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Interactive comment on "Influence of basement rocks on fluid evolution during multiphase deformation: the example of the Estamariu thrust in the Pyrenean Axial Zone" *by* Daniel Muñoz-López et al.

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This paper by Munoz-Lopez et al. reports structural and geochemical evidence of several multi-phase fluid-flow along the Estamariu thrust located in the Pyrenean Axial Zone combining detailed structural and microstructural observation to O, C, Sr and $\Delta 47$ isotopes. The techniques employed here are adequate and I'm glad to see application of $\Delta 47$ thermometry in the Axial zone. The dataset is sound, and the conclusions are reasonable. The authors document a complex fluid-flow history along the thrust during Alpine compression and Neogene extension involving different sources of fluid

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at different temperatures. This paper should be published as it is an important regional contribution. As stated by the authors, there is a long list of works studying the fluid-flow along thrust faults affecting the sedimentary cover (e.g. Southern Pyrenean zone), but just a few focuses on the basement from the Axial Zone.

Although this work should be published, there are several points that need to be addressed/commented during revision.

1. The structural analysis and description are very detailed but somehow confusing. Here are some suggestions that could clarify the description: - Adding sub-titles such as 4.1.1. Adding sub-title such as Hanging wall, Main Thrust, and Footwall would help a lot.

- I would also recommend adding a general schema synthetizing all the relationship between the observed structures and microstructures. The current Figure 3 does that, but it is still confusing;

- Also, I found the adopted typologies for structures “Sr, Sm, Ssp, SD, etc. . .” confusing and did not catch up what the subscript letter (‘r’ and ‘m’) refer to. What about calling these foliations the same way (unless they are associated to different tectonic phases) and just describe them (morphologies, intensity, orientation) in the sub-section. This would simplify understanding of the numerous stereoplots presented in Figure 3. I also noticed that some of these foliation typologies are not called in the text. For example in line 199: “The foliation within the thrust zone affecting the Devonian hanging wall strikes NW-SE and dips 40 – 50o NE, similar to the regional foliation in the protolith, but it is more closely spaced, generally between 0.2 and 1 cm (Fig. 6A, B).” Specify in the text if this foliation corresponds to “Sr”. The same comment is applicable for all the section 4.1.

- You mentioned pressure solution surfaces e1 and e2 but it was not clear on which basis they were differentiated. Is there any cross-cutting feature? The orientation of these features (if any) are not presented on stereoplots.

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2. The authors report warm temperature fluid-flow event (up to > 200ËŽC), presumably hydrothermal fluid for the CC3 and CC4 calcite phases. As you know, $\Delta 47$ composition of carbonate may be altered by $\Delta 47$-reordering when carbonate experienced temperature in excess of 200ËŽC (maybe lower temperature). Although, I'm convinced that these hydrothermal events did not altered previous carbonate phases (cc1, cc2), I would like to see the authors discussing potential (or not) $\Delta 47$-reordering and how it could be ruled out. Here are some ways to discuss that: - Is there some metamorphic/Fluid Inclusion/chronology work in the same area reporting temperature-time relationship of this hydrothermal event? If this hydrothermal event if short, the solid-state $\Delta 47$ probably did not occur; - Is the thermal history of the area constrained by other studies? If it is the case, the authors could use re-ordering models (e.g. Stolper and Eiler 2015; Lloyd et al., 2017) to see if the $\Delta 47$ composition of the different calcite phases may experience re-ordering. - Alternatively, the authors may acknowledge that further re-ordering is possible but unlikely due to the short time.

3. I have noticed few poorly constructed sentences. I would suggest the English to be checked before re-submission. I won't make any comment on that as I'm myself always struggling with English.

Minor comments: l. 28: Deformation associated with crustal shortening is mainly accommodated by thrust faulting and related fault zone structures: Add references. l. 30: "The reactivation of faults may produce changes in the hydraulic. . ..": Add References. l. 174: Which fractionation curve is used to calculate the oxygen isotope composition of water? l.180 – 181: "The main slip plane is undulose, producing changes in the strike direction and dip, and generates a 2 – 3 m thick thrust zone, which is thicker in the hanging wall, up to 2.5 m thick": Do you mean the thrust fault consists to a deformation zone affecting both hanging wall and footwall, with deformation zone thicker in the HW? l.187: "In the studied outcrops, the Devonian Rueda Formation from the hanging wall is characterized by a well-bedded alternation of dark to light grey limestones with dark grey shales": Does this refer to S0, Sr, Sd? Please specify.

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l.190-192: “Deformation in the Devonian protolith (i.e., outside the thrust zone) corresponds to a decametric anticline (Fig. 2B), which has associated an axial plane pervasive regional foliation (Sr) concentrated in the pelitic intervals (Fig. 5B)”: looking at the stereoplot from Fig. 3, the bedding (S0) seems to define a fold oriented E-W (although only based on 3 measurements). In contrast the Sr does not seem parallel to the axial plane and is more or less oriented N-S (even slightly folded). How can you explain this?

l. 203-204: “When present, these stylolites are very systematic with densities between 5 and 8 stylolites/cm.” Should the intensity be given in number/cm2?

l. 201 – 202: “At mesoscale, SD has related shear surfaces (Ci) defining centimetric S-C-type structures, again indicating reverse kinematics (Fig. 6A).”: Do you have a closer view of the C-S relationship?

l.220-222: “The vein cement (Cc2) is milky white in hand sample and consists of up to 3 mm blocky to elongated blocky crystals (Fig. 6G) with a dull to bright orange luminescence (Fig. 6H).”: To me, e2 and V1b are clearly cogenetic as their crosscutting relationship are ambiguous (as stated by the authors). It is also interesting to see that V1b is extensional (Mode I) but also show mode II with conjugate opening (Fig. 6F). In any case all these structures formed under the same field stress and can be assumed contemporaneous.

l.226: “They are parallel or locally branch off cutting the foliation planes in the subsidiary thrust zone”: What are the textures of these veins? They seem to show interdigitated texture in agreement with extension opening. These are important as they give indication of the opening regime and stress field.

l.246: You state here v4 for fault. However, you previously used V labels for veins. It is confusing even if we expect slickenside onto these faults.

l.252-253: “Shear fractures (V5) are locally mineralized with a greyish microsparite

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calcite cement (Cc5).": Any Figure to document?

l. 400: Huyghe et al. (2018): "Impact of topography, climate and moisture sources on isotopic composition (δ18O & δD) of rivers in the Pyrenees: Implications for topographic reconstructions in small orogens" reported new isotope lapse rates for the Pyrenees. This study should be cited here as it supports very well you high elevation hypothesis. The authors could even use these lapse rates to document the paleo-elevation.

Figure 11: This figure is really good!

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