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Interactive comment on "Water resources in the Badain Jaran Desert, China: New insight from isotopes" *by* Xiujie Wu et al.

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Reviewer 2ïijŽ General opinion This manuscript (hess-2016-692; Water resources in the Badain Jaran Desert, China: New insight from isotopes Xiujie Wu, Xu-Sheng Wang, Yang Wang, and Bill X. Hu) is a concise presentation of the application of well-established isotope techniques in identification of groundwater sources for a group of desert lakes in China. A relatively small amount of isotopic data points to recent precipitation being the sole source of water in the coupled groundwater-surface water system. The isotopic evidence for that seems to be unequivocal, however, some questions (see specific comments) should be addressed in order to strengthen the line of reasoning. On the other hand, data on stable isotopic composition of DIC are not used at all and the part explaining 14C patterns requires some elaboration. Interpretation of presented data could be supported with a more detailed description of the hydrological

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setting and limnology of the lakes. Text reads well, it is comprehensible and clearly presents the context, goals and conclusions of the study, however the description of the sampling campaign needs to be improved. My recommendation is to accept the manuscript after major revision.

Specific comments 1. Given that only few lakes were sampled a question arises, not addressed in the manuscript, if results of this study apply to all lakes of the Badain Jaran Desert. How big is the part of the desert where the lakes occur? It is not delineated on Fig. 1. Is the hydrogeological setting uniform throughout that part of the desert, so that the recharge – discharge pattern proposed in the manuscript might apply for the whole area? Reply: This is a constructive comment. Accordingly, in the revised manuscript, additional information and discussions are presented to address the question: (1) Section 2 has been significantly revised to show how the lakes are limited in the southeastern part of the desert and concentrated in a relatively small area (a 50-km-width rectangular zone around site-C in Fig. 1A) as well as how the aquifer system of sediments is relatively uniform in horizontal in the desert. At the regional scale, the Quaternary sediments are relatively uniform as fine sands and role as a continuous unconfined aquifer. The thickness of this aquifer is generally 100-300 m. (see Page 3, Line 7-9)

(2) We do not perform the discussion and analysis just based on our data that limited in a few lakes and sites. As shown in Figure 5, our data agree with the 2H-18O relationship revealed by most of the samples data in previous studies that covering most of the lakes and wells in the desert. In addition, the slope of the evaporation lines obtained in this study is comparable to the existing results (Chen et al., 2004; Chen et al., 2010; Wu et al., 2014).

(3) The limitation of the sample data is mentioned in the discussion part, Section 5.3. (see Page 12, Line 22-27)

2. Did conditions of evaporation during the evaporation experiments correspond to

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the period of infiltration (also for recharge areas in the mountains)? Reply: In the revised version, this problem is analyzed and discussed in Section 5.2 as follow: (1) Our evaporation experiments were conducted in the summer and may not represent evaporation conditions in other seasons. However, the similarity between the evaporation line determined through our evaporation experiments (Fig. 3a) and those derived from measurements of natural water samples (Fig. 4) implies that seasonal variations in meteorological conditions do not significantly alter the evaporative δD-δ18O pattern in the desert (see Page 8, Line 13-16) (2) Figure 5a also shows that the shallow groundwater samples from the Yabulai Mountain area fall above the evaporation lines in the BJD, but follow a trend line (EL Yabulai: y=4.2x $-$24.1) that extends through some of the lakes (Fig. 5a). This suggests that shallow groundwater in the Yabulai Mountain may be a source for some of the lakes in the BJD or the evaporation-infiltration conditions in the mountain areas were different from those in the desert. (see Page 10, Line 3-6) 3. (p. 2, line 25-27) Does this sentence refer to Qilian Mountains mentioned further in the discussion? Reply: The sentence is revised. It is the Qilian Mountains. (see Page 2; Line 25)

4. (p. 3, lines 8-9) What is the relevance of the information on the depth of root penetration? Reply: This sentence is misleading. It is removed in the revised version. 5. Chapter 3.1 Field Sampling. This part lacks some detail on the study area and sampling procedures. How many lakes were sampled? Five, or also some other of the "various" lakes? Provide their surface areas, maximum depths and volumes if known and explain if these characteristics are typical for the region. Provide information on wells depths and screening intervals as this is important in evaluation of well samples. Are the wells regularly used? If not, then 20 minute long pumping (with a peristaltic pump?) might not be enough to obtain a representative water sample from the aquifer. Reply: Accept. Additional descriptions are presented in Section 3.1. (see Page 4, Line 5-11) 6. (p6, lines 23-25) Was the good vertical mixing of lake waters confirmed by measurements of temperature and conductivity? Reply: Additional descriptions are presented in Section 4.2. Good mixture of water in the Sumu Barun Jaran Lake has

been also confirmed from the measurements of temperature and electric conductivity profiles in the summer (Chen et al., 2015). (see Page 7, Line 8-10) 7. (p. 9, lines 13-14) Are there any data on groundwater flow directions/hydraulic heads in the lake area to support this notion? Generally, the hydrogeological conditions are poorly explained in the manuscript. Reply: These sentences are misleading. They are deleted in the revised version. Section 2 has been significantly revised to express the hydrogeological conditions in the BJD. (see Page 3, Line 7-8, 16-23) 8. (p.10, lines 5-14) The bicarbonate and 13C DIC data do not support the gradual dilution of 14C with the old inorganic carbon derived from carbonate dissolution along the entire groundwater pathway. Both parameters change significantly only between points WS2 to WS1 pointing to isotopic exchange as a cause of the apparent increase of radiocarbon ages between WS4 to WS2. This discussion would benefit from any quantitative considerations on the isotopic evolution of DIC along the transect. However, the conditions of carbonate dissolution and isotopic exchange are controlled by aquifer properties which are not described in the manuscript. Reply: We agree that the varying 14C and 13C are not fully caused by the gradual dilution. In the revised manuscript, additional information about the aquifer properties are presented in Section 2 and Section 5.3. A quantitative analysis of the possible radiocarbon dilution factor is added and discussed in Section 5.3. The corrected 14C dating results are shown in Table 3. (see Page 3, Line 7-8, 16-23; see Page 11, Line 26-33; Page 12, Line 1-14) 9. (p.10, lines 27-29) The vertical homogeneity of lake water implies only good vertical mixing. The (isotopic?) steady state is a separate issue and can be assessed only from the temporal patterns. Is there any evidence for lake waters being in the steady state? By the way, what causes vertical mixing of the lakes? Wind or diurnal water temperature fluctuations? Reply: Accept! “Steady state” is not confirmed. In my opinion, the discharge of groundwater to the lakes is the most possible reason that courses vertical mixing. (see Page 12, Line 33) 10. Figs. 1B and 8 are not consistent with respect to the relative positions of wells and the Sumu Jaran Lake. The lake is located between W3 and W2 in Fig. 1B and to the west of W1 in Fig.8. Reply: The Fig 1B in last version is enlarged and changed to

Fig 1C and the exhibiting size of it is revised to clearly show the position of wells. (see Page 18) Technical comments 11. (p. 1, line 26) please remove “arid regions” Reply: It is revised in the manuscript. 12. (p. 7, line 22) “and ARE strongly” Reply: It is revised in the manuscript. 13. Fig. 7. Should be “brackish” not “blackish” Reply: It is revised in the manuscript.

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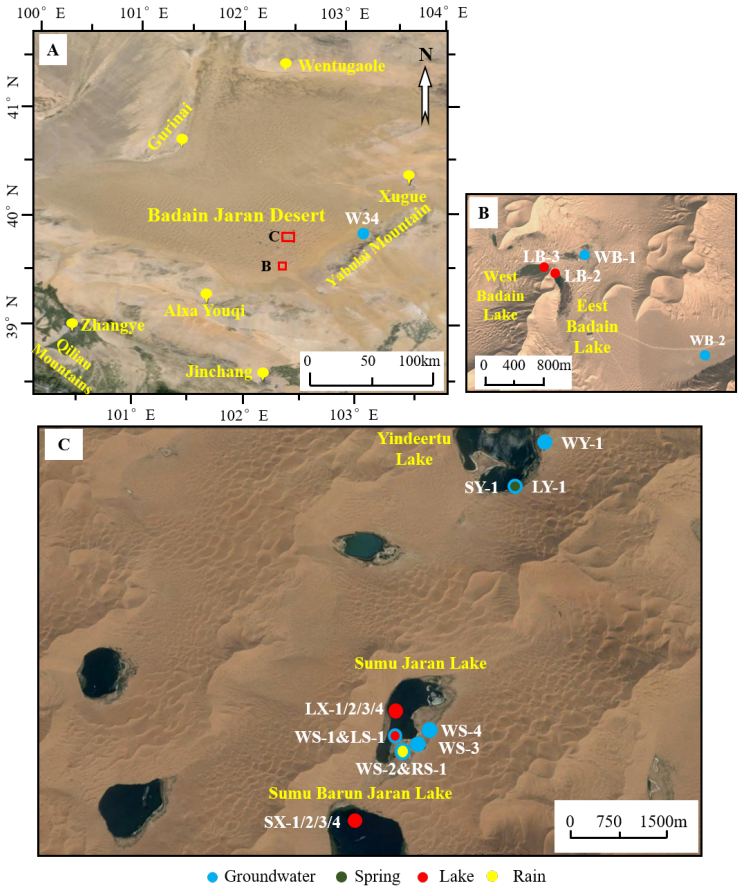

Fig. 1. Figure 1: Maps showing location of the Badain Jaran Desert (A), the Badain lake sampling area (B) and the Sumu Jaran lake sampling area (C). W34 in (A) is sampling site of Gates et al. (2008a).

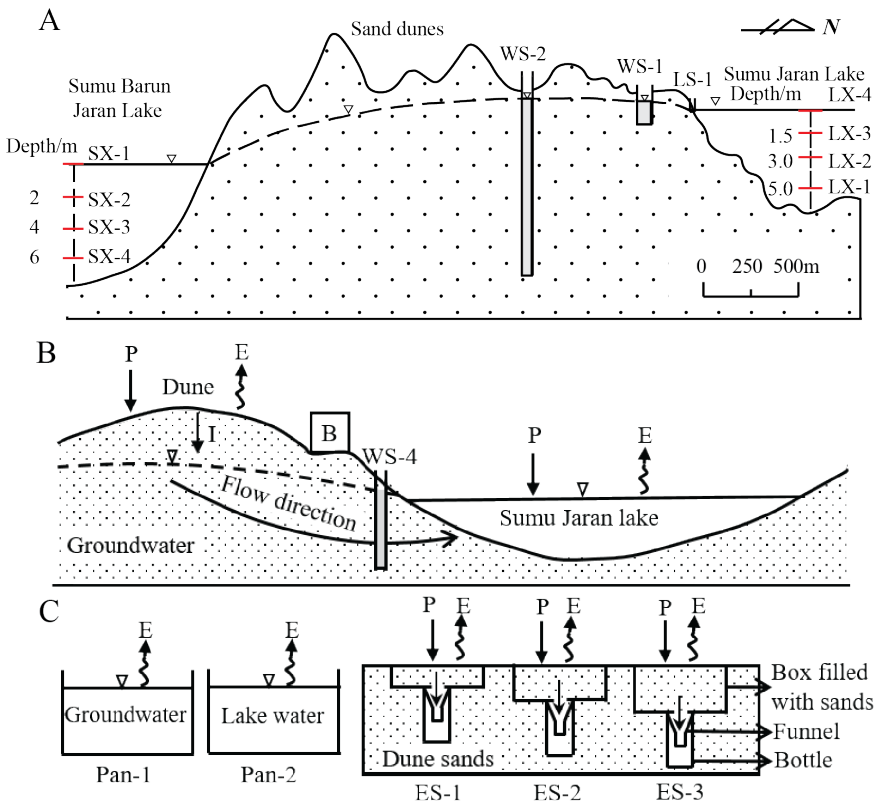

Fig. 2. Figure 2: Schematic diagram showing the cross-section profile between the Sumu Jaran Lake and the Sumu Baran Jaran Lake as well as the water sampling points (A) and the groundwater flow direction (B)

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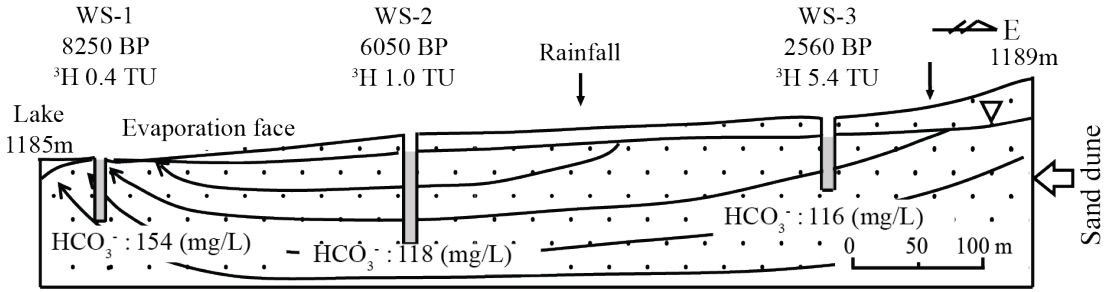

Fig. 3. Figure 7: The flow model of groundwater near the Sumu Jaran Lake. The HCO3- concentrations of each wells are shown in the figure.

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