iverach et al.

Anonymous Referee #2

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General Comments: This manuscript has potential to be a very interesting article and could have a big impact on our current understanding of the interactions between alluvial aquifers, regional aquifers, and surface-water systems. The topic should have broad interest to other research on alluvial aquifers and broad applicability to global alluvial groundwater systems. The combined geochemical tracer and multiple isotopic tracer approach is a potentially robust way to sort out these interactions. However, the manuscript suffers from poor organization and lack of specificity in the methods and interpretations. This prevents a recommendation to accept the article as it is currently written. Instead, the recommendation is to accept after major revisions including the organization and technical detail of the article. In addition, it was very difficult to read

the manuscript due to awkward syntax and lack of focus (see Specific Comments).

The major findings/contributions of this manuscript hinge on the authors' interpretations of the isotopic and geochemical data. In general, these sections need much more clarification than is provided and in some cases, additional data mining may be ncessary (although I think the latter is the smaller of the issues). For example, a considerable emphasis is placed on 3H concentrations. However, almost all of the 3H concentrations are close to background or are 3H dead. This has implications for the mixing model and it has implications for the residence time estimates. It's not unusual to find 3H dead waters which have slightly elevated 36Cl/Cl ratios. 3H, even from the bomb-pulse, is decaying faster than 36Cl even in the presence of mixing with recent recharge and sometimes 36Cl does a better job of sorting out mixing than 3H (especially for waters that are 100 years or older). However, the real strength that the authors have is the ability to sort out young and old fractions (relative terminology) using 14C pmc. In the absence of carbonate exchange and mixing in the aquifer (another topic which needs additional clarification) the 14C pmc value is very useful in sorting out these endmembers as the authors attempt to do in Figures 5 and 6. In any case, the authors need to provide additional clarification on how they sorted out the mixing processes that affect these tracers.

Regarding data mining, this manuscript and the authors' interpretations would be strengthened by providing the 3H, 13C, and 36Cl/Cl of modern precipitation. Are these data available? If so, cite them. This would enhance the mixing model which is used to determine the fractions of GAB water in the LNA. This calculation also needs additional clarification and the authors should present the equation and discuss sources/estimates of uncertainty in this calculation.

Specific Comments: Line 56: This paragraph lacks focus. The authors bring in agriculture and it's not clear how this is connected to the bigger issue.

Line 64: What is meant by the international export market?

Lines 65-78: What is the focus here? Aquifers in general or alluvial aquifers?

Line 81:It's not just the half-life that is important, the tracer systematics including mixing and processes that affect their interpretations are needed.

Lines 96-105: The manuscript needs a focused statement about the current knowledge gaps (this should be developed in the Introduction more succinctly) and what is new and novel about this research in addressing those gaps. The manuscript would benefit from a clear hypothesis statement or statement of science questions. This, in my opinion, would help focus the entire manuscript and the authors should return to this statement in the opening paragraph of the Conclusions.

Lines 208-213: This sentence is difficult to understand, yet this paragraph is critical in identifying the knowledge gaps.

Line 237: This is a good place to re-state or reiterate what is missing by identifying the knowledge gaps and how your research addresses those gaps. Lines 292-293: Please clarify the statement on NH4 concentrations.

Line 336: Does it make more sense to separate the Results and Discussion. This may help streamline and better organize the manuscript.

Lines 343-362: This needs to be better organized, perhaps start with description of how GAB works hydrologically, then describe the ratios and their implications for the LNA. Suggest breaking this paragraph into 2 new, concise paragraphs.

Lines 375-376: Be assertive here. This does suggest...rather than may suggest.

Lines 376-378: Needs clarification.

Lines 380-381: Please provide sources of F- and how that relates to the point you are making.

Lines 416-431: Please clarify. Most 3H values are close to background or are dead with respect to 3H. This complicates your interpretation, but you seem to pull it back

in focus with the figure. Suggest picking specific sites and describe what the data is telling you.

Lines 432-434: Prevalence of 3H?? Again, the 3H values are almost all very low or 3H dead. Consider rewording and clarifying this statement. Also, are there recent 3H values for precipitation?

Line 434: 3H and 14C and not entirely consistent are they? This needs clarification. Why are they inconsistent?

Lines 432-445: Please clarify and provide a more concise discussion on mixing effects.

Line 458: What about 36Cl/Cl of modern precipitation? High 36Cl/Cl can be indicative of mixing of bomb-pulse with recent (low 36Cl/Cl) recharge. But, low 36Cl/Cl can also imply very old groundwater (your case). Can you clarify this uncertainty with modern precip?

Line 487 (Figure 7): Please cite Phillips (2000) Chapter 10.

Lines 510-523: Please provide the equation used to calculate the mixing proportions. Can you also provide estimates of uncertainty in these calculations? Are there other solutes or solute ratios (Cl/Br for example) which may be more suitable for these calculations? It's not clear how this was estimated.

Line 535: Can you provide plots showing the spatial map of appropriate chemical concentrations?

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