

Interactive comment on “Time scales of regional circulation of saline fluids in continental aquifers (Armorican massif, Western France)” by A. Armandine Les Landes et al.

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Dear referee #1,

Thank you very much for the time spent reading our paper. We have carefully read the comments and remarks and revised the manuscript accordingly. Here below, after each reviewer’s comments, is a description (in black) of the new modifications made in the manuscript (modifications in the modified manuscript appear in red).

1. First Comment from referee #1

Review of “Time scales of regional circulation of saline fluids in continental aquifers

C5484

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(Armorican massif, Western France)” submitted by A. Armandine Les Landes et al. to Hydrology and Earth System Sciences (Hess). The first recommendation I would like to make is the very simple but very important addition to the title of this paper: insert the term “crystalline rock” after “continental”, so that the title becomes “ saline fluids in continental crystalline rock aquifers. I have been working a long time on saline fluids in continental sedimentary basins but have not closely followed the literature on waters in crystalline rock aquifers, such as the Armorican massif. If I had been paying more attention upon receiving the request for a review, I would have suggested the selection of someone else as a reviewer.

1.1. Response

We agree with your suggestion about the title of our paper and we inserted the term "crystalline rock".

1.2. Author’s changes in manuscript

Thus on your advice the complete title will be: "Time scales of regional circulation of saline fluids in continental crystalline rock aquifers (Armorican massif, Western France)".

2. Second Comment from referee #1

I would also include the term “crystalline rock” or crystalline basement” in the abstract and in key search terms.

2.1. Response

In the same way, we inserted these terms in the abstract and as a keyword (see below).

2.2. Changes in manuscript

Lines 30, 37 and 43 Abstract and Keywords

3. Third comment from referee #1

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I have read through the manuscript, and the research results seem both reasonable and well-presented. However, it would have been useful to have included some of the isotopic results mentioned in passing on p. 6607, line 18, particularly oxygen-hydrogen systematics.

3.1. Response

I agree that it would have been useful to include some of the isotopic results. Nevertheless, the addition of isotopic results in this paper could provide more complexity that does not seem necessary. These isotopic results are presented and described in another paper: “Impact of climate changes during the last 5 million years on groundwaters in basement aquifers“ recently submitted by Luc Aquilina (co-first author of this paper) to PNAS (Physical Sciences / Earth, Atmosphere and Planetary sciences). I therefore suggest adding the previous reference where the readers will find a detailed description of isotopic results, analytical methods, interpretation of isotopic measurements and complementary information on the paleohydrogeology of the Armorican aquifers. Moreover, according to your following comment, you will find complementary information on mechanisms that explain the displacement and the mixing between meteoric and marine waters after a transgression (see response below).

3.2. Changes in manuscript

The reference Aquilina et al. 2014 has been added. Line 241

4. Fourth comment from referee #1

I can see influx of marine waters into the system by density-driven flow during marine transgressions. It is less clear to me from the manuscript how marine waters become displaced or how mixing occurs with meteoric waters after a transgression.

4.1. Response

As stated above, complementary information can be found in the paper: “Impact of climate changes during the last 5 million years on groundwaters in basement aquifers“.

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However, the displacement of marine waters and the mixing occurring with meteoric waters are the underlying processes used in the two conceptual models to explain the paleo-functioning of Armorican aquifers. During marine transgression, seawater was introduced into the basement by density-driven flow. This mechanism induced the displacement of former fresh groundwater by seawater. Then due to diffusion process taking place on million year (according to the time since transgression) the diffusion length scale (few hundred meters) leads to a perfect mixing between marine waters and freshwaters already present in the whole rock porosity. Third, following transgression, the marine signature contained in the system is flushed out by groundwater circulations fed by meteoric waters. The preservation of marine signature throughout the Armorican basement and the clear increase with depth underlines the limited downward fresh groundwater circulation loops. But, the flushing process leads to the displacement of marine waters in the upper part of Armorican aquifers. The limited depth of groundwater circulations is explained by the dense hydrological network, the high sea-level and the low topography relief within the Armorican massif and characterizes the salinity increase with depth.

4.2. Changes in manuscript

Sentences have been added Line 413-425

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 6599, 2014.

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