Interactive comment on “From oil field to geothermal reservoir: First assessment for geothermal utilization of two regionally extensive Devonian carbonate aquifers in Alberta, Canada” by Leandra M. Weydt et al.

Leandra M. Weydt[1], Claus-Dieter J. Heldmann[1], Hans G. Machel[2], Ingo Sass[1,3]

[1]Department of Geothermal Science and Technology, Technische Universität Darmstadt, Schnittspahnstraße 9, 64287 Darmstadt, Germany
[2]Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G 2E3, Canada
[3] Darmstadt Graduate School of Excellence Energy Science and Engineering, Jovanka-Bontschits-Straße 2, 64287 Darmstadt, Germany

Correspondence to: Leandra M. Weydt (weydt@geo.tu-darmstadt.de)

Author’s comment on “Short comment 1 – Heat flow in the Hinton area, Alberta, Canada” by Jacek Majorowicz

Thank you very much for the kind advice and the detailed proofreading. In accordance with your suggestions for improvement, we have amended the relevant parts in the manuscript as shown below:

Jacek Majorowicz – C2 line 7: “*1.The reference should be Weides and Majorowicz (2014) as given below in the References.”*

Answer: I apologize for this mistake. It has been corrected accordingly.

Jacek Majorowicz – C2 line 9: “*2, Heat flow in the cited map in Weides and Majorowicz (2014, their Fig. 3) for the studied area of the Alberta basin is not reaching 80 mW m-2 It is less than 70mW m2. The heat flow in the WCSB generally ranges from 30 to 100 mW/m2, being 60.4 mW/m2 on average according to Weides and Majorowicz (2014). The heat flow values has been corrected for paleoclimatic surface temperature forcing (Majorowicz et., al. 2012).”*

Answer: Thank you very much for this correction. The associated section in chapter “1 Introduction” in page 3 line 1 has been changed to: “The area around the town site of Hinton in the western region of the Alberta Basin (Fig. 1) is of particular interest because well data analysis indicates flow rates of more than 400 $m^3 h^{-1}$ and temperatures up to 150 °C at depths of approximately 5 km (Lam and Jones, 1985).” General information about the geothermal gradient and heat flow in the WCSB was added to page 2, line 30: “This appears feasible because, although this province is characterized as a ‘low enthalpy region’ (Grasby et al., 2012; Lam and Jones, 1985 and 1986) with a moderate average geothermal gradient of 33.2 °C km^{-1} and an average heat flow of 60.4 W m^{-2} in the WCSB, recent studies using data from several tens of thousands of oil and gas wells suggest that at least some of the Upper Devonian carbonate aquifers are suitable for geothermal utilization (Weides and Majorowicz, 2014)".

Jacek Majorowicz – C2 line 15:*"The attached average geothermal gradient map (Fig.1) shows that there are much 'hotter' areas in the WCSB in Alberta and these are to the north and east of deep part of the foreland basin in the Hinton area."*

Answer: This is correct. The two carbonate complexes were selected because

- A lot of communities in Alberta are located in this area (this applies especially for the Rimbey-Meadowbrook Reef Trend)
- There is increasing public interest in geothermal energy utilization in the Hinton-Edson area (Southesk-Cairn Carbonate Complex)
- the general growing interest in repurposing abandoned oil and gas wells to find new possibilities to reduce the demand of fossil fuels and to reduce CO_2-emissions
- there are similarities in rock type, depth and structure of the Devonian aquifer systems with the Jurassic Malm-aquifer in the Southern German Molasse Basin, which offers the possibility of knowledge transfer between Alberta and Germany.
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Jacek Majorowicz – C2 line 20:"*However, such deep wells are expensive and economics of drilling two 5km wells into the deepest sedimentary horizons will end up with extremely high mineralized waters and rather poor porosity/permeability (Lam and Jones, 1985)."*

Answer: This pilot study was intended to be an initial inquiry into the the Upper Devonian carbonates with respect to geothermal utilization and to create an initial data set of rock properties relevant to geothermal exploration and modelling. To assess the economic feasibility of this reservoir more data is needed, e.g. the corrected heat flow and temperature data (Majorowicz et al., 2012; Nieuwenhuis et al., 2015), salinity, flow rates, potentiometric surfaces, and hydraulic heads to name just a few. The high TDS content in the formation waters of the Leduc and Nisku formations (Rostron et al., 1997; Bachu et al., 2008) is a critical parameter for geothermal production.

Therefore, well data provided in the AccuMap or GeoScout databases need to be evaluated and interpreted carefully, which is beyond of the scope of this study. A short section will be added to the chapter "discussion and conclusions" to provide an overview of further steps.

We don't agree with the statement that porosity and permeability are generally poor at these depth levels. According to Amthor et al. (1994), there is an overall decrease of porosity/permeability with depth in the Leduc Formation in the WCSB, but it has also been shown that especially the dolomitized reef sections retain their porosity/permeability compared to limestones at the same depth level or compared to well cores which are located in the shallower parts of the basin. An example is presented in this manuscript: Well 2-36-54-23W5 (>4 km depth), located in the western part of the Southesk-

Cairn Carbonate Complex, shows the highest porosity and permeability of all wells in this dataset. Porosity and permeability can be highly variable within aquifers at a local scale. However, it must be taken into account that high porosity and permeability values do not naturally guarantee high flow rates. Therefore, a careful evaluation of the well data and other existing information on the reservoir must be carried out to localize the most promising areas.

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