

## ***Interactive comment on “Towards geologically reasonable lithological classification from integrated geophysical inverse modelling: methodology and application case” by Jérémie Giraud et al.***

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Dear Reviewer,

Thank you for your insights and comments. We have implemented most of the recommendations you made to the exception of a few where we thought that an alternative was possible and another one where we think that a clarification accompanied with a modification of the prose suffice. Seeing that some information that were not essential to the paper had the potential to confuse the reader, we decided to remove the

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incriminating bits. This removal alters neither the meaning nor the main message of the paper. Please find below our detailed answer to the different points you raised. To refer to a specific paragraph of comment, we reproduce the title you wrote in *italics*, followed by our answer.

### **Detailed answer:**

*Justifying the SOM:* We have added what you suggested (page 6 line 15 on the non-revised manuscript). We added a sentence to the text of the manuscript: “In our case, the utilisation of SOM for partitioning the input models allows the recovery of lithology, which is a geological quantity reflective of all input data. It is also useful in that, as we will see later, the consistency of the recovered lithological model can be analysed from a geophysical point of view.”

*Lithology probabilities:* We agree with the point raised here. We have adjusted the wording. We replaced ‘lithology probability’ with a more appropriate term. Instead of using ‘lithology probability’, which we calculated as the ‘relative apparition frequency’ for each unit of the SOM, we use ‘prediction accuracy’ of that same unit. In this case, the former and the latter are interchangeable as they are calculated in the same fashion (equation 7). We think that using prediction accuracy is clearer and more appropriate in the context of a paper relying on SOM.

For the sake of simplicity, and to maintain the accessibility of the manuscript to a broad audience, we plotted the box-plot of the prediction accuracy for the different lithologies as it complements the prediction accuracy for each lithology. We think that such statistics are a useful addition to Figure 10 that provide the reader with summary statistics and an estimate of the overall confidence one can place in the recovered lithologies volume without looking in the details. It also complements the results shown in the evolution of the prediction accuracy as a function of the number of elements in the SOM. Since this may be useful but is not essential to the manuscript, we added it to the appendices (Appendix B).

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*Probability uncertainties:* The ‘probability uncertainties’ are not essential to the manuscript and removing it from the document does not alter the message significantly. Therefore, we have removed it from the paper. Future work in this direction would be an interesting way to infuse a little bit of real-world physics into simple machine learning algorithms like SOM; however, since this idea did not come from us we did not add it to the manuscript. Information about the positive recovery rate is provided for the reader by the boxplot mentioned above. In the revised version of the manuscript, the assessment of the prediction accuracy is shown in the appendix where the box plot of prediction accuracy is shown. We have added the following in section 3.2.3: “For completeness, assessment of the prediction accuracy of the different lithologies is shown by the corresponding boxplot in Appendix B”.

*Selecting the number of SOM units:* We agree with your comments about the evolution of the prediction accuracy. However, in the case we present, the prediction accuracy increases until reaching approx. 750 units. Beyond this point, it stabilizes and oscillates around the maximum values. This is not obvious from the Figure. To lift this ambiguity, we have added the following statement to the legend of Figure 8: “Note that after 750 units, the quantization error for the different lithologies stabilizes and oscillates around its maximum values”.

*Geophysical consistency:* We agree that additional information would help support the point we make about geophysical consistency and have added more information about the comparison between the updated model’s response and the original inversion model’s response. To compare how they differ we have added to the manuscript the misfit maps – before and after classification. We have added the corresponding maps in Appendix. Note that the data misfit maps are, overall, similar.

*Figure 9:* We have added the number of cells that were modified. The following was added to the manuscript: “a total of 2561 inclusions was identified” in the text accompanying the figure.

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*Additional modifications of the manuscript:* to improve readability, we made a few minor modifications to the manuscript, dealing with wording.

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