

Interactive comment on “Formation of linear planform chimneys controlled by preferential hydrocarbon leakage and anisotropic stresses in faulted fine-grained sediments, Offshore Angola” by Sutieng Ho et al.

Anonymous Referee #2

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1. GENERAL COMMENTS

The paper contains novel scientific concepts and ideas about the interaction between polygonal faulting and chimneys within the scope of SE. Substantial conclusions are reached and presented around the orientation of linear chimneys with respect to polygonal faulting, and how these features can be used to work out timing of hydrocarbon migration. Scientific methods and assumptions seem valid and are outlined, I suggest a couple of ideas below which would improve this further. The description of the results obtained is clouded by figures, I suggest how these can be re-ordered and simplified

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to better convey the results. The authors do credit related work and clearly indicate their contribution. The title clearly reflects the contents of the paper. The abstract is not as clear as it might be due to poorly constructed sentences, however in principle it summarizes the contents of the paper and I make suggestions to improve the grammar.

The overall presentation of the authors results and ideas is badly let down by the quality of the figures and of the referencing to the figures in the text. I suspect some of the figure references in the text are “broken”, with the figures cited in the text not always supporting the argument. This makes the paper hard to read (and review). It appears to me that the authors do have the necessary material to back up what they write in the paper, however these are in need of substantial reordering. I suggest how this can be done below.

The language suffers from typos and a few examples of poor grammar, I suggest how this can be rectified in detail below. I am satisfied that mathematical formulae etc are correct. As I suggest above, the number of figures can be reduced. I suspect that the second seismic survey referred to in the text does not add anything, but it is difficult to tell. The number and quality of references appears to be appropriate, although I have not checked this in detail.

Given the scientifically interesting ideas and discussion, I consider this paper worthy of publication in SE, however the presentation needs some potentially substantial work first on presentation first.

In this review I run through how I would lay out the figures, and share my notes on how the text can be further improved.

2. FIGURES

I suggest a significant overhaul of the figures, cutting out what does not contribute to the story. By doing this the number of figures can be slightly reduced, but all of the figures can be significantly decluttered, making it easier for the reader to see and

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understand the interesting conclusions the authors have reached.

DATA and METHODS

Fig 1: Simple map highlighting position of the two seismic surveys to the coastline and the wide geological environment described under "Regional Setting"

Fig 2: Sample seismic line on each dataset through a feature of interest, showing what this looks like on full, near, mid and far offset data, demonstrating the resolution of the data etc

GEOLOGICAL SETTING

Fig 3: A super-regional seismic line (if possible), or as regional line as you can manage across the two datasets with penciled in interpretation if data confidential, showing the rift, sag and passive margin sequence and geometry. Include an inset zooming into the interval of interest, highlighting the different units.

Fig 4: A map highlighting the features of interest (perhaps after your existing figure 1) with: 1) a multi-segment seismic line going through each of the synclines and diapirs. Use this seismic line to support statements made about timing of syncline subsidence etc 2) a short seismic line or lines (two maximum) highlighting the other features described in section 3.2

OBSERVATIONS AND DISCUSSION

Fig. 5: A seismic line highlighting a PHAA and NHAA. These should be clearly labeled and not covered by interpretation.

Fig 6: A map and one seismic section through one of each of the three different types of chimney highlighting the properties of the chimney on seismic (again interpretation and labels should not obscure the raw data). For the chimneys with no clear base, show one with branching and the other with distortions

Fig 7: Three different maps highlighting each of the three anisotropic PF array types

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you recognize in Tier 2 and one map of an isotropic PF array in Tier 2. Also show how the linear chimneys interact with each of the three anisotropic PF array types you describe in Tier 2 and one map showing how chimneys interact with isotropic PF array in Tier 2

Fig: 8: Three seismic lines showing the three different ways chimneys interact with polygonal fault planes

Fig 9: Something similar to your Fig 7b

Fig 10: Figure containing one map and one section in support of observations in 4.1.3

Fig 11: Maximum of two seismic lines illustrating the relationships described in section 5.1

Fig 12: Your Fig 9

Fig 13: Your Fig 10

Fig 14: Your Fig 11

Fig 15: Your Fig 12

This should reduce the number of figures from 19 (including your appendices) to 15, also ensure the remaining figures all serve a purpose and clearly illustrate what is described in the text. You will hopefully find doing this that the figures are less cluttered with less insets (as per the other reviewers review) and that these will support your very interesting text much better.

Please bear in mind the following hints when reproducing these figures:

(a) on amplitude maps, please ensure your color scale is centered on zero (so that it is clear that red/orange is negative and black/grey positive or vice versa) At the moment, for example on your existing figure 4C, it is impossible to tell what parts are anomalous (negative amplitude) and which are positive amplitude.

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(b) Please ensure labels do not obscure the features of interest, and if something is traced onto a feature of interest (for example your existing figure 2b), that there is an uninterpreted seismic line beside it

Once these figures have been made, please then check the text very carefully to ensure that figure references in the text match these new figure numbers.

3. TYPOS / NOTES READING THE PAPER

Unless otherwise noted, replace the equivalent text with the text I give in "inverted commas"

P1 L2: "Angola. These features are termed "Linear Chimneys"."

P1 L3: "Hydrocarbon migration"

P1 L4: Remove "the" (second word in line)

P1 L7: Replace "e.g." with "such as"

P1 L11: "The initiation of polygonal faulting occurred 40 to 80 m"

P1 L12 "The majority of Linear Chimneys nucleated in the lower part of the PF tier below an impermeable layer within the tier. The filling of lower parts of the polygonal fault tier demonstrate the presence of pore space within the lower part of the tier. The PF gas traps restrict the leak points..." NOTE it is possible to have porosity / gas without significant permeability

P1 L17 "...polygonal faults coupled with..."

P2 L3 "flow directions in the subsurface and the distribution..."

P2 L5 "...structures formed during fluid leakage records the style..."

P2 L8: Replace "leakage" with "leak"

P2 L23: "... documented chimneys having elliptical cross-section and described the

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planform ratio of these chimneys for the first time."

P2 L25 replace "orientations" with "orientation"

P2 L26: Reference in brackets

P2 L28 "... align parallel to these"

P2 L32 "However, neither factors that determined the linear planform of these chimneys nor the reason why gas charged fluid migrated into the PF tier have been investigated."

P3 L1 "It has been documented that"

P3 L5: "interactions between the orientation of magna fluid conduits and tectonic stresses. Nakamura established"

P3 L6: "...different tectonic regimes, noting, for instance, that aligned..."

P3 L11: Delete "Based on seismic observations"

P3 L12: "in shallow buried sediments based on seismic observations, thereby"

P3 L18-19: Statement not supported by fig. 1

P3 L19 "The seismic data has a"

P3 L21 "The dominant frequency is slightly"

P3 L24: Please describe which angles are covered by the near, mid and full stack

P3 L26: "rule out whether the studied features are"

P3 L29: "... to map the linear fluid venting structures as accurately as possible"

P3 L30 "are present on the near, mid and far offset volumes"

P4 L4: Figures cited do not support text

P4 L8: Add reference

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P4 L14: Which figure in Ho 13?

P4 L20 Ho et al 2012a, fig 6a in this paper OR Fig 6a in Ho et al 2012a?

P4 L26 Replace "Relied" with "Relief"

P4 L27: Replace "Isopach" with "Constant"

P4 L 28: "Below which a large number of gas accumulations are interpreted" (also explain why these are interpreted to be gas accumulations)

P5 L2: Spell out that PHAAs are acoustically hard (increase in acoustic impedance) and NHAAs are acoustically soft (decrease in acoustic impedance). Use PHAA and NHA or PHA and NHA, don't use what you currently have (PHAA and NHA). Section 4.1.1 I struggled to find the observations in the text in the figures - some figure references may be wrong. See my separate comments on how to tidy up the figures to make things easier for the reader Section 4.1.2 I struggled to find the observations in the text in the figures - some figure references may be wrong. See my separate comments on how to tidy up the figures to make things easier for the reader

P7 L30: Do not see the described feature on the referenced figure

P8 L2: Same comment as P7 L30

P8 L19: Sentence does not make sense to me

P8 L30: Replace "Some might hypothesize" with "It could be argued" Section 5.2.2 Explain why strong soft anomalies are interpreted as gas. Has the seismic been balanced correctly?

P9 L28: "1) the presence of an"

P9 L33: Figure reference incorrect

P10 L14: Fig 6D does not exist

P12 L23: Sentence does not make sense

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P13 L8: "... Study area may be because" The notes which follow on the figures are some observations, these may or may not be relevant given my recommendation to reorder and rearrange the figures.

Figure 1: A multi-segment seismic line showing the labelled geometries would be helpful

Figure 2: Features of interest on the seismic line obscured by illustrations

Figure 3: "A few faults propagate above the Tiers-2 (interval A)": This is confusing, interval A is above Tier 1, not Tier 2

Figure 4: Please center amplitude maps on 0. It is difficult to tell which parts of the amplitude maps are negative or positive at the moment.

Figure 5: (A) (i)/(ii) and (iii) should be swapped around (show seismic line first, and then maps of given horizon). Likewise for figure 5B

Figure 6: Labelling of maps is confusing, please label the horizon used for figure 6b on figure 6c. Amplitude limits of inset to figure 6a are not labelled.

Figure 7: Figure caption does not match figure, check this.

Figure 8: Cannot see location of seismic line on figure 8b. Amplitude map should be centred on 0.

Figure 9: "Low permeable layer" should be "low permeability layer"

Figure 10: Poor grammar in figure caption, suggest rewriting. Not sure what middle block diagram between block diagram to left and seismic line to right adds in a, b and c?

Figure 11: I like this figure, but no caption for figure 11d.

Figure 12: I like this

Figure A1: It is good to have a summary map like this, however I cannot see the grey

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area this study is based on.

Figure A2: This seems to be a key figure, not sure what it is doing in appendices. Ensure amplitude maps are centred on 0 so it is clear what is anomalous.

Figure A3: Would a reference to Ho 2013 suffice instead of reproducing this here?

Figure A4: This seems to be a key figure, not sure why it is in appendices. Ensure amplitudes centred on 0

Figure A5: Where is "appendix A"? Do you mean "Appendix 1"? This seems to be a key figure, why is it in appendices?

Figure A6: The amplitude map sin a(ii) shows PF cells filled by amplitude anomaly which IS INTERPRETED to represent gas fill. Ensure amplitude maps centred on 0.

Figure A7: I like this, is this a key figure?

4. OTHER NOTES I have not had time to check the reference list for typos. Given the number of typos I have identified, I recommend that the paper be thoroughly proof-read prior to publication by a number of different people to ensure the paper is typo free. Given the figures need reordering, redoing and representing in a different order, I have not reviewed the figures or figure captions in any further detail other than listed above.

5. CONCLUSION I like the paper and feel it should be published, subject to the alterations I suggest above. I hope my comments are constructive and useful to the authors in helping them improve the quality of the presentation of the material.

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2018-34>, 2018.