

## ***Interactive comment on “Bayesian geological and geophysical data fusion for the construction and uncertainty quantification of 3D geological models” by Hugo K. H. Olierook et al.***

**Gautier Laurent (Referee)**

g.laurent.research@gmail.com

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1. Does the paper address relevant scientific questions within the scope of SE? yes
2. Does the paper present novel concepts, ideas, tools, or data? yes
3. Are substantial conclusions reached? yes
4. Are the scientific methods and assumptions valid and clearly outlined? yes
5. Are the results sufficient to support the interpretations and conclusions? yes

C1

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? yes
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? yes
8. Does the title clearly reflect the contents of the paper? yes
9. Does the abstract provide a concise and complete summary? yes
10. Is the overall presentation well structured and clear? yes
11. Is the language fluent and precise? yes
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Mainly but some explanation seems to be missing and some badly located (cf annotated manuscript)
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? In places, some clarifications cf. comments below and in the attached document.
14. Are the number and quality of references appropriate? yes
15. Is the amount and quality of supplementary material appropriate? yes

### **1 General comments**

The manuscript entitled “Bayesian geological and geophysical data fusion for the construction and uncertainty quantification of 3D geological models” presents an interesting approach for integrating geophysical and geological observations

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into a probabilistic modelling approach of subsurface. Joining the gap between geological and geophysical inversion of subsurface has been a long-standing problematic and this study takes one step toward this objective. Being from the geological side of this problematic my main observations are that the geological description of the subsurface that is used in this study remains relatively simple (probably for sake of parsimony, as required by inversion problems). I would not place this remark as a criticism for this study but rather as an acknowledgment that further research is needed for improving the parameterisation of geological models.

This study has the merit of showing the interest of coupling geophysical and geological inversion. Therefore, I find it valuable for the community and I would recommend accepting it for publication provided some minor revisions.

## 2 Specific comments:

The parameterisation consist of a Gaussian process with an RBF interpolation of depth map of the geological contacts. You should better discuss the limitations of this approach on the geometry of the contacts. At least it cannot reproduce multi-z structured, but it would also have limitations for vertical or sub vertical contacts. As you mentioned in the introduction Obsidian was designed for basins, ie. With layers being roughly horizontal. Isn't it limiting the sampling and more generally the applicability of the method to other geological regions? The description of this geological parameterisation was apparently supposed to be supported by fig. 3 but several reference to this figure in page 6 line 1 and 10 are apparently not pointing at the right thing. The user-defined control points of the Gaussian process are not show as expected. In addition, it would be interesting to show the prior distribution for the parameters describing the depth of the geological interface, which has apparently been omitted.

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You chose to ignore some lithologies based on their smaller cover of the surface. What is the mag sus and density of these formations? They are ignored (because barely seen on surface) but are they going to affect the magnetic and gravity field?

I think you should clarify the way you introduce and discuss you probabilistic approach of the lithological observations. Unless there are arguments for taking particular care with these observations, they seem to me to be rather hard constraints as compared to gravity and magnetic responses. Of course, observations could be misinterpreted, but unless the two discussed units are very similar, you would not need chemical analysis or dating to assign them to one or the other group. On the other hand, gravity and magnetic field are by nature ambiguous.

Why are the high probability areas that outcrop in the middle of the modelled region so different between fig 9b and 10a? On 9b it looks roughly circular whereas it has a crescent shape on 10a.

Please refer to the annotated manuscript for more detailed comments and corrections.

Please also note the supplement to this comment:

<https://www.solid-earth-discuss.net/se-2019-4/se-2019-4-RC3-supplement.pdf>

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Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2019-4>, 2019.

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