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Interactive comment on "From widespread Mississippian to localized Pennsylvanian extension in central Spitsbergen, Svalbard" *by* Jean-Baptiste P. Koehl and Jhon M. Munoz-Barrera

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Dear Dr. Lenhart, thank you very much for your input on the manuscript, it is highly appreciated. Here is our response to your comments. We hope the changes we implemented improve the shortcomings of the manuscript highlighted by your comments and suggestions. Please do not hesitate to contact us shall this not be the case for some comments.

1. Comments from Dr. Lenhart Comment 1: Throughout the manuscript, detailed descriptions of geological structures, formations etc. and the correlations of observations made in Svalbard with similar structures in e.g. the Barents Sea or northern Norway

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are made. However, in many cases, the location of structures, outcrops etc. is not shown on maps and it is unclear over what distances structural correlations are made. Therefore, some of the correlations and interpretations between structural trends can appear a little farfetched and undermine the good work, especially for readers who are unfamiliar with the geology and tectonic history of the wider study area. Supplementary structural element and plate-tectonic reconstruction maps may help to support the interpretations made by the authors. In general, more references to relevant figures are needed throughout the text.

Comment 2: In general, the description of field observations is very detailed and easy to follow. However, I recommend being more quantitative when it comes to extension direction, fault dip, amount of displacement, bed thickness etc. This additional information gives the reader a better idea about the size of structures and enables a better comparison with observations from other field or subsurface studies. In addition, most figures presented in the manuscript require horizontal and vertical scale bars.

Comment 3: The current manuscript is very focused on the reconstruction of the Carboniferous tectonic history of Svalbard, but wider implications of the study results are not discussed. Obvious additional discussion themes could address the role of structure reactivation and stress field perturbations in more detail. Another possibility could be the use of this study as a potential analogue to subsurface studies in the Barents Sea or a comparison of the findings to other studies (e.g. field, subsurface, or modelling studies). Addressing the wider implications of this study will increase the impact of the manuscript and make it applicable to a wider scientific audience.

Comment 4: The abstract is currently very long and contains complex sentences (e.g. the last two sentences). The rational and motivation of the study is briefly stated in the middle of the abstract (L19-20). However, to emphasize the importance of the study, I suggest moving statements about the study motivation to the first part of the abstract and to add comments on the wider implications of the study. For example: Why is this study important locally and how can the results improve our understanding of e.g.

the tectono-stratigraphic evolution of Svalbard? What are the implications for studying basin evolution in the presence of pre-existing basement structures? What is the role of local stress perturbations in fault reactivation? etc. Comment 5: L24: What is the strike of these basin-oblique, NNE-dipping faults? How do they relate to WNW-ESE-directed extension? Could it be that strike and dip got mixed up and that the faults strike NNE?

Comment 6: L32: pre-existing, not existing

Comment 7: L33: transverse faults, not fault

Comment 8: L37: add commas and write décollements with an é: : : :and shallow dipping, bedding parallel, duplex shaped décollements: : :

Comment 9: L37-38: Out of curiosity – Why would mechanically softer layers such as shales prevent further fault movement? Wouldn't thrust faults preferentially move along the shales? Please clarify your thinking here/in the main text (see later comment L571).

Comment 10: Introduction: The rational and local importance of the study is well explained in the Introduction. A statement about the wider implications of the study would open it up to a wider audience, provided that a 'wider implications' paragraph is added to the discussion section as well.

Comment 11: L: 70: 'control' would be a better word than 'influence'

Comment 12: Geological Setting: The geology of the study area is very well described, but the structural elements, formations, and localities that are introduced throughout this section are not shown in Figure 1 (apart from the Billefjorden Fault Zone).

Comment 13: I suggest adding a figure that shows the location and geometry of the geology and structural elements present in the study area in more detail. This will also provide a bit more context and spatial reference to the outcrop photographs shown in later sections of the manuscript. In addition, a regional cross-section across the area may help to illustrate the deformational history and vertical and horizontal relationship

between formations better.

Comment 14: In general, more references to figures are needed to better guide readers who are unfamiliar with the area. As a suggestion, the authors could include a couple of plate-tectonic reconstructions and structural elements maps in the supplementary material to illustrate the Paleozoic plate configuration of Svalbard, Greenland and Norway, as well as major extensional and compressional events.

Comment 15: L83: Neoproterozoic as one word

Comment 16: L140-141: What was the direction of contraction/plate movement during the Ellesmerian Orogeny? Was it SW?

Comment 17: L145: successions in the footwall and hanging wall of faults?

Comment 18: L168. kilometer-scale

Comment 19: Methods: The description of the methodology is rather short. The resolution, age, and workflow to interpret the satellite images is not provided.

Comment 20: L201: rephrase; e.g. In areas that are difficult to access, satellite images of exposed basement rocks were used to identify brittle faults in exposed Proterozoic basement rocks: : :.

Comment 21: Results: Basement rocks: L219-221: Can you indicate the faults that cross-cut the Atomfjella on a map? Where is Ny-Friesland?

Comment 22: L224-225: See previous comment. Please indicate the mentioned localities on a map, otherwise the reader has no idea about the location and distance between areas with WNW-ESE-trending faults and basement structures. A map will help to support your interpretation.

Comment 23: Sedimentary rocks: L234: south-to-southwestward

Comment 24: L241: How thin are these beds? Be quantitative.

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Comment 25: L244: ‘: : :previous descriptions. Plural.

Comment 26: L248: Remove ‘However’. Start sentence with: Iron nodules found in the upper part: : :

Comment 27: L250: Replace ‘On the contrary’ with ‘However’,

Comment 28: L259 and throughout this paragraph: How thick are the described sandstone and shale beds? There is no scale in the photograph in Figure 7.

Comment 29: Brittle faults: L276: You state the amount of displacement along these faults in the figure caption, can you also add it in the text?

Comment 30: L278: Can you quantify the amount of thickening?

Comment 31: L288: décollements

Comment 32: L292: décollements

Comment 33: L307: cross-cut

Comment 34: L301 & 303: cross-cutting

Comment 35: L315: cross-cut

Comment 36: L320: Is it possible to estimate the amount of displacement across the Overgangshytta Fault? e.g. order of magnitude. I see that you provided an estimate on L355, but it would be nice to also have this in the results section.

Comment 37: Discussion: The discussion section represents a very thorough examination and discussion of possible interpretations for the observed structures. Parts of the discussion/interpretation can be supported by additional figures to support the author’s arguments and to better guide the reader. The current manuscript does not include a section on the wider implications of the results of this study. I suggest to add a paragraph on this at the end of the discussion section.

Comment 38: L325: The first sentence of the Discussion section repeats the last sen-

tence of the previous paragraph (L318-321). I suggest rephrasing these sentences to avoid too much repetition.

Comment 39: L328-330: This sentence suggests that, based on the fault core width and amount of deformation, the Overgangshytta Fault does not terminate nearby. Can you support this interpretation with a reference to studies that investigated the relationship between fault length/displacement and deformation zone size?

Comment 40: L345: kilometer-thick

Comment 41: L348: meter-to-kilometer-scale, down-to-NNE

Comment 42: L360-381: It is difficult to believe how basement structures in Spitsbergen correlate to fault zones in northern Norway without showing plate-tectonic reconstructions (see earlier comments on the lack of supporting figures). The Timanian Orogeny has not been introduced at the beginning of the manuscript. At the moment, the interpretation of the WNW-ESE-striking faults appears to be based on long-distance, map-view correlations and may seem a little farfetched. However, additional figures illustrating the geometrical and plate-tectonic relationship between the correlates basement structures in Spitsbergen, the Barents Sea, and northern Norway may support and clarify the presented interpretation.

Comment 43: L410-411: Can you quantify the amount of reverse displacement along the fault? e.g. meter-scale or tens-of-meter?

Comment 44: L412: décollement

Comment 45: L416: What is the scale of these ‘minor thrust faults’?

Comment 46: scale of these ‘minor thrust faults’?

Comment 47: L435 and following paragraph: What is the dominant extension direction during the Mississippian? How does it relate to the N-S, NE-SW, and WNW-ESE-striking faults observed in the area? Was there a preferential reactivation of faults

oriented perpendicular to the extension direction? Or may local strain perturbations be responsible for the activation of basin-oblique faults?

Comment 48: L439: Can you quantify the amount of thickening? It looks very minor on the outcrop photograph in Figure 8. Please add vertical and horizontal scales to every figure.

Comment 49: L440: cross-cutting

Comment 50: L447: is believed

Comment 51: L450: paleo-current data

Comment 52: L465-469: This sentence is very long and complex. Please rephrase. Add commas between shallow-dipping, bedding-parallel, duplex-shaped décollements.

Comment 53: L470-476: See previous comment above. It is difficult to picture the spatial and geometrical relationship between WNW-ESE-striking faults in Spitsbergen, northern Norway and Greenland without any maps. These seem to be very long-distance correlations unless you show that these faults originate from the same locality during Late Devonian-Carboniferous.

Comment 54: L491: Again, what is the Mississippian extension direction? How does the stress field look like?

Comment 55: L493: cross-cutting

Comment 56: L497: Please quantify the dip angle of the Billefjorden Group

Comment 57: L508: (b) not (a)

Comment 58: L512: Where is Kongsfjorden and the Brøggerhalvøya located? Please indicate on a map.

Comment 59: L523: local absence of the Late Mississippian unconformity

Comment 60: L533: What is the direction of compression/transpression?

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Comment 61: L540: How far away is the Finnmark Platform from the study area? This seems to be a very long/distance correlation.

Comment 62: L546 and following paragraph: What was the extension direction? Was it stable or did it change? Can the activity of faults that are not preferentially aligned towards the extension direction be explained by local, potentially basement fabric-controlled, stress/strain perturbations? It would be nice to illustrate fault activity (e.g. initiation phase, interaction and linkage phase etc.) and extension direction through time on map-view sketches.

Comment 63: L571: décollements; How thick are the shale beds? Are they thick enough to decouple faulting on N-S faults fromWNW-ESE faults? It would be good to support this statement with a literature reference, e.g. studies on mechanical stratigraphy (Wilkins, S. J., & Gross, M. R. (2002). Normal fault growth in layered rocks at Split Mountain, Utah: influence of mechanical stratigraphy on dip linkage, fault restriction and fault scaling. Journal of Structural Geology, 24(9), 1413-1429.)

Comment 64: L577: cross-cut

Comment 65: L578: Please quantify the amount of offset

Comment 66: L582: small amounts: plural

Comment 67: Conclusions: Each conclusion point consists of a single, very long and complex sentence. Please consider breaking them up into multiple sentences to make it easier to follow them. Consider adding a conclusion point that illustrates the wider implications of your study results.

Comment 68: L650: pre-existing Neoproterozoic faults; remove 'which' at the end of the sentence.

Comment 69: L663: décollements

Comment 70: L666: décollements

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Comment 71: Figure 1B: The map doesn't show many localities and formations that are mentioned in the text. Please add them. It would also be useful to have a structural elements map for the Late Devonian-Carboniferous covering Svalbard, the Barents Sea, northern Norway and Greenland (see comments above). A map like this would make it easier to follow your thinking and interpretations.

Comment 72: Figure 2: The orange and green colours shown in the stratigraphic chart are not explained in the legend. Please add them.

Comment 73: Figure 3: Although you stated an approximate scale of each satellite image at the end of the figure caption, please add a scale bar in every image. The interpreted foliation and lineaments are actually difficult to see on the dark rocks. Is there any change to improve the image quality?

Comment 74: Figure 4: What do the pink and blue arrows indicate? Not all brittle faults have a dip direction indicator? Is the dip of these faults unknown?

Comment 75: Figure 5: Please add vertical and horizontal scales to photograph A. The label 'Fig. 4b' in photograph A seems to be wrong. Comment 76: Figure 6: Please add horizontal and particularly, vertical scale bars. An approximate outcrop size is not enough.

Comment 77: Figure 7: Please add horizontal and vertical scale bars. Location of 7A is not indicated in Figure 4.

Comment 78: Figure 8: Please add horizontal and particularly, vertical scale bars – at least in B and C. An approximate outcrop size is not enough. Indicate the location of these outcrops on Figure 4.

Comment 79: Figure 9: Please add horizontal and particularly, vertical scale bars. An approximate outcrop size is not enough. Indicate the location of these outcrops on Figure 4.

Comment 80: Figure 10: Please add horizontal and particularly, vertical scale bars.

An approximate outcrop size is not enough. Indicate the location of these outcrops on Figure 4. Add 'southeastward view of the Overgangshytta Fault' for the description of A in Figure caption. Location of 10D is not shown in 10A.

Comment 81: Figure 11: Please indicate profile location in Figure 4 and add approximate horizontal and vertical scales. Profiles like this greatly help the reader to follow the description of your observations and interpretations. It might be useful to refer to this figure earlier in the manuscript, e.g. in the results section.

Comment 82: Figure captions: - Replace crosscut with cross-cut where applicable

2. Author's response Comment 1: structural element and plate-tectonic reconstruction maps are probably not appropriate in such a short study with a relatively small study area. However, we believe that the comment of the reviewer is highly relevant to the next publication the main author is currently writing, which deals with the regional geology of Spitsbergen in the Mississippian and regional Cenozoic reactivation of Mississippian faults. In the study area, structural correlations are made over a maximum distance of 1 km in the field (Figure 4), 10–12 km for satellite images (Figure 1 and 3), and up to ca. 1000 km in the discussion when the findings of the present study is compared to recent findings in the NW Barents Sea (Anell et al., 2016) and in the SW Barents Sea (Koehl et al., 2018a). Comment 2: agreed. The size of scales and outcrops were added in figure captions were missing. However, the short duration of the fieldwork period in the area, and the number and quality of accessible outcrops did not always allow for quantitative measurements (only a few fault surfaces accessible for measurement; see stereonets in fig. 4). Comment 3: agreed. The present manuscript represents a relatively local study with greater implications than simply the geology of central Spitsbergen. However, the authors are aware of existing models (Braathen et al., 2011; Smyrak-Sikora et al., submitted) conflicting with their interpretation and would rather not extrapolate the results of such a small study area to the whole margin. Multiple disagreement in interpretation with initial co-authors of the manuscript (notably Prof. Olaussen, Dr. Smyrak-Sikora, and Dr. Johannessen – University Centre

in Svalbard – and Prof. Stemmerik – Natural History Museum Copenhagen) incites the authors of the present manuscript to cautiousness. Nevertheless, the main author is currently writing another manuscript focused on the regional geology of Spitsbergen in the Mississippian, using the findings of the present manuscript as supporting evidence to further argue for a regional model for the northern Barents Sea and west Spitsbergen margins. Regarding the use of field examples shown in the present study as analogues to subsurface studies in the Barents Sea, it is partly addressed in chapter 5.2, sub-chapter 3, paragraphs 3–5, in which reference to offshore studies is made (e.g., Anell et al., 2016; Phillips et al., 2016; Fazlikhani et al., 2017; Koehl et al., 2018a). Paragraph 3 compares an offshore study of the Gullfaks–Visund Fault (Cowie et al., 2005) to the Billefjorden Fault Zone, while paragraph 4 insists on the importance of Mississippian growth strata onshore Spitsbergen for seismic studies in the Barents Sea, notably building on the results of Anell et al. (2016) in the northwestern Barents Sea and their interpretation of thickened strata between basement and Permian strata. Paragraph 5 further compares offshore studies in Lofoten–Vesterålen (Bergh et al., 2007) and western Troms (Indrevær et al., 2013) to infer the extension direction.

Comment 4: agreed. However, the brief introduction of the succession of tectonic events at the beginning of the abstract is crucial for the reader to grasp the ambiguity of the scientific problem dealt with in the present manuscript (tectonic setting during the deposition of sedimentary rocks of the Billefjorden Group). Regional implications are not directly relevant to the present manuscript, although mentioned in the introduction chapter as suggested by the reviewer in subsequent comments, and will be dealt with in three upcoming manuscripts investigating contractional structures in sedimentary rocks of the Billefjorden Group in adjacent areas in central Spitsbergen (Koehl, in prep. b), and regional oblique-slip margin-oblique faults throughout Spitsbergen (Koehl et al., in prep) and Bjørnøya (Koehl, in prep. a).

Comment 5: the term “NNE-dipping” gives both the dip (to the NNE) and implies the strike (WNW–ESE) of the fault(s). This type of writing aims at keeping the manuscript

relatively short (although it is already long for the type of study and size of the study area). We hope it is alright to keep it this way throughout the whole manuscript.

Comment 6: agreed.

Comment 7: agreed.

Comment 8: agreed.

Comment 9: shale décollements decoupled deformation between lower basement faults and Pennsylvanian (to Cenozoic) sedimentary cover, and, thus, prevented further vertical movement along basement-seated faults.

Comment 10: agreed.

Comment 11: agreed.

Comment 12: agreed.

Comment 13: agreed. However, the use of a regional cross-section might not be this useful for such a local study. Nevertheless, the first author of the present manuscript is currently writing another manuscript on the same topic at a regional scale in Spitsbergen and will use the suggestion of the Dr. Lenhart in this future manuscript.

Comment 14: disagreed. Again, this manuscript is a very local study and crowding an already quite long manuscript with regional maps an tectonic reconstructions might not be appropriate, but it may be relevant for the first author's upcoming regional manuscript.

Comment 15: agreed.

Comment 16: agreed. Very good point, the manuscript is not clear enough.

Comment 17: agreed.

Comment 18: agreed.

Comment 19: agreed.

Comment 20: disagreed. The current sentence illustrates better our point in that the satellite images where carefully selected because of the relevance of the area they cover, not because the area was difficult to access.

Comment 21: agreed. However, the faults crosscutting the Atomfjella Antiform mentioned in this sentence are located north of the area shown in figure 1b (see Witt-Nilsson et al., 1998) and can therefore not be included on the map.

Comment 22: agreed for Ny-Friesland and the Atomfjella Antiform (now shown in figure 1a and 1b respectively). However, smaller localities like Mittag-Lefflerbreen are already mentioned in figure 3 and would rather overcrowd figure 1.

Comment 23: agreed.

Comment 24: agreed.

Comment 25: agreed.

Comment 26: agreed.

Comment 27: disagreed. “On the contrary” better illustrate our point.

Comment 28: agreed.

Comment 29: agreed.

Comment 30: agreed.

Comment 31: agreed.

Comment 32: agreed.

Comment 33: agreed.

Comment 34: agreed.

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Comment 35: agreed.

Comment 36: agreed. However, this topic cannot be addressed in the result chapter and the

comment was implemented in the first subchapter of the discussion.

Comment 37: agreed. However, as mentioned in our response to previous comments, the present manuscript is a local study that will represent the corner stone of a regional study in Spitsbergen. The wider implications will be addressed in this next manuscript.

Comment 38: agreed.

Comment 39: agreed. Highly relevant comment, which led to a reorganization of sub-chapter 5.1 and to a significant improvement of the manuscript.

Comment 40: agreed.

Comment 41: agreed. However, the denomination “down-NNE” is often used in similar scientific articles and the authors would therefore prefer to keep the formulation this way.

Comment 42: agreed. The manuscript currently lacks reference to relevant paleo-tectonic reconstructions. However, the authors would prefer not to include any plate tectonic reconstruction map to the manuscript because it is nor the aim neither part of the results of the manuscript.

Comment 43: agreed.

Comment 44: agreed.

Comment 45: agreed.

Comment 46: agreed.

Comment 47: this topic is addressed in paragraph number 5 of the last sub-chapter of the discussion (“Switch from widespread to localized extension”).

Comment 48: agreed.

Comment 49: agreed.

Comment 50: agreed.

Comment 51: agreed.

Comment 52: agreed.

Comment 53: comment addressed in our response to comment 42.

Comment 54: comment addressed in our response to comment 47.

Comment 55: agreed.

Comment 56: agreed.

Comment 57: the authors used “(a)” and “(s)” to show that the observed tilting might results from displacement along one or several faults. However, this formulation does not seem to be clear enough and the authors addressed the issue.

Comment 58: agreed.

Comment 59: agreed.

Comment 60: agreed.

Comment 61: the Finnmark Platform is located some 800 km away from the study area, i.e., the study area and the Finnmark Platform and closer to each other than the Caledonides of northern Norway and the Caledonides of Svalbard. Although our correlation might seem farfetched right now, the correlation of the Caledonides across the North Atlantic Ocean and the Barents Sea might have been farfetched too a few decades ago. Moreover, multiple studies tend to suggest such Timanian affinity is possible (see Mazur et al., 2009; Majka et al., 2010; Klitzke et al., 2018, submitted; Koehl, in prep.).

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Comment 62: the authors believe that the extension direction was constant (see Bergh et al., 2007; Eig and Bergh, 2011; Hansen and Bergh, 2012; Koehl et al., 2018) and, alone, may explain all the observed fault patterns and kinematics.

Comment 63: agreed. However, the thickness of the coaly beds in the Billefjorden Group is already extensively mentioned in the result chapter, section 4.2, paragraph 1.

Comment 64: agreed.

Comment 65: agreed.

Comment 66: agreed.

Comment 67: disagreed. Again, the present manuscript is a local study with regional implications. However, the regional implications would be too farfetched if the authors were to propose a regional model for Spitsbergen and the Barents Sea only based on a local field and remote sensing study. Regarding the “complexity” of the conclusion points, these will be the foundations of two upcoming manuscript and, thus, need to be very specific and detailed in order for the reader to link the present manuscript to upcoming work.

Comment 68: agreed.

Comment 69: agreed.

Comment 70: agreed.

Comment 71: agreed. However, the present manuscript is a local study targeting a small audience of (geo-) scientists working with Svalbard and the Arctic. Thus, the authors argue that a regional map with structural lineaments may not be appropriate to include. Such maps may be found in Bergh et al. (2007), Indrevær et al. (2013), Anell et al. (2016), Koehl (2018) and Koehl et al. (2018a, 2018b).

Comment 72: agreed.

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Comment 73: agreed. However, it is not possible to improve the quality of the satellite images.

Comment 74: yes, the dip of some of the faults interpreted from the satellite images is unknown. Pink and blue double-arrows indicate outcrop exposures of the Hultberget Formation and Billefjorden Group respectively, as indicated in the caption of figure 4.

Comment 75: disagreed. The person in the lower right corner is the scale. In addition, the label “figure 5b” in figure 5a correctly indicates the location of figure 5b.

Comment 76: agreed. However, vertical and horizontal scale being the same, there is no need to add both.

Comment 77: agreed. However, vertical and horizontal scale being the same, there is no need to add both.

Comment 78: agreed.

Comment 79: agreed.

Comment 80: agreed.

Comment 81: agreed. However, figure 11 is a schematic N–S profile across the study area shown in figure 4. Adding a line to show the approximate location of the profile would crowd figure 4 too much. Figure 11 is the proposed model for the study area and is quite interpretative and sometimes speculative. Thus, it might not be judicious to mention it in the result chapter.

Comment 82: agreed.

3. Changes implemented Comment 1: added references to figures throughout the main text.

Comment 2: added “Person as scale in the lower right corner” in the caption of fig. 2a; “Rifle orange cover as scale (ca. 1.20 m-long)” in the caption of fig. 2c; “Camera cover

(15x10 cm) as scale" in the caption of fig. 2d; "and 2–2.5 m high" in the caption of fig. 6; "The outcrop is approximately 10 m high" in the caption of fig. 7a; "The outcrop is ca. two meters high" in the caption of fig. 7b; "The outcrop is ca. three meters high" in the caption of fig. 7c; "shows the width of the core" in the caption of fig. 10a; "The fault core is limited by the dashed white and dashed red lines and is ca. 3 meters wide" in the caption of fig. 10e; "Ca. one km-long" in the caption of fig. 11.

Comment 3: no change.

Comment 4: shortening of the last two sentences of the abstract: deletion of ", thus suggesting that normal faulting along this major fault initiated as early as the Mississippian" lines 36–37, and of "Mississippian margin-oblique" line 40.

Comment 5: no change.

Comment 6: implemented suggested change.

Comment 7: implemented suggested change.

Comment 8: implemented suggested changes.

Comment 9: no change.

Comment 10: addition of a few lines on regional implications lines 60–70.

Comment 11: implemented suggested change.

Comment 12: addition of the Atomfjella Antiform, Odellfjellet Fault, Balliolbreen Fault, and Løvehovden Fault to figure 1b.

Comment 13: addition of a few key structural elements to figure 1b (see response to comment 12), and addition of all the outcrop photograph location on figure 4.

Comment 14: no change.

Comment 15: implemented suggested change.

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Comment 16: addition of “west-directed thrusting” lines 150–151.

Comment 17: implemented suggested change.

Comment 18: implemented suggested change.

Comment 19: addition of 10 lines (lines 215–224) on the satellite photograph resolution and on the interpretation methodology with regards to field outcrops.

Comment 20: no change.

Comment 21: addition of the location of “Ny-Friesland” in figure 1a

Comment 22: Ny-Friesland and the Atomfjella Antiform are now shown in figure 1a and 1b respectively.

Comment 23: implemented suggested change.

Comment 24: added thickness of beds.

Comment 25: implemented suggested change.

Comment 26: implemented suggested change.

Comment 27: no change.

Comment 28: addition of a scale in figure 7 and of the bed thickness in the relevant paragraph.

Comment 29: addition of “and offsets are generally decimeter- to meter-scale (Figure 8)” line 307.

Comment 30: addition of “tens-of-centimeter-thick” lines 311–312.

Comment 31: implemented suggested change.

Comment 32: implemented suggested change.

Comment 33: implemented suggested change.

Comment 34: implemented suggested change.

Comment 35: implemented suggested change.

Comment 36: addition of “comprised between a few meters and” line 391.

Comment 37: no change.

Comment 38: deletion of “made of sedimentary strata of the Hultberget, Ebbadalen and Minkinfjellet formations” lines 359–360, and changed “thus suggesting” into “which suggests” line 361.

Comment 39: The third paragraph of sub-chapter 5.1 was moved to the beginning of the sub-chapter. The authors also added reference to quantitative studies to the main text lines 371–375 “This is supported by quantitative studies on the width of fault cores (e.g., Forslund and Gudmundsson, 1992; Childs et al., 2009; Bastesen and Braathen, 2010; Johannessen, 2017), which indicate that faults with 2–3 meters wide core zones (like the Overgangshytta fault; Figure 10a) generally accommodate vertical displacement ranging from a few meters to several hundreds of meters”, lines 383–386 “Notably, quantitative studies discussing potential relationships between fault length and displacement show that a fault like the Overgangshytta fault is likely to be several hundred to a few thousand meters long (Watterson, 1986; Nicol et al., 1995; Schlische et al., 1996; Gudmundsson, 2000; Kolyukhin and Torabi, 2012)”, and to the reference list.

Comment 40: implemented suggested change.

Comment 41: changed “km-thick” into “kilometer-thick” line 360.

Comment 42: addition of “Although not always reconstructed in paleo-tectonic reconstructions, in the early Neoproterozoic, the position of Svalbard was probably close to the Timanian margin of northern Baltica prior to the opening of the Asgard Sea and Iapetus Ocean/Ægir Sea (Torsvik et al., 1996; Cawood et al., 2001, 2010; Cawood and Pisarevsky, 2017), and prior to the Timanian Orogeny in the late Neoproterozoic

(Roberts and Siedlecka, 2002; Roberts and Olovyanishnikov, 2004)" lines 420–426 and to the reference list. In addition, the authors added a sentence about the Timanian Orogeny in the introduction lines 84–87.

Comment 43: addition of ", potentially accommodating a few meters to several tens of meters of reverse displacement" lines 482–483.

Comment 44: implemented suggested change.

Comment 45: replacement "small" by "meter" line 484.

Comment 46: addition of "(centimeter- to decimeter-scale)" line 484.

Comment 47: no change.

Comment 48: addition of "thickened by several tens of centimeters" line 514.

Comment 49: implemented suggested change.

Comment 50: implemented suggested change.

Comment 51: implemented suggested change.

Comment 52: implemented suggested change.

Comment 53: see response to comment 42.

Comment 54: see response to comment 47.

Comment 55: implemented suggested change.

Comment 56: addition of "gentle (10–30°)" to the result chapter line 263 and to the discussion chapter lines 580–581.

Comment 57: replacement of "(a)" line 591 (two occurrences) by "one or several". Deletion of "(s)" lines 591 and 592.

Comment 58: addition of "B" and "K" in figure 1a to locate Brøggerhalvøya (B) and

Kongfjorden (K).

Comment 59: implemented suggested change.

Comment 60: addition of “ENE–WSW-oriented” line 203 in the geological setting chapter and line 617 in the discussion chapter, and of “west-directed” and “thrusting” in the discussion chapter lines 616 and 617.

Comment 61: no change.

Comment 62: no change.

Comment 63: added the suggested reference to the reference list and to the main text lines 488–497.

Comment 64: implemented suggested change.

Comment 65: addition of “(< 1 km)” line 664.

Comment 66: implemented suggested change.

Comment 67: no change.

Comment 68: implemented suggested changes.

Comment 69: implemented suggested change.

Comment 70: implemented suggested change.

Comment 71: addition of multiple localities to figures 1a and 1b.

Comment 72: implemented suggested change.

Comment 73: implemented suggested change.

Comment 74: no change.

Comment 75: no change.

Comment 76: implemented suggested change.

Comment 77: implemented suggested changes.

Comment 78: implemented suggested changes.

Comment 79: implemented suggested changes.

Comment 80: replacement of “Outcrop photograph showing the geometry” by “Eastward view” line 1231.

Comment 81: addition of a scale bar to figure 11.

Comment 82: implemented suggested changes.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2018-86, 2018.

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