Solid Earth Discuss.,
https://doi.org/10.5194/se-2017-124-RC1, 2017

Solid Earth
Discussions

Interactive comment on "Mid/Late Devonian-Carboniferous collapse basins on the Finnmark Platform and in the southwesternmost Nordkapp basin, SW Barents Sea" *by* Jean-Baptiste Koehl et al.

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Received and published: 18 December 2017

Thank you for the invitation to review this paper by Koehl et al, "Mid/Late Devonian-Carboniferous collapse basins on the Finnmark Platform and in the southwestermost Nordkapp basin, SW Barents Sea," and for the opportunity to be involved in the open review process.

This manuscript provides a comprehensive overview of how structural inheritance may have played a role in the development of the Finnmark Platform area.

The authors map the 3D geometry of a newly-identified shear zone located on the Finnmark Platform and analyse how this shear zone has influenced the physiography of the overlying rift system. They relate activity along and reactivation of the identified shear zones to the formation of basement ridges and supra-detachment basins, linking these to previously documented examples in the North Sea. Furthermore, the authors propose a new model for the offshore continuation of the Trollfjord-Komagelv Fault Zone, purporting that it does not extend offshore as previously proposed.

The authors present a detailed analysis and seismic interpretation of the main structural elements of the rift system and also the shear zone located within basement, which is underpinned by a comprehensive geological history of the area, both onshore and offshore. This paper provides a very interesting and novel example of how pre-existing shear zones may influence faults and rift systems.

I have a number of issues regarding specific aspects of the paper, as outlined below. I recommend that, following these changes, this paper be accepted for publication in Solid Earth.

The authors state that they identify a NE-SW trending "zone of weakness" on seismic reflection data (LINE 200). Based on the seismic data alone, no inference can be made as to the lithological properties of the structure, rather; what is imaged is a package of prominent inclined reflectivity.

As this reflection package does not directly correlate to any structures as observed onshore, more evidence is required before the authors can state with confidence that this represents a shear zone or a zone of weakness.

In addition, the authors state that "km-thick layers bearing strong basement fabrics. . ." may be resolvable at seismic scale (LINE 438-443). References to shear zones as previously imaged and modelled in seismic data need to be included at this point to back up the, in my view correct, interpretation that this reflection package represents a shear zone. Such references include : Phillips et al. (2016); Reeve et al. (2013);

Fountain et al. (1984)

LINE 456-457 – Can you speculate as to what the minor mylonites and shear zones may correspond to? Could they correspond to fabrics within Caledonian allochthons? Or potentially thrusts between allochthons?

The authors propose a model of core complex exhumation along with excisement and incisement to explain the bowed portions of the SISZ and the exhumation of basement ridges (i.e. Figure 9; Section 5.4).

Whilst I agree that the faults appear to merge down with the shear zone structures at depth, what remains unclear is the mechanism by which the bowed portion of the SISZ forms at deeper levels. What causes the SISZ, which then influences faults in the overlying sedimentary sequence, to be uplifted and bow at a particular location at depth? During core complex exhumation, bowed portions would be expected to form towards the surface, but I am unsure as to what would drive the uplift at deeper levels (i.e. red arrow in Figure 9b, c)

Would it be possible that the fault forms first leading to the passive uplift of the shear zone in its footwall? A more detailed description of this mechanism is required, potentially with more detailed applied to figure 9.

LINE 570-571 – I think that you need to first confirm that the observed changes in thickness along the structure are real and not related to variable imaging quality of the shear zone along strike and at depth. For example, the mylonites/fabrics generating the reflections may destructively interfere in some instances.

More information is required on the data used in this study and the coverage provided (LINE 404). What is the data coverage across the area, which areas are covered by 3D seismic data? What is the typical spacing between 2D lines?

LINE 316-319 – does this imply that the faulting pre-dates the dyke emplacement, or is this able to provide any constraints on the exact dating of the faulting? It needs to

be made clearer if these dykes are associated with the faulting or just place an upper bound on the age of dyke emplacement.

Additional, more minor comments are outlined below

Figure 1 appears very cluttered, with a large number of structural elements labelled on the same figure. As such it can often be difficult to identify specific figures referred to in the text (i.e. the locations of the star symbols, LINE 364; Lofoten-Vesteralen margin, LINE 285). In addition, it is difficult to distinguish between those structures that are fundamental to the text and analysed in detail from more minor structures. Perhaps it would be worth distinguishing the key structural elements. Furthermore, the southwesternmost Nordkapp basin and the area focussed on in the study could be outlined to draw the readers attention.

The regional map shown in figure 1 currently offers little information. This should be changed to a slightly more regional version of that shown in 1A (i.e. northern Norway), allowing some regional structures to be labelled on this map instead.

Figure 2 – Would it be possible to show the location of this figure on Figure 1

Figure 4 – Details of the seismic sections are not clear on both printed and online versions of the manuscript, making it difficult to identify some of the interpretations made in the text. Would benefit from being split over two pages with each section made larger.

Figure 5 – These sections appear better quality than those shown in figure 4, with structures and interpretations clearly visible. However, sections in this figure would still benefit from being made larger.

Figure 5c – the relationship between the shear zones and the later rift-related faults shown here appear similar to the exploitative fault interactions of Phillips et al 2016, where we suggest that the fault exploit mechanical anisotropies represented by the mylonitic layers. Also applicable to LINE 725-729.

Figure 8 – Label each of the individual isochrons with the stratigraphic interval.

Figure 10 - The different shades of red used in the figure can be difficult to make out. LINE 1824 (Figure caption) – spelling mistake “0and”

LINE 49-51 – Sentence doesn’t make grammatical sense as it stands currently

LINE 69-70 – the authors state the Senja Shear Zone and the Fugloya Transfer Zone parallel the Trollfjord-Komagelv Fault Zone, this does not appear to be the case in Figure 1, with the SSZ and FTZ appearing almost perpendicular to the TKFZ.

LINE 155 – what differentiates between previous studies that map the TKFZ as a discrete structure and this study, where it is mapped as a series of discrete strands?

LINE 427 – The dykes mentioned are not shown in the magnetic map shown in figure 3

LINE 455-461 – It may be useful to compare with the seismic facies observations of Fazlikhani et al. 2017 based on observations from the northern North Sea.

LINE 469 – Spelling of occasional

LINE 463-467 – I am unable to make out such seismic stratigraphic relationships due to the imaging of the seismic sections shown in figure 4.

LINE 563 – Clarify whether you mean ‘curved’, in map view or in cross-section?

LINE 575 – I’m slightly confused by this statement, it seems that the causation should be the opposite way around. The correct phrasing and causation is given on LINE 635. The way it is phrased currently implies that the SISZ merges with the TFFC rather than the later-formed TFFC merging with the pre-existing SISZ?

LINE 588 – noteworthy needs to be changed to notably

LINE 609-615 – Good interpretation of the relationship between the two.

LINE 862-870 – Also link to additional examples earlier on to add more weight to the

interpretation of the reflection package as a shear zone

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