Dear Reviewer and Editor,

We would like to resubmit the enclosed manuscript entitled " The 4D Reconstruction of Dynamic Geologic Processes for Renowned Geologic Features", which we wish to be considered for publication in “Geoscientific Model Development”.

I would like to declare on behalf of my co-authors that the work described has not been submitted elsewhere for publication, in whole or in part, and all the authors listed have approved the manuscript that is enclosed. We hope that the manuscript will meet the publishing requirements after revision.

First, we thank and accept the opinions of the editor and reviewers modestly. We have added more detailed explanations to the points that need to be clarified.

Second, we have more carefully reviewed the relevant materials, revised the relevant expressions and added references to the papers. (lines 494-499)

Third, we have made revisions to the less rigorous statements in the text and provided a more comprehensive discussion on the settings mentioned in the article.

The responds to the comments are as following:

Response to the suggestions of Reviewer 1:

The study of Guo et al. proposes a modelling method that simulates three-dimensional and temporally dynamic (i.e., 4D) evolution of well-known geologic features, using parametric functions and vector data structures. The description of the geological features, as well as the method used for the model's implementation, is very clear. I think that this will become soon a valid tool to understand the structural evolution of the geological features. Concerning the simulation of the tectonic processes of typical geological features (section 4.2), I would ask the authors to add some references that can support the evolution described in the paper (it was not done in all cases).

Response: We appreciate your helpful and constructive comments. We provide our response below. Note that we uploaded our revised manuscript after we addressed all referees' comments. Thus, we answered your comments by describing how we revised the manuscript.

For the evolutionary process analysis part in the second paragraph of Section 4.2, we have more carefully reviewed the relevant materials, revised the relevant expressions and added references to the papers. Examples (a), (b), (c), and (e) are now supported by relevant papers. However, examples (d) and (f) are not as well known as the other examples, and we still cannot find papers on the evolutionary processes of these relics, so we can only study the evolutionary processes of these two examples from the perspective of the evolutionary process of typical tectonic processes. Examples (d) and (f) are typical angular unconformities and magmatic vein unconformities, according to the descriptions on the source website and Wikipedia, so we have conducted experiments on (d) and (f) according to the evolution of these two types of structures. (Lines 494, 499)

Response to the suggestions of Editor:

After receiving the report from one reviewer, and based on my own reading of the manuscript, I am now in a position to make a final decision to your manuscript submission process. I agree with the overall comments from the reviewer as well as with his criticism. I am attaching a pdf annotated with additional remarks/questions which I would like to carefully address in a minor revision stage before I can reconsider your manuscript for its final publication.

Response: Thank you for your affirmation and support of our research. We have made serious and detailed amendments to your valuable comments. The specific contents are reflected in the following aspects.

1. Please avoid the usage of rather generic terms, that is, try to be as quantitative as possible. e.g.: What exactly quick implies? And, how faster with respect to other similar methods? (Line 20)

Response: Thank you for pointing out these issues. We have added quantitative descriptions to address the concerns raised. Additionally, in Case 2, we have included the time taken to run each case to provide a more comprehensive analysis. (Lines 20, 506)

2. Not clear here as well, how the presenteed study will support investigating formation of geological features of interest as well as what a more intuitive representation implies. Again, try to be more quantitative. (Line 20)

Response: Thank you for your suggestion. We have incorporated the relevant domain-specific qualifiers. (Line 20)

3. man-made, anthropic in origin? (Line 27)

Response: Thank you for pointing out the wording issue. We have made the necessary changes to "man-made".

4. researchers? (Line 37)

Response: Thank you for pointing out the wording issue. We have made the necessary changes to “researchers”.

5. I am not sure I could follow here. Why having a 2D representation, despite its limitations as discussed above, limits the accessibility to the audience. Are you stating that a 2D presudo-static representation implies a certain level of "educated geological abstraction" from experts which hinders their understanding to a less educated audience? (Line 44)

Response: Thank you for your question. This is because the evolution of geology actually occurs in three-dimensional space, and representing it in two dimensions has certain limitations. Understanding three-dimensional concepts from a two-dimensional perspective requires spatial imagination, and

comprehending the geological evolution also requires a certain level of geological expertise. Therefore, for a general audience without prior exposure to geological knowledge, explaining the process of geological evolution solely through two-dimensional profiles may be challenging.

6. Are you highlighting the lack of any automatic workflows here? (Line 52)

Response: Thank you for pointing that out. We have made the necessary additions. (Line 52)

7. Allows (Line 55)

Response: Thank you for pointing out the wording issue. We have made the necessary changes to "allows". (Line 56)

8. Cannot understand what you want to state here. (Line 56)

Response: Thank you for your response. What we are trying to convey here is the method proposed by Lidal et al. for reconstructing the geological evolution process based on sketches. As the method is based on evolution sketches hand-drawn by geological experts, it is able to express the reasoning behind the evolution process of the region.

9. I would adivse a bit of caution here and, please, be specific while stating limitations of existing studies. (Line 64)

Response: Thank you for pointing that out. The sentence "the method used to simulate geological structures is too simple" is a summary of the following several flaws. The sentence order has been adjusted accordingly. (Line 64)

10. Please consider to rephrase and/or avoid such non-scientific staements. (Line 70)

Response: Thank you for your feedback. The necessary modifications have been made accordingly. (Line 71)

11. My question here; are those the whole of the geological structures you have been integrated into modules in your tools? And, how flexible (also from a suer point of view) would be to extend the modules? If not directly discussed in the introduction here, I would warmly advise the authors to have it detailed in the final discussion (possibly as a future efforts/exploitability dedicated section). (Line 83)

Response: Yes, the five geological structures mentioned in the article have been integrated. The highlight of this manuscript is that the geological structures are parameterized and modularized and called directly during simulation. Therefore, for a new geological structure, as long as a suitable parameter function can be found to simulate it, it can be easily modularized in the same way to add a new structure. Relevant explanations have also been added to the discussion section. (Line 526)

12. I would rather state that this is the convention used in your approach to label a stratum. (Line 96)

Response: Thank you for pointing out that this is just the convention of our approach for simplified stratigraphic expressions. It has been modified to be more rigorous. (Line 96)

13. geometry? (Line 190)

Response: Thank you for pointing out the error. The expression here is indeed not standardized, and the intention was to express the orientation of the fault plane in space, so it was changed to "orientation". (Line 190)

14. This is an important assumption that needs to be discussed in more details in the final discussion. And, it does not read scientific proper to neglect something because of its complexity. (Line 217)

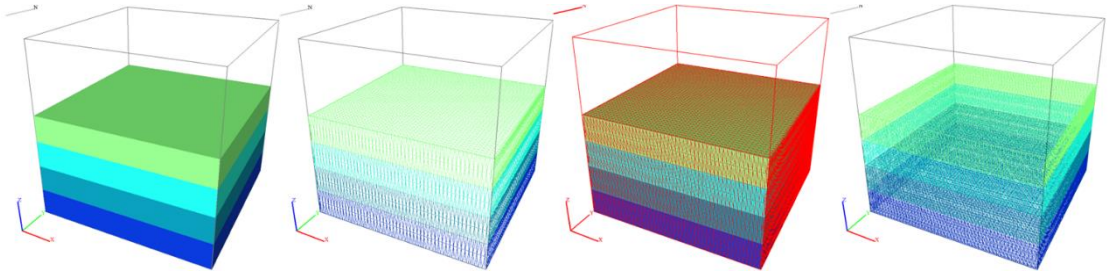
Response: Thank you for pointing this problem out. The original text has been revised and is discussed in more detail in the discussion. (Line 217, 538)

15. this can also be done if based on hexahedral elements (octree). So, it is not clear what's more advantageous for point 3 to rely on tetrahedrons. (Line 240)

Response: With hexahedral elements, it can only be cut once. For the body elements left after the hexahedral cut, not all cases can be divided into hexahedra again, so it is not possible to perform iterative cutting based on hexahedral body elements. On the other hand, the body elements left after tetrahedral cutting can be divided into tetrahedra again in all cases, so iterative cutting can be performed based on tetrahedral body elements. Therefore, we have adopted tetrahedral voxels.

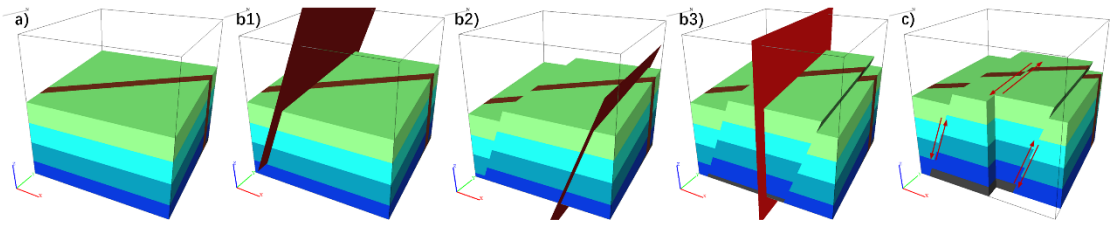
16. I would advise to provide a better graphical representation of the tetrahedral representation, possibly showing some more details also along the line of the points discussed above. (Line 16)

Response: Thank you for the suggestion. We have added more graphical representations. (Line 247)



17. all is fine, while making use of a simpplified structure to convene the main message and explain the procedure followed. However, already at this stage I would also advise to add an example showcasing a more complex, therefore realistic example. (Line 337)

Response: Thank you for your suggestion. We have added an example of a more complex fault. (Line 373)



18. If I follow your exaplantion, by defining a point and the two normals you are then limited to a planar surface only. So the question remains to which fault geometry your approache is limited to. Am I missing something? (Line 354)

Response: Yes, the fault shape is currently limited to a plane. We have added a more detailed discussion to explain this.

19. While using independent libraries (also those that semi-commercial as Qt) you should also add the relevant references and possibly (within the zenodo repository at least) the versioning of the libraries that have been used and tested again for compatibility. (Line 406)

Response: Thank you for pointing this out. We have added references to the Qt library, and the Qt version notes have been added to Zenodo. (Line 410, 624)

20. Please reprhase it. (Line 415)

Response: Thank you for pointing this out. We have rephrased it. (Line 419)

21. A final remark to the last part of the discussion, concerning mainly the limitations of the current development. I think the main assumption of uniform thickness at a stratum level should be dicsuss in more details, in relation to which degree it can be consider as a realistic approximation and what implications it has on the usability of the final model, as well in terms of what future efforts could be envisaged in order to mitigate this assumption. (Line 530)

Response: Thank you for your criticism; we have added a detailed description of the methodological limitations and possible future work to the discussion summary. (Line 538)

Thank you very much for your consideration.

Best regards!

Yours sincerely,

Jiateng Guo