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Solid Earth Discussions

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.

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Author's response to general comments

We kindly appreciate the time and effort of Reviewer 3 in reviewing the manuscript and the technical expertise as well as questions that have been raised. We are particularly thankful for the suggestions which bring new insights into improving the scientific discussion of the gas traps. We will revise the manuscript by including these

suggestions.

Reviewer 3's questions and comments are in bold and are followed by authors comments below.

1) In the proposed conceptual model, the authors have suggested that gas could not mi-grate further upward the PF plane, the reason for that could simply be the regional seal retains the gas in the lower part of PF tier but has nothing to do with the permeability of PFs? Could it be purely some lithological effects, such as permeable layers occur rather in the lower part of the PF tier and layers in the upper tier layers are less permeable or impermeable?

Total S.A.'s internal well report describes that the lithology in the upper and lower part of Tier 2 does not have a significant difference in lithology. We do not have direct access to the physical data so we have not been able to assess the possibility of preferential deposition of permeable lithologies in the lower part of Tier-2.

The reviewers point is certainly a valid possibility and accordingly we consider it in addition to the impermeable upper polygonal fault model.

In every scenario, it does not affect the interpretation and the formational model of chimneys, as overpressured fluid is suggested to not be able to escape through the upper part of PF plane, and that the upper PF must be impermeable.

2) If the more permeable (lower) part of PF tier juxtaposes against the impermeable (upper) part of PF tier, such as the model in Loseth et al. (2011), perhaps this could explain the formation of fault bound traps occurring particularly in the lower part of PF tier?

The reviewer raises and important point which naturally leads on from the question above. The authors acknowledge this possibility and will incorporate as such into the discussion along side our model.

Given that we do not know the permeability characteristics of the host sediments throughout the tier it is still possible that they are permeable to some degree. Therefore at the very least the upper part of the polygonal fault must be impermeable. Whether this is due to the upper tier sediment properties or not we cannot determine.

3) Is there any well data which can be used to indicate the lithology of PF tier?

Please see answer to question 1.

4) In the statistics there are 7 percent of Linear Chimneys which are not intersecting with any PFs and occur in the middle of the tilted PF blocks. Is the conceptual model of impermeable faults intersecting impermeable layer to form fault bound trap still work for these chimneys?

This is a very interesting question. Because of the length of the paper and because of the majority of chimneys stemmed from the intersection between PFs and impermeable barrier, therefore we did not explain the minority cases. However, we will address this particular point and add brief interpretation in the revised version of the manuscript.

5) Is the hypothesis of the upper part of fault is impermeable uniquely based on the number of chimneys emanated along the lower part of PFs?

Yes, since the vast majority of chimneys emanated from the lower part of PF planes, it is a powerful indicator to the permeability of PFs.

The method of counting the position of chimneys along PFs to estimate the permeability of PF was developed during Ho's 2013 thesis independent of academic supervision.

6) How if chimneys emanated along the upper part of fault (above the regional impermeable layer) or at the upper tip?

In the statistics, there is only 1 percent of chimneys emanated from the upper tip of PFs, and no chimneys emanated along the upper part of PF plane, does it mean that among all the studied PFs are only 2 of them permeable?

Yes, as confirmed by our statistics which is consistent with the counting in Ho, 2013. There is "only" 2 chimneys at the upper tip of PF, and all other chimneys do not emanate above the middle level of Tier 2, so we interpret that there are only 2 PFs which were possibly served as fluid migration pathways.

If there were chimneys rooting along the upper part of PFs it means fluid migrated up to their rooting points then broke through at such locations.
We have previously published in a peer reviewed journal the method of using the intersecting position of chimneys and PFs to investigate the permeability of PFs (see Ho et al., 2016).

We would like to take this opportunity to provide some supplementary information.

The interpretation and conceptual model of "fluid did not use the upper portion

of PF to migrate" and "intersection between permeable layer and polygonal fault plane controlling the nucleation of chimney" was proposed in the thesis Ho, 2013. The statistics presented in this manuscript is taken from the thesis has not been altered, and is consistent with the proposed conceptual model – 99% of chimney emanated along the lower part of PFs.

Author's response to the comments on figures

We will incorporate the suggestions to improve the figures in the revised version of the manuscript.

Reference

Ho, S.: Evolution of complex vertical successions of ïňĆuid venting systems during continental margin sedimentation, doctoral dissertion, Cardiff University Cardiff, UK, 2013.
Ho, S., Carruthers, D., and Imbert, P.: Insights into the permeability of polygonal faults from their intersection geometries with Linear Chimneys: a case study from the Lower Congo Basin, Carnets Geol., 16, 17, 2016.

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