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Comment on nhess-2021-399

Fabrizio Marra et al.

Author comment on "A morphotectonic approach to the study of earthquakes in Rome" by
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ANSWERS TO REVIEWER #1's COMMENTS

- As reported in the abstract and detailed in the section dedicated to the seismotectonic features of the Rome's area, the longest historical record in the world attests that no destructive earthquake affected the city of Rome during the last 2000 years. We agree with the Reviewer that this fact alone may be indicative of a low hazard. However, aim of our study is to provide a possible explanation (and we agree that we are not providing THE explanation) for this moderate seismotectonic regime. Therefore, while we agree that abstract and conclusions should be modified to smooth the direct implications of the morpho-structural analysis on the assessment of the seismic hazard, we believe that the characterization of the surface expression of the active faults in this area provides inferences on the interpretation of the present seismic hazard. We agree that such inferences could not be substantiated without combining the morpho-structural study with that of the historical and instrumental seismicity, but this is what we actually were intended to do. And we still believe that this goal may be achieved by re-writing the abstract and the conclusions according to the concepts above, and making explicit that we offer a possible explanation for the observed low seismic rate which contributes to reinforce the common belief that Rome should not expect to be affected by strong earthquakes.
- Regarding the possibility that the small surface faults may be expression of a deeper fault systems that may be not segmented as the respective surface expressions seem to be, we remark that such high fragmentation is provided by a en-echelon system of ~N-S strike-slip faults which have crustal continuity. Therefore hindering the lateral continuity of the NW-SE trending faults, which represent the most favorably oriented fault system with respect to the Present-day NE-SW extensional regime. We will highlight this factor in the discussions.
- For what concern the lack of clarity on the origin of the new "competing" tectonic regime responsible for the sinistral reactivation of dextral strike slip faults, this subject

has been thoroughly discussed in the cited previous literature (Marra, 1999, 2001; Frepoli et al., 2010) and, as the Reviewer says, is not the core of the present study. However, we will provide a more in depth explanation in the revised version of our paper.

ANSWERS TO REVIEWER #2's COMMENTS

- We are going to implement section 2 according to the suggestions. However, the earthquakes dated to the ancient periods of Rome history are very poorly constrained. In fact they are based on one account only, and directly referred to the city of Rome. This fact does not allow us to distinguish far earthquakes from close events. During Roman Ages, the definition of the term "Rome" was often associated with entire territorial possessions, e.g. the whole Italy.

To better illustrate this topic we will add the suggested table with the earthquakes that hit Rome with Intensity greater than 6.

- We will improve Figure 2 adding the requested information on the age of the tectonic features and on the different extensional stresses, along with the other suggested modifications. We will re-arrange the text accordingly to this implemented structural scheme.

Figure 3 comprehends the area where the statistical analysis of riverbed directions was performed in previous literature and it is functional to highlight the marked morphological feature of the drainage network in this region. We are going to slightly enlarge the area in order to include the epicenter of the 2020 seismic event.

- We are going to re-organize the seismicity sections, merging them together.

We remark that there is no moment tensor computation; we have computed a focal mechanism of the mainshock using first-motion polarities (57 P-wave polarities) with the code FPFIT (Reasenber and Oppenheimer, 1985). Focal mechanism with first-motion polarities is shown in figure 4.

We are going to provide a revised Fig. 4 in which we have reported all the four arrays with different colors. In the map are shown only the nearest seismic stations with respect to the epicenters. The 4 arrays are extended in the whole Central Appennine and are all used in the relocation of the small sequence.

We are also providing a table with the list and the parameters of the Ml 3.3 event and the 4 aftershocks.

We preferred to not add the location of two mainshocks because they are localized far from the mainshock's epicenter. However, we will add them in the revised Figure 4b and we will discuss in the text the fact that they are not related with the seismogenic structure.

- We will remove the tectonic lineaments from Figure 6 a) and b) and Figure 7.

and add a new figure where all the main results from the previous figures are reported (fluvial elbows, knickpoints, etc.) along with the interpreted tectonic lineaments.

We remark that the NE-SW directions are clearly overprinted by the N-S ones in this area.

- The Reviewer highlights the core of the problematics concerning the assessment of the seismic risk for Rome: in this area the seismogenic structures are buried and blind, and there are only hints of their activity at surface. Therefore, there is no information to assess which is their current and past activity and seismic rate. We believe that one indirect way to provide an estimation of the seismic potential is the morpho-structural approach, aimed at providing information of the size of the potential faults. On this regard, the scheme suggested by Reviewer #2 reporting the orientation, kinematics and age of the different stress fields that affected the study area through time, along with the geometry of the related faults, is an excellent idea.