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# *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 #3**

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This paper investigates a new variety of chimneys which exhibit linear planform and are aligned parallel to adjacent anisotropic Polygonal Faults (PFs) and salt tectonic structures. This paper demonstrates that the formation of Linear Chimneys are as a result of hydrocarbon migration influenced by anisotropic stresses around the adjacent anisotropic PFs, whose developments were perturbed by the anisotropic stress field of salt tectonic structures. The genetic relationship between tectonic faults, stress perturbation, PFs, hydrocarbon migration and the geometry of hydrocarbon leakage indicators has been demonstrated with detailed illustrations. This paper is based on



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research results in Ho's PhD thesis, and detailed analysis of chimneys and PFs on 3D seismic data used in exploration. This paper contains new concepts of hydrocarbon migration in polygonally faulted interval. The authors have nicely demonstrated the concrete role of PFs in hydrocarbon migration processes. They have put forth the conceptual model of preferential orientated PFs forming fault bound traps which control the location of hydrocarbon accumulation and overpressured gas leakage, and hence dictating the hydraulic fracturing point i.e. nucleation location of gas chimneys.

I am glad to see there has been such an advancement over what has been already published on this topic by Ho et al. (2013) & (2016). I believe that the authors must have put in an enormous amount of effort to develop this study, and the results in this paper are definitely worth to be published, however some improvements can be made, and the suggestions below could be helpful.

Paper structures The introduction is well covered especially for the historical part, however, for audiences who are not familiar with PFs, it is worth to mention briefly how PFs form and how PFs can serve as palaeo stress indicators. I believe that the latter has already been well investigated in the published works by the last author and so brief explanations and references to these works will be enough. Otherwise, later in the discussion section, it may appear too critical to jump directly into discussions of PF formational timing, although I like the way how the authors lay out and discuss the timing relationship between PFs and chimney developments.

Figures There are figures for each key observation that back up the hypothesis provided by the authors, but some times some figures are just too "busy" and make the reading difficult. The number of figures will not be an issue as soon as it is well presented and not overloaded on any single page. If it is unavoidable to show a complex set of sub figures then it will be better to separate them in two different figures. The three types of chimneys indicated by drawing in Fig. 2b should also be shown on seismic lines in a separate figure, with the corresponding drawing, before Fig. 4. For example, a simplified version of the catalogue of chimneys in Appendix 2 can be added

before Fig.4. For Fig. 4, it may need some re-organisation. The sub figures (a), (b), (d) can be one single figure, (c) and (e) can be put into a new figure. Reordering Fig. 4 and 5 could be considered. Type 1 chimney should be shown before Type 2 in the figures. If it is possible make a diagram or a table, etc, to integrate the three types of chimneys with Fig. 7a. The seismic line in 3D view in the far right of Fig. 7a is quite a representative figure, it could be shown earlier right after Fig. 3. The presentation of Figure 6 is ok, but it will be better to reorder the sub figures by labelling the insert in (a). Enlarge the figure into an entire page and it should make the reading easier. Appendix 3 and 5 could go into the main figures. Appendix 5 can be integrated in the geological section while appendix 3 can be put in the description of PF patterns.

Technical aspects There are few scientific questions which could use more clarity. 1) In the proposed conceptual model, the authors have suggested that gas could not migrate 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? 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? 3) Is there any well data which can be used to indicate the lithology of PF tier? 4) In the statistics there are 7% of Linear Chimneys which are not intersecting with any PFs and occur in the middle of the tilted PF blocs. Is the conceptual model of impermeable faults intersecting impermeable layer to form fault bound trap still work for these chimneys? 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? 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% 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





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permeable?

I was happy to read this study with many new insights and i hope that my comments and suggestions above are useful for improvements.

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