

## ***Interactive comment on “A reconstruction of Iberia accounting for W-Tethys/N-Atlantic kinematics since the late Permian-Triassic” by Paul Angrand et al.***

**Alexander L. Peace (Referee)**

peacea2@mcmaster.ca

Received and published: 23 March 2020

This short paper by Angrand et al. makes some interesting and relevant points regarding the evolution of Iberia. The description of geological events that shaped the region is detailed and well organised, needing only minor modifications and clarifications in my opinion. The subject of the paper is very timely and is suitable for Solid Earth. However, I felt that the paper required further work to be suitable for publication. In particular, the description of the methodology, the quality of the figures and some other aspects outlined below need improving. Thus, my overall recommendation is revision of the manuscript as it think it has the potential to make a good contribution to Solid

C1

Earth.

1) Description of reconstruction methodologies, workflow and examination of previous reconstructions

The paper essentially revolves around detailed examination of plate reconstructions to explore specific aspects of Iberia's evolution. This is a combination of previous reconstructions and the authors own work. This is a worthy topic for investigation given that Iberia's kinematics are a source of substantial unknowns when conducting reconstructions of this region.

As such, given that the paper is based on plate reconstructions, my main issue with the paper is that the methods related to plate reconstructions are not currently well described. This is in part because the methods are merged in with the description of the regional evolution. In addition, it was not immediately clear which aspects of the reconstructions are the authors own work and what is from previous reconstructions. I would therefore suggest separating out the workflow and methods into a dedicated section.

I also felt that because multiple reconstructions are referred to further examination of the limitations and inputs of these models is required. For example, many reconstructions have been produced for the region recently (Müller et al., 2016; Barnett-Moore et al., 2018; Nirrengarten et al., 2018; Peace et al., 2019a). Each of these models comes with simplifications and limitations depending on the aspects examined (e.g., local/global models and rigid/deformable models) and I felt that this needed further examining in the manuscript. In addition, given that the rotations for different parts of the model presented are from different previous work I felt that a summary of the poles used would be highly beneficial. This could be simply achieved in a summary table showing pole timing and location with the corresponding reference. Table 1 currently does not adequately display the required information and although the 'motion paths' on Figures 4 and 5 help somewhat they are quite hard to read.

C2

## 2) Kinematics of minor plates

Related to the previous point, the conclusion of the paper that previous work has neglected the need for an Ebro microcontinent/plate/block seems reasonable and adds to a growing bank of work demonstrating that such smaller blocks play a crucial role in such rift systems. Separating Iberia into smaller 'plates' seems reasonable given the information presented. However, it is apparent that even within relatively coherent plates/blocks there is some deformation but at what point is such an entity an independent plate? This is particularly pertinent as the boundaries between the plates are described in the manuscript 'diffuse'. The nature of diffuse deformation has been the focus of recent deformable modelling of the region which might be of use to the authors (Peace et al., 2019a). One of the problems encountered in Peace et al. (2019a) is the over thickening of crust related to strike slip deformation. Perhaps the authors could shed some insights here.

Also, I felt that description of how the kinematics of such blocks are defined requires further clarification and description. By this I mean that the large-scale kinematics of the major plates can be reconstructed from the oceanic isochrons for the Mesozoic, but this is not the case for the minor plates. The minor plates instead rely on much poorer constraints, such as timing of syn-rift sedimentation and faulting styles (as used by the authors). As such, I felt that further information on how the kinematics of Iberia's constituent plates were reconstructed is required. In addition, I felt that this aspect could have been better reconciled with the geological observations. This point may in part be rectified by addressing the point above regarding the methods.

One of the main conclusions of the work presented in the manuscript is that breaking Iberia into smaller blocks in plate tectonic models might result in more realistic reconstructions (i.e. emphasis on the Ebro block). This is in line with a number of recent studies in the region that also use smaller blocks (e.g., Nirrengarten et al., 2018). Thus, I think it should be more clearly outlined that the conclusion of the present paper supports those of the previous work. Moreover, breaking plates into smaller plates/blocks

C3

with independent kinematics presents several issues that need considering further. For example, the requirement of substantial amounts of strike slip deformation for the authors model would benefit from further examination of the geological evidence. I acknowledge that this is examined by in the manuscript somewhat but I think it could be clearer.

My final point regarding minor plates is that the authors focus on minor plates in Iberia appears to not extend to the other parts of the modelled region which I think likely over simplifies the region and perhaps the interpretation. This is demonstrated in Figures 4 and 5 where the separate Ebro and West Iberia blocks are clearly visible but not the separate blocks included in the recent models such as the Flemish Cap, Orphan Knoll, Porcupine Bank etc. (e.g., Nirrengarten et al., 2018). The importance of including these blocks is shown in Peace and Welford (2020). Essentially, these blocks play an important kinematic role and I do not think that Iberia can be accurately reconstructed without including these blocks. I suggest that the authors try to include these blocks or discuss why they are not included.

### Other minor points

Although the paper is generally relatively easy to follow there are a number of sections and sentences that require further work and clarification. Many of these are outlined in the minor points below but I suggest the authors also give the text a thorough proof read prior to resubmission. In addition, I found that although the figures convey much of the relevant information to support the paper I felt that they needed substantial work to be of publication quality. In particular, the text and other details need to be increased in size substantially. Specific aspects of the figures that need addressing are outlined in the minor points below.

Line 3 – 'rift systems'. Consider adding 'spreading' to this sentence as breakup has actually occurred in the region.

line 4 – 'significant'. Is it possible to quantify how significant?

C4

Introduction – The opening paragraph has no citations despite containing several statements that require citations. I suggest adding relevant citations to the opening paragraph.

Line 17 – ‘plate tectonic reconstructions’. As you have shown not all reconstructions are necessarily based on oceanic magnetic isochrons. I think this should be clarified.

Line 20 – I suggest adding relevant citations after ‘boundaries’.

Lines 27-29 - This sentence doesn’t make complete sense to me. Perhaps ‘if’ should be replaced with ‘although’?

Lines 29-30 – This sentence is confusing. I suggest rewording.

Line 46 – ‘evidence’. What sort of evidence. I suggest providing further details of this ‘evidence’.

Section 2 – I found this whole section quite wordy and hard to follow. I suggest refining it down to just the most essential details.

Line 60 – ‘Iberian Buffer’. If this is a quote perhaps it should have a reference?

Line 66 – ‘Atlantic province and Northwest Europe’. I feel like these locations and citations could be better organised. I suggest separating out the regions better and adding the citations that are appropriate for the specific region. Also see Sandoval et al. (2019) and Yang et al. (2020) for very recent southern North Atlantic margins work.

Line 83 – ‘abnormally high heat flow’. Abnormally high compared to what value? What is normal heat flow anyway?

Line 87 – I feel that this sentence overly simplifies the relationship between CAMP and the breakup. I suggest seeing Peace et al. (2019b) for a detailed review of this.

Lines 94-95 – I found this sentence quite awkward to follow and suggest rewording it.

Line 96 – A space is missing before the citation.

C5

Line 99 – ‘the’ is possibly missing before ‘Pangea’?

Line 99-100 – A review of insulation beneath Pangea is undertaken in Peace et al. (2019b).

Lines 110-115 – I felt that this paragraph would benefit from several references.

Lines 121-122 – Are you talking about Beta factor or stretching factor here? Please clarify.

Line 153 – Were the same blocks used here as those from Nirrengarten et al. (2018) and subsequently Peace et al. (2019a)? Or are they different? I suggest clarifying either way.

Line 155 – I suggest expanding upon why a ‘full fit’ reconstruction of Iberia is not possible? I suspect that some of the troubles are stemming from the inclusion on the Flemish Cap as part of the North American plate rather than an independent plate. Also a brief discussion of breakup anomalies offshore Iberia might be useful here.

Line 165 – ‘workflow’. I think a dedicated workflow section would be beneficial.

Line 220 – I think it would be useful to summarise the rotations described in the text as a table.

Line 239 – Why does the Iberia-Ebro boundary have a more complex tectonic history than the Europe-Ebro boundary? I suggest explaining this further.

Line 256 – Awkward wording. I suggest editing this phrase.

Figure 1 – The text is too small to read on the geological time scale.

Figures 2-3 – Details and text are too small to read on all parts of these figures. I would also suggest more clearly labelling the subfigures and describing them more fully in the captions.

References

C6

Barnett-Moore, N., Müller, R.D., Williams, S., Skogseid, J., and Seton, M., 2018, A reconstruction of the North Atlantic since the earliest Jurassic: *Basin Research*, v. 30, p. 160–185, doi:10.1111/bre.12214.

Müller, R.D. et al., 2016, Ocean Basin Evolution and Global-Scale Plate Reorganization Events Since Pangea Breakup: *Annual Review of Earth and Planetary Sciences*, v. 44, p. 107–138, doi:10.1146/annurev-earth-060115-012211.

Nirrengarten, M., Manatschal, G., Tugend, J., Kuszniir, N., and Sauter, D., 2018, Kinematic evolution of the southern North Atlantic: implications for the formation of hyper-extended rift systems: *Tectonics*, p. 2, doi:10.1002/2017TC004495.

Peace, A.L., Welford, J.K., Ball, P.J., and Nirrengarten, M., 2019a, Deformable plate tectonic models of the southern North Atlantic: *Journal of Geodynamics*, doi:10.1016/j.jog.2019.05.005.

Peace, A., Phethean, J., Franke, D., Foulger, G.R., Schiffer, C., Welford, J.K., McHone, G., Rocchi, S., Schnabel, M., and Doré, A., 2019b, A review of Pangaea dispersal and Large Igneous Provinces – In search of a causative mechanism: *Earth-Science Reviews*, doi:10.1016/j.earscirev.2019.102902.

Peace, A.L., and Welford, J.K., 2020, “Conjugate margins?”—An oversimplification of the complex southern North Atlantic rift and spreading system? *Interpretation*, v. 8, p. 1–54. <https://doi.org/10.1190/int-2019-0087.1>

Sandoval, L., Welford, J.K., MacMahon, H., and Peace, A.L., 2019, Determining continuous basins across conjugate margins: The East Orphan, Porcupine, and Galicia Interior basins of the southern North Atlantic Ocean: *Marine and Petroleum Geology*, v. 110, p. 138–161, doi:10.1016/j.marpetgeo.2019.06.047.

Yang, P., Welford, J.K., Peace, A.L., and Hobbs, R., 2020, Tectonophysics Investigating the Goban Spur rifted continental margin, offshore Ireland, through integration of new seismic reflection and potential field data: *Tectonophysics*, v. 777,

C7

doi:10.1016/j.tecto.2020.228364.

---

Interactive comment on *Solid Earth Discuss.*, <https://doi.org/10.5194/se-2020-24>, 2020.

C8