Reply to comment on se-2021-75

Anonymous Referee #1
Referee comment on "GPR signature of Quaternary faulting: a study from the Mt. Pollino region, southern Apennines, Italy" by Maurizio Ercoli et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-75-RC1, 2021

Ref#1: This is a relevant paper with substantial contribution to the understanding of Italian tectonics and seismicity. A bonus to this paper is the 3D tectonic analysis, it is always good if authors attempt a 3D model as it inspires readers to think of new conceptual tectonic and geomechanical models. The study rationale is good, background history is comprehensive and informative. The discussion and conclusions could have been sharper…

Dear Referee #1,

we really thank you for your kind revision and appreciation of our manuscript. It was one of our aims to push the reader thinking on the 3D model following our pseudo 3D GPR survey results. We're glad to hear that the manuscript structure is good, and of course, we can make an effort to sharpen more the discussion and conclusions during the revision process.

Ref#1: … attempting to do less conjecture and put more numbers on age, displacement, slip rates and earthquake recurrence etc.

Authors: obtaining more numbers, as the referee suggests, would be certainly desirable. However, we are aware of the limits of the GPR method, we would prefer maintaining a conservative approach due to the unavailability of ancillary data (detailed chronostratigraphic constraints). As we have remarked in our paper, it is a pilot study, aiming to highlight in a non-invasive way the occurrence of strong earthquakes which possibly produced surface ruptures (now buried). We aim to stimulate geoscientists and institutions to achieve further studies providing new insights and "numbers" for the area in the next future.

Ref#1: - How recent is the faulting? Is there any age control? How many meters displacement were observed and what slip-rates could eventually be derived? What is the estimated seismic recurrence and risk? I see much conjecture, but little numbers. Are such numbers available or obtainable?

Authors: our geophysical data are currently the only available for the site, and direct data from trenching or sampling (and thus a precise dating of the deposits) are currently not available. In our opinion, the faulting might be recent, Holocene in age, as some interpreted discontinuities which break up the GPR reflections are very close to the topographic surface. If the referees and editor argue that it's worth (and not too speculative), we can eventually provide a tentative estimate of the displacements interpreted on each fault (and cumulated) breaking the GPR reflections and, a preliminary slip-rate based using chronostratigraphic assumptions. But we remark these results would clearly need a direct validation to confirm the presence and magnitude of such features. On the other hand, we think the estimate of seismic recurrence periods and risk is out of the possibility of this work.

Ref#1: - Why was 3D GPR not attempted, it could have answered many of the questions above?

Authors: as we mentioned above, this pilot study was the first of this type done in the area. The Campotenese dataset was not unique collected during the GPR campaigns, but we surveyed at least other four sites. Thus, we had to find a trade-off between the time spent for the fieldworks and the density of the GPR lines to collect, also to cover a wider region instead of only a super-dense, but more limited, area. On the other hand, we surely agree that a full-3D GPR survey, upon detecting interesting areas on 2D profiles, would be the next "obliged" step possibly before trenching. It might also contribute to better address some of the above questions as well as efficiently and precisely drive the excavation.

Ref#1: - About the strong continuous wavy and undulating reflections with much attenuation as mentioned on page 10 and in Figure 5 and 7; could these also be the base of soil slips or landslides deposits coming from the surrounding foothills? It is not seldom that such landslides occur under heavy precipitation and glide over conductive clay or muscovite layers.

Authors: we absolutely agree about the presence of conductive strata enriched in clay which are responsible for the stronger attenuation. The basin hosts an alluvial valley, so such processes might be common under heavy precipitations, as suggested.

Ref#1: - On page 12, en-echelon faulting is suggested as a mechanism in the 3D fault model. However, I believe that en-echelon faulting occurs only in strike-slip or oblique-slip systems. Where is the strike-component in the VCT fault system? I thought it was only extensional/normal faulting?

Authors: En echelon faulting is often attributed to strike-slip tectonics, but both natural observations and analogue modelling experiments reveal that this pattern also occurs frequently in extensional and contractional tectonic environments (e.g., Twiss and Moore 2007; Ferril et al 2016; Clifton et al., 2000; Davis et al., 2005; Otsuki and Dilov, 2005; Giba et al., 2012). In other words, in the recent literature, the term "en-echelon" lost the former genetic meaning defined in strike-slip tectonics, becoming a geometrical term which only describes an array of structures that partially overlaps along strike. Thus, we use "en-echelon" in this latter sense.

Ref#1: - Make the GPR sections larger with more zoom. I believe the data is high quality but it is not well visible in some Figures.

Authors: The GPR lines are frequently very long, thus using more zoom will reduce their length and cutting some data which means looking at the GPR reflections in a more limited context. However, we'll make an effort to try improving the zoom of the profiles, or possibly providing such profiles in a bigger format within the supplementary material.

Ref#1: - Figure 5: so the final migrations were 2D time migrations with variable 2D velocity models?

Authors: yes, confirmed. We initially spent time testing different migration algorithms, also using simpler using 1D velocity models. But we finally opted to customize each GPR profile its own 2D model which guaranteed superior imaging results.

Ref#1: - Annotate Figure 7 outcrops photos with interfaces and structures

Authors: thanks for the suggestion, we'll update the figure by adding more annotations.

Ref#1: - Figure 9c: what are blue and red faults again?

Authors: the blue and red surfaces build up the reconstructed fault network (blue= W-to SW-dipping synthetic; red=E-to NE-dipping antithetic faults) derived by the interpretation of each GPR profile. We will update the caption.