



EGUsphere, referee comment RC1
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Comment on egusphere-2022-229

Anonymous Referee #1

Referee comment on "Structural characterization and K–Ar illite dating of reactivated, complex and heterogeneous fault zones: lessons from the Zuccale Fault, Northern Apennines" by Giulio Viola et al., EGU sphere,
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Viola and coworkers present the results of a combined structural and geochronological study of the Zuccale Fault (Island of Elba, Northern Apennines Hinterland, Italy), an iconic structure subject of several studies over the years which have also led to very different interpretations.

The manuscript is generally well-written and provides a valuable contribution in understanding the time-constrained structural and mechanical evolution of architecturally complex fault zones. The internal structure of the Zuccale Fault was addressed by means of the "Brittle Structural Facies - BSF" approach recently proposed by Tartaglia et al., (2020), and by the direct dating of some of the juxtaposed BSF using a well-consolidated methodology.

As well as being an interesting example of how to unravel the deformation history of a long-lived fault, the research is also very interesting because proposes new time constraints for the reconstruction of the structural evolution of the Northern Apennines hinterland, a crucial area for understanding the structural and geodynamic evolution of the Apennines, which is currently much debated.

Main specific comments:

- Authors suggest that the preservation of Aquitanian ages within the fault zone excludes

significant thermal overprinting possibly associated with the intrusion of the Porto Azzurro Pluton. This is quite astonishing due to the location and geological evolution of the area, and I think it would need a more in-depth discussion (i. e. addressing what would be the P-T conditions that could eventually prevent a dating in the frame of the thermal evolution of the area, thus defining the thermal window that affected the area)

- it would be useful to try to insert in the discussion, as well as in the cartoon of figure 9, the effects of the middle Miocene extensional phase. A brief discussion of how this LANF phase may have (or not) reactivated the pre-existing thrusts (negative inversion tectonics) as well as the subsequent OOSTs (including the ZF) may also have (or not) reactivated the previous LANFs (negative inversion). Definitely, it would be pretty useful to briefly discuss these possible scenarios.

- the proposed reconstruction once again brings attention to the possible emplacement of magmatic bodies during shortening in southern Tuscany. This seems to confirm what has already been proposed for the Gavorrano area (Mazzarini et al., 2004), but also for the Larderello-Travale geothermal field (Sani et al., 2016). This is consistent with the argument that the Island of Elba could be considered an exhumed analogue of the deep roots of the Larderello geothermal system, with huge implications for the evolution of the well-known Tuscan geothermal systems. I believe that a brief discussion focused on these issues would be useful in the frame of the ongoing debate, also for the important associated implications.
- Some figures need to be implemented, see comments in the annotated version of the ms.

Overall, the topic and the results are certainly of interest to a wide readership, the scientific methods and assumptions are effective and clearly outlined, the results adequate to support the interpretations and conclusions, and thus the manuscript is appropriate for being published in *Solid Earth* after minor revision.

Please also note the supplement to this comment with detailed minor points to be addressed

References:

Mazzarini, F., G. Corti, G. Musumeci, and F. Innocenti (2004), Tectonic control on laccolith emplacement in northern Apennines fold-thrust belt: The Gavorrano intrusion (southern Tuscany, Italy), in *Physical Geology of High-Level Magmatic Systems*, edited by C. Breitkreuz, and N. Petford, *Geol. Soc. Spec. Publ.*, 234, 151– 161.

Sani, F., Bonini, M., Montanari, D., Moratti, G., Corti, G., & Del Ventisette, C. (2016). The structural evolution of the Radicondoli–Volterra Basin (southern Tuscany, Italy): Relationships with magmatism and geothermal implications. *Geothermics*, 59, 38-55.

Tartaglia, G., Viola, G., van der Lelij, R., Scheiber, T., Ceccato, A., and Schönerberger, J.: “Brittle structural facies” analysis: A diagnostic method to unravel and date multiple slip events of long-lived faults, *Earth and Planetary Science Letters*, 545, 10.1016/j.epsl.2020.116420, 2020.

Please also note the supplement to this comment:

<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-229/egusphere-2022-229-RC1-supplement.pdf>