



EGUsphere, referee comment RC2
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Comment on egusphere-2022-581

Amir Joffe (Referee)

Referee comment on "Tectonostratigraphic evolution of the Slyne Basin" by Conor M. O'Sullivan et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-581-RC2>, 2022

Dear Conor (and all the other authors),

It was a pleasure to be invited to review your work, and thoroughly enjoyed reading your manuscript. As I am not an expert in this geographic area, but do have interest in basin evolution, the interaction of normal and strike-slip faults, I have read and reviewed this manuscript as such. I believe that some of the comments might be trivial to you, but please consider that with such a general title and excellent work you have performed, this manuscript has a potential to draw students and other geologists as a 'first, must read' introduction paper to this basin. Therefore, some of my comments focus on adding a little more clarity to a non-expert of the development of western Europe reader.

Overall, I think the manuscript has a potential to significantly contribute to the understanding NW-Europe, and the relationship between multiple extension phases with inherited structural relief. The authors had access to an extensive set of datasets, which they used well, even if I think that more use could have been used with showcasing more thickness maps from the 3D volumes (see detailed comments). The text is structured very well, with excellent figures that support the authors' claims, and help the reader to follow the text.

Some clarifications are needed on the impact of the Caledonian structures on the development of the basin bounding faults. Do these older structures act as weakness zones? Do you think there is any effect on transtension/transpression on the transfer zones location? And finally, why would you think initial segmentation is preserved in the Northern Slyne basin but not in the southern?

As stated above, this work is novel and should become a key reference for future studies of western Europe and rift basins. I hope the authors find my comments are useful. I have included my details below, so please do not hesitate to get in touch if any of my comments are unclear or you would just like to discuss about them.

Best of luck with the resubmission process,

Amir Joffe

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Detailed comments:

- **Line 14:** I'd add what age is "Caledonian". It would really help phrase it in the context of later events.
- **Line 15:** I'd potentially add "Initial" at the beginning of this sentence. It helps a non-expert understand they should expect a sequential sequence of rifting.
- **Lines 35-36:** You are referring here to Variscian orogenic and the opening of the Atlantic Ocean, but Figure 1A legend says Palaeozoic & Pre-Cambrian basement. I think that it would make it easier to add an age to Variscian orogeny in the text, even if this is still early in the introduction. This comment will also help understand the relationship between the Caledonian and Variscian orogenies in the next sentence.
- **Line 39:** The transition here is not easy. Are you referring to the Caledonian or Variscian structures? I'd maybe write something like "Later rift event had either reactivated Caledonian/Variscian age structure if oriented optimally (REFs) or were segmented, hindering fault growth, in cases rift structures were oblique (REFs)".
- **Line 55:** I would suggest adding: "The Slyne basin (XX km long and YY km wide)..."
- **Line 58:** You make it sounds like transfer zones are specific description of these structures located in the Slye basin. I think that you could make it a little more coherent by: "In the case of the Slyne basin, these transfer zones have been..."
- **Line 60-62:** I'm sure I miss understand something here, but it reads like you're suggesting that transfer zones are areas of reactivation of pre-existing zones of weakness. To my understanding, transfer zone area areas where normal faults transfer strain (Morley et al. 1990; Childs et al. 2019). Could you make it clearer what is your definition of transfer zones?
- **Line 92-93:** Can you highlight the location of the Caledonian terrane boundaries are in Figure 1.
- **Line 94-102:** Very clear description to a great figure.

- **Line 112:** I'd add a reference to Figure 1B at the end of this sentence. I might also think if there is a way to somehow highlight in that great figure what are the Caledonian structures? It would really help differentiating between them and the younger faults.
- **Line 149:** I'd change to: "The Carboniferous mudstones are overlain..." just to make it clear you are not referring to the Silurian metasediments you ended the sentence with.
- **Line 200:** The horizons are not in Figure 2. It would be great to have them in.
- **Line 260:** please add reference to Figure 1B at the end of this. This is a very cool observation, but complicated to understand without the figures in hand, so reference to figures is helpful.
- **Lines 273 – 274:** Not sure that I completely agree. You said that the exact location of the GGFZ is not that clear in that area, I don't think you can conclude that it acted as a barrier to the propagation of the Slyne Embayment basin bounding fault.
- **Lines 274 – 275:** I'd just add why you think they are linked. I guess you think that because of their geographical location? If so, you could add something like: "As the GGFZ transect the CSTZ and is located between the fault bounding the Slyne Embayment and the southernmost segment of fault system bounding the Northern Slyne Sub-basin, there is probable structural link between these fault systems."
- **Lines 280 – 283:** A bit long and convoluted. Could you split into two sentences, stopping after the reference to the figure. Does the HBFC has a sinistral component? If so, I think it might be helpful to add that in the text and add strike-slip arrows to figure 1B (and also to the other basement faults).
- **Line 295 – 296:** Figure 2 shows two small rectangles indicating Triassic salt in the southern basin, so maybe worthwhile removing them from Figure 2. A reference to Figure 9A could also be useful here.
- **Line 333 – 335:** could you please add reference to Figure/other paper like you did in the next sentence? As I would guess that most readers of this manuscript are not salt-tectonic experts, it would really help demonstrate your point.
- **Chapter 6:** The transition between the results (Chapter 5) and Chapter 6 makes the reading a little difficult as it is not clear what is the difference between Chapter 6 (Structural Evolution of the Slyne Basin) and Chapter 3 (Geological Settings). This is because Chapter 6 is followed by a Discussion chapter (Chapter 7). I think could easily be fixed with a sentence or two describing the role of Chapter 6 (Maybe worth thinking about making it a sub-chapter within the Discussion).
- **Chapter 6:** I think that adding thickness maps for each unit will be very useful to illustrate the relationship between the different structural elements. These cross-sections are helping, and are doing a good job at making the point you are trying to make, but as you have such an abundance of seismic data it would be really cool to see that. I understand this would require a significant amount of work, so I leave that to the authors discretion.
- **Chapter 6:** Great Glen is strike slip. Does the HBFC and the SUAG are also strike slip? If so, do they have the same direction? If no what is their original offset and how would you think that influence the location of the later faults? Does transtension/transoression have influenced the location of the basin-bounding faults or the geometry of the Slyne basin?
- **Chapter 6:** Adding a block diagram/simplified map similar to Figure 14 which demonstrates the evolution which you can use refer back throughout Chapter 6 would be useful. As there almost no use of the 3D volumes, I think that as the paper is titled tecono-stratigraphy of the basin, this sort of figure would be very helpful to a non-expert reader.
- **Lines 361 – 364:** I think that either a thickness map or illustration on the cross-section is needed here. It's very hard to judge based on the cross-sections provided if the thickness was salt-tectonic related or related to other extension related structures occurring at the time.
- **Lines 394 – 396:** This is an interesting and non-trivial observation! At first, I was certain the Late Jurassic had growth strata, but I totally agree. Does that mean this

thick unit is pre-kinematic to the main extension phase? These thickness changes are not trivial, and I would suggest adding some indication for this in the cross-sections to help readers understand that. I'd also think that a little more details on why you think that growth strata are present in the Central and Northern Slyne basins, but not in the Northern basin. Or how these faults in the Northern basin had accumulated such thick strata with not apparent growth at all. Sounds like a key feature not only to the understanding of the basin development, but also to the strain interaction between the two sub-basins!

- **Line 402:** "this fault", does that mean the basin-bounding fault or the intra-basinal listric fault?
- **Line 435 – 437:** Not clear what syn-rift episode you are referring to. A reference to a figure is missing here.
- **Lines 513 – 519:** A simplified figure is missing here to help explain this text. I think you can add more text/details to Figure 13 B&C to show how the angle between extension and pre-existing structure will affect the resulted structures. Also, as this is a critical text to your assumptions, if you could add a reference here it would help (maybe to the analogue modelling you wrote).
- **Lines 525 – 531:** I couldn't follow the differences between Figure 13B&C, or fully understand the text. An example for the confusion is: "... characteristic of extension oblique to the **basement fabric**; the key feature is that the overall orientation of the **structure** is parallel to the **basement structure**". It's not very clear who are the structures, what is the basement fabric and what are the basement structures, mainly because it's not very clear from Figure 13B what you are referring to in the text. Amending the text or adding arrows/text in the figures could help.
- **Line 542:** an earlier explanation on what is the Caledonian trend (potentially in the Geological settings) would have made it much easier to understand. See my previous comments.
- **Lines 552 – 555:** Could you suggest why the initial segmentation is preserved in the Northern Slyne basin but not in the southern? Is it the activation of the Great Glen?
- **General:** There are multiple syn-rift episodes, it would be easier if you could number/give age throughout the text when you refer to them. It's not easy to follow 'main syn-rift' or 'syn-rift', especially when the rifting episodes are not coeval in all sub-basins.