Page, Line	Comments from Referees	Author's response	Author's changes in the manuscript
Referee 3 – Report 2 Comment 1	*The authors examine porosity and permeability and make some qualitative statements regarding relevance to geothermal utilisation. But as it stands, the main conclusion in the paper is that there are parts of the Devonian reservoirs that have high permeability and this can be related to dolomitization. This has been known since the first major oil field in Alberta was discovered in one of these reefs in 1947.There has been extensive studies of these aquifer systems and their physical properties for petroleum reservoirs over the last 50 years (including one of the authors who has built a career on this) as well as more recently for potential as CO2 storage. So the very basic observations made by the authors don't add anything new to what has been long known – or they fail to show how they have added any new knowledge. Despite being the stated main goal of the study, there is little done though to assess any geothermal potential based on the observations the do make – the key question is how much energy could be extracted and at what rates. The authors could do this if they went further, and used their data to estimate geothermal resource potential, and then maybe make some new and important contributions.*	This is not exactly what we did in this manuscript. We conducted an outcrop analogue study in order to apply and testify the methods successfully carried out in Germany. Furthermore we analyzed wellbore core samples from 7 wells (~ 530 core meters) and measured thermal conductivity and permeability on the core samples from the base to the top of each core to cover as much as possible of the reservoir. The aim was to identify variations of rock properties within the reservoir (specificly for the Nisku and Leduc Formation) and to create an initial data base for geothermal modeling. I couldn't find equivalent studies dealing with this topic – not for the Upper Devonian aquifer systems. Additionally, we used existent porosity, density and permeability data from the AccuMap data base in order to correlate the existent data with our results and to show the relation between the different rock properties. Compared to the high amount of well data, there are not many core profiles including detailed rock description published. The diagenetic evolution of the formations under discussion is described in chapter 3 and could be studied in more detail in the cited references. I agree that Hans Machel 'built his career on this' topic, but it would be misleading to cite all his papers. For example Machel (2010) comprises a review about the Upper	We added "Machel, 2010; Kuflevskyi, 2015" to line 28 on page 6

		Devonian aquifer systems in general and Kuflevskyi (2015) comprises all previous studies, well data and new data of the Rimbey-Meadowbrook Reef Trend. Therefore I don't think it is necessary to describe all ~ 20 diagenetic events again. Both papers are cited several times. Rock property measurements are crucial for detailed and precise modeling (Popov et al., 2016). Therefore it is necessary to investigate the study area on a local scale, which requires new data. As shown in chapter 6 Table 4, thermal conductivity of sedimentary basins is very variable and can be also very variable within the reservoir. It is very important to characterize the thermal properties as accurate as possible, because they form the basis for further investigations For example heat flow in the study area was calculated from thermal conductivity measurements (Beach et al., 1987) and Hofmann et al. (2013) created a geological model for the Edmonton area assuming thermal conductivity values of about 2,42 W $m^{-}1K^{-1}$ for the carbonatic rocks and 1,38 W m^{-1} K^{-1} for shales. Therefore this study provides new data for a more precise modeling (thermal conductivity of the Leduc Formation is about 4 W m^{-1} K^{-1}). Beside the petrological investigations, one finding is that for further studies the dolomitized reef sections might be promising targets for hydrothermal energy utilization. The fact that the Upper Devonian aquifer systems have been intensively analyzed	

		by the oil industry is a reason WHY we have chosen this study area. The aim is to transfer new findings, methods, exploration and exploitation tools between Germany and Alberta to push geothermal energy utilization in both countries. This is well described in the introduction. We don't claim to provide a full assessment for geothermal utilization for the Alberta basin starting from geological investigation, over 3D modeling, to the construction of a power plant and to provide solutions for technical issues in one manuscript. Our aim is to create geological models integrating all available data (rock properties, reservoir data etc.), which is beyond of the scope of this study.	
Comment 2	*Title – the authors still claim that there work is the 'First assessment' of geothermal utilization of Devonian Aquifers in Alberta. This is clearly untrue and points to an overall problem of the authors not being aware of previous work in their study area. Just to name a few of the many previous studies done before:* *Lam et al., 1982; 1985; Jones et al., 1985; Bachu et al., 1991; Weides et al., 2012; Grasby et al., 2011; Majorowicz et al., 1981; Gray et al, 2012; Fergusin and Ufondu, 2017.*	The title refers to the project and the applied methods. If this is misleading, the editor should decide whether we should delete 'first' or a new title for the manuscript is needed. Referee 3 claims that we are not aware of previous work in the study area: Lam et al. 1982 "Geothermal gradients in the Hinton area of west central Alberta" used temperature data of more than 3300 wells in the Hinton area in order to estimate thermal gradients. In our manuscript already included: Lam et al. 1985 'Geothermal energy potential in the Hinton-Edson area of west-central Alberta' and Lam et al 1986 'An investigation of the potential for	The following section was added to page 2 line 6: "Previous studies predominantly focused on determination of heat flow, geothermal gradients and reservoir temperature (e.g. Garland and Lennox, 1962; Majorowicz and Jessop, 1981; Lam et al., 1982; and more recent Majorowicz et al. 2012, 2014), while only a few considered water chemistry and recovery (Lam and Jones, 1985, 1986). More recent studies considered parameters like porosity and permeability (e.g. Weides et al., 2013, Weides and Majorowicz, 2014, Ardakani and Schmitt, 2016) or injection and production rates in combination with reservoir tempertatures (Ferguson and Ufondu, 2017)."

		geothermal energy recovery in the Calgary area in southern Alberta'. We preferred to cite the most important and/or newest paper. Jones et al 1985 is already included in the manuscript. Bachu 1991'On the effective thermal and hydraulic conductivity of binary heterogeneous sediments' focus on several upscaling methods on the example of the Upper Cretaceous Mannville Group. This study would be relevant in the next step of the project, when it is necessary to upscale the properties to reservoir scale in a geological model. Weides et al. 2012 'Geothermal exploration of Paleozoic formations in Central Alberta ' is cited in the manuscript, not as the online version from 2012, but as the printed version in Canadian Journal of Earth Science from 2013 as Simon Weides did it in his PhD thesis. Grasby et al 2011 'Geothermal energy resource potential of Canada' includes nearly the same extensive overview about geothermal research in Alberta like Grasby et al. 2012 'Geothermal energy resource potential of Canada. Open-File report' which is included in the manuscript. "Majorowicz et al 1981" – It exists only "Majorowicz and Jessop 1981" with the title 'Regional heat flow patterns in the	

		western Canadian sedimentary basin' which presents one of the first studies concerning heat flow in the study area. Updated and new findings are included in the more recent works from Majorowicz in Majorowicz et al. 2014 and Majorowicz et al 2012, which are cited in the manuscript. We preferred to cite the current state of knowledge. Ferguson and Ufondu 2017 focus on the geothermal assessment in the WCSB with focus on injection and production rates as well as estimated reservoir temperatures. It was published after the manuscript had already been written. I agree to mention this study in the manuscript	
Comment 3	*Page 2, Line 17: The authors continue to make false claims regarding the place of Alberta in global CO2 emissions. The Environment Canada data they reference does not support their claim. They may have miss-read the table of reported emissions rather than the relevant table of total emissions. Environment Canada has clearly recorded that Saskatchewan is the largest per Capita Co2 emitter in Canada for the last decade or so. As well, the reference they cite as support does not make reference to Alberta in a global context. There are clearly jurisdictions within the United States that have higher per capita emissions than any province in Canada. I could not find the data easily, but I am sure there would be jurisdictions within Saudi Arabia or other major oil producing regions of the world that*	It would have been beneficial if Referee 3 would cite the data he mentioned. Furthermore the statement is in the manuscript is written in **past tense** and we don't claim that Alberta has the highest per capita CO_2-equivalent emission today. This statement was intended to show the need for new alternatives for energy production. To avoid further discussions we decided to delete this section.	We changed the beginning of chapter 1: "Canada currently emits about 730 Mt a^{-1} CO_2-equivalent, of which the Province of Alberta emits nearly 300 Mt a^{-1} (Environment Canada, 2016, 2017: last reliable numbers are for 2015). Therefore Alberta belongs to the five provinces in Canada with the highest emission rates (Environment Canada, 2016, 2017). The main reason for this pattern is the industrial generation of energy (electricity and heat) from coal and gas, which currently provide about 40 % each of the energy mix in this province, along with the huge mining operations of the oil sands deposits. The oil sands industry alone currently accounts for about 10 % of Canada's CO_2 -equivalent emissions (Canadas Oil Sands, 2017), tendency rising. However, the trend of increasing CO_2-emissions could be significantly reduced if alternative and/or renewable energy sources were implemented to a larger degree. For Canada to meet or at least approach the targets of the Paris Accord from 2015 regarding the reduction of CO_2-emissions, geothermal energy should become part of the energy mix in Alberta." We changed the Abstract. "The Canadian Province of Alberta has

	would also have larger per capita emissions.		one of the highest per capita CO_2-equivalent emissions in Canada, predominantly due to industrial burning of coal for the generation of electricity and the mining operations in the oil sands deposits."
Comment 4	*Page 2, Line 24: The authors continue to make inappropriate political comments. How do they know that Alberta has favoured 'business over environment' .are they privy to secret cabinet documents that can support that claim? What does it even mean, does not every political jurisdiction in the world have to make that choice to balance development and environmental protection every day? I've been to Germany, were the authors are from, many times – and I see a heavily industrialised country with very little natural environment left – they have a centuries long history of favouring industrial development over environmental protection. Maybe that's the reason Alberta has such a high rate of tourists from Germany who come to see true nature? So then, what gives the authors the right to speculate that Alberta will not change to be more environmentally concerned – especially as the province has recently made a major political shift to a government that is advancing climate polices. Certainly Germany has not shown any positive trends as they are Europe's largest producer and burner of coal and are the worlds largest producer of lignite, the dirtiest coal there is. Will Germany's 'business over environment' policies every change? Hard to say. This all reminds me of a recent news*	This sentence was already deleted in the last version of the manuscript. Referee 3 should read the manuscript more carefully. It is not our aim to degrade Alberta and we don't claim that European countries – in this case Germany – are handling environmental problems better. But the fact that renewable energy should be integrated in the energy mix of both countries triggered this study. The study is part of a larger project which focuses on the assessment of carbonatic aquifers for geothermal utilization in GERMANY and Alberta. The cooperation aims to transfer the knowledge between these two countries to push geothermal utilization in general. I will not consider the remaining part of R3's comment.	No changes needed.

	headline I saw titled: "Germany is a coal-burning, gas guzzling climate change hypocrite'. Perhaps this may offend the authors, much as their comments on Alberta politics offends me as an Albertan – in the end though, none of this belongs in a science discussion and I'm perplexed why they insist to keep these inappropriate political comments in a science paper.		
Comment 5	*Page 3, Line 5: This claim of 'few hard data' is false. The authors are only referring to geothermal studies. However the Devonian Reef systems in Alberta hosted major oil and gas pools and as such have been the subject of extensive investigation of there petrophysicsal properties and aspects such as porosity, permeability etc. There are numerous studies and papers on this. Fergusin and Ufondu, 2017 examined all available data. A simple search for 'Nisku Reservoir' returns over 2000 results on Google Scholar. In addition to extensive petroleum industry research, these reservoirs have also been examined for CO2 storage, and as such there has been also extensive work done to characterise hydrogeological properties for that purpose.*	Page 3 line 5 includes "The area around the town site of Hinton in the western region of the Alberta Basin (Fig. 1) is of particular interest because…." I don't see a connection to the reviewer's comment? Exactly -'hard data' refers to geothermal rock properties like thermal conductivity, thermal diffusivity and heat capacity. This is written in the sentence! In this study we focused on the **geothermal rock properties**. Previous studies like Grasby et al. 2012 point out a lack of knowledge for thermal conductivity measurements in the study area. We don't claim that we are the first group doing reseach concerning geothermal energy potential in the study area. Most of the previous studies focus on geothermal gradients and heat flow estimation. We are focusing on rock properties. In my opinion that are different topics covering different scales. Furthermore, the AccuMap data base does not include detailed core profiles including lithology and rock description. Only a few papers exist in the study areas	We deleted 'and/or petrophysical' in line 10 on page 3 to avoid misinterpretations.

		which include detailed rock description. Again – the fact that the Devonian aquifer systems already have been intensively analyzed is a reason why we started this project. We don't want to repeat analyses which have been carried out before. We want to use the existing data and integrate them into a 3D geological model considering heat flow, temperature, hydraulic and rock properties etc., but also limiting factors like salinity. Ferguson and Ufondu 2017 definetly did not examined **all** available data (well data from >600000 wells?). They used injection and production rates as well as estimeated temperature data. Until now, no study exist which included all available data.	
Comment 6	*Page 4, line 6: This claim is not true, there have been early studies that have done detailed assessments of geothermal potential of Devonian aquifers, including those that the authors now include in the reference list (e.g. Lam and Jones). As well, Fergusin and Ufondu, 2017 also examined Devonian systems. The authors need to do a better job at describing previous work and how their contribution is different and adds to that.*	Page 4 line 6 include "Such analogue studies offer a cost-effective opportunity in areas with a low density of drill holes…" Again, I don't see a connection to the reviewer's comment. Same answer as above.	See changes above.

Comment 7	*Page 5, line 1: British Columbia is not north of Alberta, and as the authors define the WCSB as east of the Rocky Mountains, then it does not extend to the SW into BC as that area is within the Rocky Mountains. Also, I would not say that the portion with in Saskatchewan is 'minor' at all.*	Page 5, line 1 includes: "Most of our work is on these two aquifers. In addition, for comparison we also investigated a small part of a third Devonian aquifer…" I can't identify the connection to the reviewer's comment. It is written on page 5 line 19: "The Western Canada Sedimentary Basin (WCSB) is a large geological feature that is located mainly in Alberta east of the Rocky Mountains and to a minor extent in the adjacent provinces of Saskatchewan and Manitoba, with marginal excursions into the northern United States to the south and into British Columbia to the southwest, west and north."	We changed line 19 on page 5 as followed "The Western Canada Sedimentary Basin (WCSB) is a large geological feature that is located mainly in Alberta east of the Rocky Mountains and in the adjacent provinces of Saskatchewan and Manitoba, as well as in the northern United States and in northeastern British Columbia (Grasby et al., 2012)."
Comment 8	*Page 6, ln 10: These comments have uncertain value, is there a problem with data just because its 'old'? If the data was collected in acceptable means then its perfectly fine. These comments only have value if there are new data measurement techniques that supersede previous work. As well, the outcrops indicated aren't really inaccessible.*	Page 6 line 10 describes the subsurface geology in the study area "which ultimately resulted in the wedge-shaped triangular geometry in cross section of the foreland basin…" I don't think R3 read the actual version of the manuscript? We don't claim that "old" data is not useful for actual research. However, the divided bar apparatus is less commonly used in the geothermal industry because the method was identified as less accurate/is more error-prone than the methods used in this study. But it is not my aim to degrade previous work. I don't see any problems adding new data to already existing data sets. "inaccessible" refers to page 7 line 3 "However, except for a few old studies	No changes needed.

		from remote and almost inaccessible areas such as the Ancient Wall and Miette reef complexes (Mountjoy, 1965, Mountjoy and McKenzie, 1974, Mattes and Mountjoy, 1980), only one 'modern' study is available that provided data on the diagenetic alteration of outcrops in this region, i.e., from Nigel Peak (Köster et al., 2008)". The sentence before clearly says that the outcrop we choose or found where relatively accessible which is necessary for sampling large rock samples.	