

Comments of Referee #1

In this article, Löberich and Bokelmann present a new study on the cause of seismic anisotropy in the upper mantle beneath the Central Alps. After selecting high-quality, pre-existing shear-wave splitting measurements from several seismic networks, the authors apply a recently developed technique that describes the azimuthal dependence of shear-wave splitting parameters in the case of non-vertical rays of core-refracted phases. The authors integrate the resulting shear-wave splitting measurements with insights from tomographic velocity models and surface deformation directions, concluding that a Couette-Poiseuille flow is likely responsible for the fast-polarization orientations observed.

1) I recognise there is some effort in putting the paper together, however, the article is poorly presented. English is below standard for publication with outright errors of spelling, grammar and faulty construction of sentences that very often compromise the flow and understanding of the article. Similarly, the structure of the paper is far from being acceptable (see comments below) and figures are frequently not thoroughly described. Not being a native-English speaker myself, I understand the struggle and frustration of writing in a foreign language, but I always make sure that a native speaker reads my drafts. This is the main advice I would give the authors. While I believe that there can be value in this study, written English along with lack of structure and logic often prevent the reader from understanding what the authors want to convey. I am afraid that this must be revised before the manuscript can be accepted for publication, or even go through a more technical review. I recommend major revision of the paper and highlight the need for this to be implemented. In principle, the revision effort should not be overwhelming if the authors have access to a native speaker. Below are some recommendations that could improve the structure of the manuscript. I am not providing any corrections about the syntax and grammar as this would be too onerous:

- *We tried to improve the structure and grammar of the manuscript during the revision and hope it is now easier to understand.*

2) As a general comment, I find the paper to be unnecessary long. Key messages are too often buried in text. Answers to the questions “Why did you do this work?”, “What did you do?” and “What did you achieve?” are hard to dig out. Indeed, I struggled to understand most of the paper.

- *During the restructuring we tried to shorten the manuscript.*

3) Tectonic setting is confusing and not sufficient, it needs improvement.

- *We understand that this section might be difficult to understand, but as our paper does not focus on alpine history we see this paragraph more as background information and want to keep it short, as also Referee #3 suggests. We thus only kept page 4 and tried to improve readability.*

4) Whole page 5 is clearly part of the Introduction but it is in the tectonic setting? You are discussing previous studies and stating hypothesis and objectives.

- *We agree and shifted it to the Introduction.*

5) You are mixing “Results” with “Method and Data” and “Discussion”. There are parts of Section 4 (Results) that should be in Section 3 (Method and Data), and parts of Section 4 that should be in Section 5 (Discussion). This is where the manuscript loses all its logic and flow. You should essentially reorganise all the sections but Abstract and Conclusions.

- *As the method itself is very recent and we still test their potential, it is sometimes difficult to clearly separate those section from each other. Yet we agree to some degree and shifted parts of the Result section to Method and Data. The comparison with tomography is usually part of the Discussion, but it motivates the subarea investigation and thus further results. However, we shortened the comparison with tomography somewhat and tried to avoid extensive interpretations.*

6) Once all text is revised and clarity improved, it will be possible to evaluate the results of this study. As of now, speculation seems to dominate your arguments, rather than evidence-based conclusions. Also, interpretation has a large emphasis on previous studies rather than concentrating on what you are bringing to the table.

- *We present a method that has the potential to distinguish between different deformation mechanisms and is thus able to differentiate between an asthenospheric and lithospheric cause of seismic anisotropy from shear-wave splitting measurements. Over decades this has been assumed to be impossible and the origin of observed azimuthal anisotropy patterns thus remained in question. We pick up previous models of Barruol et al. (2011) or Salimbeni et al. (2018) in the light of our new observational constraints, and expand this to types of observations (tomography, GNSS measurements, ...). In agreement with previous findings our procedure reveals an asthenospheric cause (high-temperature mechanism) of anisotropy in the northern Central Alps and further constrains a Poiseuille flow type.*