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Interactive comment on "Plio-Quaternary tectonic evolution of the southern margin of the Alboran Basin (Western Mediterranean)" *by* Manfred Lafosse et al.

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In this paper the authors propose a Plio-Quaternary tectonic evolution of the southern margin of the Alboran Sea, mainly based on the interpretation of multichannel seismic reflection profiles and other relevant stratigraphic information and multibeam data. They identify at least two evolutionary phases for this area: a first ,mostly compressive phase of Tortonian age, ending during the early Quaternary, with a remarkable development of imbricated folds and local occurrence of volcanism and strike-slip structures; (ii) a strike-slip phase with a significant extensional component, which started after 1.8 Ma; within this phase, an important role has been played by the Al-Idrissi fault zone

(AIF), which splits the Alboran ridge and, according to the author's interpretation, may represent the present-day plate boundary between Africa and the Alboran domain. As a general comment, the paper should be significantly reduced in length and better organized, especially in the data presentation: in the present form, it is quite difficult to follow the text because it imposes to flip from one figure to another. This because the location maps are distributed in several figures, and for this reason it is difficult to understand the key points presented by the authors. I suggest presenting a single index map in which all the presented profiles are indicated in bold. In the paragraph Data, the authors should present the summary of the acquisition parameters used, and the data processing done (better in a dedicated Table).

We agree with the referee, and as suggested by the referee 2, we add the missing lines in figure 3. We thank the referee for the suggestion of presenting the dataset in a dedicated table. Yet, we believe that the Materiel and Method section is short enough as it presently is. However, we have tried to enhance the clarity of this section.

Another point, which should be clarified, is the relationship between the Quaternary subsidence and the strike-slip tectonics, as presented in paragraph 4.2.1. Indeed, it is not clear from the text. Is this part important in the general context of the paper?

In many strike-slip contexts, vertical motions are associated with faults activity (e.g. the Dead Sea Basin along the Levant fault, Smit et al., 2010). In this paper, we propose that the inception of the transgression of the continental shelf is linked to the propagation of the Al-Idrissi fault. It is important for the general context of this paper because it marks the change of a tectonic regime from the Pliocene to the Quaternary. In a regional context, it is a contribution to date the start of the inception of the present-day Eurasia Africa plate boundary as proposed in Gràcia et al., (2019). We have tried to enhance the clarity of this point.

In addition, I do not see the importance of the question raised in the paragraph 4.3. It is quite obvious that changes in tectonic styles (and the consequent structural elements

produced) are related to changes of direction of stress field.

We agree with the referee. The title was confusing. In the corrected version, we changed the title of this section to "Evolution of the southeastern limit of the Betico-Rifian tectonic domain." . It is indeed well known that changes in far-field stresses can cause changes in local tectonic regime. It has been proposed for example to explain the change of tectonic regime along the Alboran Ridge during the Pliocene and Quaternary (Comas et al., 1999; Martínez-García et al., 2013). It was partly based on the idea that a change in Nubia-Eurasia-America plate motion occurred after 3.16Ma (Calais et al. 2003). However, more recent plate tectonic models suggest that the direction of convergence is constant through time since 6Ma (DeMets et al. 2015). Two recent publications (Galindo-Zaldivar et al., 2018; Gràcia et al., 2019) propose that the Al-Idrissi fault zone is a recent feature, and corresponds to the present-day Africa-Eurasia plate boundary. Therefore, the questions are how can we explain the change of local tectonic, and can we propose a model explaining the evolution of the Alboran tectonic and the inception of the Al Idrissi fault zone.

The authors should identify what are the most important structural elements derived from the interpretation, and propose a plausible mechanism, avoiding such a long discussion.

We agree with the referee. The discussion was indeed a bit long and confuse. Following the remark of the referee 1, we added a table to clarify the timeline of the tectonic events. However, we do not agree with the referee, evidences of rotations of the Alboran Basin are well established (Crespo-Blanc et al., 2016) and it must influence the evolution of the major faults.

Some of the seismic profiles cross the AIF. Apparently, in the presented data it does not appear as a regional, relevant strike-slip fault accommodating the oblique movement between the two domains.

We agree with the referee, the AIF appears to produce a very limited lateral displace-

ment (<10km). We argue that it is the consequence of its young age and that the overall regional deformation rates are low (Gràcia et al., 2019; Martínez-García et al., 2017).

In the earthquake distribution map, the main clusters are located to the south, within the Nekor Basin, and only a few events are located at the Alboran ridge. Have you an interpretation about this?

Our interpretation is that the main active structure is the Al-Idrissi fault zone. The many strike-slip earthquakes (Mw >6) demonstrate it (Buforn et al., 2004, 2017). This fault zone shifts the NAR and the SAR: the SAR is passively extruded southwestward and the deformation localized on the Nekor and Fez faults to the South of the Rifian Massif. The eastern bloc of the AIF is transported northward causing compression in the Central Alboran Sea (e.g. Estrada, et al. 2018). A compressive foreshock during the last seismic crisis (e.g. Buforn et al. 2018) indicates a local reactivation of compressive structure along the SAR, yet in the immediate vicinity of the AIF, and only in relation to the activation of strike-slip segments of the AIF.

Possibly we are facing not a single structure, but most probably a sequence of subvertical lineaments distributing the strain, or, in other words, a diffuse transfer zone.

We agree with the referee. Several fault segments distribute the deformation northward of the studied area in the Adra fault zone and may continue southward affecting the Alboran Ridge and the studied area. Present-day indentation of the central Alboran Sea is likely accommodated through several transfer faults continuing southward (Estrada et al., 2018; Galindo-Zaldivar et al., 2018). However, to the exception of the AIF, these incipient fault zones are not visible at the seafloor in the studied area and their activity is not demonstrated. Gravity anomaly interpreted as incipient faults in Galindo-Zaldivar, et al. 2018 could also correspond to underplated magmatic material following tectonic corridors. Yet, we believe that this discussion is out of the scope of the present paper.

Most of the presented seismic profiles contain the interpretation superposed. This makes difficult for the reader to follow the interpretation and verify its goodness. For this reason, I suggest to present the uninterpreted and interpreted version of the lines (as an example, the profiles in Fig. 6). Finally, I suggest having the text corrected by a native English speaker. Based on the above, I suggest a moderate revision for this paper.

We agree with the referee. We will give the uninterpreted version of the seismic lines in supplementary material. We will present a modified figure according to referee's comment.

Specific points:

Line 41: takes control?

We modified the sentence accordingly: "The Africa-Eurasia NW-SE oblique convergence leads to a tectonic reorganization during the Late Miocene (Comas et al., 1999; Do Couto et al., 2016)."

Line 52-53:...around 8-7 Ma in the...

We replaced the text by "7-8 Ma"

Line 62:Dot after the) Line 64: use the acronym WAB

We modified the text according to the referee's comment.

Line 66: delete "*this*"

We modified the text accordingly.

Line 77:...of thesouthwestern...

We modified the text accordingly.

Line 78: We analyse

We modified the paragraph: "In the present work, we address the structural evolution of the southwestern margin of the Alboran Basin toward the termination of the TASZ through the Plio-Quaternary. We analysis multi-resolution 2D seismic reflection data, TOPAS profiles, and multibeam data. Based on our recent dataset and our seismic stratigraphic interpretation, we observe that the structural subdivision of the Alboran Basin and its margin may reflect a Pleistocene change in tectonic style. We propose a new tectonic model explaining the evolution of the SAR and the Al-Idrissi fault Zone in the southern margin of the Alboran Basin."

Line 84: write "*is*" *, instead of* "*corresponds to*"

We did not modify this part.

Line 108 and 111: extensional

We modified the text accordingly.

Line 129: has triggered?

We modified the text and this part of the sentence has been deleted

Line 133: relative displace-ment? Please explain which plates are involved

We modified the text accordingly: "GPS kinematics shows a WNW-ESE convergence rate of 4.6mm/yr between Africa and Eurasia plates (Nocquet and Calais, 2004)"

Line 160: multichannel seismic profiles

We modified the text accordingly.

Line 171:...interpretation to perform the...

We modified the text accordingly.

Line 178: why you use this acoustic velocity? Have you performed velocity analyses on the data? This should be clarified

We did not perform velocity analysis, we used the velocity analysis for the ODP well 976 from Soto et al. 2012. It is now clarified in the paper.

Line 183: sedimentary sequence

We modified the text accordingly.

Line 192: evidence

We modified the text accordingly.

Line 198:...to a 4-8 km wideconic...

We modified the text accordingly.

Line 199: This sentence is unclear...rewrite

This sentence has been modified to be more concise and clearer.

Line 212: unconformably

We modified the text accordingly.

Lines219-220: conversion in depth based on what velocity? (see comment above)

We did not perform velocity analysis, we used the velocity analysis for the ODP well 976 from Soto et al. 2012. It is now clarified in the paper.

Line 225:this sentence is unclear... Line 241: this sentence is unclear...Line 247: ???

We reworked the paragraph to be more concise and to enhance its clarity.

Line254:...fault zone composed by...

We modified the text accordingly.

Line 290: why sinistral shear? Explain

We moved this sentence and reformulate.

Line 292:..Quaternary at..

The text has been modified to : "The aggradation of contourites at the foot of the SAR indicates a relative quiescence of the folding during the Quaternary after 2.6 Ma (Juan et al., 2016)"

Line 295: equivalent volcano? This is unclear...re-phrase

We rephrase: "The lateral continuity of the highly reflective facies from west to east suggests that the Small Al-Idrissi and the Big Al-Idrissi volcanoes are continuous structures which are offset by local extensional faults during the Pleistocene (Fig. 8 and 10)."

Line 304:...could be the product of MCS...(please explain the acronym and the meaning of this).

We corrected the typo.

Line 309: paleo-ria???

From Wikipedia: A submergent coastal landform, often known as a drowned river valley.Please note that the expression 'paleo-ria' is from Romagny et al., (2014).

Line 325: implies

We reformulate and the comment is not valid anymore.

Line 336: Evidence of...

We reformulate and the comment is not valid anymore.

Caption of Fig. 2:...modified from and from...???

We modified the caption accordingly.

Caption of Fig. 3: indicate NB,BB,..

We modified the caption accordingly.

Fig 6: please present uninterpreted and interpreted profiles, at a larger scale!

We will present the uninterpreted profiles in the supplementary materials

Caption of Fig. 8: there is a repletion of sentence (the seismic line shows.)

We modified the caption accordingly.

Fig. 9: I donot see the location of this figure

The position of the line was given in the figure 3 and 10. However we modified the figure 3 for clarity.

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