

### **S. Majid Hassanizadeh (Referee)**

**Interactive comment on “The millennium old hydrogeology textbook “The Extraction of Hidden Waters” by the Persian mathematician and engineer Abubakr Mohammad Karaji (c. 953–c. 1029)” by Behzad Ataie-Ashtiani and Craig T. Simmons**

I enjoyed reading this manuscript. It gives a thorough description of Karaji's work, its scientific as well as historical significance, and its practical value. It is definitely a valuable addition to this issue of HESS. I believe the manuscript needs to be improved as some statements are not accurate (please see below for examples).

**Response:** We appreciate the positive appraisal of Prof Hassanizadeh and the useful comments that will be addressed in the following response.

Also, the text needs improvement; I have provided quite a few suggestions in the annotated pdf file. - I would like to suggest including a figure showing a sketch of a qanat and its various elements. This will be beneficial for the reader, and will it easier for the author when explain a qanat (in subsection 1.2, lines 83-90).

**Response:** With thanks we have considered all the annotated comments on the Pdf file and have mostly implemented them. We have avoided providing a sketch of qanat as we speculate it is known to HESS readers and it can be found easily by any internet search.

The description of figures provided at the end of the manuscript is somewhat superficial and does not really help the reader to understand the figures and their importance. It is also not possible for most readers to read the Arabic text accompanying figures. Aren't these pages translated into English by Schade? If they are, I suggest the authors provide give copies of pages from Schade's book instead of the original Arabic pages.

**Response:** As this is essay is an historical account of the Karaji's contributions, we suppose the original figures and pictures of the original book would be noteworthy for the readers. We have provided the essence of the relevant text regarding the figures in the captions to the extent that is matched to the scope and aim of the essay.

Qanats were not in use only in arid areas of the Iran, as suggested in line 77. They were in use everywhere in Iran, including mountainous regions in northern (except for the Caspian Sea coast) and western parts of Iran, with plenty of water.

**Response:** We have not stated that qanats were only used in the arid areas. The text is “we may speculate that the topic was of great practical interest in the arid area of the Persia plateau.” Although there are qanats in the mountainous regions (e.g. in Tehran), the major development and application of this system is in arid and semi-arid regions.

In referring to the qanat tunnel, various words have been used (aqueduct, channel, tunnel) without being clear to the reader that they are all the same thing. I suggest using one word (e.g., tunnel) in all cases. In particular, I suggest avoiding the use of aqueduct, as it is too closely associated with the Roman aqueducts.

**Response:** Agreed and modified.

Actually, the qanat technology went to Northern Africa before going to Spain. In other words, one could say: "A second major diffusion of Qanat technology occurred with the conquests of Islam into Northern Africa, the peninsular Spain, and the Canary Islands." Also, it is worth mentioning that qanats are found in India as Southerly as Kerala and in Chinese Turkmenistan.

**Response:** Agreed and modified.

I am not sure the procedure described in lines 173-178 has been really an effective way of water filtration (as suggested in line 177). For water to lose its salinity and heaviness, due to passage through neat ground soil [Isn't this double? ground soil? Why not just soil?], an ion exchange process must occur. So, it must be a soil with some special characteristics. Also, I can't see how water would lose a portion of its salinity and heaviness when leaking from a new pot! Perhaps the authors should elaborate on the potential of this procedure for reducing salinity.

**Response:** The major part of the provided lines, the quoted part in italics, are the translations from Karaji's book. In the last sentences we have emphasized that this based on the available knowledge and apparatus of Karai's time: "The treatment Karaji outlined is essentially a water filtration process based on the knowledge and apparatus of the time."

I do not think the presentation in lines 212-220, linking the laws about water rights and safe distances between wells and qanats to Islamic laws, the script, and the prophet Muhammad's practice, is justified. There existed wells and qanats in Iran before Islam and cities and villages had laws and customs ruling such things. Also, I wonder whether exact numbers given by Karaji (lines 214 and 215) can be found in Islamic records. Moreover, I don't see the value of linking Karaj's writings to Islamic laws. If this is needed, I think a more detailed investigation with references, in order to document such a link, should be provided.

**Response:** The issue protection boundary of wells and qanats based on religious laws was explained by Karaji in his book from page 67 to 79 (Xadiv Jam, 1966). In his explanations he referred to the opinions of Islamic law scholars' (e.g, Hassan Basri, Abu Yousef, Abu Hanifeh) who had referred to prophet Muhammad's practices and sayings.

We have added this explanation to the revised manuscript.

Protection zone of wells and qanats is a term used in relation to contamination (i.e. protection from pollution) and not to the use and extraction of water (which is the context in line 212). I think the proper terms here are ownership limits and well boundaries.

**Response:** Protection zone has been used here in a more general sense that the existing wells and qanats would not be influenced by establishing a new well.

Please also note the supplement to this comment:

<https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-407/hess-2019-407-RC3>

supplement.pdf.

**Response:** We appreciate these comments. The comments were considered and modified.