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Interactive comment on "Devonian–Mississippian collapse and core complex exhumation, and partial decoupling and partitioning of Eurekan deformation as alternatives to the Ellesmerian Orogeny in Spitsbergen" *by* Jean-Baptiste P. Koehl

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Dear Sir, Madam, thank you very much for your input on the manuscript, it is highly appreciated. Here is my response to your comments. I hope the changes I implemented improve the shortcomings of the manuscript highlighted by your comments and suggestions. Please do not hesitate to contact me shall this not be the case for some comments.Please note the figures of this discussion were attached as supplements.

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Please do not hesitate to contact me should you require high-quality versions of the figures.

1. Comments from anonymous referee Comment 1: General Comments. This contribution presents new field data along with seismic profiles from the area of Central Western Spitsbergen to support a radical reinterpretation of the post-Caledonian geological evolution of Svalbard. Comment 2: The new data is limited to ca 130 field measurements from one outcrop near the defunct Russian coal mine of Pyramiden. Comment 3: The proposed new concept is supported by newly interpreted seismic sections from the Templefjorden area some distance south of his field study area and a satellite image to the west. The latter lacks any real interpretation for the reader to see what exactly can be gained from the image to support his following re-interpretation. Comment 4: The authors re-interpretation enlists support from a wealth of references many of which are of doubtful relevance and could be omitted. Comment 5: Other references are given that are supposed to support the central ideas but are not balanced by consideration of others that may be contradictory. Comment 6: Basically, there are too many references. Comment 7: In general, the author starts by suggesting that a particular point may be explained by (with references) then later refers to such statements as a matter proven fact. Comment 8: The principal concept is not supported by any significant data generated by the author. Comment 9: The study area is too limited to propose such a large conceptual step-change and it is evident that the author has not gathered any of his own field data from the critical areas he enlists as failing to meet the widely accepted, current interpretation that the Svalbardian Event is represented in Svalbard. He is thus not in a strong position to discuss the merits of either interpretation. Comment 10: The contribution is far too long and the first step should have been to consolidate the data from the reported field area. The author should then work toward gathering data from those areas he considers critical and balancing such against that reported published accounts. Comment 11: Specific Comments. The field data is a welcome addition to the existing knowledge and will go toward furthering knowledge on the evolution of the Billefjorden Trough. Comment 12: I am not convinced by

many of the details presented in the interpreted seismic sections. The sections were interpreted quite differently by Baelum & Braathen (2012) especially section NH8706 (Koehl Figure 4d). Comment 13: This figure and the detailed Figure 4f (Koehl) is over-interpreted, the array of east-dipping thrusts above the Wordiekammen sequence are not easily distinguished. The interpreted fault propagation folds to the west seem to have an easterly vergence? The underlying Devonian-Mississippian sequence is syn-rift? Comment 14: Again, Koehl's Figure 4. g (section NH8802-32) is complex and the Wordiekammen sequence is clearly syn-rift and most of the interpreted duplexing is within the Devonian which could reflect the Svalbardian deformation? The overlying Wordiekammen sequence is less deformed and could reflect later West Spitsbergen Fold Belt's effects. Comment 15: Consideration of the role of exhumed metamorphic core complexes in the deformation of the Devonian rocks although interesting is really beyond the scope of this contribution given the data presented. It is not enough to troll the literature to support this aspect of his interpretation. The topic has been raised by Braathen et al., 2017 and discussed in detail by Piepjohn & Dallmann, (submitted). Allied to the question of the role of exhumed MCC's in controlling the subsequent geological development of any emerging orogen is the extent to which pre-existing basement structures have been reactivated. Comment 16: A consequence of the collapse of the Caledonian Orogen would be, during a tectonic subsidence phase, to unroof the orogen to a least the brittle-ductile transition zone. Active normal (brittle) faulting would be responsible for most of the later exhumation. The degree of fault activity can be judged by the nature of the sediment build-up. For the Devonian Basin of Northern Svalbard, the Riveratoppen/Lilleborg / Siktefjellet conglomerates include large olistolith like fragments of the basement suggesting strong, Devonian very high-level normal faulting. Some syn-sedimentary deformation of the accumulating sediments is found. Comment 17: Determining the role and timing of ductile deformation (mylonites) is fraught with difficulties (Platt et al., 2014: Cooper et al., 2017) in many exhumed metamorphic core complexes reported in the literature. In the case of Keiserhjelmen Block of Northern Svalbard (Braathen et al 2017) illustrate the mylonites (Figure 4c) from within the Generalfjella Marbles (Hjelle, 1975). The ages Braathen et al., 2017) have obtained most probably reflect some partially reset or cooling Caledonian age, and are difficult to assign specifically to a major controlling ductile shear zone. The ages are obtained are from a variety of rock types and locations (not necessarily collected by the authors?). Only one of the samples is from anywhere near the proposed detachment. Comment 18: These rocks are affected by Caledonian metamorphism and are disposed around large-scale NS striking flat-lying F1 folds. A characteristic of these marbles and associated schists is a strong mylonite fabric axial planar to the folds with a shear sense parallel to the fold axial traces. Comment 19: These rocks are exposed all the way south to Kongsfjorden and constitute most of the Løvenoyane and Blomstrand. Despite the author's dismissal of the importance of these southerly examples of the Generalfjella marbles it is important to note that they display west vergent F2 fold arrays that in many cases are seen to be fault propagation structures related to east-dipping thrust faults. Comment 20: There are, in addition, many examples of Early(?) Devonian red-bed deposits on the islands and on Blomstrand which show evidence of west directed thrust faulting, cleavage development, and minor folding. Again, it has long been known that there are pockets of Carboniferous quartzitic sandstones on Blomstrand that are undeformed. The author dismisses these showing he has not seen them in the field? Comment 21: Recently, Michalski (2019) has shown from palaeomagnetic evidence that Blomstrand has not been significantly deformed since Late Devonian time and that the F2 folds on Blomstrand are most likely of Svalbardian origin. Comment 22: Other examples of involved exhumed MCCs quoted by the author are less convincing. In particular the Pinkie Group of Prins Karls Forland. Two points should be made here, first the age of the metamorphism reported for the Pinkie Group as Svalbardian/Ellesmerian by Kosminska et al (2017) Faehnrich et al 2017 is robust. To interpret theses rocks as an exhumed MCC shows a basic lack of appreciation of the structural setting of these rocks on PKF. The Pinkie Group contains a number of high strain zones not limited to the Boureefjellet zone. The sequence of high-grade rocks is tightly infolded with the low-grade rocks which display at least two major fold phases best seen in 3D from the nunataks south of Bourrefjellet onto Monacofjellet-Jessiefjellet (west and east ridges) part of the Grampian Range. Comment 23: It is difficult to view these relations with the high-grade rocks being part of an exhumed metamorphic core complex and avoiding the importance of the Ellesmerian ages obtained. Comment 24: In conclusion, I cannot recommend publication of this contribution without a major re-write and re-focussing on the obtained field data. To promote the idea that the Ellesmerian deformation has not affected Svalbard needs much more author owned evidence from critical areas and a more balanced discussion of previous works that suggest otherwise. Comment 25: It is not enough to call on referenced works alone from other parts of the world that appear to support the author's point of view.

2. Author's response Comment 1: agreed. Comment 2: agreed. Comment 3: partly agreed. The interpretation of the satellite image in Triungen shows clearly the limitation of field-based studies arguying for Ellesmerian deformation in the area. Notably, the satellite image shows that the contact between Lower Devonian strata of the Wood Bay Formation and overlying uppermost Devonian–Mississippian rocks of the Billefjorden Group along the speculated (because completely covered by screes) location of the Triungen–Grønhorgdalen Fault Zone is covered by screes and, thus, not possible to observe, even in the field. The contact between these two units is a stratigraphic unconformity 200–400 meters to the east where flat-lying strata of the Billefjorden Group overlie tilted Lower Devonian strata, which is by no means a proof of Ellesmerian tectonism since tilting may also occur through normal faulting and extension. Most importantly, the presence of abundant black (coal-rich) screes along the speculated trace of the Triungen–Grønhorgdalen Fault Zone in Triungen suggests that the covered fault is crosscutting coal-rich strata of the Billefjorden Group. Like in Pyramiden, these coals were subjected to Eurekan tectonism and, most probably, also host structures similar to those observed in Pyramiden (bedding-parallel décollements and duplexes), thus showing that Ellesmerian deformation is not needed in this area either to explain deformation pattern differences between the Lower Devonian and uppermost Devonian–Mississippian sedimentary successions. Comment 4: dis-

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agreed. The present manuscript refers to several studies (including, Chorowicz, 1992; Roy, 2007, 2009; Roy et al., unpublished) omitted and not discussed by supporters of Ellesmerian deformation (e.g., Piepjohn et al., 1997; Piepjohn, 2000). The present manuscript shows that these forgotten contributions need to be discussed by supporters of Ellesmerian deformation because of the high amounts of uncertainty the hypothesis of Ellesmerian deformation involves. A notable uncertainty that is almost never discussed in studies arguying for Ellesmerian deformation is the impossibility to physically visit the contact between Devonian strata of the Andrée Land Group/Mimerdalen Subgroup and overlying strata of the Wordiekammen Formation and Billefjorden Group because they are located on steep cliff outcrops, and the poorly exposed character of this contact regionally, e.g., because it is mostly–completely covered by grey screes of the Wordiekammen Formation in every locality used to pin-point the timing of the folding event affecting Devonian sedimentary rocks of the Mimerdalen Subgroup in Dickson Land (Figures 2–25; see also Michaelsen, 1998, her figures 39, 41, and 53 showing highly questionable interpretations of Ellesmerian thrusts from distant outcrop transects that are physically inaccessible and mostly covered by screes). Comment 5: disagreed. The present manuscript attempts at re-establishing balance between the hypothesis of Ellesmerian deformation and that of Devonian extensional detachment folding. The present manuscript shows that if the latter hypothesis is combined to strain partitioning of early Cenozoic Eurekan deformation (attested by the presence of bedding-parallel duplexes and décollements within the Billefjorden Group in Pyramiden and Sassenfjorden–Tempelfjorden), Ellesmerian deformation is not needed to explain the strong deformation difference between Devonian rocks of the Andrée Land Group/Mimerdalen Subgroup and overlying uppermost Devonian–Permian strata of the Billefjorden Group and Gipsdalen Group in Dickson Land. The author of the present manuscript would like to point out that hardly any field-based study/contribution arguying for the occurrence of Ellesmerian deformation in Spitsbergen presents any field photograph at all to document their claim and simply present idealized summary sketches involving high amounts of interpretation and, thus, of uncertainty (e.g., Bug-

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gisch et al., 1994; Piepjohn et al., 1997; Michaelsen et al., 1997; Kempe et al., 1997; Piepjohn, 2000). Comment 6: disagreed. The large amount of references shows the great lengths to which the author of the present manuscript has had to go to get access to most of the literature about Ellesmerian deformation, notably including studies exclusively available at the local library of the Norwegian Polar Institute in Tromsø, Norway (e.g., Piepjohn et al., 1997; Kempe et al., 1997; Michaelsen et al., 1997; Michaelsen, 1998; Roy, 2007, 2009; Roy et al., unpublished). The author of the present manuscript feels that it is very important to show the reader that he has had access to most of the published literature about Ellesmerian deformation and competing hypotheses (e.g., Devonian extensional detachment folding of Roy, 2007) to present a most objective discussion. The author of the present manuscript regrets that only a few scientists have had access to the study by Roy (2007; in French), which includes tens of actual field photographs of Devonian rocks in Spitsbergen presenting a completely different tectonic model for the Devonian–Mississippian tectonic evolution of Spitsbergen. Noteworthy, the previous scientific contributions that the author of the present manuscript has spent tens of hours scanning from the library of the Norwegian Polar Institute will be made available as part of the Rock Vault project of UNIS, hopefully soon. Comment 7: disagreed. The author of the present manuscript does not pretend that the present manuscript holds the ultimate truth about the tectonic history of Spitsbergen. However, he feels that alternatives to the Ellesmerian Orogeny have been poorly (if ever at all) discussed by most recent studies, e.g., Majka and Kosminska (2017) ascribing directly latest Devonian–earliest Mississippian ages for amphibolite schist facies metamorphism to Ellesmerian deformation without considering other possibilities (e.g., deep, late Caledonian contraction like in Greenland; McClelland et al., 2006). Comment 8: agreed. However, the large datasets (thousands of measurements of bedding surfaces and fold axes) generated by Dr. Piepjohn (1994; published in Piepjohn, 2000 and Dallmann and Piepjohn, submitted) and other workers (Dallmann, 1992; McCann, 2000; Bergh et al., 2011) also support a coeval formation of Eurekan fold structures and presumed Ellesmerian folds throughout Spitsbergen. See reply to Dr. Piepjohn

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‘s comment 288 for more detailed discussion. It does not matter how many measurements one gathered in the field if these measurements and associated structures are interpreted from distant observation of mostly covered/poorly exposed and physically inaccessible outcrops. The resulting interpretation is most likely involving significant amount of uncertainty and the associated model is likely to be erroneous. Note that such uncertainty is nowhere mentioned in major studies arguying for Ellesmerian deformation, e.g., Piepjohn (2000), whereas it is clearly stated in the present manuscript (e.g., “although partly covered by screes” line 357 in present manuscript). It is also important to mention that the author of the present manuscript has physically visited all the outcrops he describes around the mine entrance in Pyramiden. Comment 9: disagreed. Though the author of the present manuscript has not had the opportunity to visit each locality he discusses in the present manuscript, the discussion is based on solid literature review (including rediscovered contributions like Roy, 2007, 2009; Roy et al., unpublished) and interaction with experts in various geoscience subdisciplines, e.g., Dr. Gilda Lopes, Prof. Berry and Prof Marshall regarding the paleontology and palonology disagreement between Dr. Piepjohn’s study (Piepjohn et al., 2000; based on one specimen of erroneously interpreted spore) and other more robust studies by specialists and experts in the field (Scheibner et al., 2012; Lindemann et al., 2013; Marshall et al., 2015; Berry and Marshall, 2015; Newman et al., 2019; Lopes, pers. comm. 2019), Dr. Dallmann and Prof. Bergh about details on the methods used to map and interpret regional outcrop transects in Spitsbergen (i.e., observations of distant, physically inaccessible and partly–mostly covered outcrops), and Erik Johannessen and Tormod Henningsen for access to field photographs of the discussed localities in Spitsbergen debated by Dr. Piepjohn and the anonymous referee (e.g., Triungen, Munindalen and Mimerdalen; Figures 2–25). Comment 10: disagreed. The implications of the findings at the Pyramiden field locality and on seismic sections in Sassenfjorden–Tempelfjorden are ground-breaking and require proper discussion with all accessible studies about Ellesmerian deformation and alternative hypotheses. The sole observation of intensely sheared coal- and coaly shale-rich sedimentary rocks of the Billefjorden Group in Pyramiden is sufficient to question the whole hypothesis of Ellesmerian deformation in Spitsbergen. Ellesmerian was created to fill a need. This need arose from the observation of folded Devonian rocks of the Andrée Land Group/Mimerdalen Subgroup overlain (supposedly everywhere in Spitsbergen) unconformably by presumed undeformed strata of the Wordiekammen Formation and Billefjorden Group. The present manuscript shows that the level of uncertainty involved in the concept of Ellesmerian deformation can no longer be ignored and that the whole hypothesis needs to be re-examined and compared to and/or combined with other alternative (e.g., that of Devonian extensional detachment folding and superimposed strain partitioning of early Cenozoic Eurekan deformation, and possibly coeval contractional deformation at depth; e.g., Pinkie Unit; Kosminska et al., 2020). The field data acquired by “Reported published accounts“ (anonymous referee’s comment 10) all support the model presented in the present manuscript (again, see reply to Dr. Piepjohn’s comment 288 for more detailed discussion). The only difference of the present manuscript with studies supporting Ellesmerian deformation is the interpretation of the datasets and the approach of the author of the present manuscript with the concept of uncertainty in interpreting distant, physically inaccessible and poorly exposed–mostly covered outcrop transects. The conceptual sketches presented in studies like Piepjohn et al. (1997), Michaelsen et al. (1997) and Piepjohn (2000) are by no means observations (and therefore proofs) of Ellesmerian deformation in Spitsbergen, but mere interpretations involving uncertainty. In addition, when actual field photograph are presented, they either show localities that do not permit to constrain the timing of folding events within Devonian rocks, either show highly questionable interpretations denying basic geological concepts such as that of reverse versus normal fault, e.g., in Michaelsen (1998, her figure 53) showing that the upper Munindalen fault (interpreted as an Ellesmerian thrust) juxtaposes relatively young red siltstone of the Dicksonfjorden Member of the Wood bay Formation over relatively old green sandstone of the Austfjorden Member of the Wood Bay Formation, and is, therefore, more likely to correspond to a low-angle Devonian normal/detachment fault or to a stratigraphic unconformity (see also reply to Dr. Piepjohn's comment 232 for more detailed discussion). Comment 11: agreed. Comment 12: disagreed. The author of the present manuscript would like to mention that he has received a formal education in seismic interpretation and marine geophysics at the University of Tromsø and in the hydrocarbon industry, including ten courses and five years of relevant supervised experience in interpreting seismic data. Thus, he believes his interpretation to be more robust than that presented in Bælum and Braathen (2012), especially since Bælum and Braathen (2012) attempted to map N–S-striking faults on subparallel NNE–SSW-trending seismic sections in Billefjorden, which are most unlikely to be properly imaged and to result in artifacts and unusual cross-section geometries. Ongoing work (Koehl et al., in prep. a; see also Figures 2–25) further questions seismic interpretation by Bælum and Braathen (2012), showing the presence of prominent WNW–ESE-striking Devonian normal faults offsetting laterally the trace of the Billefjorden Fault Zone in Billefjorden and, thus, further adding to the debate started in the present manuscript about the possible segmentation of the Billefjorden Fault Zone in Billefjorden. Comment 13: partly agreed. The quality of the figures will be improved. However, the author of the present manuscript does not agree with the claim of the anonymous referee that the laterally continuous seismic section presented in figure 4f is over-interpreted. The author of the present manuscript argues that the outcrop transects on which the concept of Ellesmerian/Svalbardian deformation is based on are over-interpreted (only a field photographs of these transects are actually published in a Master's Thesis not available online; Michaelsen, 1998). Looking at actual field photographs (Figures 2–25) of the transects observed and interpreted from the distance by Dr. Piepjohn (e.g., Piepjohn et al., 1997; Piepjohn, 2000), it becomes clear that the outcrops of Devonian sedimentary rocks are mostly made up with screes and loose material (poor lateral and vertical continuity) and that outcrops of Wordiekammen Formation are inaccessible, and, thus, that the interpretation and associated model of Ellesmerian deformation proposed by Dr Piepjohn (and others before him) involve considerable uncertainty (also see Michaelsen, 1998, her figures 39, 42 and 53, whose interpretation are doubtful). Overall, the studies by Dr. Piepjohn in

Dickson Land (e.g., Piepjohn et al., 1997; Piepjohn, 2000) do not present any field photograph that support their interpretation (published in the form of idealized conceptual sketches). The author of the present manuscript refers the anonymous referee to the supplements showing the uninterpreted version of the section sections and zoomed-in portions to better identify structures. Regarding the fold structure to the west, considering the undeformed underlying Wordiekammen Formation (directly below the fold), it is more likely to represent a thrust anticline rather than a (NE-verging) fold-propagation fold. The author of the present manuscript is not sure what succession the anonymous referee is writing about when she/he mentions "Devonian–Mississippian" since there is no succession of such age displayed in figure 4f. Comment 14: disagreed. Figure 4g is far less complex than conceptual sketches, e.g., by Piepjohn et al. (1997, their figures 9, 10, and 12) and Piepjohn (2000, his figure 4, 8 and 10) showing controversial fold geometries, most likely from overinterpreted, mostly covered (by screes) and inaccessible outcrop transects (see Michaelsen, 1998, her figures 39, 42 and 53 and Figures 2–25). The author of the present manuscript is uncertain what the anonymous referee means by "the Wordiekammen sequence" since the Wordiekammen Formation is not differenciated/segregated from underlying strata of the Gipsdalen Group and, thus, cannot assess the claim by the anonymous referee in that "the Wordiekammen sequence is clearly syn-rift". Figure 4g clearly shows that thrusts and duplexes in potential Devonian rocks of the Andrée Land Group/Mimerdalen Subgroup in Reindalspasset flatten and/or die out upwards, potentially due to strain partitioning of Eurekan deformation, but not everywhere (especially in the central part of the seismic section) where they interact with duplexes and a major anticline of tectonically thickened strata and phyllitic (i.e., intensely sheared; Eide et al., 1991) coals of the Billefjorden Group, thus, most likely suggesting that duplexes and thrusts within Devonian and uppermost Devonian–Mississippian sedimentary rocks formed synchronously during Eurekan deformation. The significantly less deformed character of Pennsylvanian–lower Permian successions (which are made of significant amounts of more brittle carbonate- and sandstone-rich units) suggests that Devonian (relatively rich in shales; Friend and Moody-Stuart,

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1972; Murascov and Mokin, 1979) and uppermost Devonian–Mississippian rocks (relatively rich in coals and coaly shales; Cutbill et al., 1976; Aakvik, 1981; Gjelberg, 1984; Koehl and Muñoz-Barrera, 2018) acted as weak (buffer) units that localized Eurekan deformation and shielded overlying, more brittle successions from deformation. Comment 15: disagreed. The present manuscript shows a restoration of the Mariekammen Shear Zone prior to early Cenozoic Eurekan deformation suggesting normal kinematics for this structure. In addition, the present study discusses the highly doubtful interpretation of field photographs in Michaelsen (1998; ignoring the geological concept of reverse versus normal faults) in Mimerdalen and Munindalen (Dickson Land), on which studies like Piepjohn et al. (1997) and Piepjohn (2000) are based. The present manuscript shows that some of the interpreted Ellesmerian thrusts are more likely to correspond to moderately dipping extensional detachments (or alternatively to tilted angular unconformities) since relatively young rocks of the Dicksonfjorden Member of the Wood Bay Formation are juxtaposed against relatively old strata of the Austfjorden Member (e.g., Michaelsen, 1998, her figures 39 and 53). Moreover, the author of the present manuscript rediscovered works by Dr. Jean-Claude Roy showing numerous field photographs of the Devonian succession in northern Spitsbergen suggesting the presence of low-angle detachments (e.g., Woodfjorden detachment) and associated folds in Andrée Land (Roy, 2007, 2009; Roy et al, unpublished). Re-evaluated kinematics along the Mariekammen Shear Zone (southern Spitsbergen), reinterpretation of Ellesmerian thrusts as moderately dipping extensional detachments in Dickson Land, and the rediscovery of work suggesting the presence of low-angle Devonian extensional detachments and associated folds in Andrée Land (omitted in studies arguing for Ellesmerian deformation) all support the hypothesis of core complex exhumation tested by Braathen et al. (2018a, 2020). In addition, aeromagnetic data from the Geological Survey of Norway over Spitsbergen and seismic data onshore–offshore Spitsbergen suggest that core complexes extend from northwestern to southern Spitsbergen (Koehl, 2019a pp. 53–68, 2019b, 2020). The author of the present manuscript agrees that core complex exhumation is discussed by Dr. Dallmann and Dr. Piepjohn in their submitted contribution (Dallmann and Piepjohn, submitted) and their comment to Braathen et al. (2018a; Dallmann and Piepjohn, 2018), and also agrees partly with Dr. Dallmann and Dr. Piepjohn in that the amount of top-north movement along the Keisarhjelmen Detachment was overestimated by McCann (2000) and, therefore, by Braathen et al. (2018a; see reply to Dr. Piepjohn's comment 262 for more detailed discussion). Regardless, despite arguing against core complex exhumation in northwestern Spitsbergen, Dallmann and Piepjohn (submitted, pp. 23) still write: " the basic idea of an extensional detachment [. . .], which could have been active during some of the Lochkovian and been responsible for the formation of the uplifted core complex (Bockfjorden Anticline) and some of the northward transport of sediments (olistoliths of Rivieratoppen), cannot be ruled out", and even incorporate core complex exhumation to their tectonic history (their figure 15): "the Bockforden Anticline may have been initially uplifted as a core complex with the Friedrichbreen Fault functioning as an extensional detachment for the rotated fault blocks during crustal thinning". Furthermore, the study by Braathen et al. (2018a) includes geochronological ages supporting Devonian core complex exhumation, whereas previous workers arguing for a Caledonian origin of the structures within the Bockfjorden Anticline as Caledonian do not include any geochronological age constraints. Even though Dr. Dallmann and Dr. Piepjohn disagree with core complex exhumation, arguing that some WNW–ESE-striking faults in northwestern Spitsbergen do crosscut the Bockfjorden Anticline, these observations are not at all incompatible with the models of core complex exhumation of Braathen et al. (2018a; however involving minor amounts of top-north movement) and of Eurekan strain partitioning (present manuscript). WNW–ESE-striking are abundant within Devonian strata and less frequent within basement rocks of the Bockfjorden Anticline (McCann, 2000; Braathen et al., 2018b), and this is best explained by the presence of an extensional detachment into which at least some WNW–ESE-striking Devonian normal faults sole into (Braathen et al., 2018a). Some of the faults were simply reactivated/overprinted during subsequent Carboniferous extension and/or Eurekan deformation, thus explaining the fact that at least some WNW–ESE-striking faults do crosscut the Bockfjorden Anticline as shown by Dr. Dallmann and Dr. Piepjohn (Dallmann and Piepjohn, 2018 and submitted). Comment 16: agreed. Comment 17: the fact that “Determining the role and timing of ductile deformation (mylonites) is fraught with difficulties” (anonymous referee’s comment 17) does not lessen the value of geochronological ages obtained by Braathen et al. (2018a), and neither does the fact that some of the dated samples were not collected by these authors as long as good research practice and good communication was employed between the research teams involved. Comment 18: agreed. Comment 19: partly disagreed. The author of the present manuscript is not dismissing the importance of west-verging (east-dipping) the folds in marbles in Blomstrandhalvøya. He simply argues that the presence of such folds in Proterozoic marbles in Blomstrandhalvøya and throughout northern, central and northwestern Spitsbergen is by no means sufficient to argue for a latest Devonian age for the thrusts and folds observed in the marbles and, thus, to support the occurrence of Ellesmerian deformation in Spitsbergen, especially in the light of evidence for strain partitioning of Eurekan deformation between northern and southern Spitsbergen by a major WNW–ESE-striking, NNE-dipping, inherited Timanian fault extending from Kongsfjorden to Sassenfjorden–Tempelfjorden and Storfjorden (Koehl, 2019, 2020; Koehl et al., in prep. b; also see replies to Dr. Piepjohn’s comments 24, 25, 45, 62, 92, 247, 256, 266 and 267 for more detailed discussion about inherited Timanian faults in Spitsbergen). Comment 20: partly agreed. The folds, thrusts and cleavages in Lower Devonian rocks in Blomstrandhalvøya may all be Eurekan structures since no reliable dating is available. The author of the present manuscript does not consider that the dating of poorly preserved (Buggisch et al., 1994 even specify that “The assignation to published species is difficult due to the poor preservation of the elements”, i.e., the dated Conodont fauna) Pennsylvanian Conodont assemblages in only one cave sedimentary infill away from the investigated deformation belts in Blomstrandhalvøya constitutes a strong enough argument to support the occurrence of Ellesmerian deformation in Spitsbergen. The author has not physically visited the Blomstrandhalvøya locality. However, he has had a look at the field relationships reported as a sketch (unfortunately not a field photograph)

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in Buggisch et al. (1994, their figure 4) and still argues that the undeformed character of these caves does not support Ellesmerian deformation in Spitsbergen since surrounding basement rocks near the cave are, as well, relatively–completely undeformed (simply tilted towards the east, which may as well reflect normal faulting and extension). For a more detailed discussion, the anonymous referee is refered to the reply to Dr. Piepjohn's comment 268. Comment 21: disagreed. Michalski (2018) most certainly does not argue that "the F2 folds on Blomstrand are most likely of Svalbardian origin" (anonymous referee's comment 21). The samples of Michalski (2018) assign "the deformation of Blomstrandhalvøya and Lovénøyane basement rocks mainly to the Caledonian tectono-genesis". Michalski (2018) speculates that some of the folds could, as well, be Svalbardian/Ellesmerian (using question marks) because of his knowledge of existing literature arguing for the occurrence of Ellesmerian deformation in the latest Devonian in the study area. However, the study by Michalski (2018) shows that "the F2 folding [. . .] becomes distant from the reference path (Fig. 8), hence suggesting the magnetic fabric post-dates the folding", i.e., that the folding occurred prior to the magnetic fabric and, therefore, that the folding could well be Caledonian in age. In addition, the study of Michalski (2018) shows that pyrrhotite (a common metamorphic ferromagnetic mineral in Svalbard's Caledonian basement; Michalski et al., 2012, 2014, 2017) was demagnetised by c. 350°C in some of the samples. Such a temperature is in the range of what could be expected during core complex-related deformation and associated (amphibolitic facies) metamorphism (e.g., Snoke, 1980; Lister and Davis, 1989; Krabbendam and Dewey, 1998; Beaudoin et al., 2015; Yin et al., 2017). Thus, it is conceivable that core-complex related deformation and metamorphism may have had some input on the results of Michalski (2018). Comment 22: partly agreed. The author of the present manuscript agrees with the anonymous referee that "the age of the metamorphism reported for the Pinkie Group as Svalbardian/Ellesmerian by Kosminska et al (2017) Faehnrich et al 2017 is robust" (anonymous referee's comment 22). However, possible temperature conditions along core complex-bounding detachment may record as well amphibolite facies conditions (Snoke, 1980; Lister and Davis, 1989; Krabbendam and Dewey, 1998; Beaudoin et al., 2015; Yin et al., 2017). Thus, it is possible that the ages obtained by Kosminska et al. (2017) and Faehnrich et al. (2017) actually reflect extensional detachment faulting (and folding?) under amphibolite facies conditions, especially considering the normal sense of shear along the Bouréefjellet fault zone pointed out by the present study (see present manuscript lines 1249–1258). Moreover, high-strain zones and ultramylonites are common in metamorphic core complexes (Snoke, 1980; Lister and Davis, 1989; Bailey et al., 2007; Cao et al., 2011, 2013a, 2013b; Yin et al., 2017). Furthermore, the reinterpretation of the author of the present manuscript of the ages obtained by Kosminska et al. (2017) and Faehnrich et al. (2017) is supported by the presence of a potential late Paleozoic metamorphic core complex on seismic data in the northwards prolongation of Prins Karls Forland, northwest of Spitsbergen (Koehl, 2019, 2020; see also Figure 27 in present reply). Nevertheless, the discussion about the Late Devonian–Mississippian ages obtained by Kosminska being recently published (Kosminska et al., 2020), it is now possible to assess the meaning and implications of these ages. The author of the present manuscript agrees that the “postulated [. . .] prograde metamorphism” (to quote Kosminska et al., 2020) in Neoproterozoic rocks of the Pinkie Unit may reflect Late Devonian–Mississippian contractional tectonism. However, since rocks of the Pinkie Unit were located at great depth in the Late Devonian–Mississippian, they cannot be used to infer contractional tectonics in surface sedimentary rocks (e.g., Andrée Land Group and Mimerdalen Subgroup), especially since deep contraction and related prograde metamorphism are commonly associated with surface extension in periods of late–post-orogenic collapse (Platt, 1986; Rey et al., 2001, 2011; Teyssier et al., 2005). Thus, geochronological ages and inferred prograde metamorphism of Kosminska et al. (2020) in Prins Karls Forland may as well reflect deep, late Caledonian contraction analogous to and coeval with eclogite-facies metamorphism in eastern–northeastern Greenland (Gilotti et al., 2004; McClelland et al., 2006; Augland et al., 2010, 2011), i.e., having no consequences for the model of Devonian–Mississippian core complexes and Eurekan strain partitioning and decoupling argued for in the present manuscript.

In addition, the author of the present manuscript calls for caution when interpreting geochronological ages with such broad spreads (336–430 Ma for their monazite population I, 261–419 Ma for their population II, and 226–443 Ma for their population III, i.e., all ranging from Caledonian ages to Carboniferous/Permian/Late Triassic ages) and such large associated $\sigma 1$ errors (12.4–20.2 Ma for their population I, 19.6–49.9 Ma for their population II, and 17.1–64.4 Ma for their population III; see online supplement S1 of Kosminska et al., 2020), especially when discussing a tectonic episode (Ellesmerian deformation) that may have lasted for as little as 3 million years (see submitted manuscript), i.e., four to twenty times shorter than the lowest associated error of any spot age from Kosminska et al. (2020). Errors associated to weighted-average ages for all three monazite populations (6–16 million years) are also (two–five times) greater than the estimated duration (3 million years) of Ellesmerian deformation in Dickson Land. Such large $\sigma 1$ errors suggest that the obtained ages by Kosminska et al. (2017, 2020) may be inappropriate to discuss the timing of Ellesmerian deformation (if it occurred; Schaltegger et al., 2015). However, these ages are indeed appropriate to discuss the timing of possible late Caledonian events (Schaltegger et al., 2015) since Caledonian contraction initiated in the Ordovician and terminated in the Devonian–Mississippian (i.e., possibly lasted for > 100 million years) and, thus, has a timespan that is longer than the errors associated to the ages of Kosminska et al. (2020). Comment 23: partly agreed. Since Ellesmerian deformation is not needed anymore to explain deformation patterns in Dickson Land, which are most likely related to strain partitioning and decoupling of Eurekan deformation along local bedding-parallel duplexes and décollements, e.g., in Pyramiden, Sassenfjorden–Tempelfjorden and Reindalspasset in the present manuscript and in Billefjorden in Koehl et al., in prep. a (see also Figure 26), and since core complex exhumation was recently demonstrated in northwestern (Braathen et al., 2018a, 2020), and in central Spitsbergen (Koehl, 2019, pp. 53–64), and northwest of Spitsbergen (Koehl, 2019, 2020; see also Figure 27), it is natural to discuss the possible relationship of the ages obtained by Kosminska et al. (2017) and Faehnrich et al. (2017) in Prins Karls Forland with potential core

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complex exhumation. Regardless, the author of the present manuscript agrees that the prograde metamorphic assemblages in Kosminska et al. (2020) suggests contraction. However, since the rocks of the Pinkie Unit where buried at great depth in the Late Devonian–Mississippian, they may as well reflect deep late Caledonian continued contraction like evidenced in eastern–northeastern Greenland (Gilotti et al., 2004; McClelland et al., 2006; Augland et al., 2010, 2011) but have no implications for surface sedimentary rocks of the Andrée Land Group and Mimerdalen Subgroup since (near-) surface extension is commonly coeval with deep continued contraction during late–post-orogenic collapse (Platt, 1986; Rey et al., 2001, 2017; Teyssier et al., 2005). Comment 24: disagreed. The data and datasets published by previous authors (including field measurements and field photographs) are possible to use to support one's hypothesis or to reinterpret when major errors and uncertainties are discussed (especially in the interpretation of field photographs in Michaelsen, 1998). See reply to Dr. Piepjohn's comments for more detailed discussion about questionable interpretation of outcrop transects in Dickson Land in Michaelsen (1998; e.g., replies to Dr. Piepjohn's comments 41, 232, and 255) and the high amounts of uncertainty involved in the model of Ellesmerian deformation (e.g., replies to Dr. Piepjohn's comments 3, 4, 9, 17, 23, 24, 38, 50, 70, 179, 203, 225, 226, 227, 232, 237, 238, 276, and 278), which is based on distant interpretation of physically inaccessible and mostly covered–poorly exposed geological features (also see Figures 2–25). The author of the present manuscript argues that, thus far, supporters of the Ellesmerian Orogeny in Spitsbergen have omitted/disregarded the work done on alternative hypotheses such as that of extensional detachment and associated folding in central–northern Spitsbergen, e.g., the studies by Chorowicz (1992), Roy (2007, 2009) and Roy et al. (unpublished) are not discussed in any contribution arguying for Ellesmerian deformation in Spitsbergen. The present manuscript attempts to reestablish balance between the model of Ellesmerian deformation and those involving alternative hypotheses (e.g., extensional detachment folding combined with superimposed strain partitioning and decoupling of Eurekan deformation, and possibly including deep, late Caledonian contraction). Comment 25: agreed. The author of the present manuscript uses referenced works from all over the world (which is common scientific practice in a manuscript) to support his interpretation of his own datasets and his reinterpretation of existing datasets, including notably large field measurement datasets by Dr. Piepjohn and Dr. Dallmann that support the hypothesis of the author of the present manuscript (see reply to Dr. Piepjohn's comment 288) and erroneously interpreted and overinterpreted field photographs in Michaelsen (1998; on which many studies about Ellesmerian deformation in Dickson Land are based, e.g., Piepjohn et al., 1997; Piepjohn, 2000).

3. Changes implemented Comment 1: none. Comment 2: none. Comment 3: none. Comment 4: none. Comment 5: none. Comment 6: none. Comment 7: none. Comment 8: none. Comment 9: none. Comment 10: none. Comment 11: none. Comment 12: none. Comment 13: quality of the figures improved. Comment 14: none. Comment 15: none. Comment 16: none. Comment 17: none. Comment 18: none. Comment 19: none. Comment 20: none. Comment 21: none. Comment 22: added “Recently postulated prograde amphibolite-facies metamorphism in the Pinkie Unit may suggest Late Devonian–Mississippian (371–355 Ma) contractional tectonism in rocks of the Pinkie Unit in Prins Karls Forland (Kośmińska et al., 2020). Nevertheless, since these rocks were located at great depth, the Late Devonian–Mississippian ages obtained for prograde amphibolite facies metamorphism have no implications for Late Devonian deformation in shallow-crustal rocks in Dickson Land since deep contractional tectonics are commonly associated with near-surface extension during late–post-orogenic collapse (Platt, 1986; Rey et al., 2001; Teyssier et al., 2005). Late Devonian–Mississippian, (postulated) prograde, amphibolite facies metamorphism in Prins Karls Forland may correlate with late Caledonian eclogite facies metamorphism in deep portions of the crust along the conjugate eastern–northeastern Greenland margin (Gilotti et al., 2004; McClelland et al., 2006; Augland et al., 2010, 2011), which developed synchronously with the deposition of Devonian–Mississippian collapse basins along low-angle extensional detachments at the surface (Stemmerik et al., 1991, 1998, 2000; Larsen and Bengaard, 1991; Strachan, 1994; Larsen et al., 2008).” lines 1279–1291. Replaced

“. Therefore, “ line 1298 by “, and since up to eclogite-facies, deep, late Caledonian metamorphism was coeval with near-surface extensional collapse and deposition of thick sedimentary basins along low-angle detachments along the conjugate eastern–northeastern Greenland margin,” Added “and/or deep late Caledonian deformation” line 1301. Added Gilotti et al. (2004), McClelland et al. (2006), Augland et al. (2010, 2011), Kosminska et al. (2020), Stemmerik et al. (1991, 1998, 2000), Larsen and Bengaard (1991), Strachan (1994), Larsen et al. (2008), Platt (1986), Rey et al. (2001), and Teyssier et al. (2005) to the reference list. Comment 23: see reply to comment 22. Comment 24: none. Comment 25: none.

Additional revisions by the author of the present manuscript -Line 16: added “Lower–lowermost Upper” and “of the Andrée Land Group and Mimerdalen Subgroup”. -Line 18: added “, petrological, exploration well”. -Line 20: added “, which”. -Line 21: added “,”. -Lines 22, 824, 942, 2037: added “Lower–lowermost Upper “. -Lines 23, 25, 38, 72, 266, 453, 457, 471, 483, 496, 498, 501, 513, 521, 557, 574, 598, 606, 609, 611, 650, 661, 671, 682, 719, 725, 741, 847, 855, 858, 892, 896, 897, 904, 909, 966, 977, 978, 983, 985, 1008, 1063, 1065, 1115, 1145, 1174, 1297, 1305, 1309, 1319, 2013, 2031: added “early”. -Lines 23, 38, 598, 603, 642, 741, 939, 2007: added “Eurekan”. -Line 23: added “in Pyramiden, Sassenfjorden–Tempelfjorden and Reindalspasset”. -Lines 23–24: deleted “In addition, Devonian strata probably experienced syn-depositional, post-Caledonian, extensional, detachment-related folding.”. -Lines 25, 96: added “–Tempelfjorden”. -Line 33: changed “have deposited” in to “be preserved”. -Line 35: added “and reinterpretation of previous datasets, the”. -Lines 35–36: changed “juxtaposition of Proterozoic basement rocks against” into “thrusting of Proterozoic basement rocks over”. -Line 37: added “a combination of Devonian syn-depositional, extensional, detachment-related folding,”. -Lines 48, 1218, 1334: added “greenschist–“. -Line 55: deleted “, “. -Line 62: added “Vogt, 1938; “. -Line 63: added “and most well-constrained”. -Lines 64, 546, 641, 649, 662, 681, 808, 1007, 1025: added “Lower–lowermost Upper “. -Lines 65, 175, 287, 776, 786, 795: added “uppermost Devonian–“. -Line 70: changed “through” into “throughout”. -Line 76: added

“Ellesmerian”. -Line 80: deleted “Error! Reference source not found.”. -Lines 89, 191, 196, 621, 667, 924, 997, 1066, 1099, 1110, 1145, 1153, 1160, 1333, 2019, 2058: added “early” and “Eurekan”. -Line 90: added “–gently tilted”. -Line 110: changed “However” into “Nevertheless”. -Line 135: changed “post–late” into “late–post”. -Line 149: changed “in” into “from”. -Line 152: replaced “–“ by “ and “. -Lines 158, 223, 766, 1061, 2036: changed “contraction” into “deformation”. -Line 174: added “Harland et al., 1974; “. -Line 176: added “–lowermost Upper”. -Line 183: added “–gently dipping”. -Lines 184, 926, 993: changed “Carboniferous” into “uppermost Devonian”. -Line 187: changed “juxtaposes” into “thrusted” and “against” into “over”. -Line 198: changed “m-thick” into “meter-thick”. -Line 199: deleted double space. -Lines 200, 539, 1095, 1105, 1113, 1121, 1122, 1126, 1131, 1164, 1175, 1183, 2047: added “Middle”. -Lines 210, 1237: changed “Th–U” into “U–Th”. -Line 215: added “that deep” and “Potential Ellesmerian greenschist facies metamorphism and mylonitization was also identified in Oscar II Land (Barnes et al., 2020).”. -Line 218: changed “km-“ into “kilometer-“ twice. -Line 230: changed “Steeel” into “Steel”. -Line 261: added “,”. -Line 285: added “–depth”. -Line 290: changed “km-“ into “kiometer-“. -Line 293: changed “Cenozoic transpression” into “early Cenozoic Eurekan deformation”. -Line 313: changed “were” into “was”. -Line 314: added “McCann, 1993; “. -Line 317: delete “ a” and changed “section” into “sections”. -Line 320: added “, Aakvik (1981)”. -Lines 322, 327, 336, 354, 1010: added “Lower”. -Line 343–344: added “ thick red lines showing the” and replaced “;”, by “in“. -Line 354: replaced “wood fossils” by “fossil wood”. -Lines 355, 361, 370, 373, 784, 787, 797, 802: added “Lower (–lowermost Upper?) ”. -Line 357: deleted “Fig. “. -Line 358: added “ or tectonized”. -Lines 368–369: added “the “, and replaced “faults” by “fault” and “represent” by “represents”. -Line 378: added “ and fieldwork”. -Line 381: added “along the fault and “. -Line 394: moved “in Reindalspasset (Figure 1a–b)” and replaced “display” by “are characterized by”. -Line 396: added “of”. -Lines 397–398: deleted “–Middle” line 397 and added “Middle Devonian” line 398. -Line 467: added “This interpretation is supported by onshore Eurekan thrust geometries on the northern shore of Sassenfjorden (supplement 5).” and also added

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Supplement 5 to the supplements. -Lines 476, 508, 586: added “Lower–Middle ”. -Line 526: added “upwards”, “Lower–Middle” and “downwards”. -Lines 527–528: rewrote “tentatively interpreted as the potential” into “interpreted as a Carboniferous normal fault possibly representing the southwards”. -Line 550: changed “Cenozoic contraction” into “Eurekan deformation”. -Line 556: added “. These structures and geometries are typical in coal deposits reworked by contractional deformation”. -Lines 556–557: rewrote “This interpretation” into “The interpretation of bedding-parallel décollements”. -Lines 566–567: added “/subhorizontal thrust” and “; Gasser and Andresen, 2013” and added Gasser and Andresen (2013) to the reference list. -Lines 570, 571: changed “early Cenozoic” into “Eurekan”. -Line 585: changed “and to analogous structures” into “. The geometries of these duplexes, thrusts and décollements on seismic data in Spitsbergen are similar to analogous structures on seismic data”. -Line 588: changed “analog” into “analogous”. -Lines 590, 824: changed “presence” into “preservation”. -Line 599: deleted parentheses. -Lines 603–604 and 641: changed “Cenozoic transpression” into “”early Cenozoic deformation”. -Lines 609, 616, 644, 809, 818, 864, 875, 881, 905, 913, 969, 991, 995, 998, 1005, 1014, 1051, 1057, 1096, 1141, 1143, 1170, 2006, 2009, 2013, 2015: changed “Cenozoic” into “Eurekan”. -Line 613: changed “Carboniferous” into “Pennsylvanian”. -Line 622: added “further”. -Line 626: changed “the Russian” into “Russia”. -Lines 643–644: moved “in basinal areas in the hanging wall of the Odellfjellet Fault” from line 643 to line 644. -Line 652: changed “Cenozoic transpression” into “Eurekan deformation” and “soft” by “weak”. -Lines 652, 689, 712, 714, 721, 796, 1058, 1106: changed “soft” into “weak”. -Line 655: rewrote “might not be required to explain differential deformation between late Paleozoic” into “is most likely not required to explain differential deformation within Lower Devonian to Permian”. -Lines 659, 964: added “lowermost”. -Line 661: changed “transpression” into “deformation”. -Line 665: added “and stratigraphic units”. -Line 676: added “Noteworthy, a model of critical wedge taper for the West Spitsbergen Fold and Thrust Belt predicted an increasing influence of decoupling (as observed in Pyramiden, Sassenfjorden–Tempelfjorden and Reindalspasset; Figure 3b and Figure 4) towards the foreland of the fold and thrust belt, i.e., near the study area in central Spitsbergen (Braathen et al., 1999).”. -Line 683: rewrote “rigid buttress that localized” into “relatively rigid buttress, i.e., partly deforming and partly localizing”. -Line 685: rewrote “and allowed” into “, and allowing”. -Line 694: added “. In Pyramiden, this is supported by drill data from Trust Arktikugol showing that coal seams of the Billefjorden Group at the mine continue eastwards and preserve a gentle–moderate dip to the east (Aakvik, 1981, his figure 8.2.5)”. -Line 694: added “interpretation”. -Line 698: replaced “ESE” by “east-southeast”. -Line 702: added “as a steeply east-dipping fault”. -Line 716: changed “soft” into “the weak”. -Lines 721–723: rewrote “Odellfjellet Fault at depth, which branched off and ramped up into rotated, soft, coal- and coaly shale-dominated syn-rift sedimentary rocks of the Billefjorden Group, forming bedding-parallel décollements (Phillipson, 2003, 2005; Molinda, 2003; Elizalde et al., 2016) and tilted” into “Billefjorden Fault Zone at depth, branching off and ramping upwards into, soft, coal- and coaly shale-dominated syn-rift sedimentary rocks of the Billefjorden Group, forming bedding-parallel décollements (Phillipson, 2003, 2005; Molinda, 2003; Elizalde et al., 2016) and east-dipping”. -Line 731: changed “Mississippian” into “uppermost Devonian”. -Line 736: added “(Vogt, 1938; Harland et al., 1974; Piepjohn et al., 1997; Michaelsen et al., 1997; Michaelsen, 1998; Piepjohn, 2000)” and “(Figure 3b)”. -Line 739: added “(–lowermost Upper?)”. -Line 750: added “see ” and “ for location”. -Line 758: added “ (relatively rigid)”. -Line 760: changed “Odellfjellet Fault” into “Billefjorden Fault Zone”. -Lines 770–771: rewrote “an east-verging fold” into “a fold structure with bedding locally overturned to the east”. -Line 774: added “Aakvik (1981), ”. -Line 797: changed “form” into “localize”. -Line 809: added “in the early Cenozoic”. -Line 818: added “ (“BFZ?” in Figure 4g)”. -Line 826: added “in Dickson Land”. -Lines 829–830: rewrote “geometry variations along strike” into “along-strike variations in geometry”. -Line 845: added “black “. -Line 861: replaced “Mississippian” by “Billefjorden Group”. -Line 881: changed “Mississippian–Pennsylvanian” into “Billefjorden–Gipsdalen groups”. -Lines 897–898: added “in the hanging wall”. -Line 903: added “ (i.e., explaining the presence of numerous WNW–ESE-trending valleys and glaciers in this part of Dickson Land, such as Svenbreen, Hørbyebreen, Mimerdalen, Odindalen)”. -Line 930; changed “thick” into “thickened”. -Line 935: rewrote “Cenozoic strain (partial) decoupling relevant for the Triungen area as well. Noteworthy,” into “Eurekan (partial) strain decoupling is actually relevant for the Triungen area as well. Notably”. -Line 938: changed “thick” into “abundant (tectonically thickened?)”. -Line 946: replaced “,” by “and”. -Lines 947–948: rewrote “, hence, is more likely to correspond” into “. Hence, this fault most likely corresponds”. -Line 949: changed “lower” into “upper”. -Line 953: added “ (Michaelsen, 1998, her figure 39)”. -Line 959: added “or (down-west) normal faulting”. -Line 961: added “showing normal sense of shear”. -Line 962: moved “Michaelsen, 1998” after “McCann and Dallmann, 1996”. -Line 967: added “location shown in ”. -Line 998: added “local”. -Line 999: added “The presence of local Eurekan décollements between rocks of the Andrée Land Group/Mimerdalen Subgroup and of the Wordiekammen Formation in Dickson Land is supported by seismic interpretation in Billefjorden (Koehl et al., in prep.).”. -Line 1001: added “Middle–lowermost”. -Lines 1002 and 1079: added “ Member of the Tordalen”. -Line 1040: added “/or” and “detachment/”. -Lines 1058–1059: added “were folded” and deleted “were”. -Line 1060: changed “remain” into “remained”. -Line 1068: replaced “deformation” by “strain”. -Line 1073: changed “breccia” into “infill”. -Line 1079: added “ ; Newman et al., 2019”. -Line 1090: changed “and Cenozoic” into “and/or subsequent early Cenozoic Eurekan”. -Line 1094: deleted “between”. -Line 1096: changed “, and” into “from”. -Line 1097: added “Late”. -Line 1112: changed “softer” into “weaker”. -Line 1117: deleted “Fig. “ and in 23 other occurrences throughout the manuscript. -Line 1129: replaced “that” by “since the”. -Line 1142: changed “potential” into “potentially”. -Line 1156: added “like “. -Line 1165: changed “a” into “an”. -Line 1174: added “(and/or partly due to post-Caledonian, Devonian–Mississippian, extensional detachment faulting and folding)”. -Lines 1176–1177: changed “Figure 1aFigure 5” into “(Figure 1a and 5)”. -Line 1179: added “, 2020”. -Line 1187: added reference to the work by Siedlecki and Turnau (1964). The reference was also added to the reference list. -Line 1191: deleted “,”. -Line 1198: added “,”. -Line 1201: added “in”. -Line 1207: changed “suggesting” into “supporting”. -Line 1238: changed “Mesoproterozoic” to “Neoproterozoic”. -Lines 1238, 1261 and 1270: changed “Pinkiefjellet” to “Pinkie”. -Line 1264: changed “is” into “may be”. -Line 1279: added “Recently postulated prograde amphibolite-facies metamorphism in the Pinkie Unit may suggest Late Devonian–Mississippian (371–355 Ma) contractional tectonism in rocks of the Pinkie Unit in Prins Karls Forland (Kośmińska et al., 2020). Nevertheless, since these rocks were located at great depth, the Late Devonian–Mississippian ages obtained for prograde amphibolite facies metamorphism have no implications for Late Devonian deformation in shallow-crustal rocks in Dickson Land since deep contractional tectonics are commonly associated with near-surface extension during late–post-orogenic collapse (Platt, 1986; Rey et al., 2001; Teyssier et al., 2005). Late Devonian–Mississippian, (postulated) prograde, amphibolite facies metamorphism in Prins Karls Forland may correlate with late Caledonian eclogite facies metamorphism in deep portions of the crust on the conjugate eastern–northeastern Greenland margin (Gilotti et al., 2004; McClelland et al., 2006; Augland et al., 2010, 2011), which developed synchronously with the deposition of Devonian–Mississippian collapse basins along low-angle extensional detachments at the surface (Stemmerik et al., 1991, 1998, 2000; Larsen and Bengaard, 1991; Strachan, 1994; Larsen et al., 2008).”. -Line 1279: added “In Oscar II Land, Ziemniak et al. (2020) recently established that presumed Ellesmerian greenschist facies metamorphism (Barnes et al., 2020) actually initiated at ca. 410 Ma (Early Devonian), was related to a NW–SE-striking mylonitic shear zone, and was coeval with sinistral movements along the WNW–ESE-striking Vimsodden–Kosibapasset Shear Zone in southwestern Spitsbergen (Faehnrich et al., 2020). In northwestern (McCann, 2000) and central–northern Spitsbergen (Koehl et al., in prep.), Early Devonian times were characterized by the deposition of several kilometer-thick sedimentary successions of the Red Bay Group and Wood Bay Formation (Gee and Moody-Stuart, 1966; Friend et al., 1966; Friend and Moody-Stuart, 1972; Murascov and Mokin, 1979; Friend et al., 1997) along similarly striking, NNE-dipping normal (–sinistral) faults that actually merge at depth with major WNW– ESE- to NW–SE-striking, potentially Timanian shear zones (Koehl et al., in prep.). Thus, it is more probable that Early Devonian

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greenschist facies metamorphism and mylonitization in Oscar II Land was related to late–post Caledonian extensional–transtensional tectonic processes and/or to coeval, deep, late Caledonian deformation. Also in Oscar II Land, 40Ar–39Ar geochronology from Michalski et al. (2017) evidenced two episodes of significant thermal overprints at 377–326 and ca. 300 Ma, the latter of which is believed to be related to rifting. If it is possible that the latest of these two events is related to rifting, then it is natural to suggest that the first one too may conceivably be related to extensional tectonic processes (e.g., core complex exhumation and/or extensional detachment faulting).", and Michalski et al. (2017), Ziemniak et al. (2020) and Barnes et al. (2020) to the reference list. -Line 1284: added ", 2020". -Line 1285: added "/extensional collapse". -Line 1288: changed "contraction" into "deformation" and added "This is further supported by paleomagnetic and 40Ar–39Ar geochronological data from Michalski et al. (2017) that do not support a pre-Caledonian link or proximity between the Pearya terrane and western Spitsbergen, and by a study of detrital zircon in western and central Spitsbergen suggesting affinities with northern Baltica (Gasser and Andresen, 2013), i.e., that western–central Spitsbergen was located away from potential Ellesmerian deformation in northern Greenland and Arctic Canada.". -Line 1289: added "and the Early Devonian–Mississippian ages by Barnes et al. (2020) and Ziemniak et al. (2020) for greenschist facies metamorphism in Oscar II Land". -Lines 1299–1300: changed "Cenozoic contraction" into "Eurekan deformation". -Line 1313: changed "have been deposited" into "be preserved". -Line 1316: changed "Juxtaposition" into "Thrusting", and "against" into "over". -Line 1317: added "a combination of Devonian syn-depositional, extensional, detachment-related folding, ". -Line 1330: added "–tilted". -Lines 1339–1340: rewrote "of the stratigraphic contact" into "(tectonized or non-tectonized) of the unconformity". -Line 1342: added "(along the Triungen–Grønhorgdalen Fault Zone)". -Line 1364: added ", and to Erik Johannessen and Reinhard Feisel for high-resolution field photographs in Dickson Land". -Lines 1369–1370: changed "now digitized and by the author of the present manuscript and soon available from the Norwegian Polar Institute Library; list of digitized publications" into "available at the Norwegian Polar

Institute Library in Tromsø, Norway; list of publications”. -Line 1373: added “Finally, last but not least, the author thank Dr. Karsten Piepjohn, Assoc. Prof. Jaroslaw Majka and an anonymous referee for their comments and resulting improvements on the manuscript.”. -Line 1496: moved reference to Dallmann (1999) to line 1510 and changed it into Dallmann et al. (1999). Added “, Dypvik, H., Gjelberg, J. G., Harland, W. B., Johannessen, E. P., Keilen, H. B., Larssen, G. B., Lønøy, A., Midbøe, P. S., Mørk, A., Nagy, J., Nilsson, I., Nøttvedt, A., Olaussen, S., Pcelina, T. M., Steel, R. J. and Worsley, D.” line 1510. -Line 1852: added “.”. -Line 1945: changed “Haitana” into “Haitanna”. -Line 1958: added “locality”. -Line 1967: deleted “Fig. ”. -Line 1978: changed “Figure 1b” into “Figure 2”. -Line 1984: added “See legend in Figure 2”. -Line 1993: added “is shown”. -Line 1995: added “see” and “for location”. -Line 1995: added “gently east-dipping”, “(” and “–tilted?)”. -Line 1996: added “dotted “. -Line 1999: added “trace”. -Line 2012: added “and top-west Eurekan thrusts within lower Permian rocks”. -Line 2025: added “early Cenozoic”. -Line 2033: added “latest Devonian–“. -Line 2034: added “latest Mississippian–“. -Line 2096: added “ and Eurekan deformation”. -Fixed figure reference font and error messages throughout the manuscript and supplements. -Changed reference to Koehl (2019) into Koehl (2020) and added reference to Koehl (2019) throughout the text. -Changed reference to Dallmann (1999) into Dallmann et al. (1999) throughout the manuscript. -Corrected “Famenian” into “Famennian” in three occurrences in the manuscript. -Corrected “Arktikugol” into “Trust Arktikugol” in two occurences in the manuscript. âĂČ References Aakvik, R.: Fasies Analyse av Undre Karbonske Kullførende Sedimenter, Billefjorden, Spitsbergen, Ph.D. Thesis, University of Bergen, Bergen, Norway, 229 pp., 1981. Augland, L. E., Andresen, A. and Corfu, F.: Age, structural setting, and exhumation of the Liverpool Land eclogite terrane, East Greenland Caledonides, Lithosphere, 2, 4, 267–286, 2010. Augland, L. E., Andresen, A. and Corfu, F.: Terrane transfer during the Caledonian orogeny: Baltican affinities of the Liverpool Land Eclogite Terrane in East Greenland, Geol. Soc. London, 168, 15–26, 2011. Bailey, C. M., Polvi, L. E. and Forte, A. M.: Pure shear dominated high-strain zones in basement terranes, GSA Mem., 200, 93–108, 2007. Beaudoin, A., Augier,

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Figure 1: (a) Topographic–bathymetric map around Spitsbergen modified after Jakobsson et al. (2012). Abbreviations: Ad: Adriabukta; Bi: Billefjorden; Bk: Bockfjorden; Bo: Blomstrandhalvøya; Br: Brøggerhalvøya; Fi: Fiskeknatten; Ha: Haitana; Hr:

Hornsund; Is: Isfjorden; Kg: Kongsfjorden; Kr: Krosspynten; Ky: Krylen; Mi: Midterhuken; Pk: Påskefjellet; Pr: Pretender Mountain; Ra: Raudfjorden; Re: Reindalspasset; Rø: Røkensåta; Ss: Sassenfjorden; SJ: St-Jonsfjorden; Tp: Tempelfjorden; Tr: Triungen; (b) Geological map modified from svalbardkartet.npolar.no showing the main tectono-stratigraphic units and structures in the study area in central Spitsbergen. Abbreviations: AA: Atomfjella Antiform; Af: Adolfbukta; An: Anservika; BF: Balliolbreen Fault; BL: Bünsow Land;Bn: Bolen; BRF: Blåvatnet Reverse Fault; Fw: Flowerdalen; Gh: Gipshuken; Ki: Kilen; LMT: lower Munidalen thrust; Ly: Lykta; Lø: Løvehovden–Hultberget; Mn: Munindalen; Mu: Mumien; Od: Odellfjellet; OF: Odelfjellet Fault; Py: Pyramiden; Re: Reindalspasset; Rö: Reuterskiöldfjellet; Rs: Robertsonbreen; RT: Robertsonbreen thrust; Se: Sentinelfjellet; Sk: Storskarvet; Sæ: Sætherfjellet; TGFZ: Triungen–Grønhorgdalen Fault Zone; To: Torfjellet; Tr: Triungen; Tå: Tåkefjellet; UMT: upper Munidalen thrust; Yg: Yggdrasilkampen.âĂČ

Figure 2: Field photograph showing the pervasive presence of screes and loose material along the boundary between rocks of the Andrée Land Group/Mimerdalen Subgroup and overlying strata of the Wordiekammen Formation, and the poorly preserved and mostly loose outcrops of rocks of the Andrée Land Group/Mimerdalen Subgroup in southern Reuterskiöldfjellet, in Dickson Land. Photo: Jean-Baptiste Koehl. âĂČ

Figure 3: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of gently east dipping (tilted?) Lower Devonian rocks of poorly deformed red siltstones of the Dicksonfjorden Member and green sandstones of the Austfjorden Member of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Wordiekammen Formation (dashed blue lines) in Reuterskiöldfjellet. The presence of abundant grey screes (from the Wordiekammen Formation) and the poorly preserved character of Lower Devonian outcrops (mostly consisting of loose material and bedding surface only possible to identify in a few places) makes it difficult to assess the nature of the unconformity (tectonized or non-tectonized?) between Lower Devonian and uppermost Pennsylvanian–lowermost Per-

mian rocks and the nature of the boundary between the Austfjorden and Dicksonfjorden members of the Wood Bay Formation (interpreted as the upper Munindalen thrust by Piepjohn et al., 1997a and Michaelsen, 1998, her figure 53; plain red line). The gently east-dipping and poorly deformed character of Lower Devonian rocks in the area may be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment/normal fault; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is towards the north. Photo: Reinhard Feisel. âĂČ

Figure 4: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of gently dipping (tilted?) Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup (dashed orange lines) unconformably overlain by flat-lying strata of the Wordiekammen Formation (dashed blue lines) in Mimerdalen. The presence of abundant grey screes (from the Wordiekammen Formation) and the poorly preserved character of Lower–lowermost Upper Devonian outcrops (mostly consisting of loose material and bedding surface only possible to identify in a few places) makes it difficult to assess the nature of the unconformity (tectonized or non-tectonized?) almost everywhere in this area. The gently east-dipping and poorly deformed character of Lower–lowermost Upper Devonian rocks in the area may be related to Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment/normal fault; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is towards the northwest. Photo: Reinhard Feisel. âĂČ

Figure 5: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of gently dipping, poorly deformed (sub-horizontal bedding surfaces), Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup (dashed orange lines) unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Mimerdalen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between gently dipping Lower–

lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the west. Photo: Reinhard Feisel. âĂČ

Figure 6: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Reuterskiöldfjellet and Yggdrasilkampen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the southeast. Photo: Reinhard Feisel. âĂČ

Figure 7: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Sætherfjellet and Reuterskiöldfjellet. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the northeast. Photo: Reinhard Feisel. âĂČ

Figure 8: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Munindalen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata pretty much everywhere in this area. View is towards the north. Photo: Reinhard Feisel. âĂČ

Figure 9: (a) Interpreted and (b) uninterpreted field photograph showing the poor qual-

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Discussion paper

ity of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Storskarvet, Kilen and Sætherfjllet, in Munindalen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the north. Photo: Reinhard Feisel. âĂČ

Figure 10: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Kilen, in Munindalen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the north-northwest. Photo: Reinhard Feisel. âĂČ

Figure 11: (a) Interpreted and (b) uninterpreted zoom in the field photograph in Kilen. The outcrop transects of gently east-dipping (tilted?) Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup (dashed orange lines) are mostly made up with loose material and unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines). Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata, making it difficult to study the nature of the unconformity (tectonized or non-tectonized?). The gently east-dipping and poorly deformed character of Lower–lowermost Upper Devonian rocks in the area below the unconformity may be related to Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is towards the north-north. Photo:

Reinhard Feisel. âĂČ

Figure 12: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Kilen and Storskarvet, in Munindalen. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is towards the west. Photo: Reinhard Feisel. âĂČ

Figure 13: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of gently east-dipping (tilted?) Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup (dashed orange lines) unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Odinfjellet. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Upper Devonian and uppermost Pennsylvanian–lowermost Permian strata. The gently east-dipping and poorly deformed character of Lower–lowermost Upper Devonian rocks in the area may be related to Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment; e.g., ; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is from Munindalen towards the south-southwest. Photo: Reinhard Feisel. âĂČ

Figure 14: (a) Interpreted and (b) uninterpreted field photograph showing the poor quality of outcrop transects of Lower–lowermost Upper Devonian rocks of the Wood Bay Formation and Mimerdalen Subgroup unconformably overlain by flat-lying strata of the uppermost Pennsylvanian–lowermost Permian Wordiekammen Formation (dashed blue lines) in Odinfjellet. Note the presence of abundant grey screes from the Wordiekammen Formation masking the unconformity between Lower–lowermost Up-

per Devonian and uppermost Pennsylvanian–lowermost Permian strata. View is from Munindalen towards the south-southwest. Photo: Reinhard Feisel. âĂČ

Figure 15: (a) Interpreted and (b) uninterpreted field photograph of the Lykta mountain in Dickson Land (c. five kilometers northwest of Triungen) showing gently dipping (tilted?) Lower Devonian strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Wordiekammen Formation (dashed blue lines). The gently dipping and poorly deformed character of Lower Devonian rocks in the area may be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View towards the north. Photo: Erik P. Johannessen. âĂČ

Figure 16: (a) Interpreted and (b) uninterpreted zoom in the top of the Lykta mountain in Dickson Land showing that the unconformity between gently west-dipping (tilted?), poorly deformed Lower Devonian strata of the Wood Bay Formation (dashed orange lines) and flat-lying strata of the Wordiekammen Formation (dashed blue lines) is covered by grey screes from the Wordiekammen Formation and, thus, its nature is not possible to directly observe (undeformed or tectonized unconformity?). View is towards the north. Photo: Erik P. Johannessen. âĂČ

Figure 17: (a) Interpreted and (b) uninterpreted field photograph of the Triungen locality showing southwards-dipping (tilted?) Lower Devonian strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Billefjorden Group (dashed green lines) and Wordiekammen Formation (dashed blue lines). The gently–moderately dipping and poorly deformed character of Lower Devonian rocks in the area may well be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment/normal fault; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is towards the east. Photo: Erik P. Johannessen. âĂČ

Figure 18: (a) Interpreted and (b) uninterpreted zoom in southwards-dipping (tilted?) Lower Devonian strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Billefjorden Group (dashed green line) in Triungen (location shown as a black frame in Figure 17a). View is towards the east. Photo: Erik Johannessen. âĂČ

Figure 19: (a) Interpreted and (b) uninterpreted field photograph of the angular stratigraphy unconformity (dotted yellow line) between gently-dipping (tilted?) Lower Devonian strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Billefjorden Group in Triungen. Photo: Erik Johannessen. âĂČ

Figure 20: (a) Interpreted and (b) uninterpreted field photograph showing gently west-dipping strata of the Wood Bay Formation (dashed orange lines) overlain by flat-lying strata of the Billefjorden Group (dashed green lines), Hultberget Formation (dashed red line) and Wordiekammen Formation (dashed blue lines), and the probable trace of the Triugen–Grønhorgdalen Fault Zone (TGFZ; plain red line) in Triungen. The photograph shows that the trace of the TGFZ and most outcrops along the fault trace are covered by screes and loose material. View is towards the north-northeast. The gently dipping and poorly deformed character of Lower Devonian rocks in the area may well be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment/normal fault; e.g., Chorowicz, 1992; McCann, 2000). Photo: Erik P. Johannessen. âĂČ

Figure 21: (a) Interpreted and (b) uninterpreted field photograph showing the presence of abundant black screes (possibly from coals of the Billefjorden Group) and loose material along the trace of the Triungen–Grønhorgdalen Fault Zone (plain red line) between gently west-dipping strata of the Wood Bay Formation (dashed orange lines) and flat-lying strata of the Billefjorden Group (dashed green lines), Hultberget Formation (dashed red line) and Wordiekammen Formation (dashed blue lines) in Triungen. View is towards the north. Photo: Erik Johannessen. âĂČ

Figure 22: Same as Figure 21. View is towards the northwest (Lykta mountain in the background). The gently dipping and poorly deformed character of Lower Devonian rocks in the area may well be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). Photo: Erik P. Johannessen. âĂČ

Figure 23: (a) Interpreted and (b) uninterpreted field photograph showing gently dipping to flat-lying strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Wordiekammen Formation (dashed blue lines) along the northern flank of Tåkefjellet (c. five kilometers south of Triungen) in Dickson Land. The gently dipping (tilted?) and poorly deformed character of Lower Devonian rocks in the area may well be the product of Devonian extensional faulting (e.g., tilted along a low-angle late–post-Caledonian detachment; e.g., Chorowicz, 1992; Friend et al., 1997, their figure 12b; McCann, 2000). View is towards the southeast. Photo: Erik P. Johannessen. âĂČ

Figure 24: (a) Interpreted and (b) uninterpreted field photograph showing flat-lying to gently southwards-dipping (tilted?) and poorly deformed (sub-horizontal bedding surfaces) strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by strata of the Wordiekammen Formation (dashed blue lines) along the western flank of Tåkefjellet (c. five kilometers southwest of Triungen) in Dickson Land. View is towards the east. Photo: Erik P. Johannessen.

Figure 25: (a) Interpreted and (b) uninterpreted field photograph showing gently south-dipping (tilted?) to flat-lying and poorly deformed (sub-horizontal bedding surfaces) Lower Devonian strata of the Wood Bay Formation (dashed orange lines) unconformably overlain by flat-lying strata of the Wordiekammen Formation (dashed blue lines) in Bolen (c. 6–7 kilometers southwest of Triungen), and showing that the unconformity is almost completely covered by grey screes of the Wordiekammen Formation. View is towards the east. Photo: Erik P. Johannessen. âĂČ

Figure 26: (a) Uninterpreted and (b) interpreted NNE–SSW-trending seismic line in Billefjorden showing the presence of kilometer-thick Lower Devonian deposits of the Siktefjellet–Red Bay groups and Wood Bay Formation deposited along WNW–ESE-striking Early Devonian normal faults (red lines; e.g., intra Siktefjellet/Red Bay group and intra-Wood Bay Formation growth strata displayed as dotted white and dashed magenta lines) that were inverted during Eurekan deformation (open anticline above major NNE-dipping normal faults) in the footwall of the Balliolbreen Fault (not visible because parallel to this seismic line). The seismic line also shows varying intensity of Eurekan deformation, which appears to be heterogeneously distributed (e.g., plain yellow lines), and localized particularly within Lower Devonian rocks and along stratigraphic boundaries. White arrows show onlapping, toplapping and downlapping seismic reflections. Location shown in Figure 1 as a yellow line. âĂČ

Figure 27: (a) Geological map of Spitsbergen from Gasser (2014) showing the location of the Bouréefjellet fault zone as a red dot in Prins Karls Forland and the location of (b) as a blue line northwest of Spitsbergen. (b) Seismic section across two basement ridges in the northern prolongation of Prins Karls Forland's basement high (black line corresponds to top basement). (c) Zoom in (b) showing that the western basement ridge exhumed, and uplifted and tilted (toward the east) mid–late Paleozoic sedimentary rocks of the lower basin (the top of sedimentary succession is shown as a white line) and, as a result, these sedimentary units were extensively eroded over the western basement ridge (see sharp angular unconformity with overlying seismic units just below the three brittle faults shown as red lines). The location of (c) is displayed as a white frame in (b).

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2019-200/se-2019-200-AC1-supplement.pdf

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Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2019-200, 2020.