Solid Earth Discuss.,
https://doi.org/10.5194/se-2019-56-RC1, 2019

Solid Earth Discussions

Interactive comment on "Late Miocene thrusting in the North Alpine foreland: Driven by a deep-seated process and shaped by the local mechanical stratigraphy" *by* Samuel Mock et al.

Hugo Ortner (Referee)

hugo.ortner@uibk.ac.at

Received and published: 11 April 2019

The manuscript presents some new AHe age data from the Subalpine and Plateau Molasse in an area south of Berne in Switzerland, and aims to discuss these and published He data, and estimates on Late Miocene shortening all along the Subalpine Molasse and the Jura fold-and-thrust belt between Geneva and Salzburg. Therefore, there is a disproportion between the data presented, and the intepretations drawn from these data. He data are only available between Bern and Bodensee, the only complete dataset are the shortening estimates.

Major points

In the introduction, the manuscript summarizes only the geology of the Swiss Alps, and ignores the major differences in architecture of the Austrian-Bavarian-Italian Eastern Alps. Here are some of the differences that should be adressed:

1) There are no external massifs in the Eastern Alps. If the Engadine and Tauern Windows are regarded to represent something comparable, then it must be explained.

2) There are major orogen parallel strike-slip faults in the Eastern Alps that are related to Oligocene-Miocene escape tectonics. It has been shown that this is not only a surficial process but also affects the deep structure of the Eastern Alps (e.g., Ratschbacher et al., 1991; Rosenberg et al., 2004; Rosenberg et al., 2007; van Gelder et al., 2017)

3) There is a supposed subduction flip in the Eastern Alps (Lippitsch et al., 2002; Rosenberg et al., 2018; Schmid et al., 2013). This cannot be ignored when discussing deep structure.

Also Molasse basin stratigraphy changes in the Bavarian part of the foreland, from a conglomerate dominated Lower Freshwater Molasse to brackish and pelagic conditions, and in the Salzburg area the fill of the foreland basin is marine and mostly marly up to the top of the Upper Marine Molasse, coarse clastic detritus only arriving in the Upper Freshwater Molasse (see Ganss and Schmidt-Thomé, 1955; Kuhlemann and Kempf, 2002). This is relevant when discussing mechanical stratigraphy.

In the discussion chapter, section 5.1 on mechanical stratigraphy discusses only an area east and west of the Aare valley. This does not justify the title "...and shaped by the local mechanical stratigraphy". To justify this phrase in the title, you should discuss mechanical stratigraphy all along the Subalpine Molasse. There are descriptions and interpretations on the mechanical stratigraphy (see, e.g., Ortner et al., 2015). One of the main points seems to be that in the cross sections shown in this paper, the basal decollement in the Rupelian marine marls seems no longer to be relevant, above which all the folds in the Bavarian Molasse form. This is probably because you are close to the pinch-out of the Rupelian marls; but where is then the decollement? The absence

of this decollement changes mechanical stratigraphy.

It hits the reader somehow unexpected, when the authors write "We are not able to precisely allocate and to identify the source and the nature of this signal, but we expect that ongoing seismo-tomographic investigations will disclose further details to constrain the underlying driving mechanisms“ (line 23-25, page 11) near the end of the discussion, after they have described these possible driving mechanisms in the preceding sentences.

In summary, this manuscript is stuck halfway between a paper on regional geology of the Subalpine Molasse south of Bern, and a review paper on the Subalpine Molasse (which was obviously also the result of the review of a previous version). There may be two ways to escape this dilemma:

1) Downscale the manuscript to the Swiss Alps, regional aspects and the (wider) area from which data are presented. In this case the introduction and discussion chapters are mostly appropriate.

2) Upscale the manuscript to the entire Subalpine Molasse and prepare a true review paper; however this would require to significantly alter and widen the Introduction and Discussion chapters, and incorporate more data.

Minor points

See annotated manuscript

Hugo Ortner

References

Ganss, O., Schmidt-Thomé, P., 1955. Die gefaltete Molasse am Alpenrand zwischen Bodensee und Salzach. Zeitschrift der Deutschen Geologischen Gesellschaft, 105(1953): 402-495.

Kuhlemann, J., Kempf, O., 2002. Post-Eocene evolution of the north Alpine foreland

basin and its response to Alpine tectonics. Sedimentary Geology, 152: 45-78, doi: 10.1016/S0037-0738(01)00285-8.

Lippitsch, R., Kissling, E., Ansorge, J., 2002. Upper Mantle structure beneath the Alpine orogen from high-resolution teleseismic tomography. Journal of Geophysical Research, 108(B8): 2376.

Ortner, H., Aichholzer, S., Zerlauth, M., Pilser, R., Fügenschuh, B., 2015. Geometry, amount and sequence of thrusting in the Subalpine Molasse of Western Austria and Southern Germany, European Alps. Tectonics, 34(1): 1-30.

Ratschbacher, L., Frisch, W., Linzer, G., Merle, O., 1991. Lateral extrusion in the Eastern Alps, Part 2: Structural analysis. Tectonics, 10: 257 - 271, doi: 10.1029/90TC02623.

Rosenberg, C.L., Brun, J.-B., Gapais, D., 2004. Indentation model of the Eastern Alps and the origin of the Tauern Window. Geology, 32: 997-1000.

Rosenberg, C.L., Brun, J.-P., Cagnard, F., Gapais, D., 2007. Oblique indentation in the Eastern Alps: Insights from laboratory experiments. Tectonics, 26: TC2003.

Rosenberg, C.L., Schneider, S., Scharf, A., Bertrand, A., Hammerschmidt, K., Rabaute, A., Brun, J.P., 2018. Relating collisional kinematics to exhumation processes in the Eastern Alps. Earth-Science Reviews, 176: 311-344.

Schmid, S.M., Scharf, A., Handy, M.R., Rosenberg, C.L., 2013. The Tauern Window (Eastern Alps, Austria): a new tectonic map, with cross-sections and a tectonometamorphic synthesis. Swiss Journal of Geosciences, 106(1): 1-32.

van Gelder, I.E., Willingshofer, E., Sokoutis, D., Cloetingh, S.A.P.L., 2017. The interplay between subduction and lateral extrusion: A case study for the European Eastern Alps based on analogue models. Earth and Planetary Science Letters, 472: 82-94.

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, some

4. Are the scientific methods and assumptions valid and clearly outlined? yes

5. Are the results sufficient to support the interpretations and conclusions? No, not all

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? I cannot judge the validity of thermal modelling

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Mostly

8. Does the title clearly reflect the contents of the paper? More or less. However, I think the title is problematic for two reasons: (1) the authors leave the deep-seated process in the dark, probably it should not be in the title (2) the title sounds bumpy

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? There are none

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? See review letter

14. Are the number and quality of references appropriate? partly

15. Is the amount and quality of supplementary material appropriate? yes

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2019-56/se-2019-56-RC1-supplement.pdf

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2019-56, 2019.