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Solid Earth Discussions

Interactive comment on "Subsurface structures of a quick-clay sliding prone area revealed using land-river reflection seismic data and hydrogeological modelling" *by* Silvia Salas-Romero et al.

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Summary

This is an ambitious paper that shows the strengths of combining multiple data sources together. As the authors point out in the introduction, the analysis is highly multi-disciplinary and multi-methodological, and the hydrological modelling draws on a diverse set of data. Having less expertise in hydrological modelling, most of my comments pertain to the treatment of the geophysical data and the general format of the

paper.

I have two main criticisms of the paper:

a) At times, it seems a little lengthy. An aspect of this is the length of some of the paragraphs (Section 4.1, for example, is a monster which spans Pages 8 and 9!); break these up a bit to improve the appreciation of your process.

b) Sometimes the interpretation of the seismic data is also over-long, but also over-interpreted. I list some specific examples below (Points 13-16), but the key point is that not all of the seismic observations appear to have significance in the model – so I think you should restrict the discussion of the interpretation to the most relevant parameters. A full interpretation could go into supplementary material, although (see below) I'd suggest that some of this is over-interpreted anyway.

With such streamlining, the objectives of your paper will be more understandable and its significance therefore more appreciable.

Specific points

1. Title. This indicates that you reveal subsurface structures with modelling, but I'm not sure this is what you mean. Presumably, the structures you image in the geophysical data help constrain the model? A title like "Hydrological modelling of a quick-clay vulnerable area, constrained with geophysical data" would be more informative?

2. Abstract. For all the numerical analysis in your paper, the abstract contains no numbers. Can you add some in? e.g., some highlights from the geophysical dataset, and some of the hydrological parameters you use and model?

3. P1L24: "sensitive" – to what? Makes it sound a bit like they are emotional!

4. P2L4: Explain the terminology "sensitivity higher than 50"... Is there a unit or a reference system here?

5. P2L7: Surely there's no need to separate "geotechnics, geophysics or geology" out?

Aren't they're all "geoscience"?

6. Section 2.1 (and throughout): You variously refer to your seismic lines by number, or by the source acquisition method. I found this very confusing, trying to remember what method was used on what line, and would prefer that you stick to the numerical reference throughout. The table usefully informs what source was used anyway.

7. P5L25: No need to say "reflected sound waves": if they are transmitted as sound waves, they'll come back as sound waves!

8. P6L16: What velocity from the 800-4000 m/s range did you settle on? It doesn't seem to be listed anywhere.

9. P7L3: Why the different mute definition for the wireless data?

10. P7L23: What is this absolute value of error with respect to? Give it as a fraction of the typical target depth?

11. P7L25: To help with the interpretation, it might be worth tabulating the expected response of the different geologies you interpret in each geophysical dataset. Even just listing the range of seismic velocities and resistivities you might expect would help your data description.

12. P8L5: Are you implying that the borehole is 0.02 m, or 0.02 *km* away from the seismic line? If it really is 0.02 m, then it hardly seems worth reporting this, and you could just say that the borehole lies on the seismic line.

13. P8L7: The interpreted faults are not really clear, and it seems an over-interpretation particularly since refraction static corrections were not applied. Could near-surface anomalies be the origin of the discontinuities and misalignments that you claim? In any case are the faults and damage zones critical to your model? It seems to me that you could be much more tentative in interpreting them, without damaging any parameter in your model.

14. P8L8: You don't get a lot of reliable ray coverage in the refraction tomography to really talk about the velocities below reflection B1. I agree that your velocities above this horizon are likely reliable, and you do point out that they have velocities consistent with coarse-grained, saturated sediment. However, in general, I find the resistivity data (Figure 5d, Figure 6e) to provide the much more compelling evidence of a bedrock underburden.

15. P9L2: On what grounds to you interpret a kinematic response from the seismic data? You see dipping horizons, but I don't see how you can say that this represents s slip surface.

16. P9L6: I would suggest that it is beyond the capability of travel-time inversion to resolve boulders, as you claim here. I might expect that they could appear as diffractions in the seismic section, or high-resistivity anomalies, but I don't believe that the tomography would be sensitive to them. Furthermore, this over-interpretation doesn't actually appear to influence any parameterisation of your model, so the paper wouldn't be damaged if you said that your tomography has some unexplained velocity artefacts.

17. P11L20: You suggest that the seismic data shows a higher-resolution delineation of the bedrock/sediment contact, but you wouldn't be able to make this interpretation if it wasn't for the sum total of your datasets! It therefore seems unnecessary to make this assertion when you draw on inferences from all of your data – it doesn't matter which is best! Indeed, this whole section could be considered for removal as it's not clear to me that you are presenting a different hypothesis to one that has been previously postulated. It will always be the case that the use of multiple data sources leads to an improved interpretation.

Figures

1. In the interpretation of Figure 9, you correctly point out in the main text that you are prone to mistaking multiples for genuine reflections. You appear to avoid multiples, except (potentially) for the interpretation between $\sim$800-2500 m in Figure 9b. Can you

be sure that this hasn't been misinterpreted? Also, the inset figures here add very little: the data look very fuzzy, so much so that the logs don't appear to correlate with anything at all.

2. There are potentially too many figures in the paper, and 12 and 13 could be earmarked for removal as they're not very clear partly because of the limited quality of the seismic data. Could they be moved into supplementary material instead? Equally, once the interpretation is streamlined, I don't think that all the seismic lines need to be included.

3. Some figure captions need to be reduced in length, typically those relating to the seismic lines (Figures 5,6,8).

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