

## Comment on se-2021-12

Anonymous Referee #2

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Referee comment on "Tectonics, Climate and Topography: Oxygen stable isotopes and the early Eocene growth of the Pyrenees" by Louis Honegger et al., Solid Earth Discuss., <https://doi.org/10.5194/se-2021-12-RC2>, 2022

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This paper aims to utilize stable isotope geochemistry from marine strata in the South Pyrenean foreland to test the hypothesis, originally based primarily on flexural modelling, that a major topographic rise occurred in the late Paleocene-early Eocene. The authors present stable isotope measurements on whole-rock marine carbonate mudstone succession proving a 12 Ma continuous record during the early to middle Eocene (54 to 42 Ma) to provide additional constraints on a possible significant topographic growth during the early Eocene and place this important tectonic and basin reconfiguration period within the evolution of the Pyrenees, from its initiation in the upper Cretaceous to the end of convergence in the Miocene. Finally, the authors state that results of this study might allow discussing the respective roles of climate and tectonics on the topographic evolution of a mountain range. Oxygen isotopes of this record ( $\delta^{18}\text{O}$  values) show a faster decrease rate than the coeval global negative excursion associated with the Early Eocene Climatic Optimum (EECO). The authors claim that this local alteration of the global  $\delta^{18}\text{O}$  signal provided evidence of topographic growth during this period.

The approach of this paper should be praised for its interdisciplinary nature of how a research question identified and the methods to address it are identified. The paper reads well and the figures are clear and well designed. Especially the introduction is very well written. As the paper progresses, the structure is not always clear as data, interpretation and discussion are not always clearly separated.

There are several points which require discussion. As the stable isotope geochemistry of marine carbonates provides the basis for the conclusions of this study, this is the domain that should receive the most careful evaluation.

The isotopic composition of oxygen ( $\delta^{18}\text{O}$ ) preserved in continental sedimentary rocks has been used to reconstruct paleotopography and paleoelevation based the precipitation and "continentality" effects generated through Rayleigh distillation process. However, the

strata being investigated here are marine. The processes affecting the isotopic composition of marine carbonates are more complex and need to be addressed specifically. If formed in situ, the oxygen stable isotope composition could reflect changes in water depth or in water mass composition.

Furthermore, the authors use a bulk sample approach which brings an additional set of considerations which need to be made before reaching a reliable interpretation. There is no information on the mineralogy nor on the petrographic components present in the samples. This is essential to reach any conclusion. Is the carbonate land-derived? From which sources? It is marine and precipitated in the basin? Are these ratios constant throughout the studied interval? These questions are fundamental and need to be addressed with more data. Without this information the interpretations are just speculative.

The choice of samples also needs to be argued for and discussed better. Muds can form at any depth and may carry very different signatures.

Diagenesis is always a key aspect of any stable isotope discussion and has to be related to mineralogical and petrographic composition, and possibly new diagenetic phases, which record the rock fluid interaction through time. The authors use organic geochemistry proxies from organic matter present in some samples. These are not adequately discussed, but are used to make implication on T and pressure conditions. I feel the authors are not discussing this sufficiently.

These points need be better illustrated and clarified by additional data before any further discussion on the respective roles of climate and tectonics on the topographic evolution of a mountain range.