

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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Dear Dr. Marin, Thank you very much for your well-organized and comprehensive review of our manuscript. Please find our response to your comments organized in three sections: (1) Comments from Dr. Dora Marin, (2) Authors' response, (3) Changes implemented. We hope you find it satisfactory and comprehensive.

1. Comments from Dr. Dora Marin Comment 1: Although the manuscript is a good contribution to the understanding of the geology of the SW Barents Sea, it lacks a

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more global impact. Why should researchers that do not work in the SW Barents Sea read this paper? You can include a paragraph that highlights this issue. But please be concise, as the paper is already very long. Comment 2: The length of the paper should be substantially reduced. Very few people will read the entire paper with such length. In order to do this, I have the following suggestions: -Avoid repetition: you mention three times that the easternmost Hammerfest Basin should be renamed southwesternmost Nordkapp basin, and at least three times you discuss the origin of the Serpukhovian unconformity. Just mention these things once and proceed to the point. -Geological setting: You can reduce this section considerably if you only include what is relevant for your study. A figure with a stratigraphic column could probably help you summarize sections 2.1 and 2.3 into a single paragraph. The geological setting is a little unorganized. For example, in section 2.1.1 you are writing about Precambrian rocks, but suddenly you start describing faults (Lines 155–166, page 6). I suggest that you divide the geological setting in section 2.1, where you only write about lithology, and section 2.2 where you can write about the structural geology. Lines 199–200, page 7 do not belong to the geological setting, it is part of the results. Lines 233–236, page 8; 273–278, pages 9–10 do not belong to geological setting. -Section 5.6 is a summary of what you already have said. You can consider removing this section. Comment 3: Methods: be more specific about the description of your well-seismic tie. Did you make a synthetic seismogram? Which parameters did you use? Comment 4: You need to clarify the meaning of your seismic unit's tops: are they sequence boundaries (if so, what type?), formations tops or just key reflectors with stratigraphic meaning? Because in your results you sometimes write about groups, sequences or ages. Be consistent and do not mix nomenclatures. In the figure of the stratigraphic column, you can also add your seismic unit's tops. Comment 5: Results: descriptions and interpretations are mixed. You can split each section of the results into a description and an interpretation part, in order to make the results chapter easier to read. And please try also to summarize this section. Comment 6: Discussion: I have a problem with your alternative interpretation of the TKFZ. First you said that the

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TKFZ dies out before the Finnmark Platform (page 1 line 27; page 37, line 1128; page 38, line 1144), but in your alternative (contradictory) interpretation you suggest that the TKFZ could have been partially eroded in the Finnmark Platform, but it might be possible to find its prolongation in the Loppa or even in the Veslemøy High. To support your interpretation, you mention some WNW–ESE faults in Veslemøy High, referring to Kairanov et al., 2016. First, the figures of this reference are not easy to find for the readers (since this was a conference presentation). Second, what is the timing of the faults in the Veslemøy High compared to the TKFZ? Are they even the same type of faults? You are not showing data that supports your alternative interpretation of the propagation of the TKFZ to the W. Comment 7: Figure 1: the font size of your abbreviations is different. Why do the BSFC and BKFC have a bigger font? Why are the TKFZ and TFFC abbreviations bold? Comment 8: Figure 2: some of your fonts are bold. Why? Comment 9: Figure 4: this figure does not have scale or coordinates. It does not have a color scale. What is the meaning of the red dotted line? Comment 10: Figure 5: seismic sections are very small, and it is very difficult to see any details (e.g seismic character, amplitude, geometries). You need to make them bigger. It is difficult to agree with your descriptions and interpretations if I can not properly see the data. The sections do not have horizontal scale. You should provide the uninterpreted seismic lines (this can be in supplementary material, if there are any restriction on the number of figures). Sometimes you do not interpret the tops in the entire seismic line. Why? Is it because there is a lot of uncertainty (in that case you could use question marks). Comment 11: Figure 6: fix the order of the figures. After A comes B, not D. Add horizontal scales. Comment 12: Figure 8: it shows a time slice near the mid-Carboniferous. That applies probably only for the hanging wall. Add scale. Comment 13: Figure 9a shows a thickness map of the Devonian–lower Carboniferous, including areas as the sNB. In the seismic lines 5c, d neither the base of the Devonian or the basement are interpreted. How did you make this thickness map? Which reflectors did you use? The Mid- Carboniferous and the SISZ? Also try to make these maps bigger. Comment 14: There are many paragraphs that need a figure as a reference. If

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not, they are difficult to understand or visualize, ex: page 3, line 69; page 9, line 250; page 10, line 301; page 38, line 1159. Comment 15: Some sentences are very long, for example: page 3, lines 67–73; page 12, lines 360–364; pages 16–17, lines 490–498. Try to split them to make the paper easier to read. Comment 16: Be consistent between the names that you use in the text and the figures. Is the Senje fracture zone in line 285, the same as the Senje Shear Zone in figure 1? Page 19, line 576 says basement highs, but in figure 1 it says basement ridges.

2. Authors' response Comment 1: agreed with and added appropriate phrase to the Introduction chapter. Comment 2: -Avoid repetitions: deleted one sentence referring to the change of name of the easternmost Hammerfest basin. Shortened sentence line 899. Deletion of sentence line 899-901. Deletion of sentence line 1087-1091 and addition of the following phrase to the previous sentence “, and in agreement with eustatic sea-level fluctuations at that time (Saunders & Ramsbottom, 1986)”. -Geological setting: we agree this section should be updated, including the addition of a simplified stratigraphic chart. The geological setting chapter, though relatively long, is organized chronologically. First, we approach Precambrian basement rocks, then Precambrian faults (e.g. TKFZ; lines 155–166, page 6). Second, we address Caledonian nappe thrusting in North Norway and, third, we review existing studies about post-Caledonian sedimentary basins and faults. We believe it is important to address Precambrian faults (e.g. TKFZ) together with associated rocks and deformation events to indicate that these faults correspond to long-lived, basement-seated faults that may have experienced several episodes of reactivation. Thus, we would prefer to keep the geological setting organized as it is now (chronological order) rather than to split it into lithology and structural geology as suggested. Nonetheless, we understand that the length of the geological setting chapter may partly impact negatively the manuscript and we have proceeding to a partial shortening of this chapter. -Section 5.6: we agree that this section repeats what has already been argued for in previous discussion chapters. However, we believe that this section is essential to our contribution since it links all the faults and basins addressed in previous discussion chapters by providing a chronolog-

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ical evolution of the study area. We would therefore prefer to keep section 5.6. Comment 3: agreed with and updated. Comment 4: agreed with and mostly addressed with the addition of a stratigraphic chart (figure 3; cf. comment 2). We also restricted the use of the term “sequence” to intra-unit/succession reflections, e.g. dotted white lines in Devonian sedimentary unit in figure 5 & 6. Comment 5: the authors agree that distinguishing description from interpretation is important to keep the manuscript clear for the reader. Dr. Marin, herself, judiciously uses “description” and “interpretation” sub-headings in a recent manuscript (Marin et al., 2017). We, however, feel that adding supplementary sub-headings to our manuscript will only lengthen and segment a text already split in multiple chapters and sub-chapters. We therefore prefer not to use the suggested additional sub-headings. Comment 6: to clarify: the fault-tip process zone model is from Koehl et al. submitted. Our model in the present contribution is that the TKFZ may partly be preserved in pre-Devonian basement rocks and observable on seismic data across basement highs. Indeed, the reference support we use (Kairanov et al., 2016) is from a conference presentation, which makes it difficult but not impossible to the reader to check our argumentation. The faults observed on the Veslemøy High are sub-vertical, WNW-ESE to NW-SE trending and, thus, geometrically similar to the fault segments of the TKFZ. Further, WNW-ESE trending faults on the Veslemøy High (Kairanov et al., 2016) do not propagate into Mesozoic-Cenozoic sediments and are constrained to basement rocks, hence suggesting that they may represent analogs or even the westwards continuation of the Neoproterozoic TKFZ. Comment 7: agreed with and adjusted. Comment 8: agreed with and corrected. Comment 9: agreed with and corrected/updated. Comment 10: agreed with and updated. Comment 11: agreed with and fixed. Comment 12: agree that the figure needs a scale-bar. However, we believe it is no need to specify that “Intra-Permian” in (a) and “Mid-Carboniferous” in (b) refer to the hanging-wall of the TFFC and MFC since we already mention “in the southwesternmost Nordkapp basin” for both (a) and (b). We furthermore argue that changing “in the southwesternmost Nordkapp basin” into “in the hanging-wall of the TFFC and MFC” would minimize the attention of the reader to the footwall portion of the seismic

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cube, which is actually the most important portion of the figure showing that the inferred linkage between the TFFC and TKFZ probably does not exist. Comment 13: the SISZ and adjacent basin-bounding fault complexes were used as base Devonian. We added an explanatory sentence to the figure caption. Comment 14: agreed with and updated with appropriate references, apart from page 9, line 250 where we believe sufficient figure references were used to highlight specific structures. Comment 15: agreed with and changed. Comment 16: agreed with the lack of consistency. The term Senja Shear Zone shall not be used. Instead, we now consistently use “Senja Shear Belt” for the onshore Precambrian belt and “Senja Fracture Zone” for the offshore prolongation of the Senja Shear Belt. Page 19, line 576, “basement highs” should be changed for more consistency.

3. Changes implemented

Comment 1: we highlight the regional impact of our contribution on Arctic regions as follow: “The goal of this paper is to contribute to the understanding of tectonic and sedimentary processes in the Arctic in the Late Devonian-Carboniferous. To achieve this, we demonstrate the presence of an overall NE-SW trending, NW-dipping, basement-seated, low-angle shear zone on the Finnmark Platform, the Sørøya-Ingøya shear zone (SISZ; Figure 1), and to discuss its role played in shaping the SW Barents Sea margin during late/post-orogenic collapse of the Caledonides in late Paleozoic times and its influence on the formation and evolution of Devonian-Carboniferous collapse basins.” Comment 2: -Avoid repetitions: deletion of the following sentence: “This basin was named the “easternmost Hammerfest basin” by Omosanya et al. (2015). We find this name inappropriate and tentatively rename this basin the “southwesternmost Nordkapp basin”, as argued for later in the text”. -Geological setting: addition of a stratigraphic chart for the study area. Deletion of lines 152-153, 158-160, 212-217, 351-353, 384, 392-397 and 410-415. In addition, we proceeded to partial shortening of the results and discussion chapter as follow: deletion of lines 520-521, 645-647, 971, 1109-1112, 1178-1179 and 1245-1247. -Section 5.6:

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no changes. Comment 3: the following sentence from the methods chapter was updated to “The present study uses ties to wells 7120/12-4, 7128/4-1 and 7128/6-1 and 7124/3-1 based on publicly available well data (www.npd.no) and private well-tie seismograms”. Well-tie seismogram used in the present study are private data and cannot be published. We hope the explanatory sentence is satisfactory as it is now. Comment 4: addition of a simplified stratigraphic chart of late Paleozoic successions and restricted use of the term “sequence”. Comment 5: no changes. Comment 6: the final paragraph of section 5.5 was largely modified and now includes the geometrical similarities of faults on the Veslemøy High and fault segments of the TKFZ: “However, if the TKFZ ever extended westwards, portions of its western prolongation might be preserved in offshore basement highs such as the Loppa and Veslemøy highs (Figure 1). More work is needed on this hypothesis, but a possible insight is the recent observation of subvertical, WNW-ESE trending brittle faults analog to the TKFZ in basement rocks of the Veslemøy High (Kairanov et al., 2016)”. Comment 7: bold fonts in figure 1 now correspond to the most important faults and basins dealt with in the present contribution. Font size of BSFC and BKFC are now the same as other structural elements. Comment 8: bold fonts now highlight the main faults and basins dealt with in the paper. Comment 9: addition of an arrow pointing northwards, a color-scale from the original publication, of a scale bar and of an explanatory sentence regarding dashed red lines (from the original publication; Gernigon et al. 2014) in the figure caption: “Dashed red lines represent faults inferred by Gernigon et al. (2014).” Comment 10: seismic sections of figure 5 were split to enlarge them and horizontal scale were added. In addition, uninterpreted versions of the sections will be submitted as supplements. Comment 11: order of figures changed as suggested and addition of a scale-bar in (a). Comment 12: scale-bar added to the figure and decapitalizing of “Intra-Permian”, which becomes “intra-Permian”. Comment 13: added explanatory sentence: “Note that in this part of the margin, the SISZ and basin-bounding faults were used as base Devonian reflections.” In addition, the three maps were enlarged as suggested. Comment 14: page 3, line 69, we added a reference to figure 1.

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Page 9, line 250, nothing was changed. Page 10, line 301, a reference to figure 1 was added. Page 38, line 1159, reference to figure 1 and Koehl et al. (submitted) were added. Comment 15: Page 3, lines 67–73, the sentence was shortened into “The SW Barents Sea margin off Western Troms and NW Finnmark is segmented by margin-oblique, NNW-SSE to WNW-ESE trending transfer fault zones, e.g. Senja Fracture Zone and Fugløya transfer zone (Indrevær et al., 2013), which may represent analogs of the onshore, Neoproterozoic, WNW-ESE trending Trollfjorden-Komagelva Fault Zone (TKFZ) in eastern Finnmark (Siedlecki, 1980; Herrevold et al., 2009) and to the Kokelv Fault on the Porsanger Peninsula (Figure 1; Gayer et al., 1985; Lippard & Roberts, 1987; Rice, 2013)” and the following sentence was added later in the same paragraph: “Onshore-nearshore, margin-parallel fault complexes include the Langfjord-Vargsund fault (LVF; Figure 1) trending NE-SW and possibly representing an analog to the TFFC and MFC”. Page 12, lines 360–364, the sentence was split into two as follow: “Devonian sedimentary rocks are yet to be reported in North Norway and along the SW Barents Sea margin. However, Devonian sedimentary deposits are present in western Norway (Osmundsen & Andersen, 2001) where they represent a several km-thick succession made up with clastic deposits that notably include rhythmic sandstone and coarse-grained conglomerate units. These were deposited in the hanging-wall of a major, low-angle extensional shear zone, the Nordfjord-Sogn Detachment Zone (Séranne et al., 1989; Wilks & Cuthbert, 1994; Osmundsen & Andersen, 2001)”. Pages 16–17, lines 490–498, the sentence was shortened and split as follow: “On the Finnmark Platform (Figure 1 & 2), the base of upper Carboniferous sedimentary sequences is difficult to identify (cf. “mid-Carboniferous” reflection in figure 5). In places, it appears as a linear, moderate to low amplitude seismic reflection that separates subparallel reflections of lower and upper Carboniferous sedimentary rocks, whereas in other places this reflection is irregular and truncates high-amplitude coal-bearing sedimentary deposits of the Billefjorden Group, and/or high-amplitude reflections produced by basement rocks (figure 6a), and/or low-amplitude reflections in Devonian sedimentary strata (figure 6b & c)”. Comment 16: minor changes include

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lines 69-70 where “Senja Shear Zone” becomes “Senja Fracture Zone”, figure 1 where “SSZ” becomes “SFZ” and line 1705 where “SSB = Sørøy sub-basin” becomes “Senja Shear Belt” and “SFZ = Senja Fracture Zone” was added. In addition, page 19 line 576, “basement highs” was changed into “basement ridges”.

Please also note the supplement to this comment:

<https://www.solid-earth-discuss.net/se-2017-124/se-2017-124-AC2-supplement.pdf>

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2017-124>, 2017.