Dear reviewer,

We thank you for the interesting suggestions. Please, find below our response to your questions and comments, which we will include in the revised version of the manuscript.

Following your three main points:

- You mention that the introduction and conclusion need some work in terms of the relevance of this work in comparison to previous studies. In the West Netherlands Basin, geothermal exploitation is going swimmingly with currently 14 producing geothermal doublets. However, as noted in Willems et al. (2020), the most recent article on the Jurassic reservoir rocks within the area, these geothermal projects also demonstrate that much of the aquifer geology remains unknown. According to Willems et al. (2020), there is still a lack of understanding about (1) regional sedimentary aquifer architecture, (2) sub-seismic structural geology, and (3) aquifer rock properties. This research provides a detailed overview of the relevant geological history of the West Netherlands Basin, which is required for geothermal development. As a result, we provide a better understanding of regional structural and sedimentary aquifer architecture. We'll include this in the revised version of the manuscript.
- We will include some information about the various types of geothermal energy in the introduction, but we will concentrate on the type of geothermal system used in the West Netherlands Basin.
- This is an intriguing suggestion for the well dataset and the possibility of producing a net-to-gross map or porosity-depth charts. Today's knowledge enables the Dutch geological survey (TNO) to create maps with a regional overview of porosity, permeability, net-to-gross, etc., all publicly available on ThermoGIS. Please find the maps at the bottom of this document for more information. The well dataset has a shortcoming in that the hydrocarbon wells only target structural highs. As a result, the Nieuwerkerk Formation is lacking in data. Geothermal projects drilling and logging the Nieuwerkerk Formation in the northeastern section of the research area are helping to solve this problem. However, there is still a data gap in the eastern part of the study area, where no geothermal wells have been installed.

See below our response to the list of comments that you gave us. The grammar and language corrections will be updated in the revised manuscript.

Comments	Response
15: just geothermal doublets? Maybe consider expanding to include other geothermal developments as well to widen the scope of the paper.	We agree and we will replace *'geothermal doublets'* with *'geothermal wells'*.
44-45: it would be interesting to hear how many projects targeted each of these three reservoirs.	One project focuses on Cretaceous sands, eleven on Jurassic sands, and two on Triassic sands. We'll include this information in the text if we can confirm it.
46-49: Is there any data available about the success rate of geothermal exploration in the WNB? If so, it would be good to include it here to give context to these statements.	Unfortunately, this kind of data is mostly confidential.
48-49: As this is a key statement and related to your outcomes, it might be worth explaining how thickness and heterogeneity is important here i.e. a thicker and more homogenous	Thanks for this suggestion. We'll add an explanation that includes the following; *A thicker and more homogenous reservoir is preferred over a thin and heterogeneous one because it*

reservoir is better than a thin and heterogenous reservoir.	*allows for better fluid flow, higher heat extraction, increased energy recovery, and simplified engineering. These advantages lead to more efficient and sustained geothermal energy production.*
Introduction: this provides a good overview of the geothermal scene in the WNB, however its unclear what your study is doing differently. I think a few lines in the final paragraph which differentiate your work from previous studies would be great.	Yes, we'll include a few lines about this. Previous studies focussed on the northwestern part of the onshore West Netherlands Basin. Our study includes also a part of the northeastern onshore area of the basin. Furthermore, previous research was based on older seismic datasets, this reprocessed dataset became publicly available last year, thus not used in scientific publications before.
Figure 1 caption: a) The white lines on a light blue background are not the easiest to see. I would suggest either changing the colour of the inversion markers or adding a boundary line around the zones. b) It is unclear why the wells are coloured the way they are. I assume this is the deepest formation encountered in each well? Please add a line in the caption explaining this to help the reader.	a) Good point, we'll give the inversion markers a different colour. b) Yes, this is correct. We forgot to include some information about the well colours in the caption. Thanks for noticing this!
93: What does the Zechstein Group consist of in the study area? It's not shown in Figure 2 so mention the lithology here to help your reader. Probably worth checking each unit there to make sure you are consistently describing them (e.g. age, stratigraphic name, broad lithological overview).	We have improved the text as follows: *'starts with the Late Permian Zechstein Group. The very few deep wells that have been drilled into the Zechstein Group have encountered carbonates and shales, but no evaporites.'*
113-115: This is a very large well database but no mention is made here as to what these wells were used for. Expand on this here to help the reader. I assume just formation tops, as the cube was depth converted. Were there any mismatches between formation tops and the depth converted cube?	Yes, we only used the well tops that were provided by the Dutch Geological Survey on nlog.nl. As some of the used wells date from the start of hydrocarbon exploration in the basin in the 50's, and the lithostratigraphic nomenclature changed over time, not all well tops are matching. We'll include some more information about this in the text.
153-154: Always good to include the uninterpreted lines so your reader can understand what features and reflectors you are interpreting, nice one!	Thank you!
152-153: It would be good to describe these active geothermal projects in a bit more detail (e.g. are these closed-loop, open-loop, etc.), given the scope of this paper. Their location relative to inverted structures will allow the reader to see your results in action.	The geothermal projects are open-loop systems. We'll include this to the text. We'll improve Figure 6 by adding boundaries showing the rates of inversion in the area. Additionally, we'll highlight the geothermal wells in Figure 1.b.
159: I would call this the 'youngest' megasequence (or just megasequence 1) as,	Good point, we'll change this.

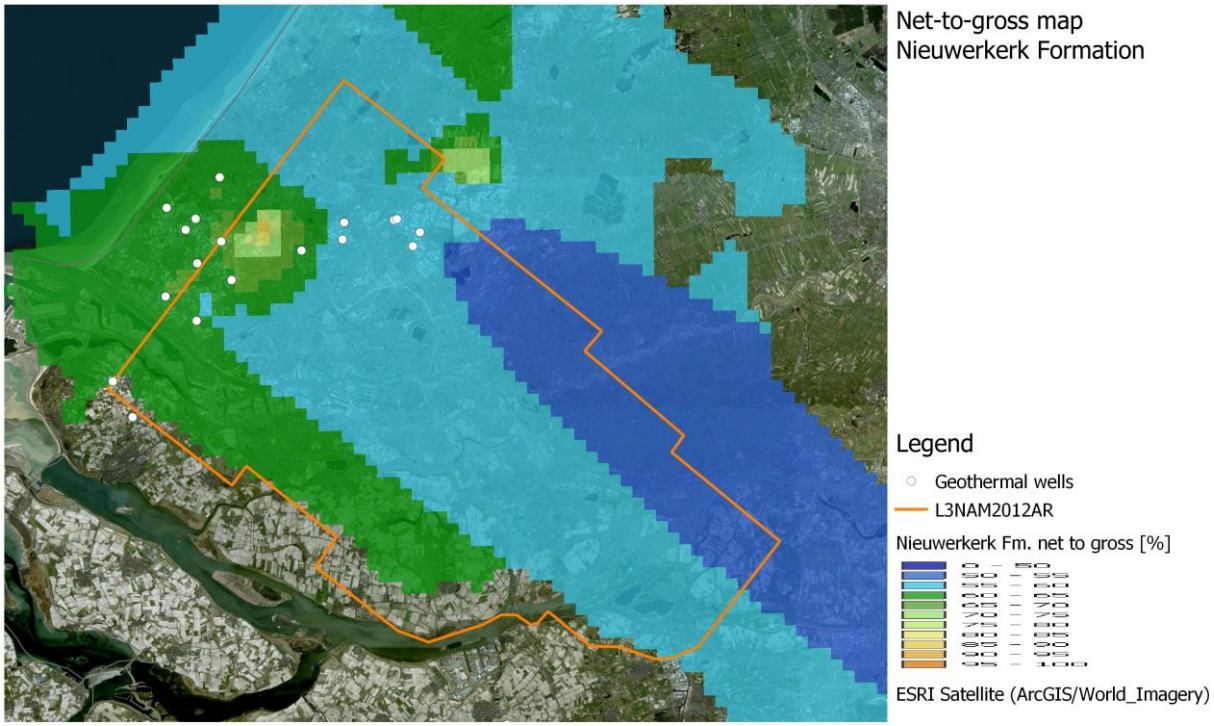
strictly speaking, the 'first' megasequence will be the oldest in terms of geological evolution.	
<u>175:</u> Like the comment above, use of 'first' here could be confusing for the reader. Additionally, to avoid confusion '3' should be spelled out (i.e. three) as it is referring to the three megasequences and not megasequence 3.	Ok, we'll change the text.
<u>217-218:</u> I would caveat the use of horizon flattening to describe thickness changes, particularly in more deeply buried units. Horizon flattening is a useful 'quick-and-dirty' technique to get broad ideas of unit variation across a section, but doesn't account for things like differential compaction due to thickness variations in shallower units, which can be particularly important in high porosity rocks like the Nieuwerkerk Formation.	We agree and we have changed the text as follows: *'The thickness changes are even better visible on the flattened section (despite all the limitations and biases of the flattening procedure), where the package shows at least four distinct asymmetric fault-bounded half-grabens.'*
<u>Strikeline 3415:</u> I'm unsure if having this strike line is particularly helpful for showcasing the WNB. Structural interpretation on a line parallel to the structural trend will give a false sense of the structures and is best done on lines parallel to the direction of principle movement. It might be worth including one more dip-line, perhaps to the south of the dataset, to give the reader an indication of change along the length of the basin.	We agree with the comment, but for the sake of precision, it is important to show at least one line oriented parallel to the main trend of structures. Also, strike lines allow to image transverse faults.
<u>Figure 5:</u> If we are imaging a normal fault (fault i) this obliquely, we would expect the apparent dip to much shallower than the very high angles interpreted here. Additionally, should the absence of megasequence 6 on the Lansingerland High be explained in-text (no mention is made currently)? It is different to the other three sections seen so far.	The steep attitude of fault *i* suggests the occurrence of oblique segments along the trace of this fault. This will be mentioned in the text. The absence of megasequence 6 on the Lansingerland High in figure 5 is not correct. There should be a thin layer present. We'll update the figure, thanks for pointing this out.
<u>267-268:</u> As you mention changes in seismic facies, does this relate to changing sedimentology and possibly reservoir quality? Can these be used as indicators for geothermal explorers working in this basin?	Most likely, yes. The reservoir's infill is derived from a fluvial-deltaic environment. As a result, the reservoir rock (megasequence 5) lacks a homogeneous infill. We didn't want to emphasize this too much on this in this work, because we're preparing a follow-up study on the subject.
<u>332-334:</u> While you're correct the North Sea Dome likely doesn't have much impact on the WNB, it is important to realise that this far from the epicentre of this event, the effects likely to be relatively subtle, and possibly overprinted by later structural evolution. Maybe worth mentioning this as a caveat.	Yes, thank you. We'll add this to the text.
<u>337-338:</u> As this is the first mention of igneous activity, it's worth expanding on this a bit more	We know there are igneous rocks present, because some wells accidentally encountered

here: does this impact the geothermal prospectivity of the basin? There are no igneous structures interpreted on the sections or shown in the strat column, where do they occur?	them. Most of them are located in megasequences 5 and 6. So, this includes the geothermal reservoir. Likely, the locations around the igneous intrusions are less suitable for geothermal exploitation, as the intrusions 'cooked' the reservoir in these areas. There might be one volcanic intrusion present on dipline 3410, encountered by well IJS-64. Yet, this one is located in megasequence 6. We'll look into that a little further and see if we can identify it on the seismic here. Regarding the stratigraphic column, good point! We'll look into that as well. However, the igneous rocks are not very well dated, wherefore it is difficult to put them on the right location in the stratigraphic column.
<u>338-340:</u> Why are we considering these faults are sealed? Is it the lithology towards the top of megasequence 5? Worth clarifying this here to help your reader. Also, do we have evidence of this? Are there any fault-seal studies that be referenced, or are they hydrocarbon accumulations trapped in tilted fault blocks to demonstrate seal effectiveness?	This is our fault. The term sealed refers to packages that are post-kinematics, but it can be misleading when dealing with reservoirs. We will reorganize the text as follows: *'We observe that the upper portion of this megasequence postdated all the normal faults (excluding those showing evidence of reverse reactivation).'*
<u>383:</u> Attributing deformation to the Laramide seems a bit unrealistic here, given several other events occurring much closer to the WNB at this time, including the incipient Alpine Orogeny, the opening of the North Atlantic, and the development of the North Atlantic Igneous Province to think of a few.	That is an interesting point. We'll emphasize this further in the text.
<u>389-399:</u> I wonder is it worth talking about the Triassic at all here, as it is not mapped and is not the focus of the study? I leave this to the authors' discretion.	As the Triassic is one of the exploited reservoirs, it made sense to mention it briefly. The results of this study might gain some new insights and help geothermal exploration of the Triassic sands.
<u>407:</u> As you state these values are depth and not elevation, they do not need the negative symbol in front of them.	You're right, we'll change this.
<u>408-409:</u> I think it might be useful to have a short introductory section earlier in the manuscript, probably between the intro and geological framework sections, which briefly explains the different types of geothermal energy, and highlight which ones are active or planned in the Netherlands.	Good point, we'll add this to the introduction.
<u>422-423:</u> As there is such a large well database to support this manuscript, would it not be possible to produce a net-to-gross map for each reservoir unit, to validate these claims?	This is an interesting question that we intend to investigate further in the future. Unfortunately, this is beyond the scope of this research paper as it would require an additional dedicated data and methods section, along with new figures. The Dutch geological survey, on the other hand,

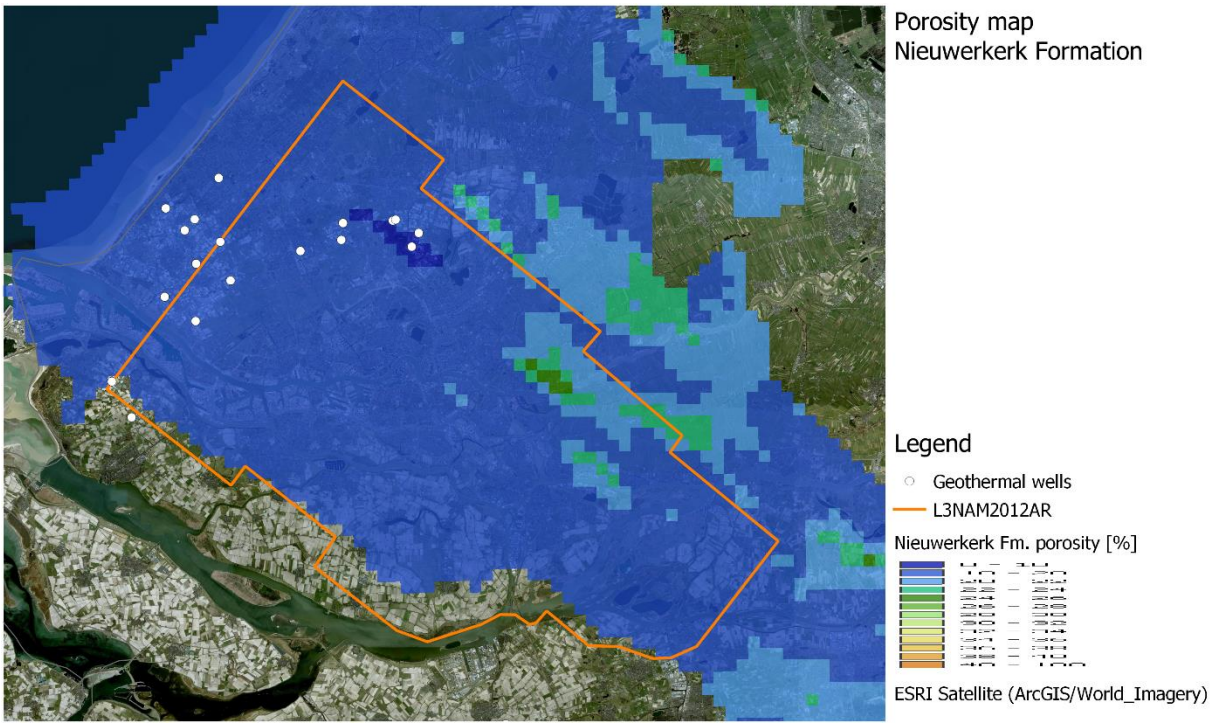
	provide a net-to-gross map of the Nieuwerkerk Formation, which can be accessed on ThermoGIS. This net-to-gross map is attached at the bottom of this document. The problem with hydrocarbon wells only targeting structural highs is highlighted here. The Nieuwerkerk Formation lacks data as a result of this. In the northeastern section of the research area, this problem is partially resolved by geothermal projects drilling and logging the Nieuwerkerk Formation. However, there is a lack of data in the eastern part of the study area, where no geothermal wells have been drilled.
426-427: Is there any published data or interpretations to support this? If not, perhaps include a general reference which states the degree of fracturing in inverted structures. Breached hydrocarbon accumulations might also support this supposition.	There is no published data that we're aware of. We'll include a general reference.
436-439: As with the comment above, perhaps a porosity vs depth plot could be made from available well data? Comparing the inverted and non-inverted reservoirs will likely show that the inverted areas will have poorer porosity due to deeper burial and greater mechanical compaction prior to inversion when compared to non-inverted areas. This could help support your findings in this study.	This is an interesting question. Yet, like our response to the question above, this is beyond the scope of this research paper as it would require an additional dedicated data and methods section, along with new figures. However, please find below a porosity and permeability map similar to the net-to-gross map that is also made available by TNO on ThermoGIS.
441-446: I would highlight what new findings you have here, to make your work stand out from existing literature. Similar to what has been suggested for the introduction above.	That is an excellent point. We'll add more text about this later. For an explanation of what is new in this research, see the beginning of this response letter.

TNO Geologische Dienst Nederland: ThermoGIS v2.2, https://www.thermogis.nl/mapviewer, last access: 17 August 2023.

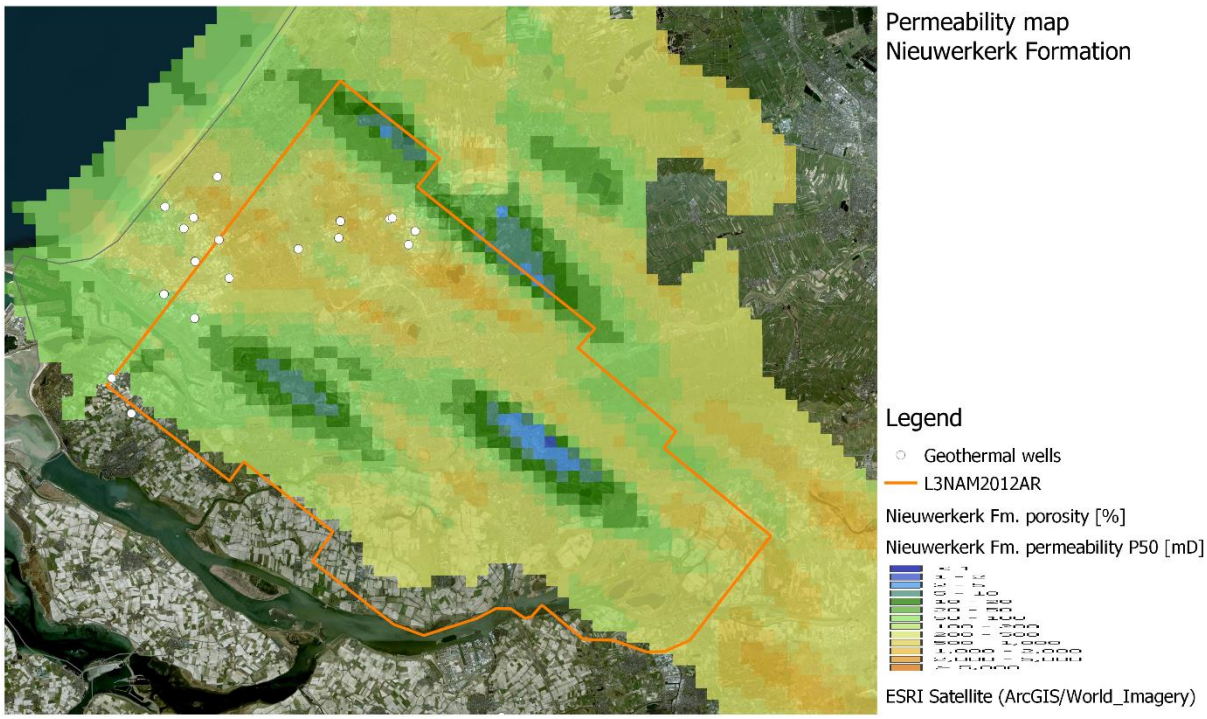
Willems, C. J. L., Vondrak, A., Mijnlieff, H. F., Donselaar, M. E., and van Kempen, B. M. M.: Geology of the Upper Jurassic to Lower Cretaceous geothermal aquifers in the West Netherlands Basin – an overview, *Netherlands Journal of Geosciences*, 99, e1, https://doi.org/10.1017/njg.2020.1, 2020.



Net-to-gross map, made available by TNO on www.thermogis.nl. The map is displayed with the seismic 3D dataset that is used in this study and all geothermal wells that are drilled in the area.



Porosity map, made available by TNO on www.thermogis.nl. The map is displayed with the seismic 3D dataset that is used in this study and all geothermal wells that are drilled in the area.



Permeability map, made available by TNO on www.thermogis.nl. The map is displayed with the seismic 3D dataset that is used in this study and all geothermal wells that are drilled in the area.