

## Comments to the Authors

The manuscript on “*Water resources in the Badain Jaran Desert, China: New insight from isotopes*” by Xiujie Wu, et al. is providing evidence that groundwater in the Badain desert is locally recharged and consists of young water based on stable isotope samples collected from groundwater wells, lakes and during evaporation experiments. The authors argue against opinions published earlier (e.g., Chen et al. 2004, Gates et al. 2008). Beside stable isotopes, a main argument against old groundwater originating from the Qilian Mountains – as proposed earlier - is that DIC based carbon-14 ages are impacted by old carbonates. The authors argue that evaporative enrichment of stable isotopes and the extrapolation of the evaporation line back to source water on the LMWL proves that recharge occurs locally. The manuscript is covering a very interesting topic and research site, it is well written and structured. The collected data (two campaigns, 21 stable isotope samples, 7 carbon-14 groundwater ages) is combined with data from earlier studies of other authors. The material collected for this work seems to be satisfying but the authors could improve the manuscript, especially the methods chapter and their presentation of figures and tables. I recommend to accept the paper for HESS after major revisions. My comments given below aim for an additional improvement of the manuscript.

### General comments

- Since water resources are the main topic/title and there were plans to use these resources for a large water diversion project (Chen et al., 2004) in a very sensitive (arid) environment, a better description of hydrological components and an overall balance would be helpful. Would it be possible to calculate the recharge area that has to feed an evaporation loss of the lakes given? It would be interesting for the readers to get a better description of the hydrogeology and aquifer characteristics in the area (unconfined aquifer, page 11, line 3).
- Are the evaporation experiments and especially the pan size that were used representative for real evaporation processes? How were the pans constructed and installed? - Metal rings – e.g., in comparison to “class-A-evaporation pan” recommendations.
- The given evaporation lines should be directly compared and values discussed with those of other studies (e.g., Wu et al. 2014, Chen et al., 2004). Because a main argument for source water relies on an extrapolated value of the LMWL it would be necessary to provide best evidence for this value.
- The method section lacks precise description and detailed information (e.g., on conducted  $^{14}\text{C}$  corrections, gas preparation methods for stable isotopes). Would it be possible to correct for the described carbonate contribution based on measured values? Would it be possible to use DOC for  $^{14}\text{C}$ -dating or other dating approaches? Was hydrochemistry data evaluated from the collected samples as well?

### Specific comments

Title:

- Use “Groundwater studies ...” instead of “Water resources ...”, otherwise your work should focus more on hydrological budget quantification and hydrogeological aspects.

Introduction:

- Page 2, lines 31-33: This sentence is summarizing results and would fit better into the conclusion or abstract section.

#### Methods:

- You mention the GNIP station Zhangye. Please add the distance in km to the study site and further information on time sampled, number of samples used for LMWL.
- IAEA/WMO, the internet link should be given as a reference in the references section. See also recommendations for referencing to GNIP data on the WISER database at IAEA.
- Page 5, line 6: "...artificial rainfall with 250 mL in 6 min ..." It would be more informative to provide irrigation intensities in mm/min for 6 min.
- Page 5, line 13: I would recommend "Isotope analyses" or "Laboratory methods" instead of chemical analyses, because hydrochemistry is not discussed and isotope methods are no chemical methods.
- Page 5, line 17: "...Five groundwater samples ..." In Table 3 seven ages are given for groundwater!?
- Page 5, line 24. For the stable isotope analysis please give the specific gas preparation methods that were used, e.g., Gasbench, H-device, or TCEA?
- Page 5, line 26. Please use appropriate definition of delta values.  $R_{SA}/R_{ST}$  and not  $R_{V-SMOW}$ . This is especially important because you also give  $d^{13}C$  values in Table 3. These are not defined against V-SMOW but VPDB I guess!
- Your precision is given as 1‰ and 0.1‰ for  $d^2H$  and  $d^{18}O$  respectively. Your d-excess results therefore should not be given with commas (see values in Tables as well). What is the precision for your  $d^{13}C$  values? What are the precision of your  $^3H$  values? Did you test any post corrections for  $^{14}C$  DIC?

#### Results and discussions

- Page 6, line 10-14: Please give d-excess values without digits.
- Page 6, line 11: Why did you distinguish between groundwater and lake water? Please discuss results!
- Page 6, line 22: You show that d-excess values are negatively correlated with  $d^{18}O$  values (Figures 4b, 6b). Please discuss what this exactly means in your case. Usually these plots are used to argue for water vapor origin.
- Page 6, line 27: "... as Fraction Modern (Fmdn)..." Usually given in percent modern carbon as pMC. See also Table 3.
- Page 8, line 10: "... from nearby IAEA GNIP ..." Please provide information on distance and elevation of the station.
- You do not describe and discuss field parameters EC given in Table 2.
- The discussion on  $^{14}C$  free carbonate contribution to DIC is vague. Figure 9 is difficult to understand.

#### References:

Please point out all Chinese references (in Chinese) for the international readers that do not understand Chinese language.

#### Figures and Tables:

- Figure 1. Please include location of GNIP station Zhanye in Fig. 1A)
- Figures 2 and 3 could be merged together
- Figure 6: The two diamond dots are not clearly visible, not visible in 6b. "Land water" should be rephrased! Soil water?
- Figure 7: E – fluxes are misleading! Evaporation from groundwater to lake water fluxes could be better placed at boxes.
- Table 1: d-excess values without digit.

- Table 2: Category should be rephrased into type. EC is given in mS not Ms! d18O and d2H measured against VSMOW. d-excess values without digit.
- Table 3: Temperature without digits or consistently. d13C against VPDB.

### **Technical corrections**

- Page 1, line 11: “(d<sup>2</sup>H-d<sup>18</sup>O) instead of (=d<sup>2</sup>H...)”) instead of (=d<sup>2</sup>H...)
- Page 1, line 25: “... are scarce in arid regions, due ...” Please delete “in arid regions”
- Page 2, line 5: progress instead of progresses.
- Page 3, line 3: “... to104° ...” Space is missing.
- Page 5, line 20. Beta instead of Bata.
- Page 5, line 20. Beta Analytic Inc. (Miami, Florida, USA).
- Page 6, line 22: “ ... and that it is negatively ...” instead of “...and strongly and negatively ..”

### *Figures and Tables:*

- Table 2. Table caption should include all columns. Location, date and EC is not mentioned.
- Figure caption Figure 5: delete space between d18 and O.
- Figure caption Figure 6: Please correct figure caption (e.g., d18O).