

## ***Interactive comment on “Shallow subsurface geology and seismic microzonation in a deep continental basin. The Avezzano Town, Fucino basin (central Italy)” by Paolo Boncio et al.***

**Anonymous Referee #4**

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GENERAL COMMENTS This paper concerns the results of a basic microzonation study which was carried out in central Italy, in the area of Avezzano. This town was completely destroyed by the 1915 earthquake. According to the Authors, the local geological conditions, due to the location of the town along the marginal areas of an intramontane continental basin, have remarkably contributed to the amplification of the damages. The study of the geological, morphological and structural control-factors on the local seismic site response can thus potentially represent a significant contribution of broad interest, considering that several old villages and towns of central and southern Italy are located in comparable geological and morphological settings. In its present form the manuscript, representing a very good and detailed technical report of

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the microzonation studies, has a local relevance and leaves almost unresolved some fundamental issues. Nevertheless, if framed in a more detailed and exhaustive geological model, the robust dataset that includes geological and geophysical data could be a valid base of knowledge to turn the paper in a scientific paper of broad interest. The Authors correctly emphasize the crucial importance of a solid geological model in interpreting the seismic site characterization. Paradoxically, the interpretation of the geological data seems to be too poorly detailed, if compared with the large amount of available information. The individuation of the causes of the local site effects of the 1915 event and the evaluation of future seismic responses on the new town should require a more detailed geological model, beyond the objectives of the basic microzonation analysis, taking into account all the possible aspects (geometry of the thrust system, location and arrangement of the Quaternary normal faults, location of the active and capable faults, lithological lateral variations within the cover units) that may contribute to the amplification of the ground motion. The peculiar complexity of the geological setting of the site imposes the application of 2D or 3D simulation model of the seismic response that requires analyses more advanced than those planned for the basic (first level) seismic microzonation. A possible target of the paper should be to propose a geological model responding to the requirements for a more advanced (third level) seismic microzonation study. The presented data are largely sufficient to achieve this target. In the next specific comments I suggest to the Authors some issues to be solved in the revision of the paper.

### **SPECIFIC COMMENTS**

In the geological setting and in the following sections are almost obscure on both the significance and the role of the SSE-dipping Tre Monti Fault System, during the evolution of the intramontane basin. The Fucino Basin is, in fact, described as an half-graben connected to the motion, since the Late Pleistocene, along the SW-dipping Fucino master fault system. It is unclear the origin of the Lower Pleistocene depocenter (pull-apart? thrust-top?) bordered by the Tre Monti system. This issue is relevant

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in term of geometry of the faults along the northern border of the basin that should represent the most impressive tectonic feature buried in the subsurface of Avezzano. The Author should also explain the present-day kinematics of the active segments of the northern border, associated to the normal faulting along the Fucino master normal fault. I would also point out the discrepancies in Fig. 1 where the active faults reported in the map are absent in the geological profile. I suggest to draw an original transect, illustrating the geometry of the active faults and their relation with the previous features of the thrust system. Would be also useful provide a regional scale cross section across the northern border of the basin to help the full understanding of the tectonic setting of the Avezzano area by readers not familiar with the area.

The adopted methodology is inspired to the application of the National Civil Protection guidelines for the first level microzonation studies that are necessary, but clearly insufficient to represent the complexity of the examined geological context. The Authors are thus invited to point out how their approach has significantly improved the guidelines, with specific regards to the implementation of the geological field analyses to employ as tool for deciphering analogous geological setting.

The new structure of the Geological-Technical Map proposed in the paper represent a very good proposal aiming at preserve and better exploit the original geological data on which the entire microzonation process is based. Coherently with this appreciable purpose, I invite the Authors to consider the structural features as part of the base geological map, as they actually are, rather than part of the geomorphological and hydrological map. This would help for a better reconstruction of the 3D subsurface geometry that also include the sharp vertical offsets of the bedrock-covers contact across the main fault planes.

The three types of margin adopted as model do not consider any role, control or indirect interference between the site response and the primary geometry of the Neogene thrust belt of Apennines. Some evidences along the transect G-G', almost parallel to the transect from Cavinato et al., 2002 of Fig. 1, would suggest the possibility of

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a different interpretation of the geometry of the margin, consisting of the NE dipping carbonate monocline of Mt. Salvino. The authors extend the monocline beneath the flysch sequences, flooring the Upper Pliocene-Lower Pleistocene alluvial and lacustrine deposits of the basin. They attribute to the flysch strata the same attitude of the carbonates. This implies a sharp strata truncation of the flysch levels along the unconformity at the base of the lacustrine deposits and an exaggerated thickness of the flysch monocline concealed beneath the basin. I invite the Authors to discuss and eventually refuse the geometry of the margin proposed in Cavinato et al. (2002) that interpreted the carbonate monocline as the forelimb of a ramp anticline overthrusting the flysch sequence lying almost parallel to the base of the alluvial and lacustrine deposits.

The geometry of the normal faults buried along the northern border of the basin is too poorly defined if compared with that of the segments exposed at the eastern edge of the same margin. The Authors are invited to better reconstruct the continuity of the buried structures tectonically controlling the margin.

The Authors should try to solve the uncertainties about the lithofacies of Lac 1 and Lac 2 along the marginal areas beneath the town of Avezzano. They are also invited to synthesize the different columns related to the 1D subsurface models referred to the single microzones in a 2D model emphasizing the lateral discontinuities and their possible role in determining the seismic site response.

Finally, the conclusions are too generic. I expect that Authors make some further efforts to define the different causes that were directly responsible for the amplification of the damages in the Avezzano area and consequently delineate the good practises to employ in the geological analyses for the seismic microzonation of similar complex settings.

I hope the Authors can find the above listed comments constructive and useful for the improvement of their paper.

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