Reply on RC2
Giulio Viola et al.


Bologna, July 23, 2022

We thank Reviewer 2 for the constructive inputs provided to our manuscript. We are pleased to see that the Reviewer appreciated the proposed methodological approach to the study of long-lived, complex fault systems. Also, we appreciate the fact that, although our data seem to confirm that alternative takes from those commonly reported by the majority of the community on the evolution of the Zuccale Fault (ZF) are partly necessary, the Reviewer thinks that our model is quite well supported by the new data. This is indeed an important point, in our opinion. To discriminate between existing models, it inevitably becomes necessary to produce and make available new results and data that can assist in stepping forward in a specific direction. The results presented here are analytically sound "hard numbers", which require us to take them into account and use them while refining the understanding of this spectacular structure.

As in the case of Reviewer 1, Reviewer 2 only has minor comments and requests of improvements on the part of the study that deals with the regional framework of the ZF and on how this needs to be partly revisited in light of the new dates.

In the following we address those comments individually and anticipate the changes that we will be implementing to the resubmitted text to improve it as per these useful inputs.

In Italic font are the original comments, while our replies/rebuttal are in normal font. We do not comment in here on all editorial aspects that will certainly be attended to in the revised version.

The data here provided suggest a different interpretation, following the one proposed by Musumeci et al. (2015), and consider the Zuccale Fault as a thrust fault active at different times from the Aquitanian to the Miocene-Pliocene boundary. The provided interpretation is quite well supported by presented data but I feel that it needs a more detailed
description of the relationships among fault activity and the intrusion of the Porto Azzurro pluton. In figure 9, the one that summarizes the tectonic significance of the Zuccale Fault, the evolution step in which the granite intruded the already formed stack is missing and I strongly suggest the authors to consider it in the in the figure.

A similar comment has been proposed by Reviewer 1. Both Reviewers commenting on the same issue with basically the same suggestion and request for improvement has convinced us about the necessity to comply with this request. As already written in the reply to Reviewer 1, we originally abstained from elaborating in detail on the relationships between tectonics and plutonism because we thought it could excessively complicate both the discussion and the figure. After all, that part of the story is studied and thoroughly discussed in Vaselli and Musumeci (2012), Massa et al. (2017) and Papeschi et al. (2017) which we extensively quote in our work. This notwithstanding, the amended version of the text will be shortly expanded to also contain an add-on on this aspect and Figure 9 will be amended accordingly.

Line 241: Is there any information related to the depth of emplacement of the Porto Azzurro pluton

The estimated pressure-temperature (P-T) conditions of the Porto Azzurro contact aureole are reported as ranging from 300 °C (biotite zone) to 650 °C (andalusite–K-feldspar zone and wollastonite zone), with $P_{\text{max}} < 0.18$–$0.2 \text{ GPa}$ (Duranti et al., 1992). Recently, fluid-inclusion studies (Caggianelli et al., 2018) and detailed investigations of the migmatitic layering of the hosting Calamita Schist unit (Papeschi et al., 2019) showed that these P-T conditions are diagnostic of low-pressure/high-temperature (LP/HT) contact metamorphism and indicate that the Porto Azzurro pluton was emplaced at a very shallow crustal level. The revised text will explicitly report these constraints.

Line 388: Please add a brief description of the Calanchiole Shear Zone

We will be happy to comply with this request in the new version of the manuscript.

Line 635-642: I feel this paragraph may be obscure to readers not accustomed to the Apennines geology. The extensional phase that affected the Northern Apennines and its timing need to be described in brief to better support the interpretation proposed by the authors.

We are happy to comply with this request in the new version of the manuscript. We will specifically address the Mid-Miocene evolution of the Northern Apennines orogenic prism in terms of the significant extensional phase that affected it. We will also amend Figure 9 so as to introduce this further step of the complex local tectonic evolution (see also specific comment to Figure 9).

As to the other requested changes to the figures we will implement them all.

Giulio Viola